Cover page

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The impact of Wild Boars (*Sus scrofa*) on Danish natural habitats in Tofte Skov and Høstemark Skov, Lille Vildmose

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Abstract

The wild boar (*Sus scrofa)* is one of the most widely distributed species in the world, found at all continents, except Antarctica. Wild boars are one of the most successful mammals in the world and highly successful at establishing in new habitats. There are very few scientific studies, documenting the effect of rooting and other food seeking activities, of Wild boar impact on plant composition and diversity. This project aims to assess the impact of wild boars on different types of habitat in two fenced nature reserves in Denmark Tofte Skov, Lille Vildmose with wild boars and Høstemark Skov, Lille Vildmose with no Wild boars as reference.

To test wild boars influence on flora, in different types of habitats, four types of treatments, unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF), was examined at seven sites in Tofte Skov two sites with bracken *(Ptreridium aquilinum)* heath and open woodland, two forest sites, swamp forest, scots pines and Three grassland sites, Grassland, meadow and meadow surround by common alder (*Alnus glutinosa)*, four similar sites in Høstemark was found for floral comparison to Tofte Skov sites: one bracken site: Open woodland, One forest site: Scots pine and two grassland sites: Meadow and meadow surrounded by common alder.

This study suggests that the rooting activities of wild boar, alters the plant community and maintains a more varied vegetation on some nature types, which creates a broader array of niches and microhabitats. However, the rooting might also alter other types of habitats to less varied vegetation.

The long-term influence on plant communities could not be concluded from this study and more long-term studies on how wild boars affect plant communities is required.

Introduction

Wild boars were once native to Denmark but were eradicated in 1801. For the past few decades, wild boar has been migrating closer to Danish boarders. Very little is known about how wild boar reintroduction, could affect their once native and natural habitats, as opposed to the plethora of knowledge, available for habitats, where wild boar has been introduced and through rooting behaviour affect their habitats (Cole & Litton, “2014”; Singer, Swank, & Clebsch, “1984”; Bratton, “1975”; Arrington, Toth, & Koebel, “1999”.)

Current studies on the impacts and alterations, rooting can inflict on plant species and community levels are to some extent contradictory, and there are still gaps in the knowledge about wild boars.

Studies reviewing the existing literature, on wild boar diet and impacts, indicate significant differences in their dietary composition (especially between native and introduced ranges), but there is a general lack of quantitative data on the impact they may cause in their native environments (Schley & Roper, “2003”; Massei & Genov, “2004”; Ballari & Barrios-García, “2014”.)

In many studies rooting is described as “damage,” having negative consequences when impacting agricultural lands and forestry or on specific ecologically valued species (Lombardini, Meriggi, & Fozzi, “2016”; Massei & Genov, “2004”.) According to (de Schaetzen, van Langevelde, & WallisDeVries, “2018”.), this negative classification of rooting, is unfortunate because disturbance is a natural and important part, in ecosystem functions. Reintroducing or using wild boars directly as a tool, in nature conservation management, or restoration of natural ecosystems could potentially have a positive effect, although this has only documented by a few studies (de Schaetzen, van Langevelde, & WallisDeVries; Welander., “1995”; Smit et al., “2015”.).

An insufficient number of studies from wild boars’ native range, as well as from neighbouring countries, makes it difficult to predict, compare, or apply how the general patterns of wild boars could affect Danish habitats. But even with a sufficient number of scientific studies, from native ranges and neighbouring countries, could be difficult to apply to Danish contexts.

Here, variations in agricultural practices, human infrastructure, human population densities, climate, soil composition, ecosystems and community structure between countries (for example

Denmark and Sweden) could lead to different responses (from plant and animal communities) to rooting.

The main purpose of this thesis is to gain knowledge on how the rooting behaviour of wild boar impact the plant composition and species richness of their native habitats.

Studies were conducted at bracken sites: Heath with bracken around the sides, open woodland with beech and common oak with bracken underneath, and at Forest sites: Swamp forest and scots pine (*Pinus sylvestris)*.

Studies were furthermore conducted at Grassland sites: Grassland, meadow and meadow with common alder around the sides.

This study compares plant species richness and abundance of two fenced nature reserves in Denmark; Tofte Skov with Wild boars and Høstemark forest with no wild boar present. Furthermore, an assessment of plant species richness and abundance in Tofte Skov and Høstemark forest individually, was conducted.

Background

Wild boar history

Over the past decades, wild boar (*Sus scrofa)* populations, have expanded in large parts of Europe. This expansion is presumably, caused by a combination of different factors, such as lack of predators, reduced hunting pressure, high reproductive rates and adaptability, changes to more intensive agriculture and reintroduction/captive escapees (Barrios-Garcia & Ballari, “2012”.) Wild boars are native to Denmark; however, the last free-living wild boar is believed to have been shot in 1801 in Jutland, and the species was thus, eradicated mainly due to crop damage. Wild boars are at present day, still unwanted in Denmark and classified as harmful wildlife, by the government and hunting all day, year-round is allowed for stray individuals migrating over the border from Germany. The governmental decision that wild boars are unwanted in Denmark, has caused a heavy public debate with arguments for and against a free-living population of wild boars (Miljøstyrelsen “2018”).

Wild Boar Biology

The wild boar is an ungulate, in the *suidea* family and adult wild boar weigh between 35-230 kilo. Wild boars´ is one of the most widely distributed, large mammals in the world, present on all continents except Antarctica and highly successful at establishing in new habitats (Kotanen, “1995”.) Wild boars have the highest reproductive rate among ungulates and in rare cases under ideal conditions, sows are ready to conceive piglets at 6-8 months of age, however most commonly around 18-20 months age and breeding year-round if conditions are right (Singer, “1981”.) On average a sow gives birth to between 2-5 piglets, although litter sizes are highly variable, depending on how energy-rich the food supply is (Alban et al., “2005”; Massei, Genov, & Staines, “1996”.) Wild boars live in social family groups, of closely related sows and their piglets, males mainly live solitary, outside the breeding season. When males reach sexual maturity, they leave the family groups, while the young females might stay in the group, or leave to form new family groups (Alban et al., “2005”.) Wild boars can inhabit a large variety of landscapes; ranging from agricultural cropland, different forest types and open terrains, however the best suited habitats include swamps, meadows and deciduous forests. Wild boars can adapt to live in most types of landscapes and habitats, if food sources, shelter and water are available, as well as wet areas for wallowing. In addition to wild boars' inclination, for adaptation to different habitat types, they can also adapt to eating, various types of food from, different sources available to them(Genov, “1981”; Ballari & Barrios-García, “2014”; Herrero et al., “2005”; Schley & Roper, “2003”.). Wild boars are opportunistic omnivores, feeding on all types of organic matter, and their diet is composed of both plant, fungi and animal contents and approximately 400 species of plants and animals has been shown to be part of their diet, albeit plant materials such as grass, leaves, roots, nuts, fruits and agricultural crops are thought to be the predominating food source, making up for 80-90% of their diet (Massei, Genov, & Staines, “1996”; Ballari & Barrios-García, “2014”; Genov, “1981”.) Plant materials as beech and acorn mast is the preferred natural energy-rich food (Massei & Genov, “2004”; Schley & Roper, “2003”.) and in good mast years, they seem to favour a diet mainly composed of mast from common beech (*Fagus sylvatica)* and common oak (*Quercus sylvatica*), while in poor mast years, their diet shifts towards grass and roots (Groot Bruinderink, Hazebroek, & van der Voot, “1994”.). The animal content in their diet can include invertebrates, rodents, birds, fish and eggs (Genov, “1981”; Massei & Genov, “2004”.).

Depending on the habitat type, wild boars may carry out different functions, at different trophic levels, acting as crop pests, frugivores, predators, destroyers, dispersers or creators of seed banks of plants, by epi- or endozoochory (Ballari & Barrios-García, “2014”; Dovrat, Perevolotsky, & Ne'eman, “2012”.). Wild boars' foraging activities in the soil surface layers, impact and alter their surrounding habitat, acting as ecosystem engineers. An ecosystem engineer, mechanically alters and impacts biotic, abiotic or both factors in the environment (de Schaetzen, van Langevelde, & WallisDeVries, “2018”; Byers et al., “2006”.). Ecosystem engineers can create, maintain or destroy habitats and have positive or negative impacts on other species, ranging from insignificant to large effects (de Schaetzen, van Langevelde, & WallisDeVries, “2018”; Byers et al., “2006”.)

Rooting

Usually wild boars root within ranges from 5-15 cm into the soil surface layer (Massei & Genov, “2004”.), creating depressions and/or elevations in the landscape. Soil disturbances is usually seen as patches of overturned soil (Kotanen, “1995”.) potentially having direct or indirect impact on plant, animals and invertebrate communities. Wild boars tend to root in patches varying in size, abundance, depth and intensity, shown to remove up to 80% of understory plant cover (Singer, “1981”.). They frequently re-root the same patches, with varying depth and intensity according to season and food availability (Groot Bruinderink, Hazebroek, & van der Voot, “1994”; Singer, “1981”.). Rooting can potentially increase, the structural complexity of soil surface layers, by mixing layers of litter, humus, mineral soil, belowground plant biomass and rocks etc. Effects on soil complexity in rooted patches, could be both be a heterogeneous process giving a more complex soil structure or be a homogeneous process effectively mixing the soil horizons, reducing the complexity of the soil surface layer, similar to ploughing (Singer, “1981”.). Soil properties can be affected by rooting and this may accelerate both decomposition of organic matter by mixing litter and soil layers, and leaching of nutrients, from leaf litter and soil (Groot Bruinderink, Hazebroek, & van der Voot, “1994”; Singer, Swank, & Clebsch, “1984”.). A study from an oak, beech and pine forest, showed an increased concentration in mineral soil and microbial biomass in rooted sites, which was indicated to improve growth conditions for some species. However, the total plant cover and seedling establishment, was reduced in rooted areas (Wirthner et al., “2012”.).

Rooting presumably has a significant impact, on belowground animal communities, such as invertebrates, moles and mice etc. Rooting has been shown to, directly impact soil invertebrate communities by foraging on them, however rooting has also been shown to indirectly impact soil invertebrates, by changing the soil properties. Some studies on wild boars, both in native and introduced range, estimated that rooting decreased, populations of soil macroinvertebrates and microarthropods, however did not affect their diversity (Howe, Singer, & Ackerman, “1981”; Massei & Genov, “2004”.) and decreased insect pest larvae, in forestry plantations through predation (Massei & Genov, “2004”.). Although more scientific studies would be required, as it is basically unexplored. Wild boars also affect animals such as ground nesting birds (Massei & Genov; P.M Pavlov & Edwards, “1995”.), while only few studies, have actually quantified the impacts, on both plant and animal communities (Massei and Genov, “2004”.).

Many studies show, that rooting lowers plant diversity (Sweitzer and Vuren, “2002”; Webber, Norton, & Woodrow, “2009”; Busby, Vitousek, & Dirzo, “2010”.) and alters species composition (Singer, Swank, & Clebsch, “1984”.). Some studies suggest, that impact of rooting on plant communities directly increase (Kotanen, “1995”; Welander, “1995”.), or decrease plant cover and species richness (Genov, “1981”; Singer, “1981”; Singer, Swank, & Clebsch, “1984”; Wirthner et al., “2012”.) depending on the species and area in question. Other studies show that rooting decreased plant cover, but increased microhabitat diversity and species richness (de Schaetzen, van Langevelde, & WallisDeVries, “2018”.). A study from Sweden found an increase in the number of plant species, in various habitats affected by wild boar rooting activities (Welander, “1995”.). Studies from Germany mention, wild boars’ negative impact on crops, gardens and forest regeneration fences etc., however, some forestry studies from both Germany and Sweden, also consider wild boar rooting to have a positive impact on natural regeneration and biodiversity (Welander “1995”; Alban et al., “2005”.). Additionally, German studies found wild boar to be important in both endozoochorous and epizoochorous dispersal (Schmidt et al., “2004”.).

One of the plant species affected by wild boars is bracken *(Pteridium aquillinum).* Bracken is one of the world’s most common and widely distributed plant species (Henney, “2012”.) and has shown to cause, major successional problems (Lowday & Marrs “1992”). When first established in an area, Bracken is almost impossible exterminate, due to its underground network of rhizomes, which acts as both underground dispersal and as energy storage for the bracken. Brackens has become a problem, in some habitat types such as upland, marginal land and lowland heath, where it limits biodiversity, by creating a monoculture, outcompeting and out shading other plant species (Marrs, “2000”; Lowday & Marrs, 1992; Pakeman & Marrs, “1992”.). Besides outcompeting other plant species, bracken contains toxins that are poisonous to horses, sheep and cattle, however wild boars or domestic pigs can seemingly tolerate the toxins and in low mast years, bracken constitutes a supplementary food source making up around 30-60% of wild boars food intake, in winter time (Herrero et al., “2005”.) A study has shown that wild boar and domestic pigs affect bracken in several ways, gathering brackens for nests, trampling through, rooting in brackens, eating the roots, reducing their energy storage (Wise, “2012”.). When rooting has occurred, bracken roots are exposed to environmental conditions such as wind, frost, direct sunlight etc. (Wise, “2012”.). All of which could contribute to reducing densities of bracken creating open patches, that other plant species might utilize.

Materials and methods

Study sites

Tofte Skov and Høstemark Skov, is owned by Aage W. Jensen Foundation, are both part of Lille Vildmose nature reserves, situated on the east coast of Jutland (Fig. 1). Lille Vildmose is the largest protected nature reserve in Denmark (World Database of Protected Areas, WDPA), and it is selected as Ramsar sites, part of the Natura-2000 network (Dinesen & Kristiansen, “2013”.). It has been deemed as of high conservation value (SACs) under the EEC habitat directive whose purpose, is to protect vulnerable and threatened species and biotopes (Dinesen & Kristiansen, “2013”.). Lille Vildmose is appointed a Natura-2000 area, based on its rich flora, fauna and important habitat types (Dinesen & Kristiansen; Riis, Friis & Aaby, “2009”, ; Riis, Friis, & Aaby, “2009”.). The habitat types include coniferous plantations, deciduous forest and fragments of old-growth deciduous forests, grasslands, lakes, moors and one of the largest intact peatbogs in the Northwest European lowland and degraded areas of peat under restoration (Dinesen & Kristiansen, “2013”; Riis, Friis, & Aaby, “2009”.).

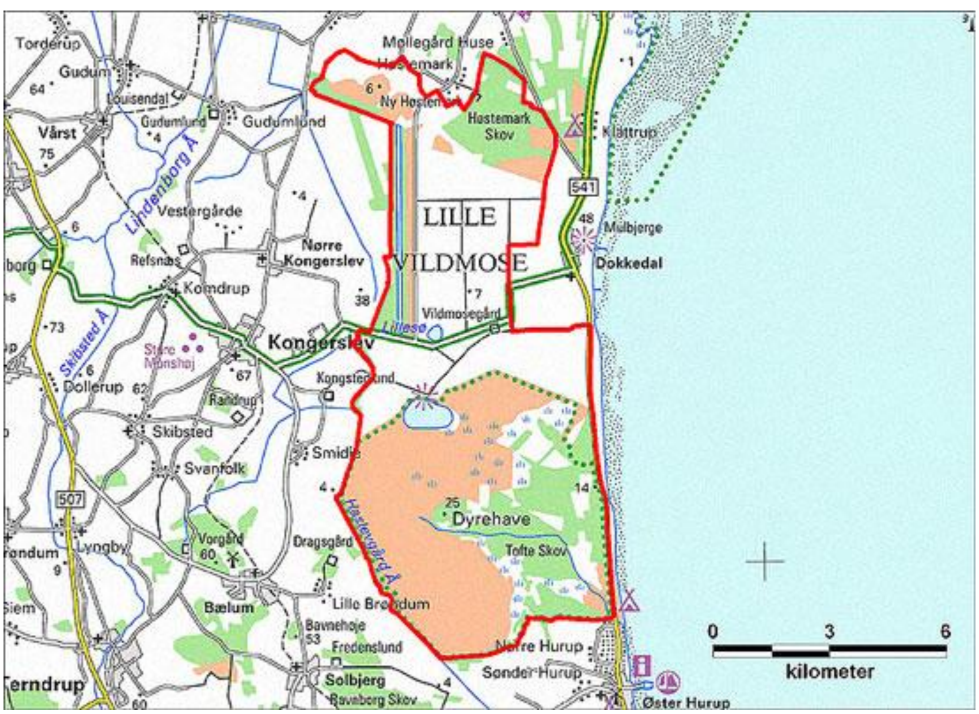


Figure 1 Map showing overview of both Tofte Skov and Høstemark Skov and distance between the two nature reserves (DOF “2011”.).

Tofte Skov

Towards the year 1900 Tofte Skov, was shaped as a cultural landscape and grazed by livestock, composed by hay fields and open woodlands with hay meadows underneath. Since then extensively grazing and rooting by red deer (*Cervus elaphus)* and wild boar has been going on for more than a century. Though the population of red deer and wild boar have varied over time, but has for the last decade, been kept at around 400 red deer and 150 wild boars. In 2001 Aage W. Jensens Foundation acquired Tofte Skov measuring, 3.993 acres, for conservation purposes. The Aage W. Jensen Foundation is obligated to keep the population of red deer between 200-400 and wild boars between 50-150 individuals. To keep the populations at a stable level, supplementary feed is allowed, in wintertime with hay from the area, though this practice will be phased out in the future, thus creating a more natural feeding behaviour. The grazing pressure ranges, from high in open woodlands, grasslands with soft grasses and the heath and low on the peat bog and coniferous plantations (Buttenschøn & Gottlieb, “2017”.).
Tofte Skov contains high valued natural assets, such as the 1960 acres large peatbog and in the north-western part of the peatbog Tofte Lake is found , old open grassed forest composed of common oak, common beech, alders and downy birch (*Betula pubescens*) , swamp forest mainly alders and oak, poor fens, grassland and meadows, this habitat diversity contains high levels of biodiversity and coniferous plantations composed of European spruce (*Picea abies*), the invasive sitka spruce and creeping pine (*Pinus mugo*) (Riis, Friis & Aaby, “2009”.).

The vision for Tofte Skov is to remove all sitka spruces, from the area along with other invasive species such as creeping pine. Raising water levels, to its original natural state, filling old drainage channels, thus recreating old creeks and a natural water flow through the area. The expected outcome is that many trees, in lower parts of Tofte Skov will die. This will shape a more open forest landscape with swamp forest, grassland meadows, poor fen, heath, and ponds. Giving the area an opportunity to flourish and have the greatest biodiversity possible (Riis, Friis & Aaby, “2009”.) (fig 2).

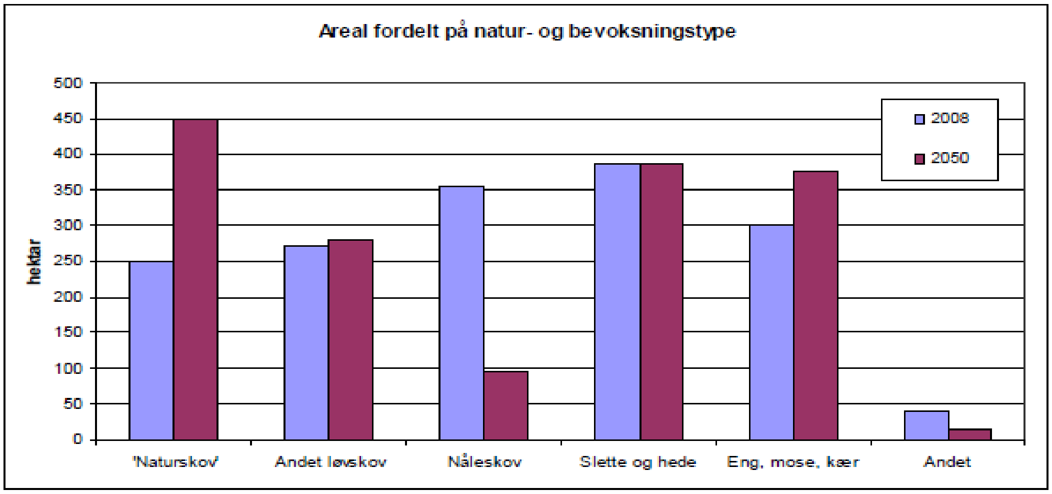


Figure 2 distribution in acres of different nature types, in Tofte Skov 2008 and visions for future distribution of nature types change through management of Tofte Skov(Riis, Friis & Aaby, "2009".).

Høstemark Skov

Høstemark Skov was bought by the Aage W. Jensen foundation in 1988 and is situated in the north-eastern part of Himmerland, close to Limfjorden and the coast of Kattegat. Measuring 574 acres, where 460 acres is fenced. towards the year 1900 Høstemark Skov were shaped as a cultural landscape and grazed by livestock, forest meadows, open woodlands with hay meadows underneath. The livestock was replaced by Red deer, which are important in terms of nature management grazing and browsing, keeping the woodland open in Høstemark Skov. since 1934 the population of red deer has maintained Høstemark Skov, keeping the population at around 150-200 red deer, if natural food sources is low, supplementary feeding is allowed and done in wintertime, with hay from the area (Riis, Friis & Aaby, "2009".).

Høstemark Skov has the potential, to become one of the most important natural grazed forests in Denmark, when measuring naturalization and the versatility of plant communities (Riis, Friis & Aaby, "2009".). The forest areas are mainly old deciduous forest, containing common oak, common beech, common alder, downy birch and common ash (*Fraxinus excelsior*) and coniferous forest plantations composed of sitka spruce, scots pines, creeping pines. Other important parts of the area are heath, meadows, grassland, bogs, ponds and has unusual large areas of swamp forest in Danish context (Riis, Friis & Aaby, "2009".).

As with Tofte Skov, the vision for Høstemark Skov is to remove, invasive species such as sitka spruce, lodgepole pines etc. The water level also here, will be raised to its original natural levels, removing all drainage channels from the area, recreating the natural water flow through the area, shaping a natural dynamically grazed landscape, with natural forest, swamps, poor fens, meadows and grasslands (Fig. 4) (Riis, Friis & Aaby, "2009".).

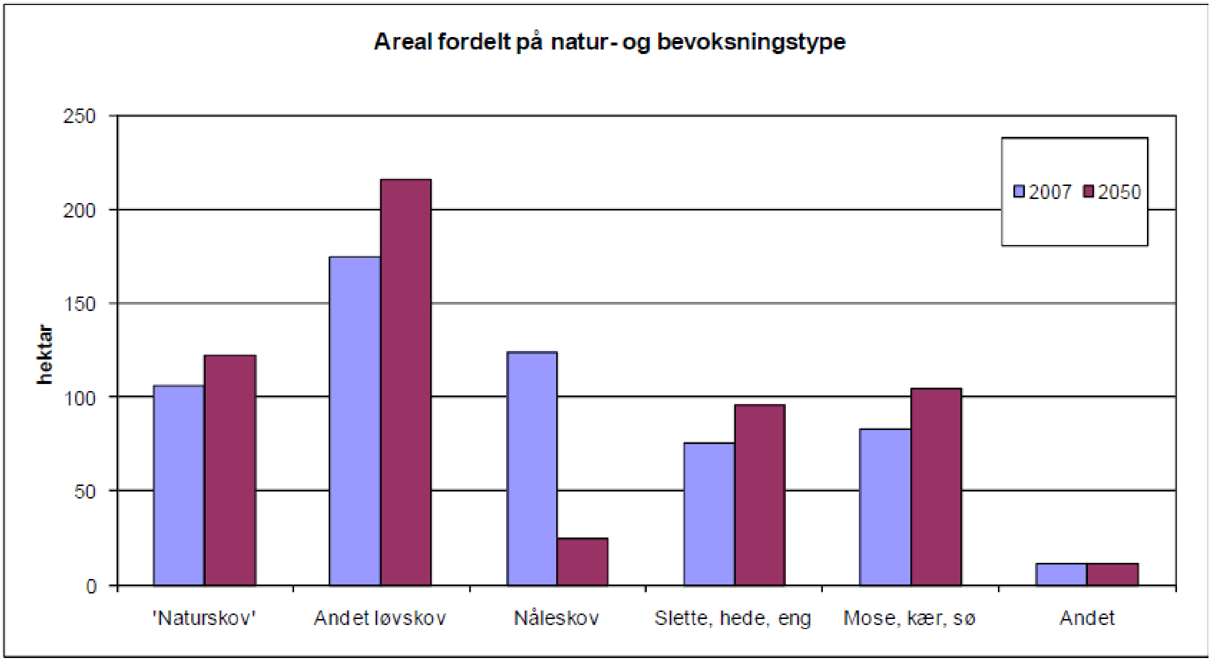


Figure 3 shows the distribution in acres of different nature types, in Høstemark Skov 2008 and visions for future distribution of nature types change through management of Høstemark Skov (Riis, Friis & Aaby 2009)

Brackens

Brackens are found in both Tofte Skov and Høstemark Skov. In 2018 approximately 30 acres of forest was infested with brackens in Tofte Skov. Here brackens form a dense understory, leading to no natural regeneration of tree seedlings and might in the long term, threaten the renewal of the forest, along with high browsing pressure from red deer, which are mainly considered browsers (Humphrey & Swaine, "1997"; Fritz & Ab, "2013".). While in Høstemark Skov, where no wild boars are present, brackens are able to go through, the natural degeneration process; building up litter layer over decades, thereby reducing the dense understory of brackens (Mars et al. 2006) slowly creating open patches for tree seedlings to establish in, renewing the forest. However, browsing pressure is also high in Høstemark Skov from red deer, which might delay or prevent trees seedlings from establishing.

Data collection

Vegetation registrations

Data was collected twice from a total of 192 plots, in start June and mid-August 2019, at sites in Tofte Skov and Høstemark Skov from four types of treatments: unrooted unfenced (CF) (fig. 13), labelled with a C on the fence (Fig. 5) and rooted fenced (RF) (Fig. 14) labelled with a R on the fence (Fig. 5) both treatments fenced in by mesh wire and 4 metal poles, one in each corner (Fig 4). unrooted unfenced (CUF) and rooted unfenced treatments (RUF), was collected with a square, constructed of metal wire (Fig. 4).

At one site in Tofte Skov, fences were set up in January 2018 with 8 plots from each treatment (Laursen 2018). At six other sites in Tofte Skov, fences were set up in start July 2018 and at four sites, comparable to Tofte Skov sites, was in set up in Høstemark Skov with 5 plots from each treatment (table 1).

In Høstemark Skov only unrooted treatments was examined (CF and CUF). All treatments measured 60X60 cm and were divided into 9 cells, when plant species was registered, got the count from minimum 1-9, depending on how many cells, it was present in (Fig. 4). Furthermore, all bracken stems were counted at bracken sites, within each treatment.

Identification of plant using the book Dansk flora 2end edt., the book Danmarks græsser, Danmarks halvgræsser and my knowledge from my background as a gardener. Plant species which could not be identified in the field, were brought back to IGN for later identification.

Table 1 shows the different types of treatments unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF), No. of plots and their distribution at habitat types and forest

	CF: Unrooted fenced	CUF: Unrooted unfenced	RF: Rooted fenced	RUF: Rooted unfenced
Tofte Skov Habitats/No. Of plots	Heath (5), Open woodland (5), Swamp forest (5), Scots pine (5), Grassland (5), Meadow/alder (5), meadow (8).	Heath (5), Open woodland (5), Swamp forest (5), Scots pine (5), Grassland (5), Meadow/alder (5), meadow (8).	Heath (5), Open woodland (5), Swamp forest (5), Scots pine (5), Grassland (5), Meadow/alder (5), meadow (8).	Heath (5), Open woodland (5), Swamp forest (5), Scots pine (5), Grassland (5), Meadow/alder(5), meadow (8).
Høstemark Skov Habitats/No. of plots	Open woodland (5), Scots pine (5) Meadow/alder (5), meadow (5).	Open woodland (5), Scots pine (5) Meadow/alder (5), meadow (5).		

Figure 4 shows the square used to collect data from both the unrooted unfenced (CUF) and the rooted unfenced (RUF) divided into 9 cells. Foto courtesy Laursen (2018) and Fenced treatment divided into 9 cells (right).

Figure 5 Rooted fenced treatment (RF), labled a R (Left) and unrooted control fenced treatment (CF) labled with a C (right).

Tofte Skov

The 7 sites in Tofte Skov , **Bracken sites**: Heath (4) and open woodland (2), **Forest sites**: Swamp forest (1), scots pine (7), **Grassland sites**: Grassland (6), meadow (3), meadow with common alder around the sides (5), coordinates of sites and overview of Tofte Skov (Fig 7).

Figure 6. the seven sites in Tofte Skov with coordinates (left) and map with position of sites and the fence line surrounding the 3744 acres representing Tofte Skov (Buttenschøn & Gottlieb 2018) & (Miljøstyrelsen n.d)

Bracken sites

4. Heath

The site is surrounded by downy birch with Brackens underneath, underneath the brackens, bog bilberry *(Vaccinium ulignosum)* grew. The sites were intensively rooted by wild boars' in large patches of bracken, rooting for bracken roots. When brackens were removed, common heather (*Calluna Vulgaris)* seedlings germinated (Fig. 7). At the heath common heather, *and cross-leaved heath (Erica tetralix)* dominated but was intensively grazed by red deer.

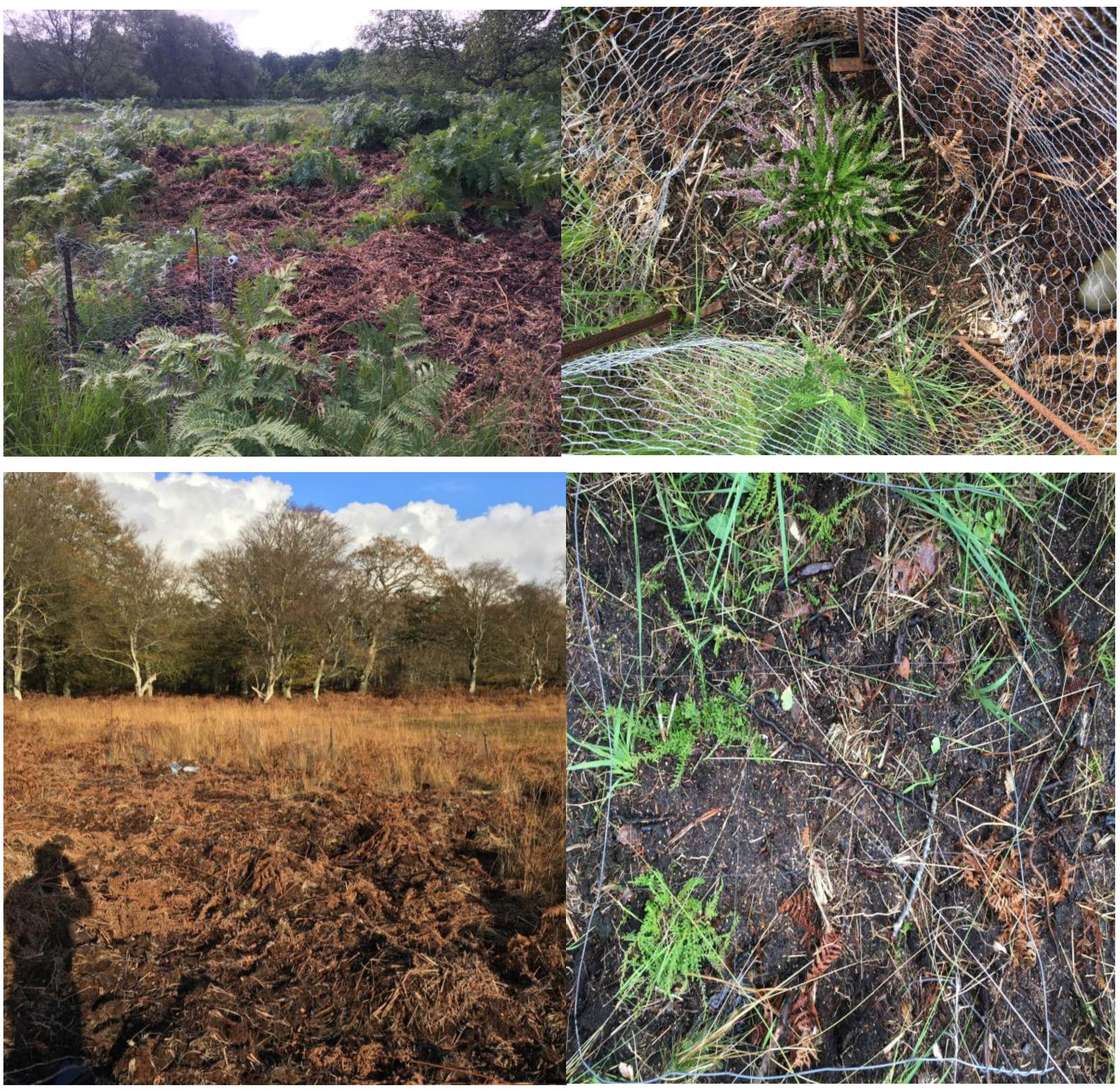


Figure 7 shows rooted patch in brackens (top left and bottom left) and a rooted unfenced treatment with Calluna vulgaris and rooted fenced treatment with Calluna vulgaris (top and bottom right)

2. Open woodland

The overstory was composed of deciduous trees such as common oak, common beech and alders (Fig. 8 top right) with sporadic rooting underneath beech, oaks for mast and in the brackens for roots (Fig. 8 top left). In unroooted patches wood millet (*Milium effusum) and* bracken was the dominating species. While in rooted patches, wood millet, wood sorrel, wild raspberry *(Rubus idaeus)* and tree seedlings of beech, was among the species found (Fig. 8 bottom left and right side).

Figure 8 Shows the Open woodland site in Tofte Skov. Wild boars rooting for Bracken roots (top left), the overwiev of the site with brackens as dense understory and common beech as overstory. Common beech seedlings, wood sorrel and wild raspberry etc. in rooted patches (bottom left and right)

Forest sites

1. Swamp forest

This site is a fringe of swamp forest, between the peatbog and the surrounding landscape. The site was wet, with soil rich in organic material and nutrients. The overstory was composed of a dense canopy of alder, with highly intensive rooting in large patches underneath, keeping the plant ground cover of plants, beneath the alders to a minimum in larges patches (Fig. 9). The dominating flora were remote sedge (*Carex remota)*, wood club rush *(Scirpus sylvaticus) and* common wood sorrel *(Oxalis acetosella).* Fences were put up in rooted patches and unrooted patches (Fig. 9)

Figure 9 show intensively rooted patches with rooted fences (left) and unrooted fence (right)

7. Scots pine

The overstory was composed of scots pines (Fig. 10 top left), unrooted patches were dominated by wavy hair grass (*Deschampsia flexuosa)* and sand sedge (*Carex arenaria)*. In rooted patches tree seedlings from scots pines germinated (fig. 10 top right). Rooting was sporadic, in small deep patches for deer truffles (fig 10 bottom left and right).

Figure 10 shows the scots pine sites in Tofte Skov (Top left), a rooted fenced treatment with scots pines seedlings (Top right) rooting for deer truffles (Elaphomyces granulatus) (Bottom left) in small deep patches (Bottom right

Grassland sites

6. Grassland

This site is a large, well-drained, due to sandy soil, dry area of grassland, with no overstory. High intensity rooting was observed, in smaller patches and large unrooted areas dominated by graminoid species, matgrass (*Nardus stricta) and wavy-hair grass* (Fig. 11). In rooted patches annual and perennial forbs dominated (Fig. 11). Limited grazing and no management at this site.

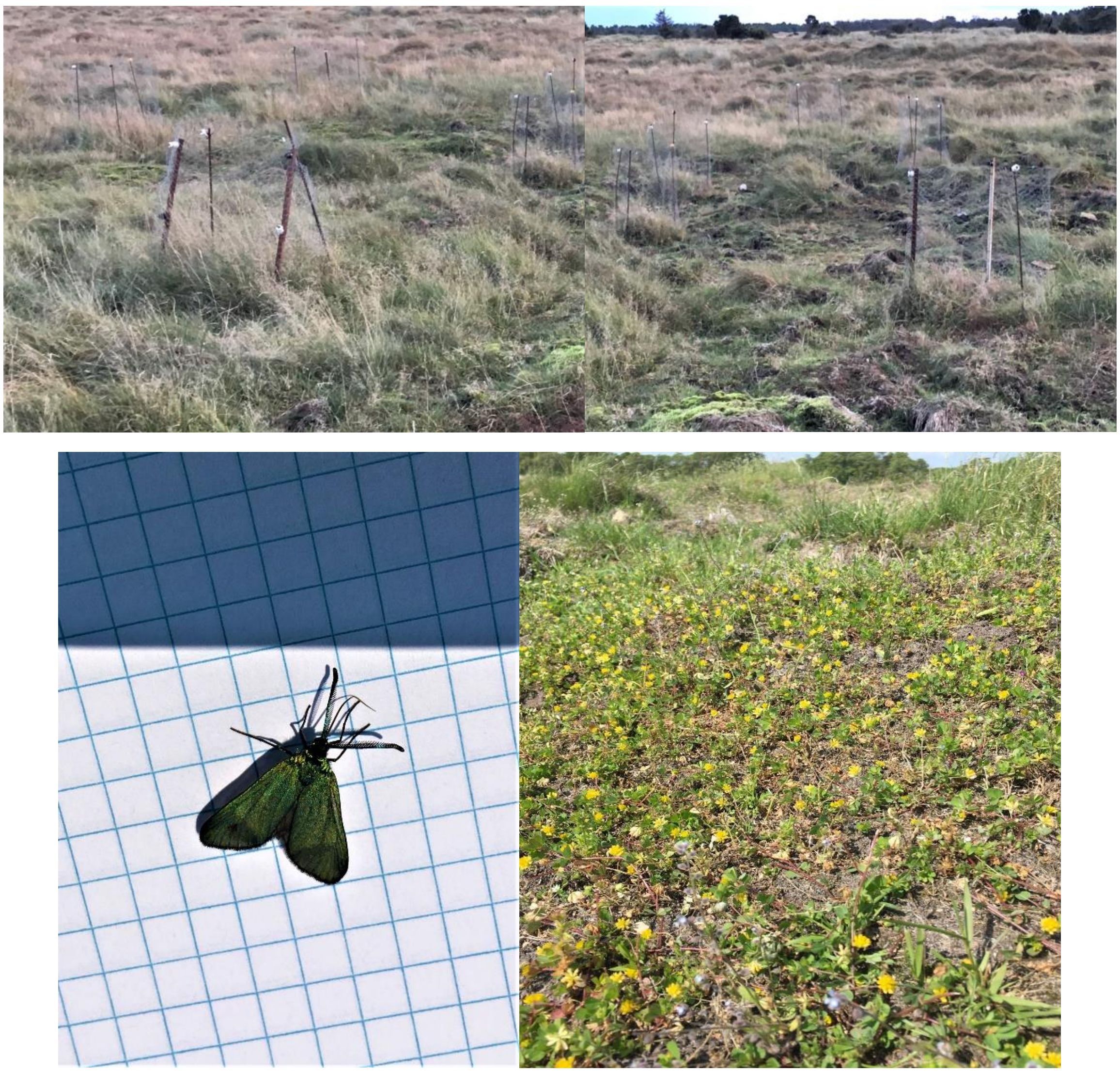


Figure 11 rooted fence on top (left) an unrooted fence top (right) a rooted patch at the Grassland site bottom (left) and a green forester (Adscita statices) photo taken while doing registrations at the grassland sited

3. Meadow 2019

Coniferous trees around the sides with high intensity rooting in large patches especially in the left side of the meadow (fig. 12 top right and 13). Mainly dominated by graminoids species in unrooted patches (fig 12) and perennial and annual forbs in rooted patches (fig 13). Managed by mowing to keep the grass fresh and soft and additional feeding is provided in the winter. At the meadow site in Tofte skov the plant structure, density and height of the plants in the fenced treatments, change greatly for the unrooted treatment, went from being graze to the ground, grass less than 5 cm high in January 2018, grass to 30-40 cm height in 2019. For the rooted fenced treatment, plant structure also change greatly from almost exclusively exposed soil in January 2018 to grass and forbs approximately 20 cm high.

Figure 12 The meadow site in Tofte Skov and the development in the unrooted fenced treatment from January 2018 to October 2019 when fences was pulled down.

Figure 13 the meadow site in Tofte Skov and the development in the rooted fenced treatment from January 2018 to June 2019.

5. Meadow/Common alder

This site had alders around the sides, and the most dominating flora in unrooted patches was common bent, sweet vernal grass *(Anthoxanthum odoratum),* Yorkshire fog *(Holcus lanatus).* In rooted patches ribwort plantain *(Plantago lanceolata),* silverweed *(Potentilla anserina),* meadow buttercup *(Ranunculus acris)* and red clover *(Trifolium pratense)* were among the dominating flora. Rooting in patches around the edges along the alders (fig. 14 top left), the middle of meadow was mainly untouched except for minor grazing, some larger common alder 2-3 meters high, had established further away for the edge of the meadow (fig 14 top left). 1-2-year old common alder seedlings were observed in rooted patches and rooted treatments (fig 14 top right and bottom).

Figure 14 shows the Meadow/alder site, with alders around the meadow and some alders also established at the meadow(Top left), a rooted fenced treatment (RF) (top right side) and a rooted patch with more than 20 Alnus glutinosa seedlings.

Høstemark

Four sites were found comparable to similar sites in Tofte Skov Meadow (1), Meadow/common alder (2), scots pine (3) and Open woodland with bracken underneath (4) with coordinates (Fig. 15)

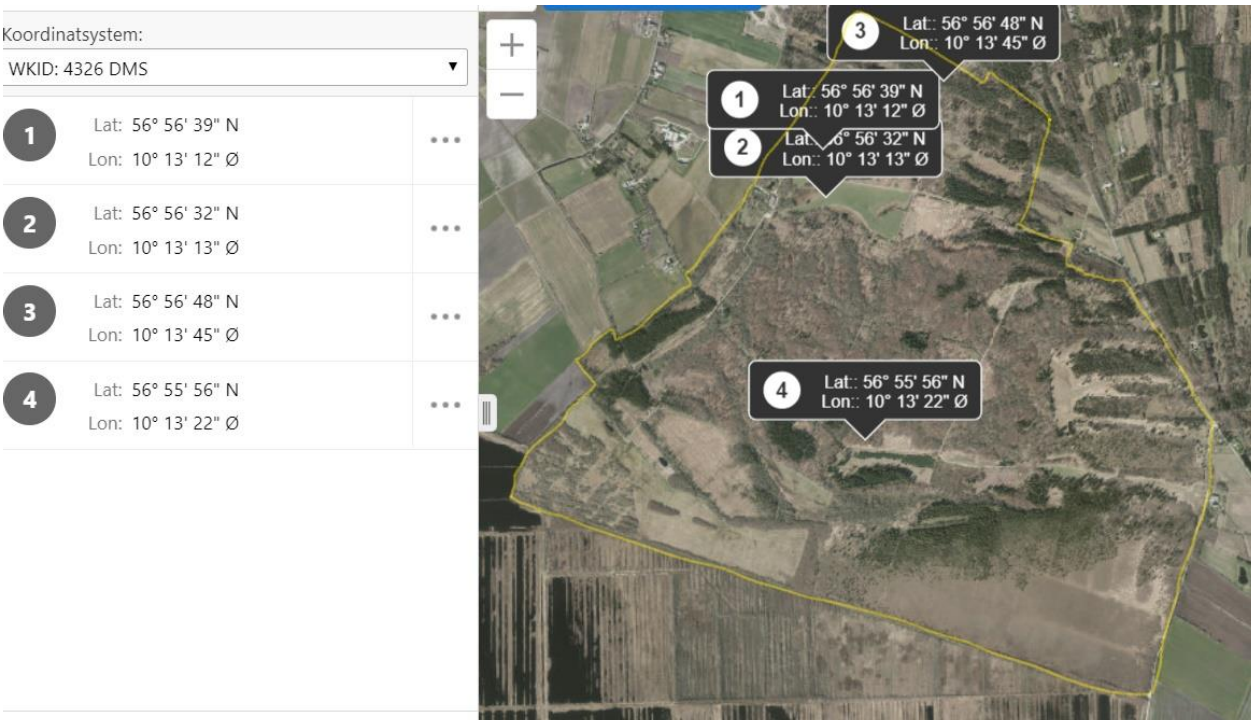


Figure 15 shows Høstemark Skov with coordinates of sites and fenceline of the 574 acres. (Miljøstyrelsen n.d).

Bracken site

4. Open woodland

Overstory was mainly composed common beech and the dominating understory was brackens. The brackens were observed to be less dense compared to the Open woodland location in Tofte Skov, and the common beech was growing under the brackens and observed older than at the Tofte Skov Open woodland site (Fig. 16). No grazing occurred, only browsing on the beech trees.

Figure 16 show the Open woodland site in Høstemark Skov, Brackens was less dense and Fagus sylvatica grew among the brackens (right)

Forest sites

3. Scots pine

The overstory was composed of scots pines and the dense understory was dominated by wavy hair grass and sand sedge, with some sporadic tree seedlings, wild raspberry and heath bedstraw (*Galium saxatile)* (Fig 17). No grazing was observed.

Figure 17 the Scots pine site in Høstemark skov, and the most frequently registered Perennial forb registered Galium saxatile.

Grassland sites

1. Meadow

Surrounded by scots pines and downy birch, with soft grasses and forbs, common bent, sweet vernal grass, ryegrass (Lolium perenne), dovesfoot geranium (Geranium molle), ribwort plantain, red clover and mouse-ear hawkweed (Hieracium pilosella)(Fig. 18). The site was intensively grazed by red deer and mowed yearly to keep the grass fresh and green, the clipping was used, as wrap for winter feeding. Also seen in (Fig 18) the grass was significantly higher in the fenced treatment, compared to the surrounding meadow.

Figure 18 Show the Meadow in Høstemark Skov with fenced treatments (left) and some of the species found dovesfoot geranium and mouse-ear hawkweed (middle) and a CF treatment (right).

2. Meadow/ common alder

Surrounded by downy birch and alders, dominated by soft grasses and perennial forbs as silver weed and meadow buttercup, eggbract sedge (*Carex leporina)* and soft sedge (Juncus effuses) underneath the common alders and downy birches. The sites were intensively grazed by red deer and mowed yearly, to keep the grass fresh and green, the clipping was used, as wrap for winter feeding. But fences were place in un-mowed patches, so this could not affect the results, as the meadow/common alder site in Tofte Skov was not mowed yearly (Fig. 19).

Figure 19 show the Meadow/common alder site i Høstemark Skov, with downy birch and common alder in the background. and an ever-present herd of red deer grazing at the meadow.

Data analysis

To understand how wild boars´ impact different habitats, by altering the landscape through rooting and grazing, statistical tests for differences in species richness (alpha diversity) and for differences in abundances of species types: Perennial forbs, graminoids, annual forbs , tree seedlings, brackens, bracken stems and Half-shrubs. The analysis was focused on comparing rooted treatments, fenced (RF) and unfenced (RUF) in Tofte Skov, to unrooted treatments fenced (CF) and unfenced (CUF) in Tofte Skov and Høstemark Skov. The analysis was also focused on differences between the two types rooted treatments and the two types of unrooted treatments, to see if data from the unfenced treatments, show the same tendencies, as the fenced treatments. Data were analysed in excel, likewise all graphs were made in excel.

Normal distribution of data cannot be assumed for data sets based on counts. So, to test for differences within or between sites, non-parametric Kruskal Wallis test were used. As Kruskal Wallis test does not assume normal distribution of residuals and is based on ranks, Kruskal Wallis test was calculated with a significance level of (≥0,05). When P-value was found (≥0,05) it indicated that at least one treatment was different from the others, but not which treatments that differed from the other. When P-value from Kruskal Wallis showed significance, Mann-Whitney U test, for independent samples, was used for pairwise comparison, testing if medians was equal between the individual treatments.

Results

Data was collected twice from a total of 192 plots from the four different types of treatments. 11136 plant registrations where made, distributed on 114 different plant species in Tofte Skov and Høstemark Skov combined, none of which considered of great importance to conservation. Table 2 shows species exclusively found within certain treatments and number of plant registrations. (see Appendix 1 for information on which site the individual species was found). The highest species count was registered in the two rooted treatments (table 2) see appendix 11 for species list

Table 2 species count within treatments, in Tofte Skov (TS) and Høstemark Skov (H)

Fence	**CF & CUF**	**CF**	**CUF**	**RF & RUF**	**RF**	**RUF**
Species Count	TS: 76 HM: 48	TS: 58 HM: 39	TS: 65 HM: 45	TS: 93	TS: 79	TS: 82

Bracken sites

Heath and Open woodland

Abundance

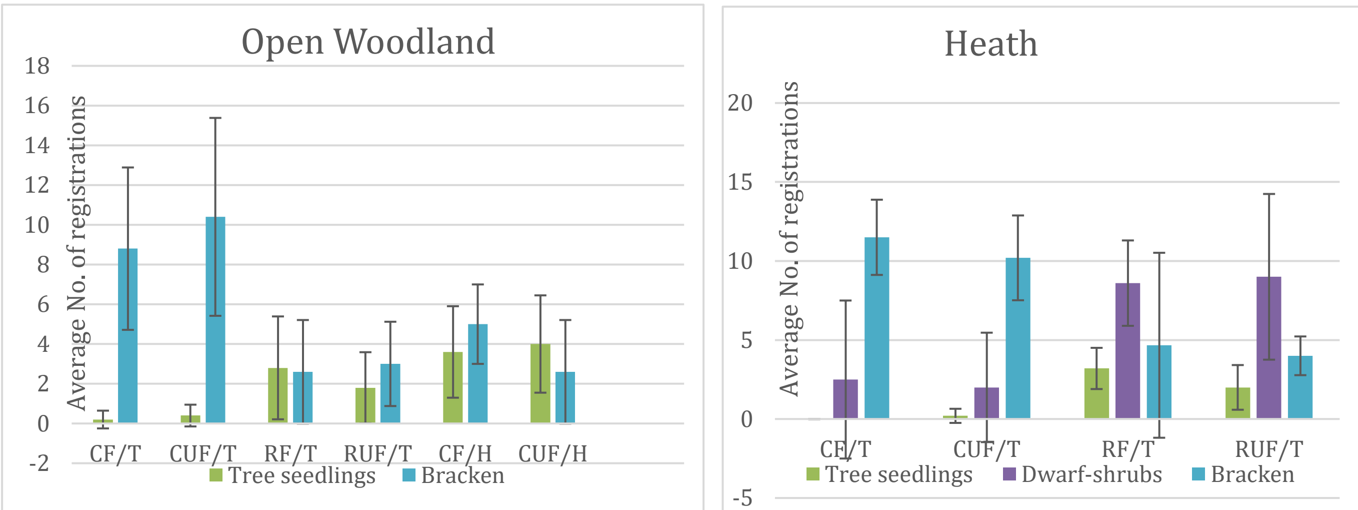


Figure 20 Abundance of tree seedlings, brackens and dwarf-shrubs. , based on 5 plots from each treatment registered twice, at the bracken sites in Tofte Skov (/T) and Høstemark Skov(/H): from the Heath and open woodland site. Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF).

The Abundance was low for both Perennial and annual forbs among all treatments and are therefore not included in the graphs. For graminoids No S.D in abundance was found open woodland ($p \geq 0,059$) and heath ($p \geq 0,052$) (appendix 15), and therefore not included, although found in lower abundances in rooted treatments.

Dwarf-shrubs (Heath)

When comparing pairwise no S.D. in abundance was found between the unrooted treatments or between the rooted treatments. Abundances was significantly higher in the rooted treatments compared to the unrooted treatments.

Bracken (Heath and Open Woodland)

for both the heath and the open woodland site in Tofte Skov, when comparing pairwise no S.D. in abundance was found between the unrooted treatments or between the rooted treatments. Abundances was significantly higher in the unrooted treatments compared to the rooted treatments. For the open woodland sites abundance of brackens was higher in the Tofte Skov unrooted treatments compared to the unrooted treatments in Høstemark, although not significantly.

Tree seedlings was found in low abundances at both sites, but mainly in the rooted treatments in Tofte Skov. for the open woodland site abundance of tree seedlings was even between rooted treatments in Tofte Skov compared to the unrooted treatments in Høstemark Skov.

The tree seedlings at the Heath site was exclusively downy birch, while at the Open woodland site the most common species registered in both Tofte Skov and Høstemark Skov was beech.

Table 3 Mann-Whitney U test for differences in abundance, of dwarf-shrubs and brackens at the Heath and Open woodland site in Tofte Skov (/T) and Høstemark Skov (/H) with no significant differences (ns) and significant differences between treatments (S.D) and the P-value.

Heath					
Dwarf-shrubs	**CUF(/T)**	**RF (/T)**	**RUF (/T)**		
Kruskal Wallis	(P≤0,030)				
CF(/T)	Ns	0,022	0,02		
CUF(/T)	-----	0,018	0,024		
RF(/T)	-----	-----	Ns		
Brackens	**CUF(/T)**	**RF (/T)**	**RUF (/T)**		
Kruskal Wallis	(P≤0,020)				
CF(/T)	Ns	0,028	0,007		
CUF(/T)	-----	0,05	0,005		
RF(/T)	-----	-----	Ns		
Open woodland					
Kruskal Wallis	(p≤0,028)				
Bracken	**CUF(/T)**	**RF (/T)**	**RUF (/T)**	**CF(/H)**	**CUF(/H)**
CF(/T)	Ns	S.D (0,011)	S.D (0,014)	Ns	S.D. (0,011)
CUF(/T)	-----	S.D (0,018)	S.D (0,030)	Ns	S.D. (0,014)
RF(/T)	-----	-----	Ns	S.D (0,038)	Ns
RUF(/T)	-----	-----	-----	Ns	Ns
CF(/H)	-----	-----	-----	-----	S.D. (0,047)

Bracken stem abundance

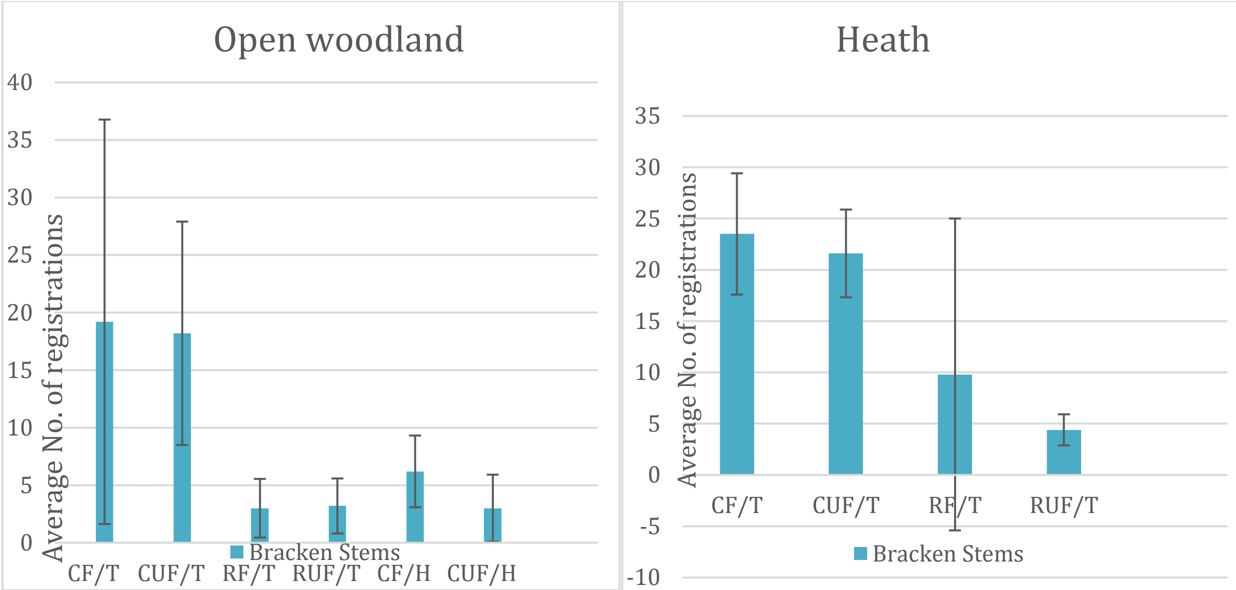


Figure 21 Average abundance for bracken stems, based on 5 plots from each treatment, registered twice, for the Heath and Open woodland site (/T) and Høstemark Skov (/H). unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF).

Abundance of Bracken Stems varied greatly both within and between treatments but was generally higher in unrooted treatments in the Tofte Skov open woodland ($p \leq 0{,}046$) and Heath ($p \leq 0{,}023$).

Mann-Whitney U test

For both the heath and Open woodland site, when comparing pairwise no S.D. in abundance was found between the unrooted treatments or between the rooted treatments in Tofte Skov, in Høstemark Skov abundance was significantly higher in the unrooted fence treatment compared to unrooted unfenced treatment. Abundances was significantly higher in the unrooted treatments in Tofte Skov compared to the rooted treatments in Tofte skov.

For the open woodland site Tofte Skov compared to Abundance of brackens was higher in unrooted treatments in Tofte Skov, compared to both unrooted treatments in Høstemark Skov, although not significantly.

Table 4 Mann-Whitney U test for differences in abundance, of Bracken stems at the Open woodland and heath site in Tofte Skov (/T) and Høstemark Skov (/H) with no significant differences (ns) and significant differences between treatments (S.D) and the P-value

Open woodland					
Bracken Stems	**CUF(/T)**	**RF (/T)**	**RUF (/T)**	**CF(/H)**	**CUF(/H)**
CF(/T)	Ns	S.D (0,011)	S.D (0,014)	Ns (0,072)	S.D (0,014)
CUF(/T)	-----	S.D (0,030)	S.D (0,030)	Ns (0,059)	Ns
RF(/T)	-----	-----	Ns	S.D (0,049)	Ns
RUF(/T)	-----	-----	-----	Ns	Ns
CF(/H)	-----	-----	-----	-----	S.D (0,047)
Heath					
Bracken stems	**CUF(/T)**	**RF (/T)**	**RUF (/T)**		
CF(/T)	Ns	0,044	0,0071		
CUF(/T)	-----	0,034	0,0045		
RF(/T)	-----	-----	Ns		

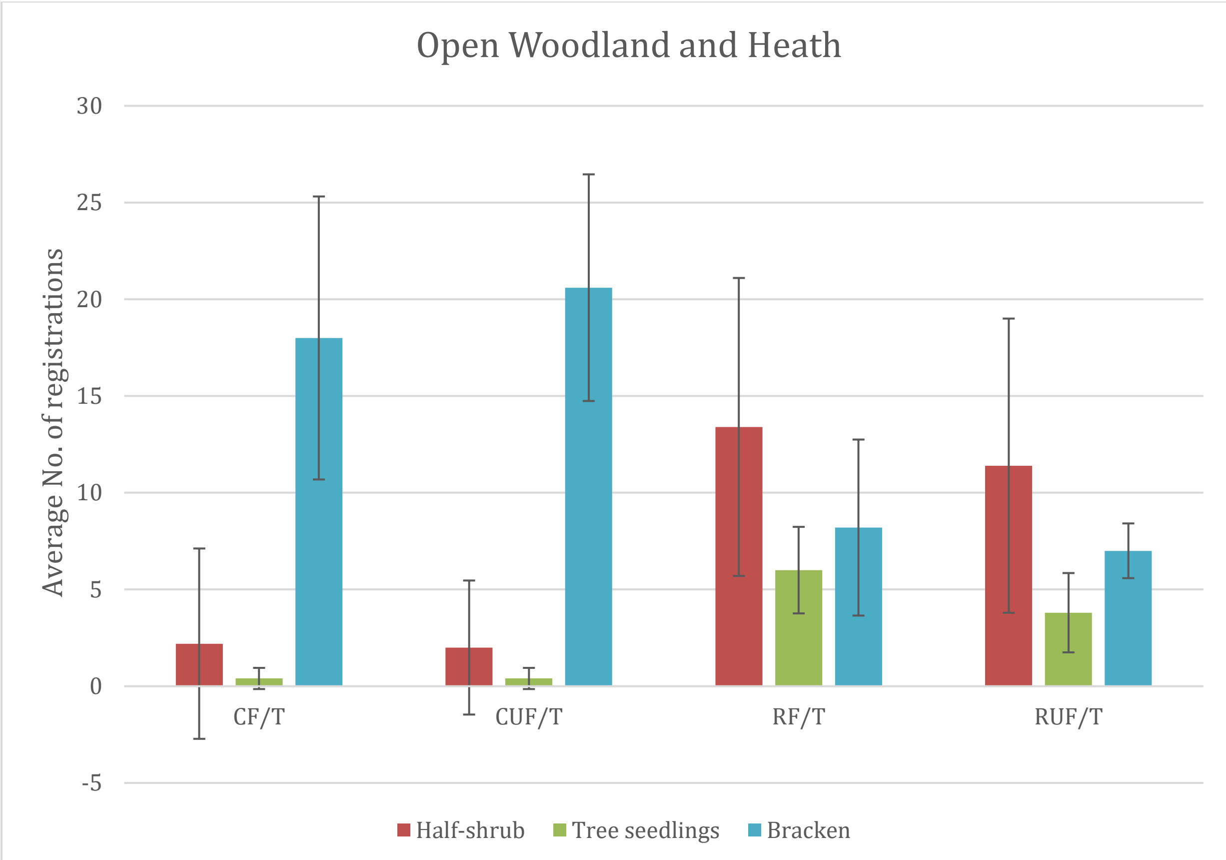


Figure 22 Average abundance for half-shrubs, Tree seedlings and Brackens, based on 10 plots from each treatment registered twice, at the bracken sites combined in Tofte Skov (/T): Heath and Open woodland sites. Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF).

The half-shrubs registered in rooted treatments, was mainly the Dwarf-shrub, common heather seedlings from the heath site, which was exclusively registered in rooted treatments and the half-shrub wild raspberry.

Mann-Whitney U test

Half-shrubs

When comparing pairwise no S.D. in abundance was found between the unrooted treatments or between the rooted treatments. Abundances was significantly higher in the rooted treatments compared to the unrooted treatments.

Tree seedlings

When comparing pairwise no S.D. in abundance was found between the unrooted treatments or between the rooted treatments. Abundances was significantly higher in the rooted treatments compared to the unrooted treatments.

Bracken

When comparing pairwise no S.D. in abundance was found between the unrooted treatments or between the rooted treatments. Abundances was significantly higher in the unrooted treatments compared to the rooted treatments.

Table 5 Mann-Whitney U test for differences in abundance, for Half-shrubs, tree seedlings and brackens at Open woodland and the Heath site in Tofte Skov (/T). with no significant differences (ns.) and significant differences between treatments (S.D) and the P-value.

Half-shrub	**CUF(/T)**	**RF (/T)**	**RUF (/T)**
CF(/T)	Ns	S.D. (0,018)	S.D. (0,024)
CUF(/T)	-----	S.D. (0,0088)	S.D. (0,019)
RF(/T)	-----	-----	Ns
Tree seedlings	**CUF(/T)**	**RF (/T)**	**RUF (/T)**
CF(/T)	Ns	S.D. (0,0045)	S.D. (0,0045)
CUF(/T)	-----	S.D. (0,0045)	S.D. (0,0045)
RF(/T)	-----	-----	Ns
Bracken	**CUF(/T)**	**RF (/T)**	**RUF (/T)**
CF(/T)	Ns	S.D. (0,018)	S.D. (0,0082)
CUF(/T)	-----	S.D. (0,0081)	S.D. (0,0045)
RF(/T)	-----	-----	Ns

Forest sites

Swamp forest

Abundance

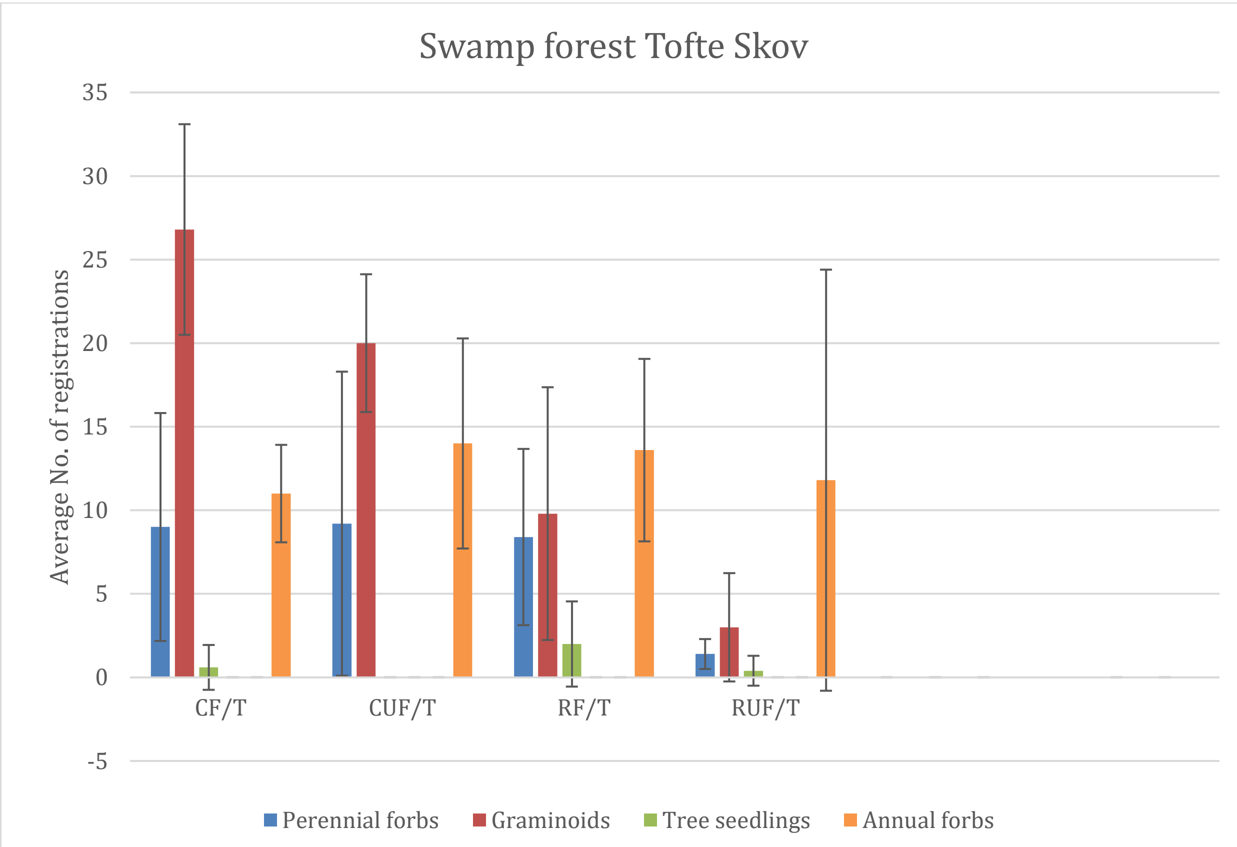


Figure 23 Average abundance for Perennial forbs, Graminoids, tree seedling and Annual forbs, based on 5 plots from each treatment registered twice, at the Swamp forest site in Tofte Skov (/T). Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF).

The average abundance of perennial forbs was even between CF, CUF and the RF treatments but varied within the treatments. Average abundance of perennial forbs was lower in the RUF treatment ($p \leq 0,050$).

The average abundance of graminoids was significantly higher in the unrooted treatments ($p \leq 0,002$), indicating that graminoids responded negatively to rooting.

Abundance of Tree seedling was generally low, but somewhat higher in the Rooted fenced treatment, no test was calculated due to low abundances, responding positively to rooting.

Abundance of Annual forbs was generally even between treatments (p≥0,74) indicating that abundance of annual forbs in not affected by rooting at this site.

The abundance of registrations was generally lower in the RUF treatment for all species types except for annual forbs, and rooting was observed as being extensive at unfenced treaments.

Perennial forbs

Abundance of perennial forbs was significantly higher in the all treatments, compared to the rooted unfenced treatment

Graminoids

When comparing pairwise no S.D. in abundance was found between the unrooted treatments or between the rooted treatments. Abundances was significantly higher in the unrooted treatments in compared to the rooted treatments.

Showing that abundance of graminoids was significantly higher in unrooted treatments.

Table 6 Mann-Whitney U test for differences in abundance, of Perennial forbs and graminoids at the Swamp forest site in Tofte Skov (/T). With no significant differences (ns) and significant differences between treatments (S.D) and the P-value.

Perennial forbs	**CUF(/T)**	**RF (/T)**	**RUF (/T)**
CF(/T)	Ns	Ns	S.D. (0,01)
CUF(/T)	-----	Ns	S.D. (0,008)
RF(/T)	-----	-----	S.D. (0,024)
Graminoids	**CUF(/T)**	**RF (/T)**	**RUF (/T)**
CF(/T)	S.D. (0,047)	S.D. (0,008)	S.D. (0,0045)
CUF(/T)	-----	S.D. (0,024)	S.D. (0,007)
RF(/T)	-----	-----	No S.D. (0,09)

Scots pine

Abundance

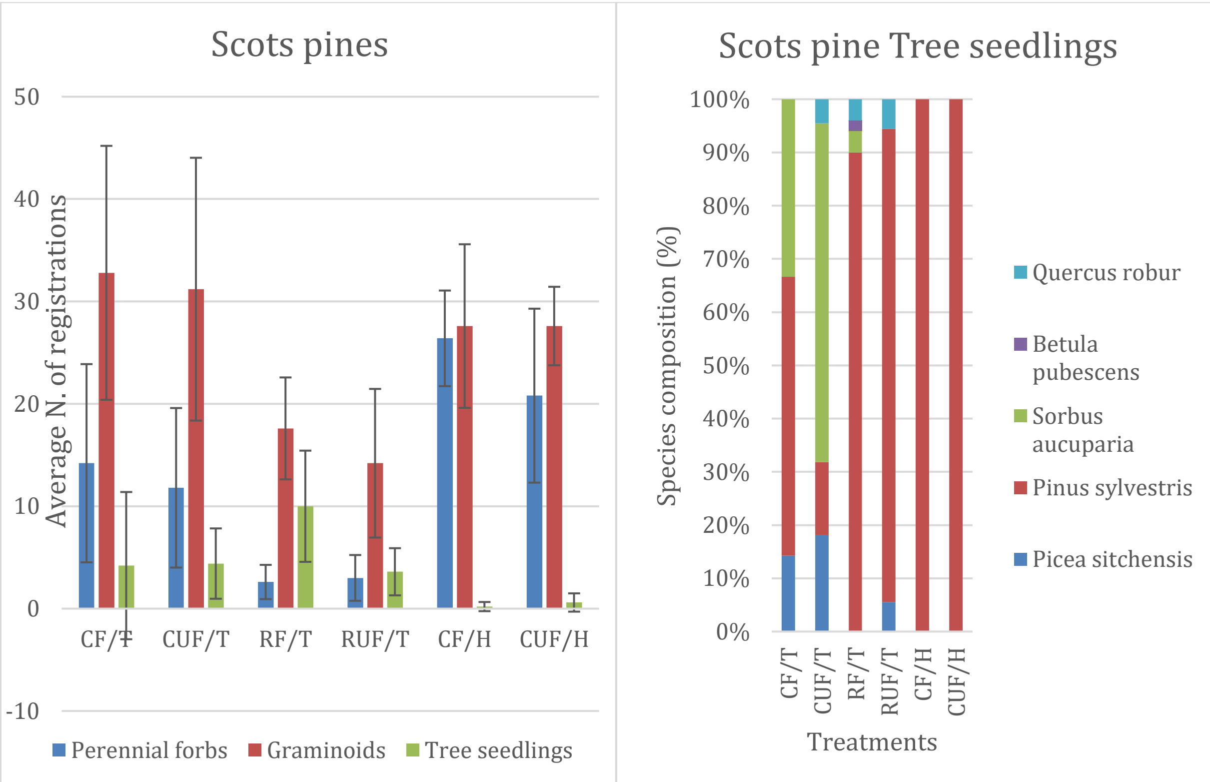


Figure 24 average abundance for Perennial forbs, Graminoids and tree seedling and tree seedling composition (%), based on 5 plots from each treatment registered twice, at the Scots pine forest site in Tofte Skov (/T) and Høstemark Skov (/H). Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF)

The average abundance of perennial forbs was highest in the unrooted treatments in Høstemark Skov and higher in the unrooted treatments, both in Tofte Skov and Høstemark Skov, compared to the rooted treatments ($p \leq 0{,}0072$).

The average abundance of graminoids was relatively even between unrooted treatments. But significantly higher in the unrooted treatments in both Tofte Skov and Høstemark Skov, compared to the rooted treatments in Tofte Skov ($p \leq 0{,}039$).

Abundance of Tree seedling was higher in the rooted fenced treatment, compared to unrooted treatments in both Tofte Skov and Høstemark Skov. Between the unrooted treatments, abundance was higher in Tofte Skov ($p \leq 0{,}012$).

Tree seedling composition varied between treatments, for the unrooted treatments in Tofte Skov, rowans had the second and highest percentage 33,33% and 63,64% , while for the rooted treatments, pines had the highest percentage 90% and 88,89%, sitka spruce was found mainly in unrooted treatment 14,29% and 18,18% and only in the rooted unfenced treatment 5,56%.

Abundance of annual forbs, Pteridophytes and Half-shrubs was not included in the graph due to low number of registrations (appendix 1).

Mann-Whitney U test

Perennial forbs

When comparing pairwise No S.D. in abundance was found between unrooted treatments in both Tofte Skov and Høstemark Skov or between the rooted treatments in Tofte Skov, except for significantly higher abundance of perennial forbs in in CF(H) compared to CUF(/T)
Showing that abundance of perennial forbs was significantly higher in unrooted treatments, and perennial forbs at the scots pine site responded negatively to rooting

Graminoids

When comparing pairwise, no S.D in abundance of graminoids was found between unrooted treatments in Tofte Skov or Høstemark Skov or between the rooted treatments. But abundance was Significantly higher in all unrooted treatments in both Tofte Skov and Høstemark Skov, compared to both rooted treatments.
Showing that abundance of graminoids in general was significantly higher in unrooted treatments in both Tofte Skov and Høstemark Skov, compared to rooted treatments in Tofte Skov

Tree seedling

When comparing pairwise, no S.D. in abundance was found between the unrooted treatments in Tofte Skov or between the unrooted treatments in Høstemark Skov.
Abundance of tree seedlings was significantly higher in all treatments in Tofte Skov compared to treatments in Høstemark Skov, except for CF(/T) compared to CUF(/H). Abundance of tree seedlings was significantly higher, in the rooted fenced treatment compared to all other treatments, in both Tofte Skov and Høstemark Skov.
when abundances of graminoids got significantly reduced, from a rooting event, abundance of tree seedlings significantly increased in rooted treatments,

Table 7 Mann-Whitney U test for differences in abundance of Perennial forbs, graminoids and Tree seedlings, at the Scots pine site in Tofte Skov (/T) and Høstemark Skov (/H). with no significant differences (ns) and significant differences between treatments (S.D) and the P-value.

Perennial forbs	**CUF(/T)**	**RF (/T)**	**RUF (/T)**	**CF(/H)**	**CUF(/H)**
CF(/T)	Ns	S.D. (0,04)	S.D. (0,047)	Ns	Ns
CUF(/T)	-----	S.D. (0,024)	S.D. (0,038)	S.D. (0,03)	Ns
RF(/T)	-----	-----	Ns	S.D. (0,0045)	S.D. (0,0045)
RUF(/T)	-----	-----	-----	S.D. (0,0045)	S.D. (0,0045)
CF(/H)	-----	-----	-----	-----	Ns
Graminoids	**CUF(/T)**	**RF (/T)**	**RUF (/T)**	**CF(/H)**	**CUF(/H)**
CF(/T)	Ns	S.D. (0,0045)	S.D. (0,0045)	Ns	Ns
CUF(/T)	-----	S.D. (0,0045)	S.D. (0,0045)	Ns	Ns
RF(/T)	-----	-----	Ns	S.D. (0,0061)	S.D. (0,0045)
RUF(/T)	-----	-----	-----	S.D. (0,0045)	S.D. (0,0045)
CF(/H)	-----	-----	-----	-----	Ns
Tree seedlings	**CUF(/T)**	**RF (/T)**	**RUF (/T)**	**CF(/H)**	**CUF(/H)**
CF(/T)	Ns	S.D. (0,038)	Ns	S.D. (0,038)	Ns
CUF(/T)	-----	S.D. (0,038)	Ns	S.D. (0,0061)	S.D. (0,014)
RF(/T)	-----	-----	S.D. (0,024)	S.D. (0,0045)	S.D. (0,0045)
RUF(/T)	-----	-----	-----	S.D. (0,0,24)	S.D. (0,03)
CF(/H)	-----	-----	-----	-----	Ns

Grassland sites

Grassland and meadow

abundance

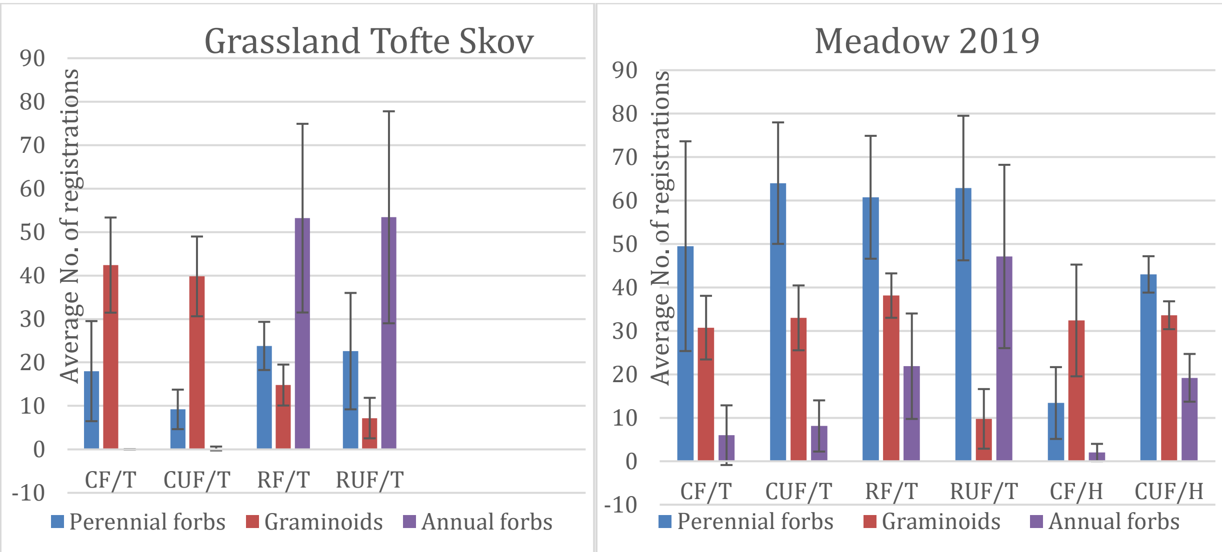


Figure 25 Average abundance for perennial forbs, graminoids and annual forbs, based on 5 plots from each treatment registered twice, at the Grassland site and the Meadow site in Tofte Skov (/T) and in Høstemark Skov/H. Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF)

The average abundance of perennial forbs for the grassland sites was higher in the rooted treatments, but for the meadow sites abundance was relatively even among the Tofte Skov treatments, but lower in the Høstemark Skov treatments, significant differences was found between treatments grassland($p \leq 0{,}04$) and meadow ($p \leq 0{,}0037$).

The average abundance of graminoids was even between the unrooted treatments, but higher in the unrooted treatments, compared to the rooted treatments for grassland($p \leq 0{,}0014$) and meadow ($p \leq 0{,}0019$).

The average abundance of Annual forbs was even between the rooted treatments, but significantly higher in the rooted treatments, compared to the unrooted treatments for Grassland ($p \leq 0{,}0013$) and meadow($p \leq 0{,}000068$). For the grassland site, the large error bar for annual forbs in both the RF and RUF treatments, is due to one plot within the treatments with low abundance of annual forbs, but with high abundance of perennial forbs (Appendix 1).

Grassland and Meadow in Tofte Skov

Perennial forbs

For the grassland and the meadow site, when comparing pairwise no S.D. in abundance was found between the unrooted treatments or between the rooted treatments.

For the grassland site, abundance was significantly higher in the rooted treatments, compared to unrooted unfenced treatment.

Graminoids

When comparing pairwise, no S.D. in abundance was found between the unrooted treatments, but abundance of graminoids was significantly higher in the rooted fenced treatment, compared to the rooted unfenced treatments. Abundance was significantly higher in both unrooted treatments, compared to the rooted treatments.

Annual Forbs

When comparing pairwise, no S.D. in abundance between the unrooted treatments or between the rooted treatments. Abundance was significantly higher in rooted treatments, compared to unrooted treatments.

Showing that when abundance of graminoids species was reduced at this site, abundance of both perennial forbs and annual forbs increased significantly in abundance.

Meadow Tofte Skov and Høstemark Skov

The average abundance of perennial forbs was even among Tofte Skov treatments. But significantly higher in Tofte Skov treatments compared to Høstemark Skov treatments

The average abundance of graminoids was even among all treatments, except for the RUF treatment in Tofte Skov, which had distinctly lower abundances of graminoids.

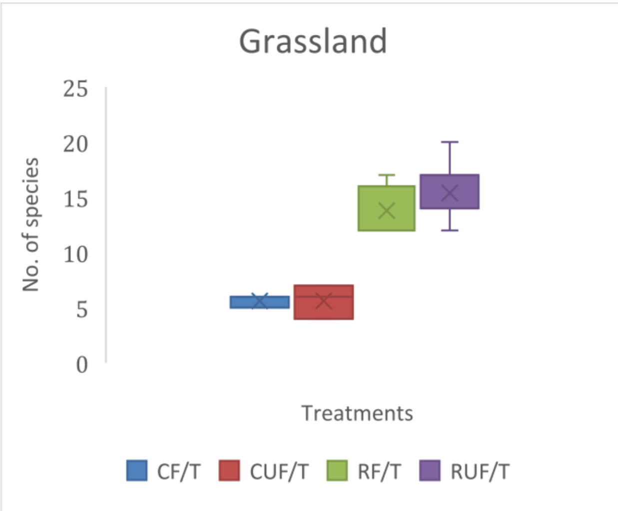
Abundance of Annual forbs was significantly higher in the rooted treatments in Tofte Skov and unfenced treatment in Høstemark Skov. Annual forb abundance was low in the unrooted treatments in Tofte Skov and almost absent the unrooted fenced treatment in Høstemark Skov.

Table 8 Mann-Whitney U test for differences in abundance, of Perennial forbs, graminoids and Annual forbs at the Grassland and meadow site in Tofte Skov (/T) and Høstemark Skov(/H). with no significant differences (Ns) and significant differences between treatments (S.D) and the P-value.

Grassland					
Perennial forbs	**CUF(/T)**	**RF (/T)**	**RUF (/T)**		
CF(/T)	Ns	Ns	Ns		
CUF(/T)	-----	S.D. (0,0045)	S.D. (0,014)		
RF(/T)	-----	-----	Ns		
Graminoids	**CUF(/T)**	**RF (/T)**	**RUF (/T)**		
CF(/T)	Ns	S.D. (0,0045)	S.D. (0,0045)		
CUF(/T)	-----	S.D. (0,0045)	S.D. (0,0045)		
RF(/T)	-----	-----	S.D. (0,014)		
Annual forbs	**CUF(/T)**	**RF (/T)**	**RUF (/T)**		
CF(/T)	Ns	S.D. (0,0045)	S.D. (0,0045)		
CUF(/T)	-----	S.D. (0,0045	S.D. (0,0045)		
RF(/T)	-----	-----	Ns		
Meadow 2019					
Perennial forbs	**CUF(/T)**	**RF (/T)**	**RUF (/T)**	**CF(/H)**	**CUF(/H)**
CF(/T)	Ns	Ns	Ns	S.D. (0,0079)	Ns
CUF(/T)	-----	Ns	Ns	S.D. (0,0017)	S.D. (0,0096)
RF(/T)	-----	-----	Ns	S.D. (0,0017)	S.D. (0,024)
RUF(/T)	-----	-----	-----	S.D. (0,0017)	S.D. (0,0096)
CF(/H)	-----	-----	-----	-----	S.D. (0,0045)
Graminoids	**CUF(/T)**	**RF (/T)**	**RUF (/T)**	**CF(/H)**	**CUF(/H)**
CF(/T)	Ns	S.D. (0,026)	S.D. (0,0059)	Ns	Ns
CUF(/T)	-----	Ns	S.D. (0,00039)	Ns	Ns
RF(/T)	-----	-----	S.D. (0,00039)	S.D. (0,05)	S.D. (0,034)
RUF(/T)	-----	-----	-----	S.D. (0,0022)	S.D.(0,000021)
CF(/H)	-----	-----	-----	-----	Ns
Annual forbs	**CUF(/T)**	**RF (/T)**	**RUF (/T)**	**CF(/H)**	**CUF(/H)**
CF(/T)	Ns	S.D. (0,0043)	S.D. (0,0012)	Ns	S.D. (0,0096)
CUF(/T)	-----	S.D. (0,0045)	S.D. (0,0023)	S.D. (0,034)	S.D. (0,0064)
RF(/T)	-----	-----	S.D. (0,014)	S.D. (0,0017)	Ns
RUF(/T)	-----	-----	-----	S.D. (0,0017)	S.D. (0,014)
CF(/H)	-----	-----	-----	-----	S.D. (0,0045)

Species richness

grassland and meadow



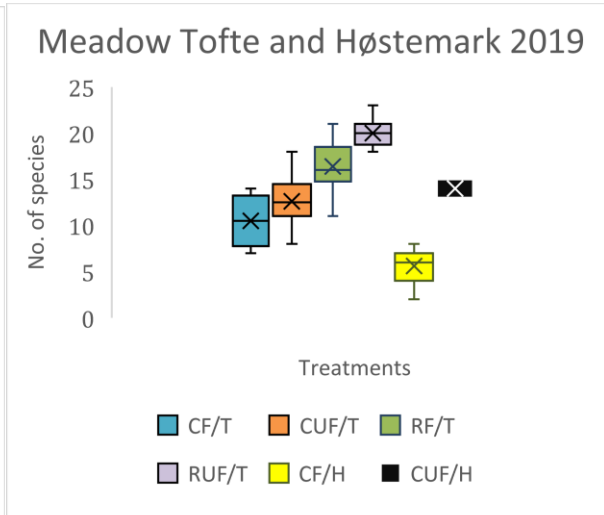


Figure 26 species richness for the Grassland site in Tofte Skov (/T), based on five plots from each treatment registered twice. with X as the median and outliers. Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF).

For both the grassland and meadow site, when comparing pairwise, no S.D. in species richness was found between the unrooted treatments or between the rooted treatments in either Tofte Skov or Høstemark Skov.

for both the Grassland and Meadow site, species richness was distinctly higher in rooted treatments, compared to unrooted treatments ($p \leq 0{,}0019$ and $p \leq 0{,}0000062$) Due to differences in number of perennial forb and annual forb species (Appendix 6 and 7).

Even though fences were put up in January 2018 at the meadow sites, species richness was still significantly higher in the rooted fenced treatment compared to all unrooted treatments.

Table 9 Mann-Whitney U test for differences in species richness, at the Grassland and meadow site in Tofte Skov (/T) and Høstemark Skov (/H) with no significant differences (Ns.) and significant differences between treatments (S.D.) and the P-value.

Kruskal Wallis test	0,0019		
Grassland			
Species richness	**CUF(/T)**	**RF (/T)**	**RUF (/T)**
CF(/T)	Ns	S.D. (0,0045)	S.D. (0,0045)
CUF(/T)	-----	S.D. (0,0045)	S.D. (0,0045)
RF(/T)	-----	-----	Ns
Meadow 2019			

Species richness	CUF(/T)	RF (/T)	RUF (/T)	CF(/H)	CUF(/H)
CF(/T)	Ns	S.D. (0,0019)	S.D. (0,00038)	S.D. (0,0052)	Ns
CUF(/T)	-----	S.D. (0,018)	S.D. (0,0006)	S.D. (0,0022)	S.D. (0,020)
RF(/T)	-----	-----	S.D. (0,014)	S.D. (0,017)	Ns (0,087)
RUF(/T)	-----	-----	-----	S.D. (0,0017)	S.D. (0,0017)
CF(/H)	-----	-----	-----	-----	S.D. (0,0045)

Meadow/Common alder

Abundance

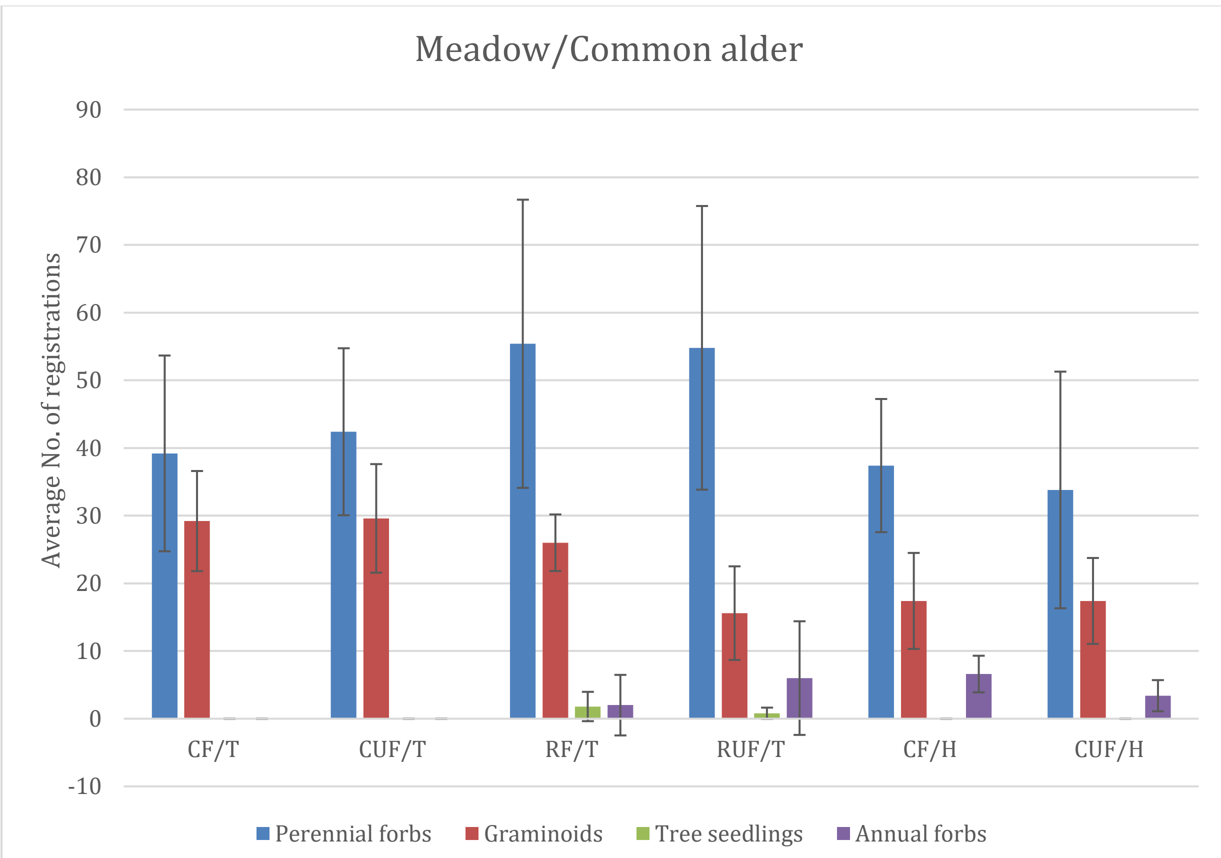


Figure 27 average abundance for Perennial forbs, Graminoids, Tree seedlings and Annual forbs, based on 5 plots from each treatment registered twice, at the Meadow/common alder site in Tofte Skov (/T) and Høstemark Skov (/H). Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF).

The average abundance of perennial forbs was relatively even among unrooted treatments in Tofte Skov and Høstemark Skov. But higher in Tofte Skov rooted treatments compared to unrooted treatments in both Tofte Skov and Høstemark Skov($p \geq 0,40$).

The average abundance of graminoids was relatively even among all treatments, except for the RUF(/T) treatment, which had distinctly lower abundances of graminoids ($p \leq 0,025$)
Abundance of Annual forbs was non existing in the unrooted treatments in Tofte Skov and only found in low abundances in rooted treatments and unrooted treatments, no test was calculated. Tree seedlings which was all Common alder, was only found in rooted treatments, but in low abundances.

Graminoids

When comparing pairwise, no S.D. in abundance of graminoids was found between the unrooted treatments in Tofte Skov or between unrooted treatments in Høstemark Skov. When comparing pairwise, abundance was significantly higher in the rooted fenced treatment compared the rooted unfenced treatment. Abundance of graminoids was significantly higher in the unrooted treatments in Tofte Skov compared to the unrooted treatments in Høstemark Skov

Table 10 Mann-Whitney U test for differences in abundance, of Graminoids between treatments, at the Meadow site in Tofte Skov (/T) and Høstemark Skov (/H), with no significant differences (Ns) and significant differences between treatments (S.D) and the P-value.

Graminoids	CUF(/T)	RF (/T)	RUF (/T)	CF(/H)	CUF(/H)
CF(/T)	Ns	Ns	S.D. (0,11)	S.D. (0,024)	S.D. (0,047)
CUF(/T)	-----	Ns	S.D. (0,014)	S.D. (0,024)	S.D. (0,038)
RF(/T)	-----	-----	S.D. (0,024)	S.D. (0,03)	Ns
RUF(/T)	-----	-----	-----	Ns	Ns
CF(/H)	-----	-----	-----	-----	Ns

Species richness

Meadow/common alder

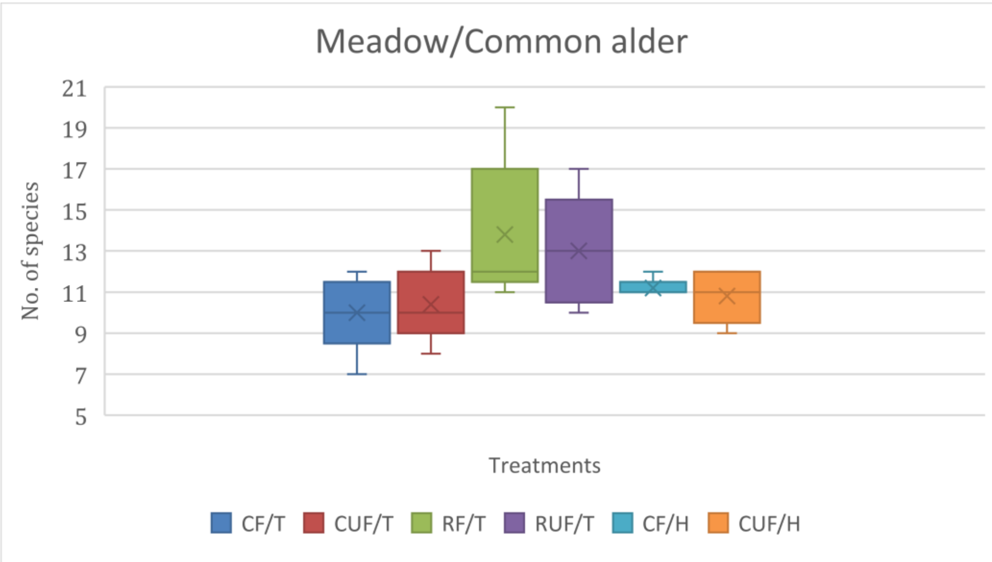


Figure 28 species richness for the Meadow/common alder site in Tofte Skov(/T) and Høstemark Skov (/H) based on 5 plots from each treatment registered twice in, with X as the median and outliers. unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF).

For the Meadow/common alder site, when comparing pairwise, no S.D. in Species richness was found, between unrooted treatment in Tofte Skov, between the unrooted treatments in Høstemark skov or between the rooted treatments in Tofte Skov.
Species richness was significantly higher in the rooted fenced treatment compared to all unrooted treatments in both Tofte Skov and Høstemark skov.
Species richness was significantly higher in the rooted unfence treatment, compared to both unrooted treatments in Tofte Skov and also higher in rooted unfenced treatment in Tofte Skov compared to both unrooted treatments in Høstemark skov, although not significantly.

Species richness	CUF(/T)	RF (/T)	RUF (/T)	CF(/H)	CUF(/H)
CF(/T)	Ns	S.D. (0,018)	S.D. (0,047)	Ns	Ns
CUF(/T)	-----	S.D. (0,03)	Ns	Ns	Ns
RF(/T)	-----	-----	Ns	S.D. (0,038)	S.D. (0,047)
RUF(/T)	-----	-----	-----	Ns	Ns
CF(/H)	-----	-----	-----	-----	Ns

Meadow 2018 and 2019

Abundance

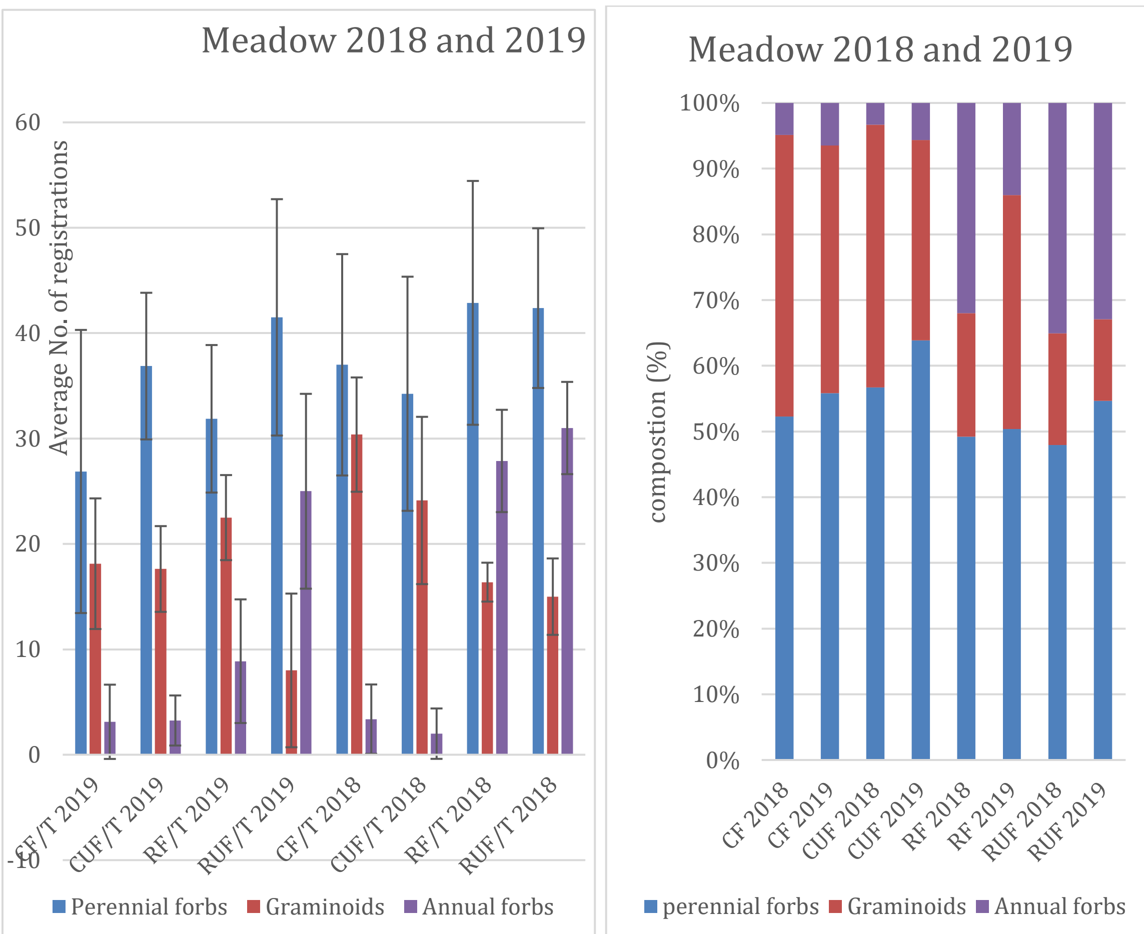


Figure 29 average abundance for Perennial forbs, Graminoids and Annual forbs and composition (%), based on 8 plots registered twice, at the Meadow site in Tofte Skov (/T) 2018 and 2019. Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF).

To correct for differences in data, as data in this study, was collected twice in 2019 and only once in 2018 by Laursen and I (2018), thus, data collected in June is not included. Data from July 2018 was compared to data collected August 2019.

In terms of the composition of species types, the main differences were shown, for the rooted fenced treatment, where Annual forbs decreased by 17,96% and graminoids increased almost the same 16,78% out of the total species type composition. For the unrooted unfenced treatment graminoids decreased by 9,43%, while perennial forbs increased by 7,12% and annual forbs increased by 2,31%.

The average abundance of perennial forbs was relatively even among all treatments from 2018 and 2019 in Tofte Skov. But lowest in the CF 2019 treatment($p \leq 0,072$).

The average abundance of graminoids was Highest in the CF and CUF treatment 2018. The rooted treatments 2018 had even abundances compared to unrooted treatments 2019. the RUF treatment 2019, had distinctively lower abundances of graminoids ($p \leq 0,0000046$).

The average abundance of Annual forbs was higher in both rooted treatments 2018 and rooted unfenced treatment 2019 and unfenced treatment in Høstemark Skov, compared to all unrooted treatments in both 2018 and 2019 and the RF treatment 2019. Although the RF 2019 treatment still had higher abundances of annual forbs compared to unrooted treatments in both 2018 and 2019 ($p \leq 0,00000011$).

Perennial forbs

When comparing pairwise no S.D in abundance was found between the unrooted treatments 2018 and 2019 or between the rooted unfenced treatments 2018 and 2019 Abundance of perennial forbs, was significantly higher in rooted fenced treatment 2018 compared to the rooted fenced treatment 2019. Showing that abundance of perennial forbs declined from 2018 to 2019 in the rooted fenced treatment.

Graminoids

When comparing pairwise no S.D in abundance was found between the unrooted unfenced treatment 2018 and 2019, but abundance of graminoids was significantly higher in the rooted unfenced treatment 2018 compared to rooted unfenced 2019 and the unrooted unfenced treatment 2018 compared to the 2019 treatment.

Abundance of graminoids was significantly higher in the Rooted fenced treatment 2019 compared to the rooted fenced treatment 2018, showing that abundance of graminoids increased in the rooted fenced treatment from 2018 to 2019.

Annual forbs

When comparing pairwise, no S.D. in abundances of annual forbs was found between unrooted treatments 2018 and 2019 or between the rooted unfenced treatments 2018 and 2019. Showing no changes in abundance for unrooted treatments between 2018 and 2019.

Abundance of annual forbs, was significantly higher in both rooted treatments 2018, compared to the rooted fence treatment 2019, showing significant changes in abundance of annual forbs from year to year, declining in the rooted fence treatment from 2018 to 2019.

Table 11 Mann-Whitney U test and Kruskal Wallis test for differences in abundance, of Perennial forbs, graminoids and annual forbs, at the Meadow site in Tofte Skov 2018 and Tofte Skov 2019, with no significant differences (ns) and significant differences between treatments (S.D) and the P-value.

Kruskal Wallis	(p≤0,072)			
Perennial forbs	**CF 2019**	**CUF 2019**	**RF 2019**	**RUF 2019**
CF 2018	Ns	Ns	Ns	Ns
CUF 2018	Ns	Ns	Ns	Ns
RF 2018	S.D. (0,029)	Ns	S.D. (0,020)	Ns
RUF 2018	S.D. (0,0050)	S.D. (0,042)	S.D (0,012)	Ns
Kruskal Wallis	(p≤0,0000046)			
Graminoids	**CF 2019**	**CUF 2019**	**RF 2019**	**RUF 2019**
CF 2018	S.D. (0,00068)	S.D. (0,00068)	S.D. (0,0050)	S.D. (0,00039)
CUF 2018	Ns	Ns	Ns	Ns
RF 2018	Ns	Ns	S.D. (0,0012)	S.D. (0,0091)
RUF 2018	S.D. (0,00039)	S.D. (0,00068)	S.D. (0,00068)	S.D. (0,037)
Kruskal Wallis	(p≤0,00000011)			
Annual forbs	**CF 2019**	**CUF 2019**	**RF 2019**	**RUF 2019**
CF 2018	Ns	Ns	S.D. (0,014)	S.D. (0,00097)
CUF 2018	Ns	Ns	S.D. (0,0023)	S.D. (0,00068)
RF 2018	S.D. (0,00039)	S.D. (0,00039)	S.D. (0,00057)	Ns
RUF 2018	S.D. (0,00039)	S.D. (0,00039)	S.D. (0,00039)	Ns

Species richness

Meadow Tofte Skov 2018 and 2019

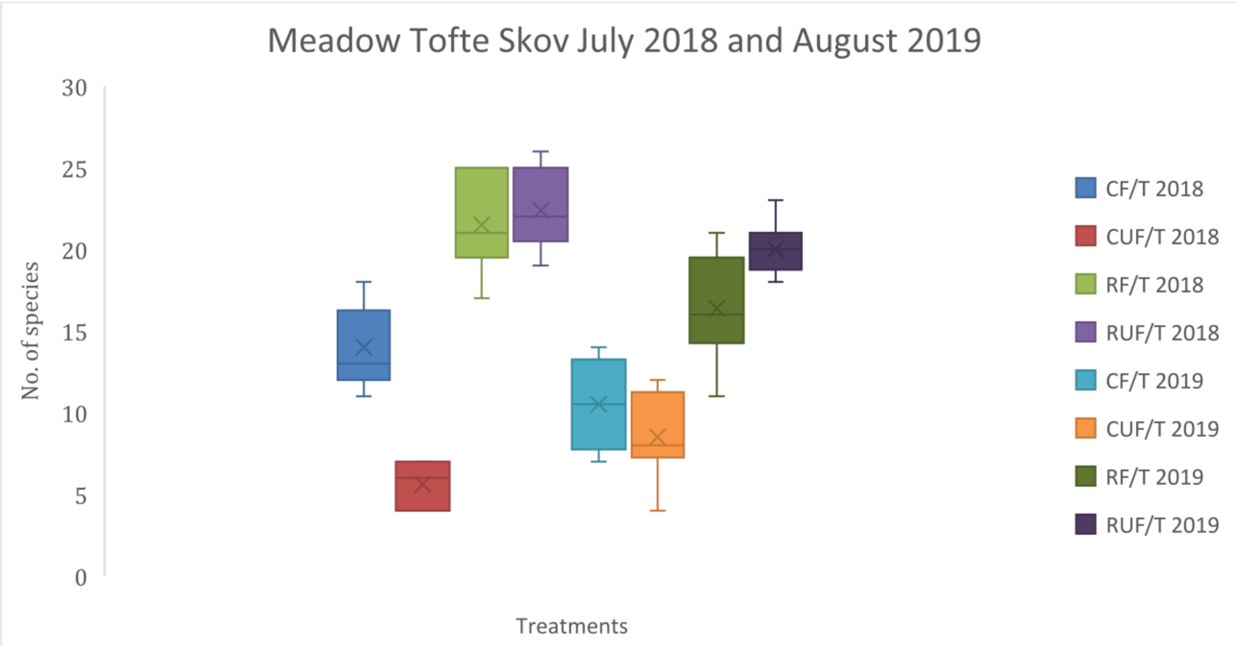


Figure 30 species richness for the Meadow site 2018 and 2019, based on 8 plots from each treatment in Tofte Skov (/T), with X as the median and outliers. Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF)

when comparing treatments pairwise no S.D. in species richness was found between the unrooted unfenced treatments,

when comparing the unrooted fenced, rooted fenced and rooted unfenced treatments 2018 and 2019 species richness was higher in 2018, the difference is mainly due to differences in registration of graminoids species (appendix 8).

Table 12 shows Mann-Whitney U test for differences in species richness, between treatments at the meadow site 2018 and 2019 in Tofte Skov with no significant differences (Ns) and significant differences between treatments (S.D.) and the P-value.

Species Richness	CF June 2019	CUF June 2019	RF June 2019	RUF June 2019
CF July 2018	S.D. (0,026)	-----	-----	-----
CUF July 2018	-----	Ns	-----	-----
RF July 2018	-----	-----	S.D. (0,0059)	-----
RUF July 2018	-----	-----	-----	S.D. (0,042)

Species richness heath, open woodland, swamp forest, scots pines

Figure 31 species richness for the heath and swamp forest site in Tofte Skov (/T),the Open woodland and scots pine site in Tofte Skov(/T) and Høstemark Skov (/H) based on 5 plots from each treatment registered twice in, with X as the median and outliers. unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF).

For the Heath, Swamp forest, Open woodland and the Scots pine site, species richness was relatively even across all treatments, species richness was low and no S.D was found species richness Heath ($p \geq 0{,}27$), Swamp forest ($p \geq 0{,}12$), open woodland ($p \geq 0{,}088$), Scots pine ($p \geq 0{,}42$) and Meadow/Common alder ($p \geq 0{,}099$). For the heath species richness was higher in rooted treatments but not significantly, due to differences in registrations of perennial forbs and dwarf-shrub species (Appendix 2). For the swamp forest the lower species richness I due to less registrations of graminoid and Perennial forb species (appendix 4).

For the open woodland site, Species richness was higher in the rooted unfenced treatment in Tofte Skov, compared to all unrooted treatments in both Tofte Skov and Høstemark Skov. The difference in species richness in due to tree seedling species, graminoids species (Appendix 3). For the scots pine sites, species richness was lower in the CF Høstemark Skov treatment is due to differences in registrations of perennial forbs and pteridophytes species (appendix 5).

General tendencies

Species richness

Tofte Skov

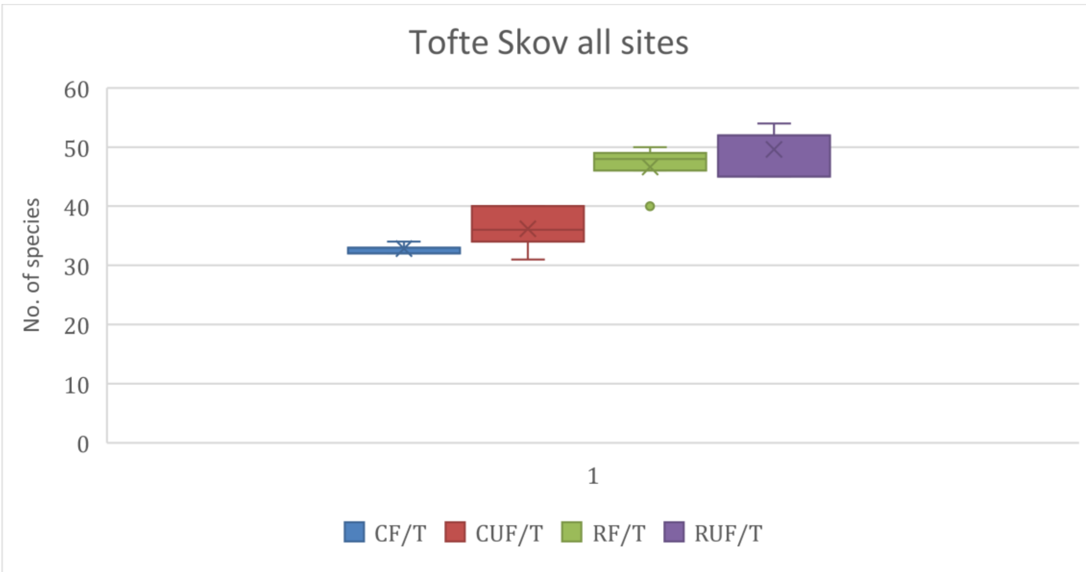


Figure 32 species richness from the 7 sites in Tofte Skov(/T) combined. Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF). Treatments: *Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF).*

When comparing pairwise no S.D. was found between the unrooted treatments or between the rooted treatments.

Species richness was significantly higher in both rooted treatments compared to the unrooted treatments.

Kruskal Wallis test	0,010		
All sites			
Species richness	**CUF(/T)**	**RF (/T)**	**RUF (/T)**
CF(/T)	Ns	S.D. (0,0045)	S.D. (0,0045)
CUF(/T)	-----	S.D. (0,0082)	S.D. (0,0045)
RF(/T)	-----	-----	Ns

Tofte Skov and Høstemark Skov

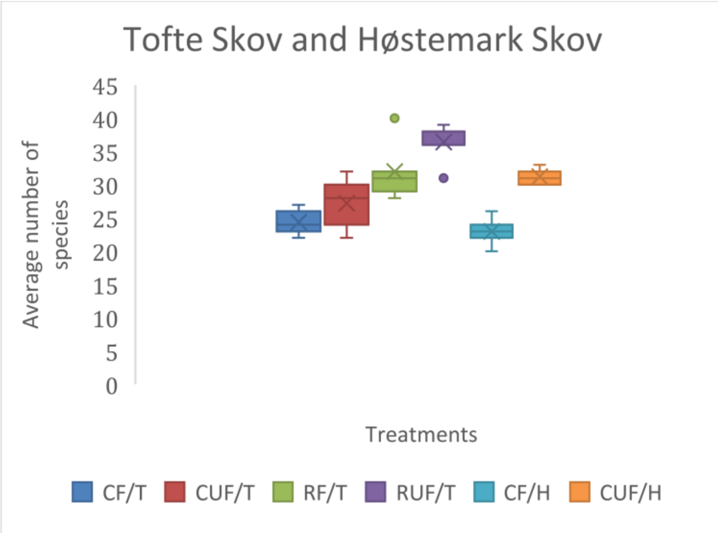


Figure 33 shows species richness from 4 sites in Tofte Skov(/T) and 4 sites in Høstemark Skov(/H) combined. Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF). Treatments: *Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF).*

No S.D in species richness was found between the unrooted fenced treatment in Høstemark Skov, compared to both unrooted treatments in Tofte Skov or between the unrooted unfenced treatment in Høstemark Skov compared to both rooted treatment in Tofte Skov.

Species richness was significantly higher in the unrooted unfenced treatment in Høstemark Skov, compared to the but unrooted treatments in Tofte Skov. Species richness was significantly higher in both rooted treatments, compared to the unrooted fenced treatment in Høstemark skov.

Species richness was higher in the rooted treatments, compared to unrooted unfenced treatment in Høstemark Skov, although not significantly. Species richness was significantly higher in the rooted treatments, compared to unrooted fenced treatment in Høstemark Skov. ($p \leq 0,0011$)

Table 13 Mann-Whitney U test for species richness, for the 4 sites in Tofte Skov and Høstemark Skov combined, with no significant differences (Ns.) and significant differences between treatments (S.D.) and the P-value.

Tofte Skov and Høstemark Skov		
Species richness	**CF(/H)**	**CUF(/H)**
CF(/T)	Ns	S.D (0,0045)
CUF(/T)	Ns	S.D (0,047)
RF(/T)	S.D (0,024)	Ns
RUF(/T)	S.D. (0,014)	S.D (0,018

Abundance

Tofte Skov and Høstemark Skov all sites

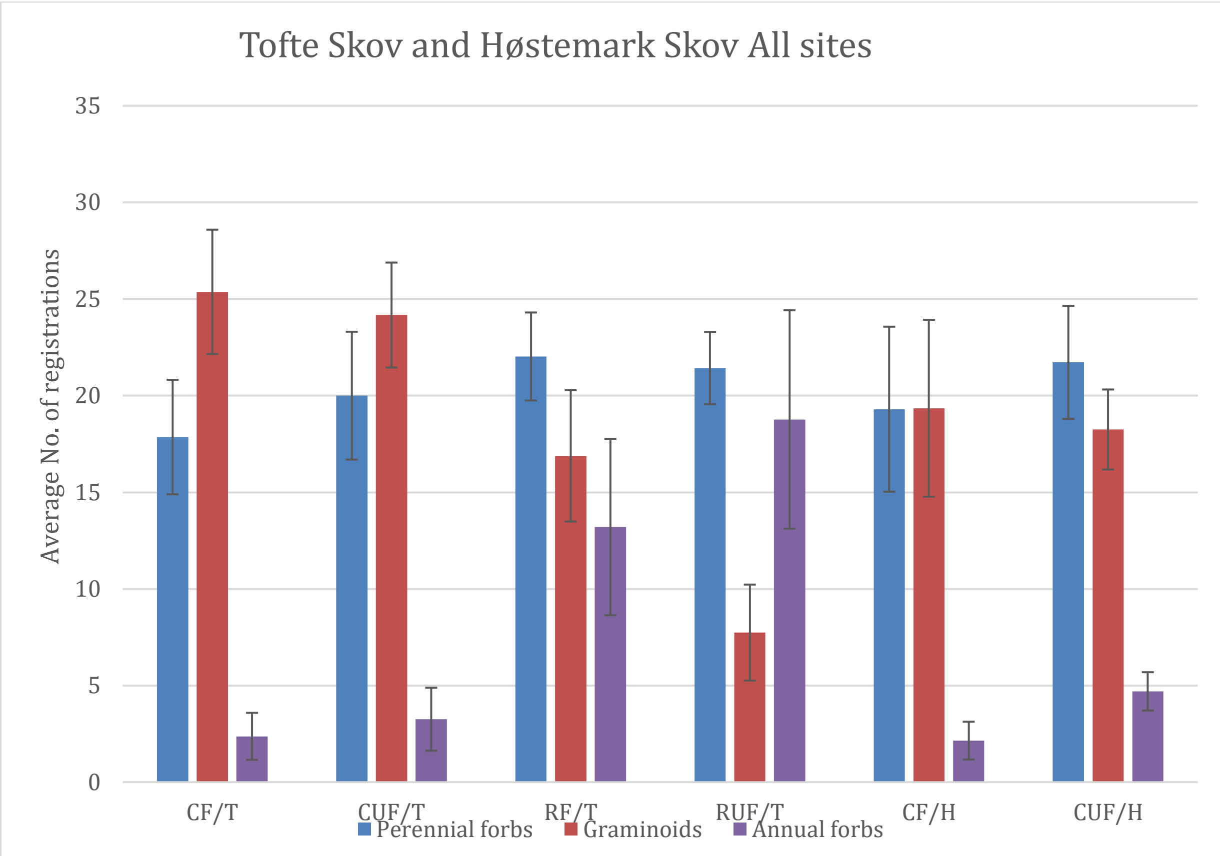


Figure 34 Average abundance for perennial forbs, graminoids and annual forbs, registered twice, from 7 sites combined in Tofte Skov (/T) and 4 in Høstemark skov(/H) data corrected for differences in number of sites. Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF).

When combing data within each type of treatment, for sites in Tofte Skov and within treatments for sites in Høstemark, correcting data for differences in sites. Abundance of perennial forbs was generally even among all treatments, but lower in the unrooted fenced treatments, although not significantly ($p \geq 0,35$). For graminoids, abundances were significantly lower in the rooted treatments ($p \leq 0,00049$). Abundances of annual forbs was significantly lower in all unrooted treatments compared to the rooted treatments ($p \leq 0,00028$).

Graminoids

When comparing pairwise, No S.D in abundance was found between the unrooted treatments in Tofte Skov and Høstemark Skov or between the rooted treatments. Abundance was significantly higher in the unrooted treatments compared to the rooted treatments in Tofte Skov. Abundance was significantly lower in the rooted unfenced treatment, compared to all other treatments in both Tofte Skov and Høstemark Skov.

Annual forbs

When comparing pairwise no S.D. was found between the unrooted treatments in Tofte Skov. Abundance of annual forbs, was significantly higher in the rooted treatments, compared to all unrooted treatments, in both Tofte Skov and Høstemark Skov.

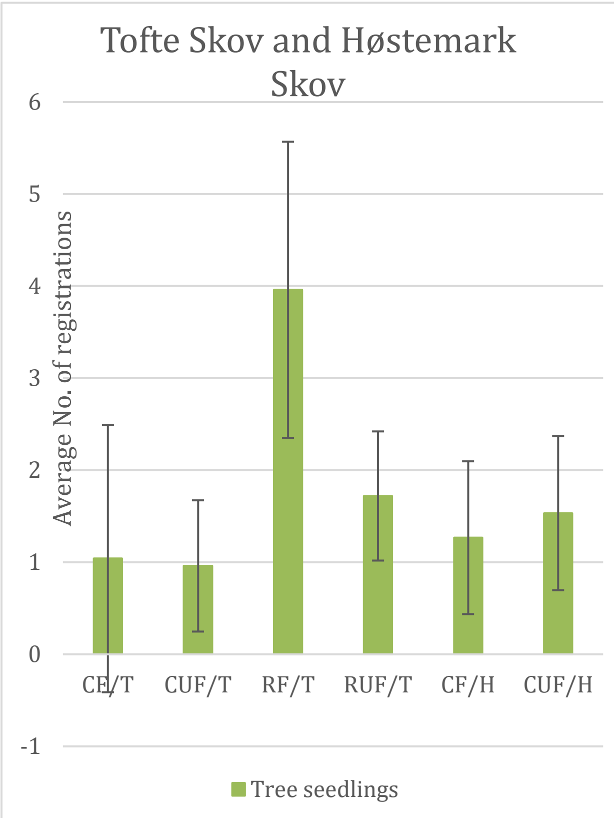
Abundance of annual forbs was significantly higher in the unrooted unfenced treatment in Høstemark, compared to both unrooted fenced treatments in Tofte Skov and Høstemark Skov

Table 14 Mann-Whitney U for test differences in abundance of graminoids and annual forbs between treatments, at the all sites site in Tofte Skov (/T) and Høstemark Skov(/H). with no significant differences (ns) and significant differences between treatments (S.D) and the P-value.

Graminoids	**CUF(/T)**	**RF (/T)**	**RUF (/T)**	**CF(/H)**	**CUF(/H)**
CF(/T)	Ns	S.D. (0,0081)	S.D. (0,0045)	Ns	S.D (0,0045)
CUF(/T)	-----	S.D. (0,0081)	S.D. (0,0045)	Ns	S.D. (0,0045)
RF(/T)	-----	-----	S.D. (0,0045)	S.D. (0,014)	S.D. (0,008)
RUF(/T)	-----	-----	-----	S.D. (0,0045)	S.D. (0,0045)
CF(/H)	-----	-----	-----	-----	Ns
Annual forbs	**CUF(/T)**	**RF (/T)**	**RUF (/T)**	**CF(/H)**	**CUF(/H)**
CF(/T)	Ns	S.D. (0,0043)	S.D. (0,0045)	Ns	S.D. (0,008)
CUF(/T)	-----	S.D. (0,0045)	S.D. (0,0023)	Ns	Ns
RF(/T)	-----	-----	S.D. (0,038)	S.D. (0,0045)	S.D. (0,0045)
RUF(/T)	-----	-----	-----	S.D. (0,0045)	S.D. (0,0045)
CF(/H)	-----	-----	-----	-----	S.D. (0,0045)

Tree seedlings

Tofte Skov and Høstemark Skov



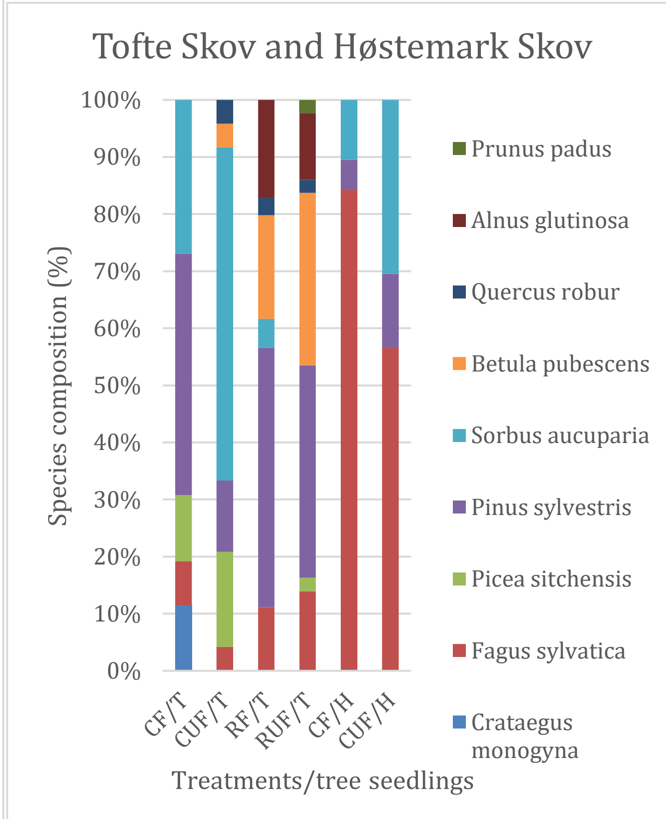


Figure 35 Average abundance and species composition (%) of tree seedlings. Based on 25 plots, registered twice from each treatment. from five sites combined: Open woodland, Heath, Swamp forest, Scots pine and Meadow/common alder in Tofte Skov (/T) and three sites in Høstemark Skov (/H). 15 plots from each treatment registered twice: Open woodland, Scots pine and Meadow/common alder. Data was corrected for differences in number of sites. Treatments: Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF).

Tree species composition varied among unrooted and rooted treatments, rowans stood for a high percentage of tree seedlings in unrooted treatment and was not registered at all in the rooted unfenced treatment. Down birch and alder wer almost exclusively found in rooted treatments, while scots pines had the highest percentage in unrooted fenced treatment, rooted fenced and rooted unfenced in Tofte Skov. Within the Tofte Skov treatments common beech was also represented in higher percentages in the rooted treatments.

the large percentage of common beeches, in Høstemark, is due to, tree seedlings were almost exclusively found at the open woodland site with overstory of common beech.

For most sites abundance of tree seedlings was low, but when combining data for the from the five sites in Tofte Skov and tree sites in Høstemark, gave a clearer image. Abundance of tree seedlings was generally higher in rooted treatments, compared to unrooted treatments($p \leq 0,00061$).

When comparing pairwise, no S.D in abundance was found between the unrooted treatments in Tofte Skov or between unrooted treatments in Høstemark Skov.

Abundance of tree seedlings was significantly higher in the rooted fenced treatment, compared to all treatments in both Tofte Skov and Høstemark Skov.

Table 15 Mann-Whitney U test amd Kruskal Wallis test for abundance of tree seedlings from five sites combined: Open woodland, Heath, Swamp forest, Scots pine and Meadow/common alder in Tofte Skov (/T) and Høstemark Skov(/H) for Tree seedlings. Unrooted fenced (CF), unrooted unfenced (CUF), rooted fenced (RF) and rooted unfenced (RUF). With no significant differences (Ns) and significant differences between treatments (S.D)

Kruskal wallis	($p \leq 0,011$).				
Tree seedlings	**CUF(/T)**	**RF(/T)**	**RUF(/T)**	**CF(/H)**	**CUF(/H)**
CF(/T)	Ns	S.D. (0,014)	Ns	Ns	Ns
CUF(/T)	-----	S.D. (0,0045)	S.D. (0,047)	Ns	Ns
RF(/T)	-----	-----	S.D. (0,0061)	S.D. (0,0045)	S.D. (0,0045)
RUF(/T)	-----	-----	-----	Ns	Ns
CF(/H)	-----	-----	-----	-----	Ns

Discussion

The main object of this thesis, was to assess and extend knowledge on the influence of wild boars on abundance and species richness of plants, by comparing sites in Tofte Skov to sites in Høstemark and to compare treatments within sites. Some clear tendencies were found at the bracken sites, forest sites and grassland sites, which is discussed below. For this study the short-term scale limits the results, and it would be valuable to gather data for several years of studying the same sites, to see the long-term response to rooting activities, although for fenced treatments, the plants did have 2 growth seasons to respond to rooting.

The two nature reserves Tofte Skov and Høstemark Skov, was chosen based on their high nature value, protected state and relatively low human disturbance. The two sites were situated, in relatively close proximity to each other (Fig. 1). The close proximity strengthens the validation of the results, when comparing these two areas, one with wild boars Tofte Skov and one without Høstemark Skov. The fact that the two areas are quite comparable, forms the foundation of this study, into how the reintroduction of Wild Boars' affect different Danish habitats, of which they were once a native species.

The focus of this study, was to assess the effect of Wild Boars directly on plant species richness and the composition of the following plant species types: Perennial forbs, Graminoid species, Annual forbs, Tree Seedlings, Half-Shrubs and the invasive Brackens.

Data was collected, from seven sites in Tofte Skov and 4 comparable sites in Høstemark Skov. It would have been ideal, to have found an equal number of study sites shared between Tofte Skov and Høstemark Skov, this was not possible. After searching Høstemark Skov, 5 similar sites were found. One sites in Høstemark Skov, got destroyed by forest machines (Swamp forest). When discovered, it was too late to put up new fences. When comparing data from Tofte Skov, to data Høstemark Skov, data was corrected for the differing number of sites.

Both the size of fences and dividing them into 9 cells, worked well and made registrations easier. Especially when registering perennial forbs, graminoids and annual forbs, as these present, was highly abundant. In General fences worked well, at keeping the wild boars out, and it was considered prior to the field work phase of this study. That having larger fences could have caused problems, with the wild boars destroying them. With the fences used, which were of a smaller size, this potential destruction would pose less of an issue to correct, so this seemed like less of a problem. Some poles worked better than other (Fig. 36). The more heavy-duty pole with a horizontal piece of metal, kept the fence in place and did not bend from wild boar activities, as the poles (Fig. 36 middle) did.

With a more generous time allowance for this study, it would have been possible to expand and study even more plots pr. treatment, which ideally could have proven, to give a stronger data set and likewise statistical analysis. However, the amount of data in this study, proved to be far sufficient to show some clear and interesting tendencies.

By the end of the study, the amount of materials used for the study ended up being 404 metal poles and 242,2 meters of fence and when all gathered for transportation, it filled a whole van (Fig. 36).

Figure 36 shows some of different poles used for the fences (right), some poles got bended from contact with wild boars (middle) and the van filled with 404 poles and 242,2 m fence material, after fences was pulled down.

Bracken sites

Open woodland Tofte Skov and Høstemark Skov

As shown in figure 20 and figure 21, the abundance of brackens was lower in Høstemark Skov in unrooted treatments and were almost at the same abundance levels as the rooted treatments in Tofte Skov. This could indicate that, the unrooted undisturbed soil conditions in Høstemark Skov, facilitates natural degeneration of Brackens (Marrs et al. 2006).

This is supported by tree seedlings, which was found in higher abundances in Høstemark Skov, compared to all Tofte Skov treatments (Fig. 21),

Furthermore, this is supported by the absence of graminoid species and the low species richness in Høstemark Skov, as the thick bracken litter layer prevents species from establishing, at the site (Appendix 10).

Heath and open woodland

The extensive rooting found at bracken sites (Fig. 7 and 8), corresponds with studies on the stomach contents of wild boar, showing that wild boars forage on bracken roots as an important component in their diet (Marrs, “2006”). Rooting activities at the heath sites, appeared to be located exclusively in the brackens and for the open woodland in the bracken and around the oaks and beeches for mast (Massei & Genov, “2004”; Schley & Roper, “2003”.).

When rooting in the bracken, for brackens roots, abundance of brackens and bracken stems got significantly reduced (Fig. 21, 22 and table 5), this left bracken roots exposed to the elements, which also aids in the reduction of bracken abundance(Fig. 7 and 8).

Rooting also appeared around the beeches and oaks at the open woodland site rooting for mast. This created patch of exposed soil, where significantly higher abundances tree seedlings germinated (Fig. 22 and 5). That tree seedlings germinated after a rooting event, applied for five sites in Tofte Skov: Heath, open woodland, swamp forest, scots pine and Meadow/ common alder. Soil disturbance (such as rooting by wild boar), resets the successional clock (Loehle et al., “2000”), creating patches in which tree seedlings could sprout (Loehle et al., ”2000”, Henney, “2012”).

Removal of brackens and disturbance, total removal or rotovating of the bracken litter layer, at heathland by human hand, has shown that heather can re-establish, at habitats previously lost to bracken (Lowday & Marrs, “1992”). At the heath site, in rooted bracken patches, heather seedlings were found germinating, exclusively and in significantly higher abundances, in rooted treatments (Appendix 2). Indicating that wild boars rooting, performs a similar kind of disturbance as shown by Lowday and Marrs (1992), by removing brackens and rotovating the bracken litter layer, even reducing thickness of the litter layer (Appendix 10).
Showing that wild boars have the potential, to assist in (re)-widening heathland, when reducing brackens. Although it could be argued, that going from monoculture of bracken, to monoculture of heather, would not matter species wise. there are however many fewer species, associated with brackens compared to heathland; 33 species of bird regularly nest in heather, while 15 species are associated brackens. Reptiles would suffer from loss of their basking spots and ticks are largely associated with brackens (Pakeman et al., “1992”). At either site bracken abundance had recovered in rooted treatments, after two growth seasons, and abundance was still significantly lower at both the open woodland and Heath site (Fig 22).
My findings suggest, that brackens are affected significantly and are reduced in abundance by rooting, which has previously been shown by (Henney “2012”; Wise et al., “2012”) and that wild boars are extremely effective at removing brackens (Wise et al., “2012”).
This study also show, that wild boars might assist in spreading brackens in the long term, as abundance of bracken brackens was higher in unrooted treatments in Tofte Skov compared to Høstemark Skov (Fig. 20 and 21), as rooting disturbs the build-up of the bracken litter layer, that would normally build-up under conditions with no disturbance, inhibiting brackens from undergoing natural degeneration (Marrs et al., “2006”), this however could not be corroborated.
The general low even species richness between treatments, at the heath site, is most likely connected to low soil pH (Appendix 13), which is also indicated by the presence of wavy hair grass, which prefer acid soil conditions. But this is also linked, to the thick bracken litter layer preventing new species from establishing (Appendix 10).

Forest sites

Swamp forest

The study shows a significantly higher abundance of graminoids, perennial forbs and higher species richness in unrooted treatments, compared to the rooted treatments, especially compared the rooted unfenced treatment, annual forbs were evenly abundant among all treatments, indicating that, they are adapted to frequent disturbances (Fig. 27 and 28). This indicates that wild boars utilize this site frequently, in search for food sources and subsequently reduce the understory, by rooting and re-rooting the site, or using the wet site for wallowing (Fig. 9). Tree seedlings were mainly found, in the rooted fenced treatment, either indicating that they need time, after a rooting event to establish, or that rooted unfenced treatment were so intensively rooted, that tree seedlings were not able to establish here. Tree seedlings were almost not present in unrooted treatments, indicating that they might need a rooting event to reduce graminoid abundance, as seen at the scots pine site, where rooting created patches of exposed soil, for tree seedlings to establish.

Scots pines

The general low and even species richness, at the scots pine site, in both Tofte Skov and Høstemark Skov, is most likely connected to low soil pH and the thick litter layer (Appendix 10 and 13), which is also indicated by the presence of wavy hair grass, which prefer acid soil conditions and the dense pine overstory reducing light, as no new species was found in the rooted treatments.

The species found in unrooted treatments, seemed to slowly return to the rooted patches with underground rhizomes for species like sand sedge and by seed dispersal for wavy-hair grass.

The significantly higher abundance of perennial forbs and graminoids in the unrooted treatments, indicates that graminoids species such as wavy hairy-grass, sand sedge and perennial forbs such as heath bedstraw and chickweed evergreen (*Trientalis europaea*), does not tolerate soil disturbances, or at least that it takes more than 2 growth season for them, to re-establish in same abundances in rooted patches.

When abundance of graminoids got reduced, from rooting by wild boars, the abundance of tree seedlings increased significantly. Which indicates that the rooted patches at the scots pine site, functions as seed beds for tree seedlings.

The scots pines seedlings, could fall directly into the rooted patches underneath, contributing with the highest percentage of tree seedlings in both rooted treatments and the unrooted fenced treatment (Fig. 24). Tree seedlings abundance was higher in the rooted fenced treatment, compared to the rooted unfenced treatment (Fig. 24). This could either be indicating that they need time after a rooting event to establish, which seems most likely as seedlings was less than 5 cm high (Fig. 10), or that there was high browsing pressure in the rooted unfenced treatments, from red deer found in large rudels, which seemed to prefer this part of Tofte Skov. This did however seem unlikely, as the tree seedlings observed were less than 5 cm high. The high abundance of graminoids and the low abundance of tree seedlings (only 4 seedlings found in total all scots pines) in Høstemark Skov, also supports that graminoids prevents or at least inhibits germinating of tree seedlings. The relatively even abundance of tree seedlings between the unrooted treatments and the rooted unfenced treatment in Tofte Skov, might be due to past rooting events, as tree seedlings seemed larger and older, compared to those found in the rooted treatments.

The recovery time after a rooting event, seems to be long underneath the pines, as not many plants had appeared or reappeared in the rooted treatments, probably due to slow growth and low soil pH (Fig. 11 and appendix 13).

Grassland sites

Grassland and meadow 2019

Annual forbs and some perennial forbs tend to be ruderal in strategy, these often tolerate disturbance better than other functional groups and are linked to early stages of succession. Additionally, ruderal traits are often associated with large seed banks and their germination success can be higher, or even dependent on disturbance such as rooting (Grime, 1977), but end up being outcompeted in the later successional stages. This explains why they were mainly present, in the rooted treatments. The effects in rooted treatments, are therefore likely to be a colonization of ruderal plants, shown at both the Grassland sited and meadow site (Fig. 25). With the significant reduction in abundance graminoids, came a significant increase in abundances of annual forbs in the rooted treatments, but also perennial forbs, especially at the Grassland site, this led to a significant increase in species richness in the rooted treatments (Fig. 26)

Meadow Tofte Skov and Høstemark Skov

Species richness was higher in the rooted treatments, but the unfenced treatment in Høstemark Skov had high species richness and no significant differences was found compared to the rooted fenced treatment, this could be due to, a dry summer 2018 (Dansk Meteorologisk Institut 2020), with low precipitation, combined with grazing , reducing the densities graminoids at the Høstemark Skov site, although not reducing abundance of graminoids, which was even between all unrooted treatments (Fig. 25).

This is supported by the relative high abundance annual forbs in unrooted unfenced treatment in Høstemark Skov (Fig. 25) also supported by a decline in abundance of graminoids in unrooted unfenced treatment in Tofte Skov and changes in composition of graminoids from 2018 to 2019 (Fig. 29).

Although it could also be due, to a general difference in species, between the site in Toft Skov and the Site in Høstemark Skov. This is supported by findings of common daisy (*Bellis perennis*), doves-foot geranium, mouse-ear hawkweed and heath bedstraw which was found in high abundances in Høstemark, Skov, almost none in Tofte Skov (Appendix 1), but almost all species in Høstemark Skov, was found in Tofte Skov. It could also be argued, that since rooted fenced treatment, in Tofte Skov had been fenced off since January 2018, that is why we see no significant difference in species richness between the rooted fenced treatment in Tofte Skov and the unrooted unfenced treatment in Høstemark Skov. This is supported by a decline in annual forbs from 2018 to 2019 (Fig. 29), this seems to be the most likely explanation. The low species richness, in the fenced treatment in Høstemark Skov, could be due to the tall grass inside the fence, outcompeting perennial forbs and especially annual forbs (Fig. 18). This was also seen in the rooted fenced treatment, from the meadow in Tofte Skov from 2018 to 2019 (Fig. 13 and 27).

Meadow 2018 and 2019

Studies show that some plant communities, are more resilient to wild boar disturbance and that areas with vegetation is adapted to frequent disturbances, where the original plant cover recovers within 6 months. A study on an American prairie rooted by wild boars, returned to original species richness and undisturbed control levels within a year (Baron, “1982”; Kotanen, “1995”.).
The meadow site showed clear successional changes, in the fenced treatments from 2018 to 2019 (Fig. 12 and 13). In January 2018, when the rooted fenced treatments were set up, the fence inside was almost exclusively patches of exposed soil, and then in June 2019, the grass inside the rooted treatment were observed to be 20 cm high and dense, this implicated significant losses in abundance of perennial forb and annual forbs from 2018 to 2019 (Fig. 29).
The lower abundance of mainly annual forbs, changed species composition, graminoids increased 16,77% while annual forbs declined 17,96% while perennial forbs contributed the same (Fig. 29) the decline was probably due to interspecific competition between annual forbs and graminoids, as abundance of graminoids increased significant, this indicates that the rooted fenced treatment is returning to more undisturbed conditions (Fig. 13).
Furthermore, the rooted fenced treatment, also lost significant species richness from 2018 to 2019 (Fig. 30). These results show that wild boars´, significantly alters species composition, increasing species richness and abundances of perennial forbs and annual forbs.
The grass was even higher, now at 30-40 cm and denser, in the unrooted fenced treatment where the grass in January 2018 was observed to be less than 5 cm high (Fig. 12). This meant for the unrooted fenced treatment, a decrease in graminoid species from 2018 to 2019, resulting in significantly lower abundances of graminoids and lower species richness, although not significantly. For perennial forbs, only one species was lost from 2018 to 2019. In the unrooted

fenced treatment yarrow (*Achillea millefolium*) (Appendix 8), which is a species adapted to high levels of disturbance (Johnston et al. 2001). Even though only one perennial forbs species was lost, significant lower abundance of perennial forbs was found in 2019.

Composition between Perennial forbs, graminoids and annual forbs, did not change from 2018 to 2019, This indicates that the lower abundance of graminoids and perennial forbs, could be due to interspecific competition and intraspecific competition, between these.

For the unrooted unfenced treatment, no significant changes was found, from 2018 to 2019 in either species richness, abundance or composition wise between the species types although species richness was higher in 2019, this might be due to the dry summer in 2018 (Dansk Meteorologisk Institut 2020), combined with grazing pressure, reduced the density of graminoids, reducing competition, thus increasing species richness .

For the rooted unfenced treatment, no significant differences were found in neither species richness nor in abundance of perennial or annual forbs, but graminoid abundance significantly were lower in 2019. Which changed the species type composition, where graminoids declined 4,32% from 2018 to 2019 and perennial forbs increased 7,75% (Fig. 27), this might be due to yearly variations in precipitation (Dansk Meterologisk Institut 2020)**,** due to a dry summer in 2018 (Dansk Meteorologisk Institut 2020), reducing graminoids from 2018 to 2019 or yearly variation in rooting patterns.

The above indicates that the meadow if left undisturbed, will relatively fast return to undisturbed conditions, if left unrooted and un-grazed (Fig. 12 and 13) and that wild boar contributes in elevating species richness and changes species composition

Meadow/common alder

Rooting at the meadow/common alder sites reduced abundances of graminoids (Fig 27). the reduction of graminoids, gave room for an increased the species richness in the rooted treatments (Fig. 28), correlated with a significant increase abundance of perennial forbs (Fig 27).

Abundance of annual forbs showed no effect to rooting and was almost absent, not responding in the same way to rooting, as the grassland and the Meadow site. The differences in annual forb abundances, could be due to differences in rooting patterns at meadow/common alder site which seemed to be more around the edges of the meadow, near or underneath the common alder, and not in the middle of the meadow(Fig. 14).

The low abundance of annual forbs could also be related to the small size of the meadow/common alder site, (smaller than the grassland and meadow site). It could also be correlated with a relatively enclosed location, which was surround by tall trees, that could be obstructing seed dispersal to the site in general. It could furthermore be explained by an absence of a seed bank, that could germinate, when the soil was disturbed by rooting.

Alders were found germinating in both rooted treatments within almost all plots indicating, that the meadow/common alder site, might undergo successional changes from meadow to forest in the long term. Also supporting this, is (Fig. 14) showing more than 20 alder seedlings in a rooted patch and 2-3-meter-high alders, at the meadow further away from the edge of the meadow, which were probably established after past rooting events.

Tofte Skov and Høstemark Skov

Species richness

When comparing the four similar sites, shared between Tofte Skov and Høstemark Skov, the differences between Tofte Skov and Høstemark Skov, is mainly driven by the species richness, from the meadow and meadow/common alder sites as the contribution in number of species was low at the open woodland site and the Scots pine site.

The significantly higher species richness in the unrooted unfenced treatment in Høstemark Skov compared to the unrooted treatments in Tofte Skov could be due to the dry summer in 2018 (Dansk Meterologisk Institut 2020), combined with grazing, reducing densities of graminoids, reducing interspecific competition between graminoids and perennial/annual forbs increasing the number of species of these.

This is partly supported by the unrooted unfenced treatment, which had higher species richness than the two unrooted fenced treatment (Fig. 33) and almost no significant differences between the two unrooted unfenced treatments.

No significant differences were found between the rooted fenced treatment in Tofte Skov and unrooted unfenced treatment in Høstemark Skov, which could be due to increased interspecific competition, due to no gazing and no rooting since July 2019 and for the rooted fenced treatment

at the meadow since January 2018 where significant reductions of annuals forbs was found. This is supported by the significantly higher species richness in the rooted unfenced treatment in Tofte Skov, compared to the unrooted unfenced treatment in Høstemark Skov.
Furthermore, it could also be a general difference in species composition, between sites in Tofte Skov and Høstemark Skov which is partly supported by differences in species at the meadow sites (Appendix 7) and Meadow/common alder sites (Appendix 9).

Tree seedlings

Wild boars rooting was recorded creating patches of exposed soil, which encouraged the establishment of birch (Betula spp.), oak (Quercus spp), rowan (Sorbus aucuparia) and holly (Ilex aquifolium) and promoted growth of several ancient woodland species, such as wood anemones (Anemone nemorosa) (Henney, “2012”). Rooting is largely thought to increase, the chance of germination for some woody species and create growth potential for some plant species, that otherwise would not thrive in forests (Singer, “1981”.). A Dutch study found no results that rooting affected germination and woody species growth positively and recorded a negative feedback of rooting frequency, on regeneration of oak and beech etc. if densities of wild boars is high (Groot Bruinderink G.W.T.A & Hazebrook E., “1996” ; Busby, Vitousek, & Dirzo, “2010”.).

Findings in this study, suggest that rooting significantly increases germinating of tree seedlings significantly. This study also found that, tree species composition differs, between rooted treatments and unrooted treatments, suggesting that different tree species responds differently to rooting.
The large percentage of rowan in unrooted treatments unfenced treatment in both Tofte Skov and Høstemark (Fig. 35) could seem odd, as these browsed by red deer (Kuiters et al., “2001”). Finding rowan almost exclusively in the unrooted treatments might indicate, that these are not dependant on soil disturbance to germinate or responds negatively to a soil disturbance.
A more likely explanation, is the differences in seed dispersal strategies, as rowan largely depend, on seed dispersal by birds, which means that seeds therefore more or less randomly are dropped via bird-droppings, due to the limited period over which this study was conducted, unrooted patches were be older, than rooted patches, which meant that the chance, of a rowan

berry had already dropped or germinated in the unrooted treatments in the past, before this study started, was higher than the chance of a rowan berry seed dropping into one of the rooted treatments while the study was conducted.

To find downy birch seedlings, almost exclusively in rooted treatments makes sense, was due to wild boars rooting, as seeds from downy birch catkins, is wind dispersed and easily gets caught in depressions in the ground, such as rooted patches.

The pine seeds, alder seeds, beech and oak mast (Fig. 8, 10 and 14), probably dropped directly into the treatments below or got moved short distances by wind or rodents.

Rooting creates patches of exposed soil, with more light and less competition from other plant species, suitable for germination and thus explaining the higher abundances in the rooted treatments. Also supported by no findings of alders in unrooted treatments, even though alder seedlings could potentially have germinated, at three sites in unrooted treatments, (Swamp forest, and meadow/common alder in both Tofte Skov and Høstemark Skov) none did, making it very likely that alders, depend of disturbance or patches of exposed soil to germinate, such as wild boars rooting.

The difference in abundance of tree seedlings between the two rooted treatments, might be due to differences in age of the rooted patch. The rooted fences were set up, in start July 2018, having two growth season for tree seedlings to establish inside fences, and the age of the rooted unfenced treatments is unknown, but might be less than two growth season, or re-rooted later than July 2018. Browsing pressure from red deer, could potentially also have reduced abundances, of tree seedlings in rooted unfenced patches, but seems unlikely, as tree seedlings found was less than 5 cm high in the rooted unfenced treatments, and showed no sign of browsing.

To sum up, the differences in species composition between the rooted and unrooted treatments, is not likely to have anything to do with preference for disturbed or undisturbed soil surfaces reacting negatively to rooting by wild boar, but due to differences in seed dispersal strategies. But wild boars rooting, significantly increases the germination chances of tree seedlings (Fig. 35).

Discussion Summary

The results suggest that wild boars reset the successional clock, reducing vegetation densities (Fig. 7, 8, 9 and 13) and that rooting significantly reduces abundance of graminoids (Fig. 34) supported by total number of graminoids registration, which was lower in the rooted treatments (Appendix 14). When graminoids got reduced from rooting microhabitats evolved, in which flowering plants, such as perennial forbs and annual forb species, can thrive increasing species richness significantly (Fig. 32 and appendix 11), also while increasing abundance significantly of perennial and annual forbs (Fig. 34). Which are beneficial for insect such as butterflies etc. that are dependent on flowering plants and patches of exposed soil for warming (Fig. 13). At forest sites wild boars rooting created patches of exposed soil, where tree seedlings germinated (Fig. 8 and 10), having the potential to help in renewing the forest. Even reducing unwanted invasive species through rooting, such as brackens from different types of habitats (Fig. 7, 8 and 22).

The removal of brackens created patches through rooting, increased tree seedlings and heather seedling germination (Fig. 22), potentially rewidening the heath, that had been overgrown by bracken, elevating species richness of birds, insects and reptiles.

The above results suggest that wild boars´ play a unique role, in Danish natural habitats, and no other animal in the Danish nature, carries out the same level of soil disturbance, changing the soil structure, mixing soil surface layers, changing plant composition and elevating species richness. However if population densities of wild boar becomes too high, as to reach a level above carrying capacity for the habitat, the rooting and re-rooting of the same patches might be too intensive. This could influence the positive effect that rooting play, as shown at the swamp forest site, where both abundance of plants and species richness was affected negatively by rooting in the rooted unfenced treatment (Fig. 23 and 31).

Laursen (2018) and others (Genov 1981; Welander 1995; Massei, Genov & Staines; Schley & Roper 2003) suggested that wild boars rooting patterns changes, from rooting to grazing in summertime, giving plants the possibility to recover in rooted patches, this was also indicated in this study, as total number of plants registered from all sites, show an increased from June to august, in the Rooted unfenced treatments (RUF) (Appendix 12).

Future studies

The complexity of wild boars' influence on the flora, makes it difficult to clearly uncover the influence wild boars´ effect on the flora. With this study of Tofte Skov and Høstemark Skov it was not possible to find an even number of study sites, so recommendations for future studies would be to find even numbers of study sites of the same habitat types as similar to each other as possible, for easy comparison and if possible. Furthermore, it would be interesting, to conduct a long-term study recording initial and long-term effect of rooting, examining if or when graminoids and bracken recover after a rooting event.

The different types of treatments examined in this study, can provide important knowledge on plant-animal interactions and for future studies it should be considered to add additional plots pr. treatments strengthening the data analysis and tendencies shown. Additional information on soil properties, such as pH, litter layer thickness and soil nutrients, and measure densities of the different species types, should be considered, within the treatments, when discussing abundances, species richness and composition of plants.

Further information on soil invertebrates, above ground insects species richness and abundances and to see if there is correlating between specific insect groups based on feeding strategies bound to the rooted treatments or the unrooted treatments, could be important knowledge, when looking at the effect of rooting.

At sites with tree seedlings, improvements for a future study, would be to count all tree seedlings, instead of count form 1-9, as done in this study. Tree seedlings was usually was present in low numbers and all tree seedlings, could have been counted easily, for a better statistical analysis of tree seedlings data.

Conclusion

The public attitude towards wild boars is somewhat negative, and the government has taken special circumstances in keeping wild boars´ out of Denmark, in fear of African swine fever, but the risk of swine fever spreading from a population of wild boars to domestic pigs are assessed to be low, while the biggest risk assessed to come from transportation of domestic pigs(Alban et al., “2005”). But a fence was still constructed along the Danish/German border, but when constructed full of holes, so other animals are able to pass the fence.

The fence is disputed, in the public, dividing nature-activists, saying that a fence full of holes, will not keep the wild boars out of Denmark and the agricultural industry, which fears the devastating consequences, if swine fever spreads to the domestic pigs (Vrå Andersen 2018).

While many studies, mainly from introduced ranges, shows negative impacts, few studies from native ranges, recorded positive impacts, such as increased species richness.

The variation found between rooted and unrooted treatments, shows that wild boars extensively impacts their natural habitats.

If wild boars are reintroduced into the Danish nature, they could possibly contribute positively to Danish natural habitats, keeping different types of habitat more varied by, increasing species richness. Wild boars were shown to contribute to the reduction of the invasive brackens in this study and other (Henney, “2012”; wise “2012”). This might also concern other invasive species, such as Japanese knotweed (*Fallopia japonica)* as shown by Dutch study (Door 2015).

Furthermore, the rooting behavior of wild boars creates patches in woodland, where tree seedlings germinates, renewing the forest. For heathlands infested with brackens, the rooting of wild boars can reduce brackens, thus rewidening the heath, as heather seedlings germinated in rooted patches.

However, results from short-term studies like this, might not give the full picture of wild boars´ effect on plant communities. It is recommended, that in the future, studies of the impact of wild boars on native habitats should be conducted long-term.

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Appendixes

Appendix 1 Location, Species type and list

	CF(/H)	**CF(/T)**	**CUF(/H)**	**CUF(/T)**	**RF(/T)**	**RUF(/T)**	

Location, Species type and list							**Total No. Of Registrations**
Common Alder/swamp		**239**		**218**	**169**	**83**	**709**
Annual forb		**55**		**70**	**68**	**59**	**252**
Cardamine flexiosa		8			19	7	34
Cerastium fontanum		1		3	10	4	18
Epilobium montanum		2			3		5
Galium aparine				1			1
Impatiens noli-tangere		22		24	9	1	56
Moehringia trinerva				6	3	1	10
Polygonum sp		8		7	11	27	53
Stellaria media		14		29	13	19	75
Deciduous tree		**3**			**10**	**2**	**15**
Alnus glutinosa					7	1	8
Crataegus monogyna		3					3
Prunus padus						1	1
Sorbus aucuparia					3		3
Graminoid		**134**		**100**	**49**	**15**	**298**
Anthoxanthum odoratum				8			8
Carex remota		71		61	34	6	172
Festuca rubra					3		3
Juncus effusus					8	1	9
Milium effusum		6		5	4	8	23
Phragmites australis		10		1			11
Scirpus sylvaticus		47		25			72

Perennial forb		**45**		**46**	**42**	**7**	**140**
Anemone nemorosa		1		1			2
Chamerion angustifolium					1		1
Oxalis acetocella		41		30	1	1	73
Rumex acetosella		1		2			3
Stellaria alsine					14	4	18
Stellaria graminea		2		6	13		21
Stellaria holostea				5			5
Taraxacum officinale				1			1
Urtica dioica				1	13	2	16
Pteridophyte		**2**		**2**			**4**
Dryopteris carthusiana		2		2			4
Grassland		**302**		**246**	**459**	**416**	**1423**
Annual forb				**1**	**266**	**267**	**534**
Arabidopsis thaliana					26	37	63
Arenaria serphyllifolia					29	28	57
Capsella bursa-pastoris					24	23	47
Cerastium fontanum					29	14	43
draba verna						5	5
Geranium molle					17	12	29
Geranium pusillum					3		3
Gnaphalium uliginosum						1	1
Myosotis stricta				1	32	27	60
Polygonum aviculare					27	75	102

Sagina procumbens						1	1
Stellaria media					25		25
Veronica arvensis					54	44	98
Graminoid		**212**		**199**	**74**	**36**	**521**
Agrostis capillaris		90		98	28	9	225
Anthoxanthum odoratum		22		23	1		46
Carex arenaria		76		45	3	8	132
Dactylis glomerata						1	1
Festuca pratensis		13		18	16		47
Festuca rubra						6	6
Holcus lanatus				3			3
Lolium perenne		11		8	26	12	57
Phleum pratense				4			4
Perennial forb		**90**		**46**	**119**	**113**	**368**
Achillea millefolium				2	6	17	25
Campanula rotundifolia						3	3
Galium saxatile		10		16			26
Galium verum		18				3	21
Linaria vulgaris					7	4	11
Medicago lupulina					9	1	10
Plantago lanceolata					18	6	24
Ranunculus acris						5	5
Rumex acetosella		9			4	16	29
Stellaria graminea		53		28	65	36	182
Trifolium pratense					3		3
Trifolium repens					4	7	11
Veronica chamaedrys						1	1
Veronica Serpyllifolia					3	14	17

Heat/Bracken		**139**		**165**	**178**	**117**	**599**
Annual forb					**2**		**2**
Epilobium montanum					1		1
Euphrasia stricta					1		1
Deciduous tree				**1**	**16**	**10**	**27**
Betula pubescens				1	16	10	27
Graminoid		**72**		**86**	**74**	**41**	**273**
Dechampsia flexuosa		72		86	74	41	273
Half-shrub		**10**		**10**	**51**	**45**	**116**
Calluna vulgaris					47	39	86
Erica tetralix					1	3	4
Vacciinium vitis-idea		3					3
Vaccinium ulignosum		7		10	3	3	23
Perennial forb		**11**		**17**	**7**	**1**	**36**
Galium saxatile		1		8			9
Linaria vulgaris					3		3
Potentilla erecta					1		1
Ranunculus acris				1	1		2
Stellaria holostea		1					1
Trientalis europaea		9		8	2	1	20
Pteridophyte		**46**		**51**	**28**	**20**	**145**
Pteridium aquilinum		46		51	28	20	145
Meadow	**239**	**699**	**719**	**848**	**988**	**989**	**4482**
Annual forb	**10**	**48**	**144**	**65**	**175**	**377**	**819**
Arabidopsis thaliana					5	18	23
Arenaria serphyllifolia					11	23	34

Capsella bursa-pastoris					2	23	25
Cerastium fontanum	10	47	64	58	99	48	326
Geranium molle			80				80
Gnaphalium uliginosum					5	1	6
Myosotis stricta				1	14	11	26
Polygonum aviculare		1			7	112	120
Sagina procumbens				4	12	108	124
Stellaria media					4	4	8
Veronica arvensis				2	16	27	45
Veronica persica						2	2
Graminoid	**162**	**237**	**252**	**264**	**305**	**78**	**1298**
Agrostis capillaris	90	140	129	142	140	37	678
Anthoxanthum odoratum	18	2	45				65
Carex leporina	11	4	3	44			62
Carex nigra	1						1
Cynosurus cristatus				5			5
Festuca pratensis		4		9			13
Festuca rubra		1					1
Holcus lanatus	7	70	3	24	123	12	239
Juncus articulatus			7				7
Lolium perenne	35	25	65	40	42	29	236
Perennial forb	**67**	**405**	**323**	**512**	**486**	**503**	**2296**
Achillea millefolium				11	64	41	116
Achillea ptarmica		13			3	4	20
Anagalliis arvensis						3	3
Bellis perennis			20				20

Cardamine pratensis	1	4	7				12
Circium arvénse			4	2	1	8	15
Galium saxatile	9		18				27
Hieracium pilosella			78				78
Leontodon autumnalis		19	26	29	27	19	120
Linaria vulgaris					7		7
Medicago lupulina			4			2	6
Plantago lanceolata	2	46	83	67	94	131	423
Plantago major		1		5		15	21
Potentilla anserina		21		46	41	52	160
Prunella vulgaris		3	1	10	24	38	76
Ranunculus acris	7	75	12	91	88	72	345
Rumex acetosella		39	2	58	29	4	132
Stellaria graminea	9	66		18	32	11	136
Taraxacum officinale	2	4	6	5	13	4	34
Trifolium pratense	36	52	62	130	21	35	336
Veronica chamaedrys		2			18	5	25
Veronica Serpyllifolia	1			1	2	28	32
Vicia cracca		51		39	22	24	136
viola tricolor						7	7
Pteridophyte		**9**		**7**	**22**	**31**	**69**
Equisetum palustre		9		7	22	31	69
Meadow/ Common Alder	**331**	**343**	**320**	**362**	**427**	**388**	**2171**
Annual forb	**33**		**17**		**10**	**30**	**90**
Arenaria serphyllifolia						3	3
Cardamine hirsuta					1		1

Cerastium fontanum			4		1	3	8
Epilobium montanum	31		13				44
Geranium molle	2						2
Sagina procumbens					8	24	32
Deciduous tree					**9**	**4**	**13**
Alnus glutinosa					9	4	13
Graminoid	**87**	**146**	**103**	**148**	**130**	**78**	**692**
Agrostis capillaris		42	4	43	38	40	167
Anthoxanthum odoratum		71		67	28	15	181
Carex arenaria						1	1
Carex demissa				2			2
Carex leporina	4	3		9	1		17
Carex nigra	5		8				13
Festuca rubra				1		1	2
Holcus lanatus		18		18	56	16	108
Juncus effuses	42	8	51	8	7	5	121
Milium effusum	36		40				76
Phleum pratense		4					4
Perennial forb	**187**	**196**	**169**	**212**	**277**	**274**	**1315**
Achillea ptarmica		1		1	1	1	4
Calamintha nepeta					9	3	12
Campanula rotundifolia					1		1
Epilobium hirsutum	18		20				38
Galium saxatile	12	1	3	7	40	10	73
Leontodon autumnalis					5		5
Linaria vulgaris		1					1
Lotus corniculatus					1		1
Lycopus europaeus	1		2				3

Lythrum salicaria	30		19				49
Plantago lanceolate		14		19	44	43	120
Plantago major					2		2
Potentilla anserine	28	44	37	25	50	72	256
Prunella vulgaris					6	12	18
Ranunculus acris	39	46	31	49	45	41	251
Rumex acetosella		20		39	30	38	127
Stachys palustris	7		5				12
Stellaria alsine	17						17
Stellaria graminea	10	1	16	2	6	1	36
Taraxacum officinale					2	2	4
Trifolium pratense		22		15	25	38	100
Veronica chamaedrys				2			2
Vicia cracca	25	46	36	53	10	11	181
Viola odorata						2	2
Ptridophyte	**24**	**1**	**31**	**2**	**1**	**2**	**61**
Equisetum fluviatile	24		31				55
Equisetum palustre		1		2	1	2	6
Open woodland/Bracken	**67**	**127**	**54**	**128**	**138**	**158**	**672**
Annual forb			**2**	**5**	**3**	**21**	**31**
Cerastium fontanum			2	3		10	15
Galeopsis tetrahit				2	3	1	6
Stellaria media						10	10
Deciduous tree	**18**	**2**	**20**	**1**	**14**	**9**	**64**
Alnus glutinosa					1		1
Betula pubescens					1	3	4
Fagus sylvatica	16	2	13	1	11	6	49
Quercus robur					1		1

Sorbus aucuparia	2		7				9
Graminoid		**46**		**39**	**47**	**50**	**182**
Calamagrostis epigejos		32		28	27	30	117
Carex canescens					2	14	16
Carex nigra		11		2	16	5	34
Juncus effuses		2		9			11
Luzula campestris					1	1	2
Luzula multiflora					1		1
Luzula Pilosa		1					1
Half-shrub		**1**			**24**	**12**	**37**
Rubus idaeus		1			24	12	37
Perennial forb	**24**	**34**	**19**	**31**	**37**	**51**	**196**
Anemone nemorosa	1	4		2		5	12
Chamerion angustifolium						1	1
Maianthemum bifolium	3		2	5		1	11
Oxalis acetocella	4	25	6	18	35	28	116
Rumex acetosella						8	8
Stellaria holostea	2	5	1	6		8	22
Trientalis europaea	14		10		2		26
Pteridophyte	**25**	**44**	**13**	**52**	**13**	**15**	**162**
Pteridium aquilinum	25	44	13	52	13	15	162
Scots pines	**252**	**214**	**229**	**210**	**107**	**68**	**1080**
Annual forb			**1**		**1**	**13**	**15**
Cerastium fontanum			1			4	5
Polygonum sp						1	1
Senecio vulgaris					1		1
Stellaria media						8	8
Coniferous tree	**1**	**14**	**3**	**7**	**45**	**17**	**87**

Picea sitchensis		3		4		1	8
Pinus Sylvestris	1	11	3	3	45	16	79
Deciduous tree		**7**		**15**	**5**	**1**	**28**
Betula pubescens					1		1
Quercus robur				1	2	1	4
Sorbus aucuparia		7		14	2		23
Graminoid	**138**	**118**	**136**	**117**	**41**	**21**	**571**
Anthoxanthum odoratum						3	3
Carex Arenaria	57	28	47	26	9	10	177
Dechampsia flexuosa	81	90	89	89	32	8	389
Holcus lanatus				1			1
Luzula campestris				1			1
Half-shrub	**5**	**2**	**3**	**11**	**2**		**23**
Rubus idaeus	5	2	3	11	2		23
Perennial forb	**108**	**71**	**85**	**59**	**13**	**15**	**351**
Galium saxatile	12	23	14	19	1	6	75
Galium sylvaticum		8		1			9
Oxalis acetocella	44		33				77
Rumex acetosella					3	2	5
Stellaria holostea		2					2
Trientalis europaea	52	38	38	39	9	7	183
Pteridophyte		**2**	**1**	**1**		**1**	**5**
Dryopteris carthusiana		2	1	1		1	5
Total No. of registrations	**889**	**2063**	**1322**	**2177**	**2466**	**2219**	**11136**

Appendix 2 Heath

species list

Heath			
CF/T	**CUF/T**	**RF/T**	**RUF/T**
Graminoid	**Deciduous tree**	**Annual forb**	**Deciduous tree**
Dechampsia flexuosa	Betula pubescens	Epilobium montanum	Betula pubescens
Half-shrub	**Graminoid**	Euphrasia stricta	**Graminoid**
Vaccinium vitis-idea	Dechampsia flexuosa	**Deciduous tree**	Dechampsia flexuosa
Vaccinium ulignosum	**Half-shrub**	Betula pubescens	**Half-shrub**
Perennial forb	Vaccinium ulignosum	**Graminoid**	Calluna vulgaris
Galium saxatile	**Perennial forb**	Dechampsia flexuosa	Erica tetralix
Stellaria holostea	Galium saxatile	**Half-shrub**	Vaccinium ulignosum
Trientalis europaea	Ranunculus acris	Calluna vulgaris	**Perennial forb**
Pteridophyte	Trientalis europaea	Erica tetralix	Trientalis europaea
Ptreridium aquilinum	**Pteridophyte**	Vaccinium ulignosum	**Pteridophyte**
	Ptreridium aquilinum	**Perennial forb**	Ptreridium aquilinum
		Linaria vulgaris	
		Potentilla erecta	
		Ranunculus acris	
		Trientalis europaea	
		Pteridophyte	
		Ptreridium aquilinum	

Appendix 3 Open woodland

species list

Open woodland			
CF/T	**CUF/T**	**RF/T**	**RUF/T**
Deciduous tree	**Annual forb**	**Annual forb**	**Annual forb**
Fagus sylvatica	Cerastium fontanum	Galeopsis tetrahit	Cerastium fontanum
Graminoid	Galeopsis tetrahit	**Deciduous tree**	Galeopsis tetrahit
Calamagrostis epigejos	**Deciduous tree**	Alnus glutinosa	Stellaria media
Carex nigra	Fagus sylvatica	Betula pubescens	**Deciduous tree**
Juncus effusus	**Graminoid**	Fagus sylvatica	Betula pubescens
Luzula pilosa	Calamagrostis epigejos	Quercus robur	Fagus sylvatica
Half-shrub	Carex nigra	**Graminoid**	**Graminoid**
Rubus idaeus	Juncus effuses	Calamagrostis epigejos	Calamagrostis epigejos
Perennial forb	**Perennial forb**	Carex canescens	Carex canescens
Anemone nemorosa	Anemone nemorosa	Carex nigra	Carex nigra
Oxalis acetocella	Maianthemum bifolium	Luzula campestris	Luzula campestris
Stellaria holostea	Oxalis acetocella	Luzula multiflora	**Half-shrub**

Pteridophyte	Stellaria holostea	**Half-shrub**	Rubus idaeus
Ptreridium aquilinum	**Pteridophyte**	Rubus idaeus	**Perennial forb**
	Ptreridium aquilinum	**Perennial forb**	Anemone nemorosa
		Oxalis acetocella	Chamerion angustifolium
		Trientalis europaea	Maianthemum bifolium
		Pteridophyte	Oxalis acetocella
		Ptreridium aquilinum	Rumex acetosella
			Stellaria holostea
			Pteridophyte
			Ptreridium aquilinum
Open woodland	**Høstemark Skov**		
CF/H	**CUF/H**		
Deciduous tree	**Annual forb**		
Fagus sylvatica	Cerastium fontanum		
Sorbus aucuparia	**Deciduous tree**		
Perennial forb	Fagus sylvatica		
Anemone nemorosa	Sorbus aucuparia		
Maianthemum bifolium	**Perennial forb**		
Oxalis acetocella	Maianthemum bifolium		
Stellaria holostea	Oxalis acetocella		
Trientalis europaea	Stellaria holostea		
Pteridophyte	Trientalis europaea		
Ptreridium aquilinum	**Pteridophyte**		

Appendx 4 Swamp forest

Species list

Swamp forest			
CF/T	**CUF/T**	**RF/T**	**RUF/T**
Annual forb	**Annual forb**	**Annual forb**	**Annual forb**
Cardamine flexiosa	Cerastium fontanum	Cardamine flexiosa	Cardamine flexiosa
Cerastium fontanum	Galium saxatile	Cerastium fontanum	Cerastium fontanum
Epilobium montanum	Impatiens noli-tangere	Epilobium montanum	Impatiens noli-tangere
Impatiens noli-tangere	Moehringia trinerva	Impatiens noli-tangere	Moehringia trinerva
Polygonum sp	Polygonum sp	Moehringia trinerva	Polygonum sp
Stellaria media	Stellaria media	Polygonum sp	Stellaria media
Deciduous tree	**Graminoid**	Stellaria media	**Deciduous tree**
Crataegus monogyna	Anthoxanthum odoratum	**Deciduous tree**	Alnus glutinosa
Graminoid	Carex remota	Alnus glutinosa	Prunus padus
Carex remota	Milium effusum	Sorbus aucuparia	**Graminoid**
Milium effusum	Phragmites australis	**Graminoid**	Carex remota
Phragmites australis	Scirpus sylvaticus	Carex remota	Juncus effusus
Scirpus sylvaticus	**Perennial forb**	Festuca rubra	Milium effusum
Perennial forb	Anemone nemorosa	Juncus effusus	**Perennial forb**
Anemone nemorosa	Oxalis acetocella	Milium effusum	Oxalis acetocella
Oxalis acetocella	Rumex acetosella	**Perennial forb**	Stellaria alsine
Rumex acetosella	Stellaria graminea	Chamerion angustifolium	Urtica dioica
Stellaria graminea	Stellaria holostea	Oxalis acetocella	
Pteridophyte	Taraxacum officinale	Stellaria alsine	
Dryopteris carthusiana	Urtica dioica	Stellaria graminea	
	Pteridophyte	Urtica dioica	
	Dryopteris carthusiana		

Appendix 5 Scots pine

species list

Scots pine	**Tofte Skov**		
CF/T	**CUF/T**	**RF/T**	**RUF/T**
Coniferous tree	**Coniferous tree**	**Annual forb**	**Annual forb**
Picea sitchensis	Picea sitchensis	Senecio vulgaris	Cerastium fontanum
Pinus Sylvestris	Pinus sylvestris	**Coniferous tree**	Polygonum sp
Deciduous tree	**Deciduous tree**	Pinus sylvestris	Stellaria media
Sorbus aucuparia	Quercus robur	**Deciduous tree**	**Coniferous tree**
Graminoid	Sorbus aucuparia	Betula pubescens	Picea sitchensis
Carex Arenaria	**Graminoid**	Quercus robur	Pinus sylvestris
Dechampsia flexuosa	Carex arenaria	Sorbus aucuparia	**Deciduous tree**
Half-shrub	Dechampsia flexuosa	**Graminoid**	Quercus robur
Rubus idaeus	Holcus lanatus	Carex arenaria	**Graminoid**
Perennial forb	Luzula campestris	Dechampsia flexuosa	Anthoxanthum odoratum
Galium saxatile	**Half-shrub**	**Half-shrub**	Carex arenaria
Galium sylvaticum	Rubus idaeus	Rubus idaeus	Dechampsia flexuosa
Stellaria holostea	**Perennial forb**	**Perennial forb**	**Perennial forb**
Trientalis europaea	Galium saxatile	Galium saxatile	Galium saxatile
Pteridophyte	Galium sylvaticum	Rumex acetosella	Rumex acetosella
Dryopteris carthusiana	Trientalis europaea	Trientalis europaea	Trientalis europaea
	Pteridophyte		**Pteridophyte**
	Dryopteris carthusiana		Dryopteris carthusiana
Scots pine	**Høstemark**		
CF/H	**CUF/H**		
Coniferous tree	**Annual forb**		
Pinus Sylvestris	Cerastium fontanum		
Graminoid	**Coniferous tree**		
Carex Arenaria	Pinus sylvestris		
Dechampsia flexuosa	**Graminoid**		
Half-shrub	Carex arenaria		
Rubus idaeus	Dechampsia flexuosa		

Perennial forb	**Half-shrub**		
Galium saxatile	Rubus idaeus		
Oxalis acetocella	**Perennial forb**		
Trientalis europaea	Galium saxatile		
	Oxalis acetocella		
	Trientalis europaea		
	Pteridophyte		
	Dryopteris carthusiana		

Appendix 6 Grassland

species list

Grassland			
CF/T	**CUF/T**	**RF/T**	**RUF/T**
Graminoid	**Graminoid**	**Graminoid**	**Graminoid**
Deschampsia flexiosa	Deschampsia flexiosa	Deschampsia flexiosa	Deschampsia flexiosa
Anthoxanthum odoratum	Anthoxanthum odoratum	Anthoxanthum odoratum	Carex arenaria
Carex Arenaria	Carex arenaria	Carex Arenaria	Dactylis glomerata
Festuca pratensis	Festuca pratensis	Festuca pratensis	Festuca pratensis
Lolium perenne	Holcus lanatus	Lolium perenne	Lolium perenne
	Lolium perenne	**Perennial forb**	**Perennial forb**
	Phleum pratense	Achillea millefolium	Achillea millefolium
Perennial forb	**Perennial forb**	Linaria vulgaris	Campanula rotundifolia
Galium saxatile	Achillea millefolium	Medicago lupulina	Galium verum
Galium verum	Galium saxatile	Plantago lanceolate	Linaria vulgaris
Rumex acetosella	Stellaria graminea	Rumex acetosella	Medicago lupulina
Stellaria graminea		Stellaria graminea	Plantago lanceolata
		Trifolium pretense	Ranunculus acris
		Trifolium repens	Rumex acetosella
		Veronica Serpyllifolia	Stellaria graminea
Annual forb	**Annual forb**	**Annual forb**	Trifolium repens

	Myosotis stricta	Arabidopsis thaliana	Veronica chamaedrys
		Arenaria serphyllifolia	Veronica Serpyllifolia
		Capsella bursa-pastoris	**Annual forb**
		Cerastium fontanum	Arabidopsis thaliana
		Geranium molle	Arenaria serphyllifolia
		Geranium pusillum	Capsella bursa-pastoris
		Myosotis stricta	Cerastium fontanum
		Polygonum aviculare	draba verna
		Stellaria media	Geranium molle
		Veronica arvensis	Gnaphalium uliginosum
			Myosotis stricta
			Polygonum aviculare
			Sagina procumbens
			Veronica arvensis

Appendix 7 Meadow Tofte Skov and Høstemark Skov 2019

species list

Meadow 2019			
CF/T	CUF/T	RF/T	RUF/T
Annual forb	**Annual forb**	**Annual forb**	**Annual forb**
Cerastium fontanum	Cerastium fontanum	Arabidopsis thaliana	Arabidopsis thaliana
Polygonum aviculare	Myosotis stricta	Arenaria serphyllifolia	Arenaria serphyllifolia
Graminoid	Sagina procumbens	Capsella bursa-pastoris	Capsella bursa-pastoris
Agrostis capillaris	Veronica arvensis	Cerastium fontanum	Cerastium fontanum
Anthoxanthum odoratum	**Graminoid**	Gnaphalium uliginosum	Gnaphalium uliginosum
Carex leporina	Agrostis capillaris	Myosotis stricta	Myosotis stricta
Festuca pratensis	Carex leporina	Polygonum aviculare	Polygonum aviculare
Festuca rubra	Cynosurus cristatus	Sagina procumbens	Sagina procumbens
Holcus lanatus	Festuca pratensis	Stellaria media	Stellaria media
Lolium perenne	Holcus lanatus	Veronica arvensis	Veronica arvensis
Perennial forb	Lolium perenne	**Graminoid**	Veronica persica

Achillea ptarmica	**Perennial forb**	Agrostis capillaris	**Graminoid**
Cardamine pratensis	Achillea millefolium	Holcus lanatus	Agrostis capillaris
Leontodon autumnalis	Circium arvénse	Lolium perenne	Holcus lanatus
Plantago lanceolate	Leontodon autumnalis	**Perennial forb**	Lolium perenne
Plantago major	Plantago lanceolata	Achillea millefolium	**Perennial forb**
Potentilla anserine	Plantago major	Achillea ptarmica	Achillea millefolium
Prunella vulgaris	Potentilla anserina	Circium arvénse	Achillea ptarmica
Ranunculus acris	Prunella vulgaris	Leontodon autumnalis	Anagalliis arvensis
Rumex acetosella	Ranunculus acris	Linaria vulgaris	Circium arvénse
Stellaria graminea	Rumex acetosella	Plantago lanceolata	Leontodon autumnalis
Taraxacum officinale	Stellaria graminea	Potentilla anserina	Medicago lupulina
Trifolium pretense	Taraxacum officinale	Prunella vulgaris	Plantago lanceolata
Veronica chamaedrys	Trifolium pratense	Ranunculus acris	Plantago major
Vicia cracca	Veronica Serpyllifolia	Rumex acetosella	Potentilla anserina
Pteridophyte	Vicia cracca	Stellaria graminea	Prunella vulgaris
Equisetum palustre	**Pteridophyte**	Taraxacum officinale	Ranunculus acris
	Equisetum palustre	Trifolium pratense	Rumex acetosella
		Veronica chamaedrys	Stellaria graminea
		Veronica Serpyllifolia	Taraxacum officinale
		Vicia cracca	Trifolium pratense
		Pteridophyte	Veronica chamaedrys
		Equisetum palustre	Veronica Serpyllifolia
			Vicia cracca
			viola tricolor
			Pteridophyte
Meadow 2019	**Høstemark**		Equisetum palustre
CF/H	**CUF/H**		

Annual forb	**Annual forb**
Cerastium fontanum	Cerastium fontanum
Graminoid	Geranium mole
Agrostis capillaris	**Graminoid**
Anthoxanthum odoratum	Agrostis capillaris

Carex leporine	Anthoxanthum odoratum
Carex nigra	Carex leporine
Holcus lanatus	Holcus lanatus
Lolium perenne	Juncus articulates
Perennial forb	Lolium perenne
Cardamine pratensis	**Perennial forb**
Galium saxatile	Bellis perennis
Plantago lanceolate	Cardamine pratensis
Ranunculus acris	Circium arvénse
Stellaria graminea	Galium saxatile
Taraxacum officinale	Hieracium pilosella
Trifolium pretense	Leontodon autumnalis
Veronica Serpyllifolia	Medicago lupulina
	Plantago lanceolate
	Prunella vulgaris
	Ranunculus acris
	Rumex acetosella
	Taraxacum officinale

Appendix 8 Meadow July 2018 and August 2019

species list

Meadow			
CF July 2018	**CUF July 2018**	**RF July 2018**	**RUF July 2018**
Annual forb	**Annual forb**	**Annual forb**	**Annual forb**
Cerastium fontanum	Cerastium fontanum	Arenaria serphyllifolia	Arenaria serphyllifolia
Graminoid	Polygonum aviculare	Brassicacea sp	Brassicacea sp
Agrostis capillaris	Veronica arvensis	Capsella bursa-pastoris	Capsella bursa-pastoris
Anthoxanthum odoratum	**Graminoid**	Cerastium fontanum	Cerastium fontanum

Carex leporine	Agrostis capillaris	Gnaphalium uliginosum	Geranium mole
Dechampsia caespitosa	Anthoxanthum doratum	Myosotis stricta	Gnaphalium uliginosum
Dechampsia flexuosa	Carex leporine	Polygonum aviculare	Myosotis stricta
Festuca pratensis	Carex pallescens	Sagina procumbens	Polygonum aviculare
Festuca rubra	Dechampsia caespitosa	Veronica arvensis	Sagina procumbens
Holcus lanatus	Dechampsia flexuosa	Veronica serphyllifolia	Veronica arvensis
Lolium perenne	Festuca rubra	**Graminoid**	Veronica serphyllifolia
Poa pratensis	Holcus lanatus	Agrostis capillaris	**Graminoid**
Poa trivialis	Juncus bonfonius	Anthoxanthum odoratum	Agrostis capillaris
Perennial forb	Juncus effusus	Dechampsia flexuosa	Anthoxanthum odoratum
Achillea millefolium	Lolium perenne	Festuca rubra	Dechampsia caespitosa
Achillea ptarmica	Poa pratensis	Holcus lanatus	Dechampsia flexuosa
Circium arvénse	Poa trivialis	Lolium perenne	Holcus lanatus
Leontodon autumnalis	**Perennial forb**	Poa pratensis	Juncus bonfonius
Plantago lanceolata	Achillea millefolium	**Perennial forb**	Lolium perenne
Potentilla anserina	Achillea ptarmica	Achillea millefolium	Poa pratensis
Prunella vulgaris	Circium arvénse	Achillea ptarmica	**Perennial forb**
Ranunculus acris	Leontodon autumnalis	Anagallis arvensis	Achillea millefolium
Rumex acetosa	Plantago lanceolata	Leontodon autumnalis	Anagallis arvensis
Stellaria graminea	Plantago major	Linaria vulgaris	Circium arvénse
Trifolium pratense	Potentilla anserina	Percicaria minor	Leontodon autumnalis
Trifolium repens	Prunella vulgaris	Plantago lanceolate	Linaria vulgaris
Vicia cracca	Ranunculus acris	Plantago major	Percicaria minor
Pteridophyte	Rumex acetosa	Potentilla anserine	Plantago lanceolate
Equisetum palustre	Rumex thyrsiflorus	Prunella vulgaris	Plantago major
	Stellaria graminea	Ranunculus acris	Potentilla anserine
	Trifolium pratense	Rumex acetosa	Prunella vulgaris
	Trifolium repens	Rumex acetosella	Ranunculus acris
	Vicia cracca	Stellaria graminea	Ranunculus repens
	Pteridophyte	Taraxacum officinale	Rumex acetosa
	Equisetum palustre	Trifolium repens	Rumex acetosella
		Veronica chamaedrys	Stellaria graminea
		Vicia cracca	Trifolium pretense

		Pteridophyte	Trifolium repens
		Equisetum palustre	Vicia cracca
			viola tricolor
			Pteridophyte
			Equisetum palustre
Meadow			
CF August 2019	**CUF August 2019**	**RF August 2019**	**RUF August 2019**
Annual forb	**Annual forb**	**Annual forb**	**Annual forb**
Cerastium fontanum	Cerastium fontanum	Cerastium fontanum	Arabidopsis thaliana
Graminoid	**Graminoid**	Myosotis stricta	Capsella bursa-pastoris
Agrostis capillaris	Agrostis capillaris	Polygonum aviculare	Cerastium fontanum
Anthoxanthum odoratum	Carex leporina	Sagina procumbens	Myosotis stricta
Carex leporina	Cynosurus cristatus	Stellaria media	Polygonum aviculare
Holcus lanatus	Holcus lanatus	Veronica arvensis	Sagina procumbens
Lolium perenne	Lolium perenne	**Graminoid**	Stellaria media
Perennial forb	**Perennial forb**	Agrostis capillaris	Veronica arvensis
Achillea ptarmica	Achillea millefolium	Holcus lanatus	Veronica persica
Leontodon autumnalis	Circium arvénse	Lolium perenne	**Graminoid**
Plantago lanceolata	Leontodon autumnalis	**Perennial forb**	Agrostis capillaris
Potentilla anserina	Plantago lanceolata	Achillea millefolium	Holcus lanatus
Prunella vulgaris	Plantago major	Achillea ptarmica	Lolium perenne
Ranunculus acris	Potentilla anserina	Circium arvénse	**Perennial forb**
Rumex acetosella	Prunella vulgaris	Leontodon autumnalis	Achillea millefolium
Stellaria graminea	Ranunculus acris	Linaria vulgaris	Achillea ptarmica
Trifolium pretense	Rumex acetosella	Plantago lanceolate	Anagalliis arvensis
Veronica chamaedrys	Stellaria graminea	Potentilla anserine	Circium arvénse
Vicia cracca	Trifolium pratense	Prunella vulgaris	Leontodon autumnalis
	Veronica Serpyllifolia	Ranunculus acris	Medicago lupulina
	Vicia cracca	Rumex acetosella	Plantago lanceolate
	Pteridophyte	Stellaria graminea	Plantago major
	Equisetum palustre	Taraxacum officinale	Potentilla anserine
		Trifolium pretense	Prunella vulgaris
		Veronica chamaedrys	Ranunculus acris

		Veronica Serpyllifolia	Rumex acetosella
		Vicia cracca	Stellaria graminea
		Pteridophyte	Trifolium pratense
		Equisetum palustre	Veronica chamaedrys
			Veronica Serpyllifolia
			Vicia cracca
			viola tricolor
			Pteridophyte
			Equisetum palustre

Appendix 9 Meadow/common alder Tofte Skov and Høstemark Skov

species list

Meadow/common alder			
CF/T	CUF/T	RF/T	RUF/T
Graminoid	**Graminoid**	**Annual forb**	**Annual forb**
Agrostis capillaris	Agrostis capillaris	Cardamine hirsuta	Arenaria serphyllifolia
Anthoxanthum odoratum	Anthoxanthum odoratum	Cerastium fontanum	Cerastium fontanum
Carex leporina	Carex demissa	Sagina procumbens	Sagina procumbens
Holcus lanatus	Carex leporina	**Deciduous tree**	**Deciduous tree**
Juncus effusus	Festuca rubra	Alnus glutinosa	Alnus glutinosa
Phleum pratense	Holcus lanatus	**Graminoid**	**Graminoid**
Perennial forb	Juncus effusus	Agrostis capillaris	Agrostis capillaris
Achillea ptarmica	**Perennial forb**	Anthoxanthum odoratum	Anthoxanthum odoratum
Galium saxatile	Achillea ptarmica	Carex leporine	Carex arenaria
Linaria vulgaris	Galium saxatile	Holcus lanatus	Festuca rubra
Plantago lanceolata	Plantago lanceolata	Juncus effuses	Holcus lanatus
Potentilla anserina	Potentilla anserina	**Perennial forb**	Juncus effusus
Ranunculus acris	Ranunculus acris	Achillea ptarmica	**Perennial forb**
Rumex acetosella	Rumex acetosella	Calamintha nepeta	Achillea ptarmica
Stellaria graminea	Stellaria graminea	Campanula rotundifolia	Calamintha nepeta
Trifolium pratense	Trifolium pratense	Galium saxatile	Galium saxatile

Vicia cracca	Veronica chamaedrys	Leontodon autumnalis	Plantago lanceolata
Ptridophyte	Vicia cracca	Lotus corniculatus	Potentilla anserina
Equisetum palustre	**Ptridophyte**	Plantago lanceolata	Prunella vulgaris
	Equisetum palustre	Plantago major	Ranunculus acris
		Potentilla anserina	Rumex acetosella
		Prunella vulgaris	Stellaria graminea
		Ranunculus acris	Taraxacum officinale
		Rumex acetosella	Trifolium pratense
		Stellaria graminea	Vicia cracca
		Taraxacum officinale	Viola odorata
		Trifolium pratense	**Ptridophyte**
		Vicia cracca	Equisetum palustre
		Ptridophyte	
		Equisetum palustre	

Meadow/common alder	**Høstemark Skov**
CF/H	**CUF/H**
Annual forb	**Annual forb**
Epilobium montanum	Cerastium fontanum
Geranium molle	Epilobium montanum
Graminoid	**Graminoid**
Carex leporina	Agrostis capillaris
Carex nigra	Carex nigra
Juncus effusus	Juncus effusus
Milium effusum	Milium effusum
Perennial forb	**Perennial forb**
Epilobium hirsutum	Epilobium hirsutum
Galium saxatile	Galium saxatile
Lycopus europaeus	Lycopus europaeus
Lythrum salicaria	Lythrum salicaria
Potentilla anserina	Potentilla anserina
Ranunculus acris	Ranunculus acris

Stachys palustris	Stachys palustris
Stellaria alsine	Stellaria graminea
Stellaria graminea	Vicia cracca
Vicia cracca	**Pteridophyte**
Pteridophyte	Equisetum fluviatile
Equisetum fluviatile	

Appendix 10 Litterlayer

Heath	**Heath Rooted**	**Heath Unrooted**	
Litter layer thickness in cm	5,6	17,4	-
Litter layer thickness in cm	7	18,8	-
Litter layer thickness in cm	8,4	20,5	-
Litter layer thickness in cm	6,4	20,6	-
Litter layer thickness in cm	9,3	16,7	-
Average depth in cm	7,34	18,8	-
Meadow (/T) and (/H)	No litter layer	No litter layer	No litter layer
Grassland	No litter layer	No litter layer	-
Meadow/common alder (/T) and (/H)	No litter layer	No litter layer	No litter layer
Open woodland	rooted (/T)	Unrooted(/T)	Unrooted(/H)
Litter layer thickness in cm	8,9	8,7	9,3
Litter layer thickness in cm	13	9,8	10,5
Litter layer thickness in cm	20,4	14,9	10
Litter layer thickness in cm	6,5	8	11,5
Litter layer thickness in cm	4	15,4	6,5
Average depth	10,56	11,36	9,56
Scots pine	**Rooted (/T)**	**Unrooted (/T)**	**Unrooted (/H)**
litter layer thickness in cm	9,1	17,6	6,5
litter layer thickness in cm	7,3	14,3	4,5
litter layer thickness in cm	8	18,4	4,6
litter layer thickness in cm	10,2	15,1	3,9

litter layer thickness in cm	6,3	15,3	6,2
Average depth	8,16	16,14	5,14
Swamp forest	Could not be measured	Could not be measured	-

Appendix 11 Total species list for individual treatments

CF/T	CUF/T	RF/T	RUF/T	CF/H	CUF/H
Annual forb	**Annual forb**	**Annual forb**	**Annual forb**	**Annual forb**	**Annual forb**
Cardamine flexiosa	Cerastium fontanum	Arabidopsis thaliana	Anagalliis arvensis	Cerastium fontanum	Cerastium fontanum
Cerastium fontanum	Galeopsis tetrahit	Arenaria serphyllifolia	Arabidopsis thaliana	Epilobium montanum	Epilobium montanum
Epilobium montanum	Galium aparine	Capsella bursa-pastoris	Arenaria serphyllifolia	Geranium molle	Geranium molle
Impatiens noli-tangere	Impatiens noli-tangere	Cardamine flexiosa	Capsella bursa-pastoris	**Coniferous tree**	**Coniferous tree**
Polygonum aviculare	Moehringia trinerva	Cardamine hirsuta	Cardamine flexiosa	Pinus sylvestris	Pinus sylvestris
Polygonum sp	Myosotis stricta	Cerastium fontanum	Cerastium fontanum	**Deciduous tree**	**Deciduous tree**
Stellaria media	Polygonum sp	Epilobium montanum	draba verna	Fagus sylvatica	Fagus sylvatica
Coniferous tree	Sagina procumbens	Euphrasia stricta	Galeopsis tetrahit	Sorbus aucuparia	Sorbus aucuparia
Picea sitchensis	Stellaria media	Galeopsis tetrahit	Geranium molle	**Graminoid**	**Graminoid**
Pinus Sylvestris	Veronica arvensis	Geranium molle	Gnaphalium uliginosum	Agrostis capillaris	Agrostis capillaris
Deciduous tree	**Coniferous tree**	Geranium pusillum	Impatiens noli-tangere	Anthoxanthum odoratum	Anthoxanthum odoratum
Crataegus monogyna	Picea sitchensis	Gnaphalium uliginosum	Moehringia trinerva	Carex arenaria	Carex arenaria

Fagus sylvatica	Pinus sylvestris	Impatiens noli-tangere	Myosotis stricta	Carex leporina	Carex leporina
Sorbus aucuparia	**Deciduous tree**	Moehringia trinerva	Polygonum aviculare	Carex nigra	Carex nigra
Graminoid	Betula pubescens	Myosotis stricta	Polygonum sp	Dechampsia flexuosa	Dechampsia flexuosa
Agrostis capillaris	Fagus sylvatica	Polygonum aviculare	Sagina procumbens	Holcus lanatus	Holcus lanatus
Anthoxanthum odoratum	Quercus robur	Polygonum sp	Stellaria media	Juncus effuses	Juncus articulatus
Calamagrostis epigejos	Sorbus aucuparia	Sagina procumbens	Veronica arvensis	Lolium perenne	Juncus effusus
Carex arenaria	**Graminoid**	Senecio vulgaris	Veronica persica	Milium effusum	Lolium perenne
Carex leporina	Agrostis capillaris	Stellaria media	**Coniferous tree**	**Half-shrub**	Milium effusum
Carex nigra	Anthoxanthum odoratum	Veronica arvensis	Picea sitchensis	Rubus idaeus	**Half-shrub**
Carex remota	Calamagrostis epigejos	**Coniferous tree**	Pinus sylvestris	**Perennial forb**	Rubus idaeus
Dechampsia flexuosa	Carex arenaria	Pinus sylvestris	**Deciduous tree**	Anemone nemorosa	**Perennial forb**
Festuca pratensis	Carex demissa	**Deciduous tree**	Alnus glutinosa	Cardamine pratensis	Bellis perennis
Festuca sp	Carex leporina	Alnus glutinosa	Betula pubescens	Epilobium hirsutum	Cardamine pratensis
Holcus lanatus	Carex nigra	Betula pubescens	Fagus sylvatica	Galium saxatile	Circium arvénse
Juncus effusus	Carex remota	Fagus sylvatica	Prunus padus	Lycopus europaeus	Epilobium hirsutum
Lolium perenne	Cynosurus cristatus	Quercus robur	Quercus robur	Lythrum salicaria	Galium saxatile

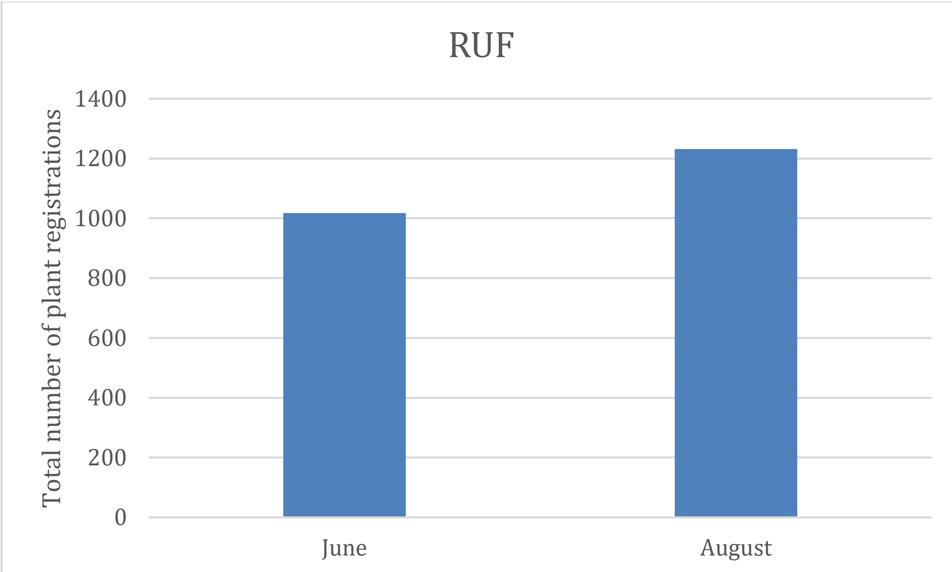
Luzula Pilosa	Dechampsia flexuosa	Sorbus aucuparia	**Graminoid**	Maianthemum bifolium	Hieracium pilosella
Milium effusum	Festuca pratensis	**Graminoid**	Agrostis capillaris	Oxalis acetocella	Leontodon autumnalis
Phleum pretense	Festuca rubra	Agrostis capillaris	Anthoxanthum odoratum	Plantago lanceolata	Lycopus europaeus
Phragmites australis	Holcus lanatus	Anthoxanthum odoratum	Calamagrostis epigejos	Potentilla anserina	Lythrum salicaria
Scirpus sylvaticus	Juncus effusus	Calamagrostis epigejos	Carex arenaria	Ranunculus acris	Maianthemum bifolium
Half-shrub	Lolium perenne	Carex arenaria	Carex canescens	Stachys palustris	Medicago lupulina
Rubus idaeus	Luzula campestris	Carex canescens	Carex nigra	Stellaria alsine	Oxalis acetocella
Vacciinium vitis-idea	Milium effusum	Carex leporina	Carex remota	Stellaria graminea	Plantago lanceolata
Vaccinium ulignosum	Phleum pratense	Carex nigra	Dactylis glomerata	Stellaria holostea	Potentilla anserina
Perennial forb	Phragmites australis	Carex remota	Dechampsia flexuosa	Taraxacum officinale	Prunella vulgaris
Achillea ptarmica	Scirpus sylvaticus	Dechampsia flexuosa	Festuca rubra	Trientalis europaea	Ranunculus acris
Anemone nemorosa	**Half-shrub**	Festuca pratensis	Festuca sp	Trifolium pratense	Rumex acetosella
Cardamine pratensis	Rubus idaeus	Festuca sp	Holcus lanatus	Veronica Serpyllifolia	Stachys palustris
Galium saxatile	Vaccinium ulignosum	Holcus lanatus	Juncus effusus	Vicia cracca	Stellaria graminea
Galium sylvaticum	**Perennial forb**	Juncus effusus	Lolium perenne	**Ptridophyte**	Stellaria holostea
Galium verum	Achillea millefolium	Lolium perenne	Luzula campestris	Equisetum fluviatile	Taraxacum officinale

Leontodon autumnalis	Achillea ptarmica	Luzula campestris	Milium effusum	Ptreridium aquilinum	Trientalis europaea
Linaria vulgaris	Anemone nemorosa	Luzula multiflora	**Half-shrub**		Trifolium pratense
Oxalis acetocella	Circium arvénse	Milium effusum	Calluna vulgaris		Vicia cracca
Plantago lanceolate	Galium saxatile	**Half-shrub**	Erica tetralix		**Ptridophyte**
Plantago major	Galium sylvaticum	Calluna vulgaris	Rubus idaeus		Dryopteris carthusiana
Potentilla anserine	Leontodon autumnalis	Erica tetralix	Vaccinium ulignosum		Equisetum fluviatile
Prunella vulgaris	Maianthemum bifolium	Rubus idaeus	**Perennial forb**		Ptreridium aquilinum
Ranunculus acris	Oxalis acetocella	Vaccinium ulignosum	Achillea millefolium		
Rumex acetosella	Plantago lanceolata	**Perennial forb**	Achillea ptarmica		
Stellaria graminea	Plantago major	Achillea millefolium	Anagalliis arvensis		
Stellaria holostea	Potentilla anserina	Achillea ptarmica	Anemone nemorosa		
Taraxacum officinale	Prunella vulgaris	Calamintha nepeta	Calamintha nepeta		
Trientalis europaea	Ranunculus acris	Campanula rotundifolia	Campanula rotundifolia		
Trifolium pretense	Rumex acetosella	Chamerion angustifolium	Chamerion angustifolium		
Veronica chamaedrys	Stellaria graminea	Circium arvénse	Circium arvénse		
Vicia cracca	Stellaria holostea	Galium saxatile	Galium saxatile		

Ptridophyte	Taraxacum officinale	Leontodon autumnalis	Galium verum		
Dryopteris carthusiana	Trientalis europaea	Linaria vulgaris	Leontodon autumnalis		
Equisetum sp	Trifolium pratense	Lotus corniculatus	Linaria vulgaris		
Ptreridium aquilinum	Urtica dioica	Medicago lupulina	Maianthemum bifolium		
	Veronica chamaedrys	Oxalis acetocella	Medicago lupulina		
	Veronica Serpyllifolia	Plantago lanceolata	Oxalis acetocella		
	Vicia cracca	Plantago major	Plantago lanceolata		
	Ptridophyte	Potentilla anserina	Plantago major		
	Dryopteris carthusiana	Potentilla erecta	Potentilla anserina		
	Equisetum palustre	Prunella vulgaris	Prunella vulgaris		
	Ptreridium aquilinum	Ranunculus acris	Ranunculus acris		
		Rumex acetosella	Rumex acetosella		
		Stellaria alsine	Stellaria alsine		
		Stellaria graminea	Stellaria graminea		
		Taraxacum officinale	Stellaria holostea		
		Trientalis europaea	Taraxacum officinale		
		Trifolium pratense	Trientalis europaea		

		Trifolium repens	Trifolium pratense			
		Urtica dioica	Trifolium repens			
		Veronica chamaedrys	Urtica dioica			
		Veronica Serpyllifolia	Veronica chamaedrys			
		Vicia cracca	Veronica Serpyllifolia			
		Ptridophyte	Vicia cracca			
		Equisetum palustre	Viola odorata			
		Ptreridium aquilinum	viola tricolor			
			Ptridophyte			
			Dryopteris carthusiana			
			Equisetum palustre			
			Ptreridium aquilinum			

Appendix 12 plant registrations rooted fenced treatment June and August

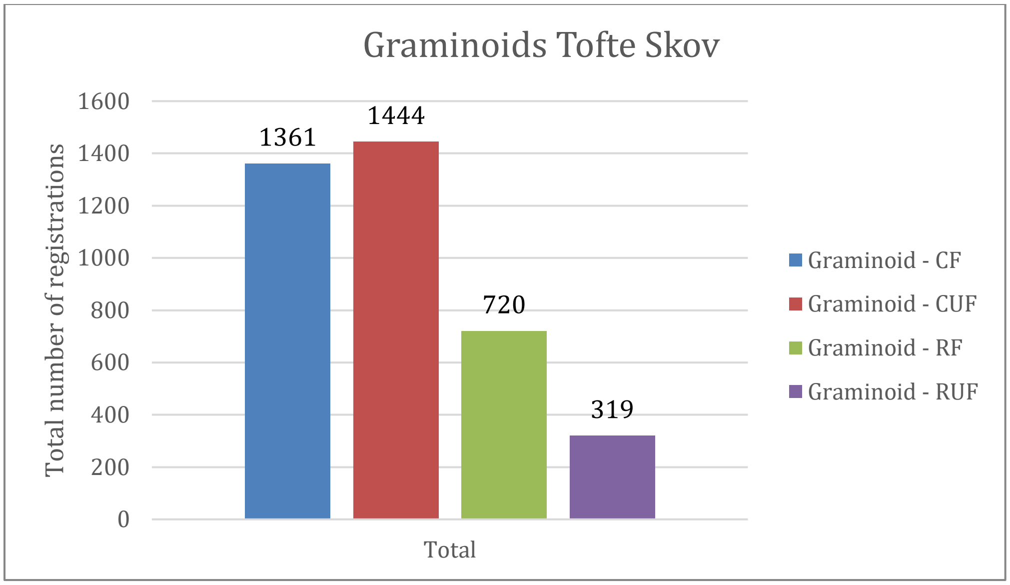


Appendix 13 Soil pH

Table 16 Laursen (2018)

Site	pH rooted	pH unrooted
Grassland	4,4	4,16
Meadow	5,29	5,5
Open wood land	5,78	3,76
Scots pine	3,29	2,9
Bracken	3,21	3,13

Appendix 14 total number of graminoids registrations



Appendix 15 graminoids heath and open woodland