Treatment of Birch Plantations in Southern Sweden with Browsing Repellents

Behandling av Björkplanteringar i Södra Sverige med Viltrepellenter

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Treatment of Birch Plantations in Southern Sweden with Browsing Repellents. Effectiveness of Trico as a browsing repellent on birch over three seasons

Behandling av björkplanteringar i södra Sverige med viltrepellenter. Effekten av behandling av Trico som viltrepellent på björk över tre årstider

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Abstract

Sweden is a forested country with 4 different cervid species. Browsing is a problem for Swedish forestry and there is a need for protecting seedlings. The main production species in Sweden is Norway spruce and Scots pine while birch is underused in Swedish forestry. However, there are signs of increased interest but there is an issue by birch being browsed by cervids. Trico is a browsing repellent that may address this problem and works using odour.

This thesis attempts to answer the following questions: Does browsing repellent against cervids in Sweden when applied to birch in early summer last and function until fall and the following winter? Whether browsing repellent applied in the fall protect the birch during winter, and remain effective in the following spring? Does application on birch both in early summer and fall provide better protection compared to application once in either season? It is hypothesised that Trico will not influence other damages or seedling morphology.

This study showed that Trico has worked as a browsing repellent against cervids for summer browsing. As there was no observed browsing during late fall and winter there was no need for repellants. Trico cover was sufficient in the spring inventory for seedlings treated in the fall but not for seedlings treated in summer only. This indicates that fall treatment may be active during next summer, but further research needs to be done on this. In this study Trico showed not to influence seedling morphology or other damage.

Abstrakt

Sverige är ett land med mycket skog och har 4 olika arter klövdjur. Bete av klövdjur är ett problem för svenskt skogsbruk, och det behövs skydd för nyplanterade plantor. Björk är en art i Sverige som hade kunnat användas mer. Det finns tecken på ökat intresse för björk men bete av klövdjur är ett problem. Trico är en viltrepelent som fungerar genom att göra en motbjudande lukt.

Den här tesen försöker att besvara följande frågor: Håller och fungerar viltrepellenter mot hjortdjur i Sverige, när det appliceras på björk under försommaren, fram till hösten och den efterföljande vintern? Skyddar viltrepellenter, som appliceras på hösten, björk under vintern, och kvarstår effekten under den följande våren? Ger applicering på björk både under försommaren och hösten ett bättre skydd jämfört med applicering endast en gång under någon av dessa säsonger? En hypotes är att andra skador och form inte kommer påverkas av Trico.

Studien visade att Trico fungerade som ett viltrepellent mot hjortdjur vid sommarbete. Eftersom inget bete observerades under hösten och vintern fanns det inget behov av viltrepellent under denna period. Täckningen av Trico var tillräcklig vid vårinventeringen för plantor som behandlats på hösten, men inte för plantor som endast behandlats på sommaren. Detta indikerar att höstbehandling kan ha effekt under nästkommande sommar, men ytterligare forskning behövs för att undersöka detta. Andra skador och form påverkades inte av Trico i den här studien.

Keywords: Birch, Trico, Cervid, Browsing,

Abbreviation	Description
SLU	Swedish University of Agricultural Sciences
Birch	Silver birch, *Betula pendula*
Spruce	Norway spruce, *Picea abies*
Pine	Scots pine, *Pinus sylvestris*
S	*Spring treatment, from inventory time spring 2026*
F	*Fall treatment, from inventory time spring 2026*
S & F	*Spring and fall treatment, from inventory time spring 2026*
U	*Untreated, from inventory time fall 2025*
T	*Treated, from inventory time fall 2025*

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1. Introduction

In southern Sweden the main species in the forest is Norway spruce (*Picea abies*) (SLU, 2023). Scots pine (*Pinus sylvestris)* and Norway spruce compose 81.9% and birch (*Betula spp*) 10.6% showing these conifers are the dominating (SLU., 2023). This is a potential problem as it creates a high dependence on a two tree species, which can be risky especially with climate change. Having birch as an alternative would spread the risk.

Southern Sweden has had a large increase of Norway spruce in the last century (Lindbladh et al., 2014) and is not native in the most southern part of Sweden (southern Skåne) (Brunet & Berlin., 2004). An option would be to replace Norway spruce with silver birch (*Betula pendula*) as it is native to the area.

Browsing damage is one of the main challenges in Swedish forestry and is one of the factors limiting the use of birch. Severe damage from browsing cause significant decrease in growth and survival of birch trees (Sisenis et al., 2016). Rotation length may be more than double the time for birch that have been heavily browsed, compared to an area with moderate to low browsing (Sisenis et al., 2016). Thus, in areas with high browsing pressure birch silviculture may no longer be economically viable (Sisenis et al., 2016).

Sweden has 4 main species of ungulates in the landscape, moose (*Alces alces*), red deer (*Cervus elaphus*), fallow deer (*Dama dama*) and roe deer (*Capreolus capreolus*) (Zvirgzdins et al., 2025c). In southern Sweden, around 12% of the inventoried silver birch main stems in young stands were browsed by moose. This was estimated from productive forest land, with an average height of 1-4 meters where at least 10% of the main stems consists of birch or pine (SLU., 2023).

The environment plays a crucial role in the browsing pressure, conditions such as snow, deer density, forage availability and deer health make it hard to estimate how much the browsing pressure will be in an area (Curtis & Eshenaur., 2022).

Moose diet varies seasonally and regionally (Czernik et al., 2013). Most abundant food in the summer for deer in Sweden was birch, willow (*Salix caprea*) and year around *Vaccinium* shrubs (Spitzer et al., 2025) whilst Scots pine is mostly browsed in the winter (Bergström & Vikberg., 1992).

To make birch more attractive to Swedish forest owners the problem with browsing needs to be solved (Liziniewicz., 2022). Swedish forest owners have a generally negative impression of birch plantations because of the low production of naturally regenerating birch and high initial cost for planting (Liziniewicz., 2022). Although recently it seems that the interest has grown with an increase of 75% of bought seedlings from 2024 to 2025, and a general trend of increased purchasing of birch seedlings since 2017 (Skogsstyrelsen., 2025b).

To combat browsing there are a few alternatives such as fencing and repellents. Fencing can be made of a variety of materials and can be removed after the birches are out of the browsing window (above the height of moose being able to browse). However, it is often high cost and high maintenance, (Zvirgzdins., 2025a) especially when protecting large areas (Zvirgzdins., et al, 2025b).

Therefore, there is need of a repellent if birch is to be planted on a large scale. Repellents work by making the plants less attractive to browse compared to unprotected plants (Curtis & Eshenaur., 2022). However, predicting what the deer will eat and prefer as forage is difficult (Curtis & Eshenaur., 2022).

In this study the repellent Trico will be assessed. Trico is an ungulate repellent consisting of a mixture of emulsified sheep fat and glue, which is intended to repel cervids from browsing (Williams., 2025). Trico has been shown to influence browsing of pine (Seppi., 2019), but the effect it has on birch is not documented. The long-term effectiveness of Trico and effectiveness in difficult climates with rain and snow is also not well documented (Dehmani., 2025).

As browsing pressure varies seasonally, and climatic conditions varies in the Swedish landscape the timing and duration of repellent application is important for it to be effective. How long the effectiveness of Trico lasts on birch in Swedish conditions is unknown. Thus, it is important to observe how application timing affects the effectiveness of Trico.
The research questions are the following:

- Does browsing repellent against cervids in Sweden applied to birch in early summer last and function until fall and the following winter?
- Does browsing repellent applied in the fall protect the birch during winter, and does the effect remain in the following spring?
- Does application on birch both in early summer and fall provide better protection compared to application once in either season?

It is hypothesized that other damage such as abiotic, insect and other mammalian damage will not be affected by the Trico treatment.

1.1 Silviculture of birch in Sweden

The main use of birch in Sweden is for pulp and fuelwood, this is due to the birches often being naturally regenerated and therefore have poorer growing qualities (Liziniewicz et al., 2022). However, when planted it is usually done with containerized 1 year old seedlings, with a planting density of around 1600-2500 seedlings per hectare (Hynynen et al., 2010), and the aim is to have about 1500-1800 main stems per hectare at the height of 1.3 meters (Skogsstyrelsen., 2025c) and (Zvirgzdins., 2025a). Planting is often done 1-2 years after final felling (Hynynen et al., 2010).

Since 2017 Sweden has had an increase of purchased birch seedlings, 6.6 million being the latest recording of delivered birch seedlings (Skogsstyrelsen., 2025b). Yet this is still small compared to the amount of Scots pine 206 million and Norway spruce 155 million (Skogsstyrelsen., 2025b). Finland and the Baltic countries have an industry for premium birch products, this could be a possibility for Sweden as well if more active management of birch was done (Liziniewicz et al., 2022).

Forests around the world are vital to combat climate change by taking up carbon from the atmosphere and sustainable future forest production is important for mitigating climate change (Zvirgzdins., 2025a). An increased use of planted silver birch in Sweden could contribute to secure future forest production. Compared to spruce, birch can support biodiversity better as there are more species and greater variety in a birch stand compared to a pure spruce stand (Humphrey et al., 1998). Pure birch stands create a different habitat for animal and flora communities compared to mixtures of spruce and pure spruce (Humphrey et al., 1998).

1.2 Cervids

To combat browsing one must understand browsing behaviours and patterns. Moose strongly affects vegetation in Sweden and causes significant damage to forest, especially in winter (Bergström & Vikberg., 1992). Moose browse on a wide variety of food available in the landscape including both young forest and older forest stands and food in non-forest land (Bergqvist et al., 2018). Scots pine is the most common winter browse for moose while birch is browsed throughout the year (Bergström & Vikberg, 1992). Birches are a medium preference for moose, yet due to their abundance in Sweden, especially on clearcuts, they constitute a large part of their diet (Danell et al., 1985).

Moose is very selective with its food choice and actively searches for the most palatable food source (Czernik et al., 2013), and their diet depends on food availability and quality (Hambeson et al., 2025). Juvenile birches are browsed the most by moose (Danell et al., 1985).

In southern Sweden damage by other cervids than moose is also relevant (Pfeffer et al., 2021). Roe deer and rodents may also cause great damage to seedlings (Hynynen et al., 2010). Roe deer and moose occupy the same habitat but have different niches (Cederlund & Nyström., 1981). Roe deer consume more plants in the field layer but start browsing instead of feeding on ground vegetation when snow depths exceed 50 cm (Cederlund & Nyström., 1981). Red deer diet changes seasonally with birch consumption increasing in the summer (Czernik et al., 2013).

1.3 Browsing and damage

Browsing on birches causes decreases in height and stem diameter, it also causes changes in form and biomass allocation (Bergström & Danell., 1987). Over time it has a negative effect on the stem straightness and the amount of spike knots below two meters (Sisenis et al., 2016). Birch stem breakage is common when moose browse in winter, not only when there is a shortage of browse (Bergström & Vikberg., 1992). Studies suggest that birch generally recovers well after browsing (Hynynen et al., 2010) and survival of browsed birches can still be high after 3 years (Zvirgzdins et al., 2025b). Browsing may also introduce fungi and reduce the quality of the timber due to discoloration (Sisenis et al., 2016).

Other damages that can affect the growth and survival of birch are fungal diseases which causes wilting and discolouration (Lilja, A,. et al 2010). Abiotic factors such as frost, drought and oxygen deficiency also cause damage (Prozherina et al., 2003) (Gansert., 2003). Hare and rodent damages may also occur (Jordan & Rushmore., 1969) as well as insect damages (Kaya et al., 2026).

1.4 Trico

Because of the problems of browsing as mentioned before there is a need to protect the birch seedlings. The deterrent effect of Trico has been found for pine in other studies (Seppi., 2019). But there have not been many studies done on birch.

One of the things that is good with Trico compared to other browsing repellent products is how long lived it is, it has been shown that it is active in up to 3 months in areas with high to moderate amounts of browsing (Curtis & Eshenaur, 2022). Trico has shown to deter cervids from untreated pine seedlings in stands that have been treated (U. Nilsson, personal communication).

This makes Trico a viable alternative to fencing, which is a very expensive, yet it cannot be applied in rain, snow or icy conditions (Curtis & Eshenaur, 2022). It is also easy to use compared to other browsing repellents as it is pre-mixed (Curtis & Eshenaur, 2022).

Trico contains 6.4% sheep fat which is made of primarily triglycerides and mostly as fatty acids (Dehmani, 2025). Trico relies on odour as a deterrent as the repellent against deer, which is caused by the triglycerides degrading which releases odour (Dehmani, 2025). Trico's recommended doses are 3-4 ml per plant, 10 litres of Trico cost from 1750 SEK to 2000 SEK depending on how much you buy in 2026, this leads to around 0,5 SEK to 0,8 SEK per seedling if sprayed to the correct amount (Skogma, n.d.). For this experiment, it took around one day to treat an area of around 1.5-2 ha, depending on weather conditions, density and terrain.

Habituation can be a problem, which is when the animal becomes used to the repellent and ignores it over time (Dehmani, 2025). Increased seasonal browsing pressure due to low forage availability can mitigate repellent effects and increase the risk of habituation causing the repellent to be less effective (Dehmani, 2025).

2. Material and methods

2.1 Study area

There were 6 different treatment areas in Southern Sweden, in Västra Götaland, Östergötland, Jönköping and Skåne county, see figure 1. There were a total of 1277 birch seedlings inventoried, and areas of plantations varied between 3-7 ha. The birches were planted in the spring of 2025.

To make the maps of treatment areas ArcGIS pro 3.6.1. was used. The maps were transferred to ArcGIS Field Maps before marking treatments in the field.

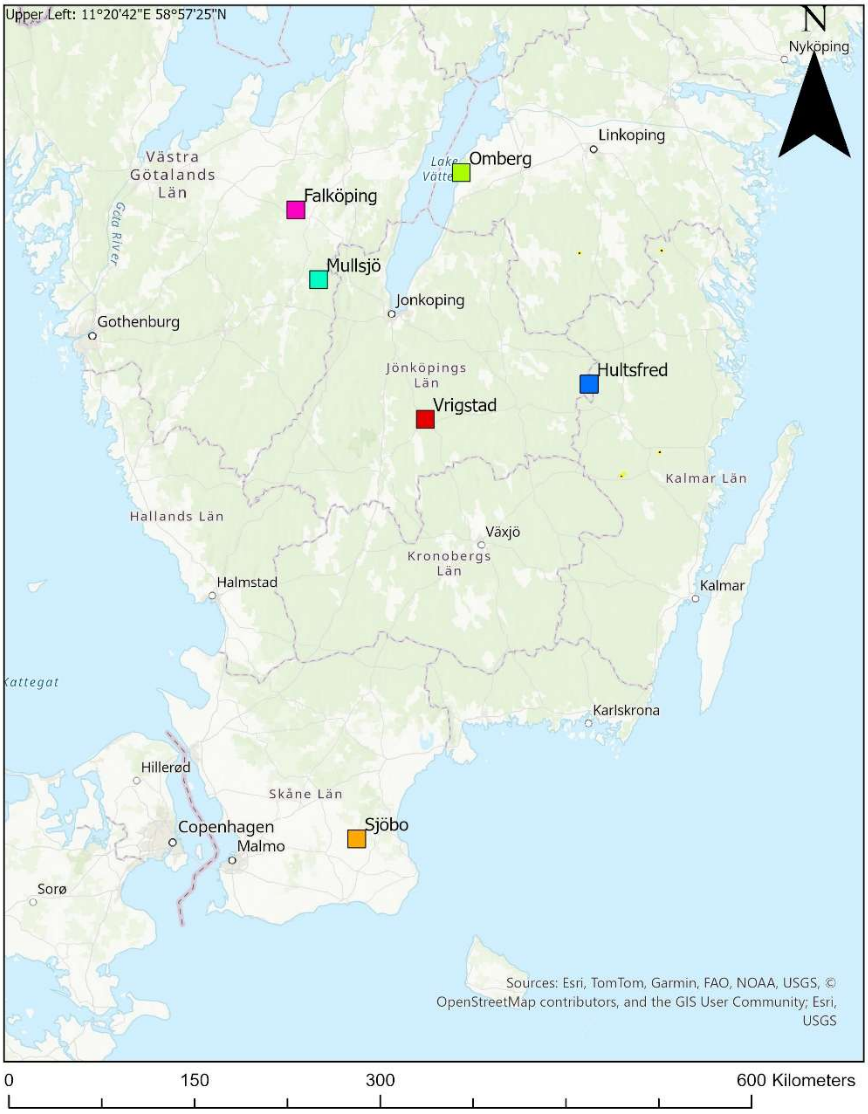

Figure 1. Map over the different sites.

2.2 Experiment layout

Every plantation was split into 5 treatment areas but only 4 areas were used in this project. Treatments were randomly assigned to treatment areas. The treatment areas varied in size between 0.75 and 1 ha. The treatments were.

1. Untreated control (C).
2. Trico treated early summer (S).
3. Trico treated fall (F).
4. Trico treated early summer and fall (S & F).

Trico application was done with a backpack sprayer. The summer treatment (S) was done in the period mid-late June 2025 and the fall treatment was done in the period September to October 2025 (F). Treatment with Trico was only done if the 24-hour period before and after treatment was without precipitation. Only planted birches were treated.

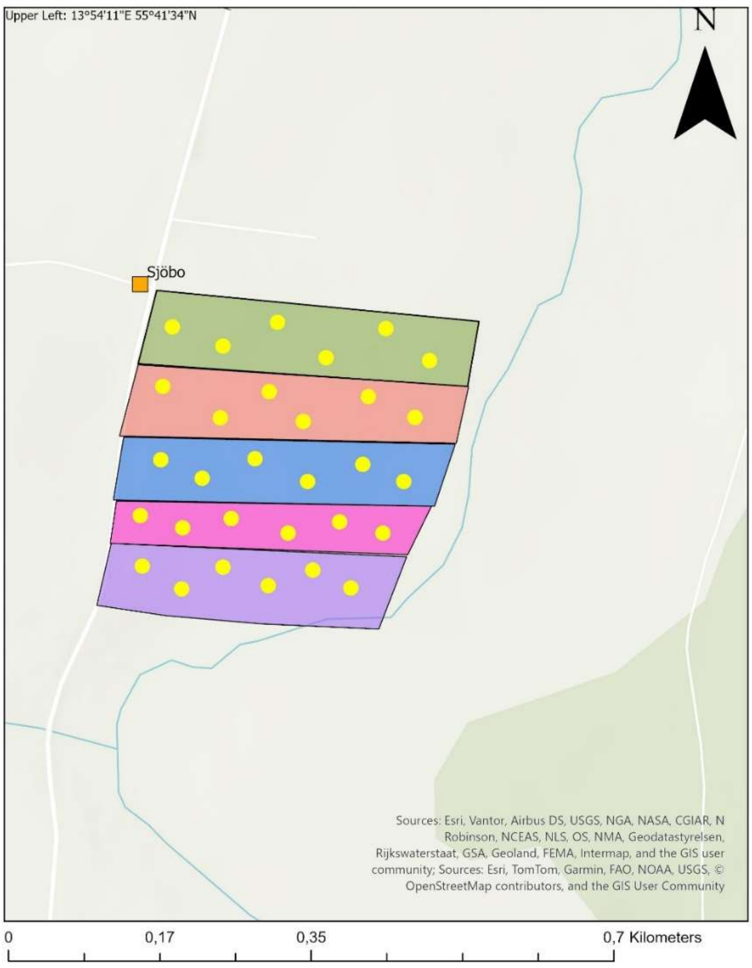

Figure 2. Example of how the plots were laid out, map over Sjöbo treatment area. Yellow dot=circular plot, green = control/ untreated area, blue= treated with Trico summer of 2025, orange= treated with Trico fall of 2025, purple= treated with Trico both in summer and fall of 2025.

2.2.1 Measurements

Six circular plots were marked in ArcGIS Field Maps within each treatment area using a systematic pattern (Table 1). Each plot had a radius of 4 m, corresponding to an area of approximately 50 m^2. In the field, planted birch seedlings within each circular plot were registered with height, distance to the plot center, compass bearing in degrees, and all observed types of damage (Table 2). Naturally regenerated seedlings were not registered. Seedling height was measured to the tallest living part of the plant. Height of dead seedlings were not registered. The plot center was marked with two colored sticks, and each measured plant was marked with a smaller planting stick. Only planted birch seedlings were measured and marked.

The circular plots were evenly distributed across each treatment area in rows to ensure that the whole area was represented (fig 2). If an obstruction covered most of a circular plot, such as a large rock, an unprepared or unplanted area, a nature conservation area, or another obstacle, the plot was moved perpendicular to the walking direction to a position 4 m from the first planted birch seedling.

Table 1. The plot setup when first approaching the plot in the summer of 2025, these had been done already for the inventory time of fall 2025 and spring 2026.

Overview of plot setup	
Variable	Description
Plot setup	
Plot shape	Circular
Radius (m)	4
Area (m^2)	50,27
Plots per Treatment area	6
Placement	Evenly spaced in rows across Treatment area.
Adjustment rule	If obstructed (rock, unplanted area, conservation area), move perpendicular to walking direction to 4 m in front of first planted birch.
Centre marking	2 colored sticks
Plant marking	1/3 cut coloured stick
Species measured	Planted silver birch

Damage was recorded separately for browsing and pine-weevil damage whereas other damage was recorded with cause and degree of damage. During the summer 2025 inventory, dry leading shoot was not recorded.

Degree of damage caused by pine-weevil and other damage was assessed with a six level scale, where 0 is no damage, 1 minor damage with no impact on growth, 2 slight damage but less than a year reduced growth, 3 damage with more than a year reduced growth, 4 sever damage with risk of death and 5 dead seedling. This was a subjective measurement with an interpretation of how much a seedling would be able to recover in a year, height from previous inventories was used as help in this estimation and a judgement of vitality of the plant.

Browsing damage on top shoot, and branches was done separately. Top shoot browsing was registered as yes or no (Table 3). Browsing on sideshoots were assessed by registering how many sideshoots that had been browsed in a four-level scale where 0 was no browsing, 1 was one to three browsed side shoots, 2 was four to ten browsed side shoots and 3 was more than ten browsed side shoots. As the plants were planted in 2025, they were mostly uniform and are thought to have roughly the same number of branches, depending on development.

Table 2. The different variables for each individual birch, green was registered in the summer inventory, orange were registered in all inventories and black were only registered in the spring of 2026

Variable	Unit / Code	Description
Distance from centre	dm (max 40)	Distance from plot centre
Angle	Degrees (360)	Angle from centre
Height	cm	Height at measurement
Cervid damage (top shoot)	Na/1	Presence or absence
Cervid damage (sideshoots)	Na-3	Severity code
Pine weevil damage	0-5	Damage class
Other damage	Na-9, 99	Cause of damage
Damage degree	Na-6	Overall severity
Form	1-5	Form class
Trico coverage	1-3	Trico coverage

Other damages were classified according to visual signs (Table 3). Fungal diseases were as wilting or discolouring like the descriptions in Lilja et al (2010), frost was bud damage and wilting in accordance to Prozherina et al (2003), drought was wilting and drying of leaves, oxygen deficiency was leaf loss and waterlogging as explained by Gansert (2003). hare was damage to the stem as explained by Jordan & Rushmore (1969), damage from cervid other than browsing which could be for example a breakage of the stem and other (figure 3). Other insect damage could be by damage to the leaf and paths of insects inside the leaf.

Table 3. The descriptions of the unit/codes, greens browsing damage, purple other damage, light blue damage degree, brown stem form, dark blue Trico coverage, grey pine weevil damage.

Cervid Side-shoot damage

Code	Description
Na	No damage
1	1-3 browsed sideshoots
2	4-10 browsed sideshoots
3	Above 10 browsed sideshoots

Other damage

Code	Description
Na	No damage
1	Fungi
2	Frost
3	Drought
4	Lack of oxygen
5	Hare
6	Deer/Moose
7	Not used
8	Other insect
9	Unknown
99	Top shoot wilt

Damage degree

Code	Description
Na	No damage
1	Light damage no growth impact
2	Medium damage less than 1 year growth reduction
3	Severe damage more than 1 year growth reduction
4	Very severe risk of death
5	Plant is dead
6	Dead since earlier

Stem Form

Code	Description
1	Straight stem
2	Crooked but continuous
3	Crooked with two leading shoots
4	Crooked with multiple leading shoots
5	Flat top shrub-like form

Trico Treatments

Code	Description
1	Sufficient
2	insufficient
3	Not covered / control

Pine weevil damage

Code	Description
0	No damage
1	Minor no growth impact
2	Slight less than 1 year growth reduction
3	Moderate more than 1 year growth reduction
4	Severe risk of death
5	Girdled

Cervid top-shoot damage

Code	Description
NA	No damage
1	Top shoot browsed

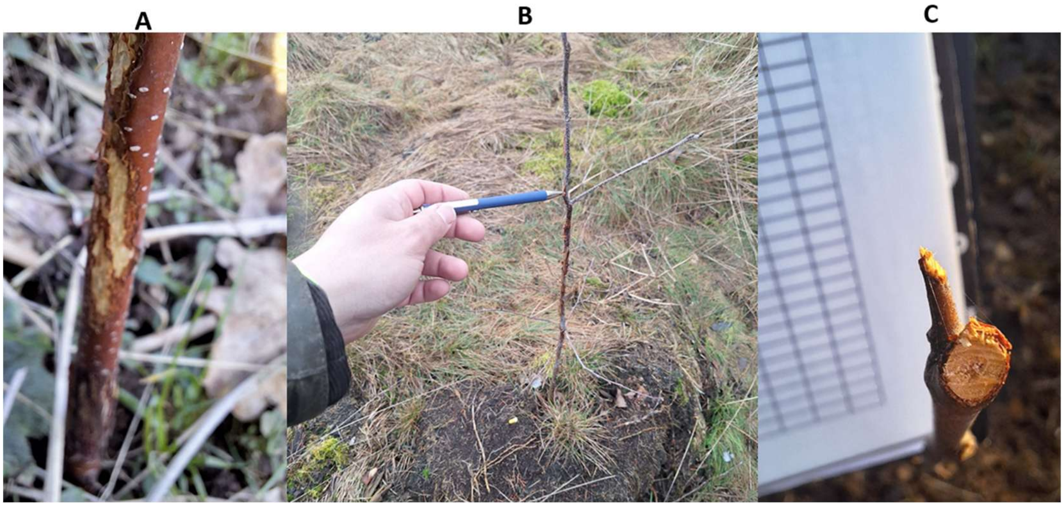

Figure 3.Pictures of damage taken in the inventory time of Spring 2026, (A) vole damage in Sjöbo Treatment area, (B) buck rub damage in Falköping Treatment area, (C) Hare damage in Hultsfred Treatment area.

Stem-form was graded from one to five, with one being the best and five being the worst form. Grade 1 is straight stem, no deformities, grade 2 is crooked but continuous stem, grade 3 is crooked with two leading shoots, grade 4 is crooked with more than 2 leading shoots, grade 5 is flat top due to browsing, shrub-like form, (Figure 4). This was a subjective measurement based on the illustration of figure 4 and descriptions of table 3.

In the measurement in the spring of 2026, Trico on the seedlings were recorded in a three-level scale; no treatment, insufficient treatment and sufficient treatment. No treatment had no visible signs of Trico, insufficient Trico had visible signs of Trico but were fractured or in the wrong place, for example at the base of the seedling. Sufficient treatment had clear visible Trico which covered the top shoot.

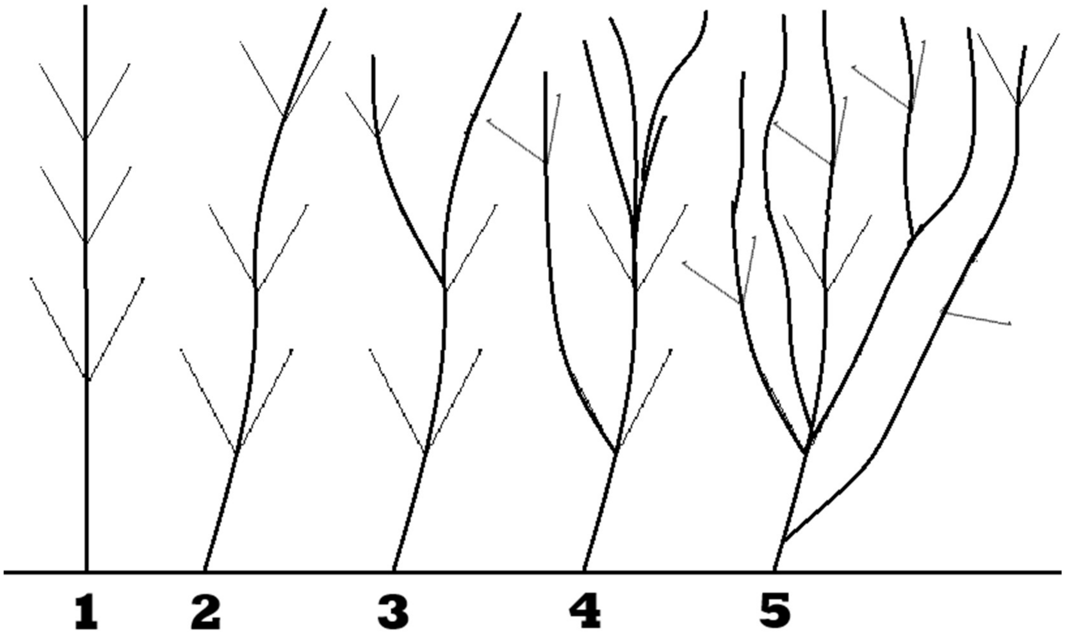

Figure 4.Grade 1 is straight stem, no deformities, grade 2 is crooked but continuous stem, grade 3 is crooked with two leading shoots, grade 4 is crooked with more than 2 leading shoots, grade 5 is flat top due to browsing, shrub-like form.

In the measurement in spring 2026, an index of faecal matter of the different cervid species was recorded. The measurements of faecal dung piles from the 4 cervid species were done using descriptions and pictures of how the faecal matter should look for the different species. The measurement of faecal pellets was done in each circular plot.

The inventory of faecal pellets was done in all circular plots. A circular plot with radius 1.78 m was used for registering the number of fallow deer and roe deer (small deer) excrement whereas a circular plot with a radius of 4 m was used for moose and red deer pellets as recommended by Bergström & Wallin (n.d.) and Svenska jägarförbundet (n.d). For all pellet piles the age of the pile was recorded as fresh pile from the last years leaf fall, old pile, and piles that are hard to define. A fresh pile is often on top of the last years leaves and has different coloration compared to an older pile. Roe deer and fallow deer were put into the same category as they are similar and hard to distinguish from each other and older methods of pellet count have been proven to have a high chance of misidentifying deer species (Spitzer., 2019).

Small deer specific

Roe deer have small pellets from 1 to 1,4 cm in length and 0,7 to 1 cm in width, they are shiny black and glossy when fresh. The droppings are cylindrical and are pointed at one end and rounded at the other (British Deer Society., n.d.).

Fallow deer have medium size pellets from 1 to 1,5 cm in length and 0,8 to 1,2 cm in width, they are more like that of red deer and are oval. They are blackish but turn brown with time (British Deer Society., n.d.). A pile should have a minimum of 10 pellets to be counted.

Red deer specific

Red deer pellets are around 2-2,5 cm long and 1,3- 1,8 cm in width, they are pointed at one end, often found in small piles of around 5 cm in diameter (British Deer Society., n.d.) and (Waldwissen.net., n.d.), see figure 7. The pellets are black and shiny and become dark brown and dull with age (British Deer Society., n.d.). Minimum of 20 pellets to be counted.

Figure 5 Red deer droppings. Photo: Ulrich Wasem (WSL) Waldwissen.net. (n.d.). The red deer (Cervus elaphus). Retrieved February 6, 2026, from https://www.waldwissen.net/en/forest-ecology/forest-and-game/game-ecology/the-red-deer-cervus-elaphus

Moose specific

Moose dropping are rounder in shape and larger around 2-3 cm and pointed at one end (Riistainfo., n.d.). Fresh pellets are covered in slime, in the winter the excrement is dark and in the summer the excrement is greener and looser (Riistainfo., n.d.). Minimum of 10 pellets to be counted.

Index

These findings were put into a table for each area showing an index of how many cervids has occupied the area. This index was then made so that one can understand the local amount of cervids and perhaps correlate that to the damages. They were later calculated into faecal piles per hectare for moose, red deer and small deer.

Overall cervid density for the area was gathered from 2 sites, Viltdata (n.d.), and Naturvårdsverket (n.d.). These were statistics over observed cervid per hour and amount of traffic accidents with cervids. They show over larger areas of Sweden with the one gathered from Viltdata (n.d.) being from counties/regions in Sweden correlating to the places where the inventories were made from 2025. The one from Naturvårdsverket (n.d.) being data over the whole of Sweden from 2019-2025. The numbers on these sites were then put into an Excell file and compared. See appendix G and H. It should be seen as an index of type and number of animals in each region.

2.3 Methods for statistical analysis

The software system R was used for statistical analysis (RStudio version 2023.12.1). The following model was used for the statistical test of browsing, other damage and Trico coverage:

$$Y_{ij} = m + A_i + B_j + \varepsilon_{ij}$$

Where, m=total mean, A_i = random block (site) effect, B_j = fixed effect of Trico treatment and ε_{ij} = random error. Differences among browsing repellent treatments were evaluated using Tukeys (HSD) test following analysis of variance ($p<0.05$).

ChatGPT was used in assisting of writing the R code. All code was reviewed and tested and modified for the correct purposes.

3. Results

Overall survival did not differ statistically between the different treatments (p=0.276) (Fig 7), with an overall mean of 88.7%. The lowest mean survival was observed in the untreated group (hereafter called C for spring 2026 and H25 C for fall 2025) at 86.7%, while the highest was found in the spring treatment (hereafter called S) at 89.4%. However, survival varied considerably between the different areas. Mullsjö had the lowest survival for the fall treatment (hereafter called F), at below 75%, but highest for the C treatment. Whereas Vrigstad had almost 100% survival for F, but just around 75% for spring and fall treatment (hereafter called S & F). The S & F also differed a lot between sites with Falköping having the highest survival for S & F. Due to there being only one treatment per area, it was not possible to perform statistical tests within the sites. For pairwise and mean values for spring 2026 see appendix A.

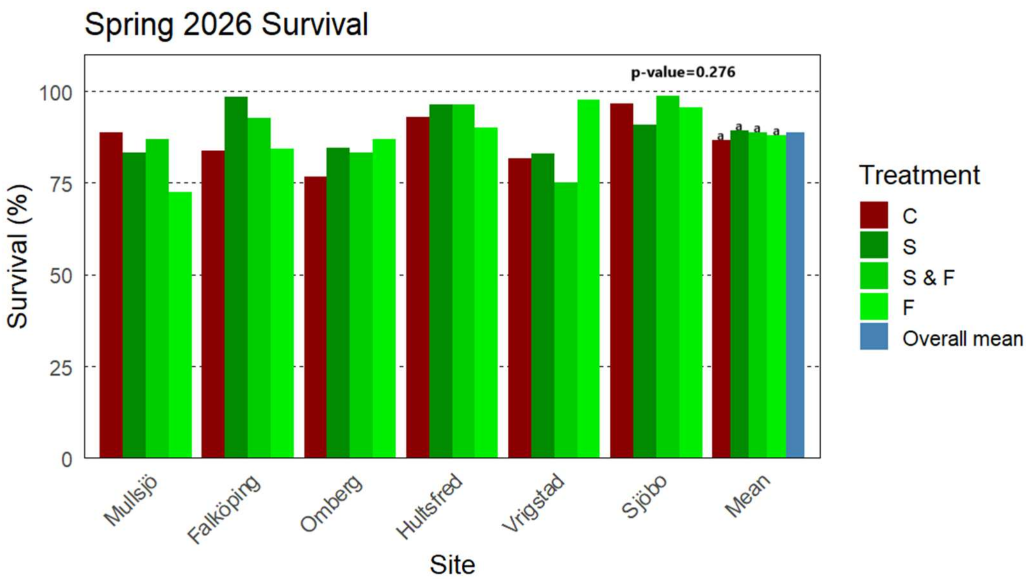

Figure 6. Survival of the birch seedlings in inventory time of spring 2026, red is C "Control" treatment, dark green is S "treated with Trico in Summer/spring 2025", medium green is S & F " treated with Trico in both spring and fall" and light green is F "treated with Trico in fall 2025", light blue is the overall mean. Letters showing results of the Tukey tests. F-value 1.42, residuals 15.

Height did not differ statistically between treatments (Fig 8), with an overall mean of 64.6 cm and a p-value of 0.066. C and F had a mean height of 60.4, S had the highest mean height at 68.3 cm, and the S & F followed with 67.5 cm.

Height varied considerably between the sites. C had the lowest height in half the sites (Falköping, Hultsfred, Vrigstad). C had the tallest mean height in Sjöbo and the second tallest height in Mullsjö. F was similarly the lowest in half the sites (Mullsjö, Omberg, and Sjöbo) and the second lowest in Falköping. F did not have the highest mean height in any of the sites but were second highest in Vrigstad. S was the highest in 1/3 of the sites (Falköping, Hultsfred), the second highest in 1/3 of the sites (Sjöbo, Omberg) and was the second lowest 1/3 of the sites (Mullsjö, Vrigstad). S & F was highest in half the sites (Mullsjö, Omberg, Vrigstad), second highest in 1/3 of the sites (Hultsfred, Falköping) and second lowest in Sjöbo. The highest recorded mean height was observed in Hultsfred for S with 91.7 cm.

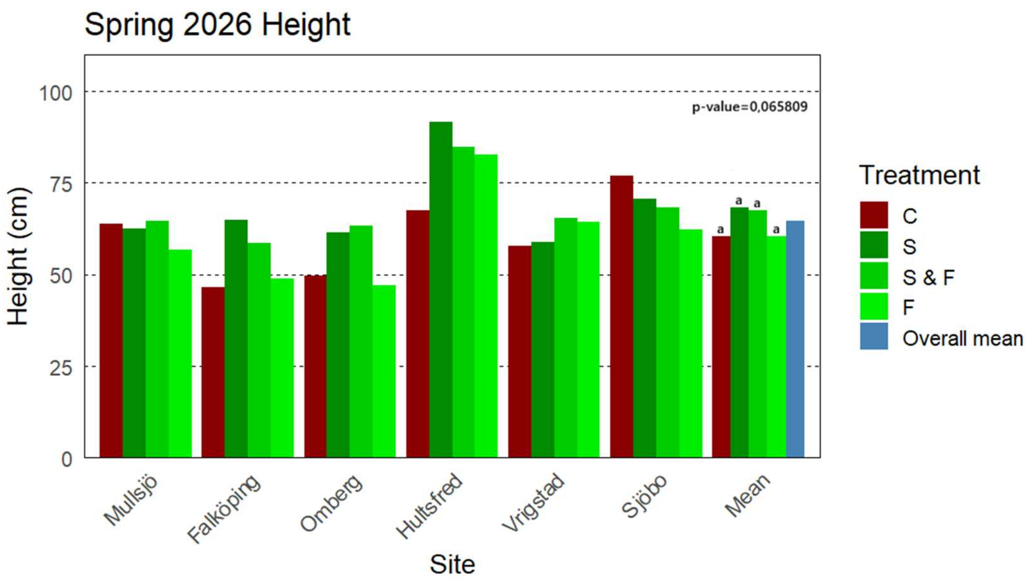

Figure 7. Height of the birch seedlings in inventory time of spring 2026, red is C "Control" treatment, dark green is S "treated with Trico in Summer/spring 2025", medium green is S & F " treated with Trico in both spring and fall" and light green is F "treated with Trico in fall 2025", light blue is the overall mean, letters showing results of the Tukey tests. F= 2.964, residuals=15. Means: C=60.358, F=60.356, S 68.3, S & F,67.5.

Browsing on the leading shoot and side shoots were found primarily during the fall inventory (Fig 9), although some side shoot browsing was recorded during the summer inventory. However, at the summer inventory Trico treatment had not been done so results are not reported for treatments separately. Almost no browsing was recorded during the spring 2026 inventory for either leading shoots or side shoots, no significant difference was observed between the treatments for Anova and Tukey tests for spring 2026 (leading shoot p=0.42 and side shoot p=0.61). For pairwise and mean values for spring 2026 see appendix A.

Focusing on fall 2025, the S and S & F treatments had been treated with Trico in early summer whereas the C and F treatments were untreated. Therefore, these two groups are compared as treated (H25 T) and untreated (H25 C). Top shoot browsing was statistically significantly different between H25 T and H25 C (p=0.00476), but sideshoots did not show statistically significant difference between treatments in fall 2025 (p=0.0877) (Figure 9). All sideshoots 1,2 and 3 were combined in the graphs and test as there were very few of grade 2 and 3.

There was a large variation in browsing between sites (fig 10), with a lot more browsing in Vrigstad on both H25 T and H25 C compared to Mullsjö. Overall, the mean number of browsed seedlings was more than 15% higher in H25 T than in H25 C, primarily due to the higher incidence of browsing on leading shoots. When combined they were statistically significant (Fig 10) (p=0.00565). For pairwise and mean values for fall 2025 see appendix B.

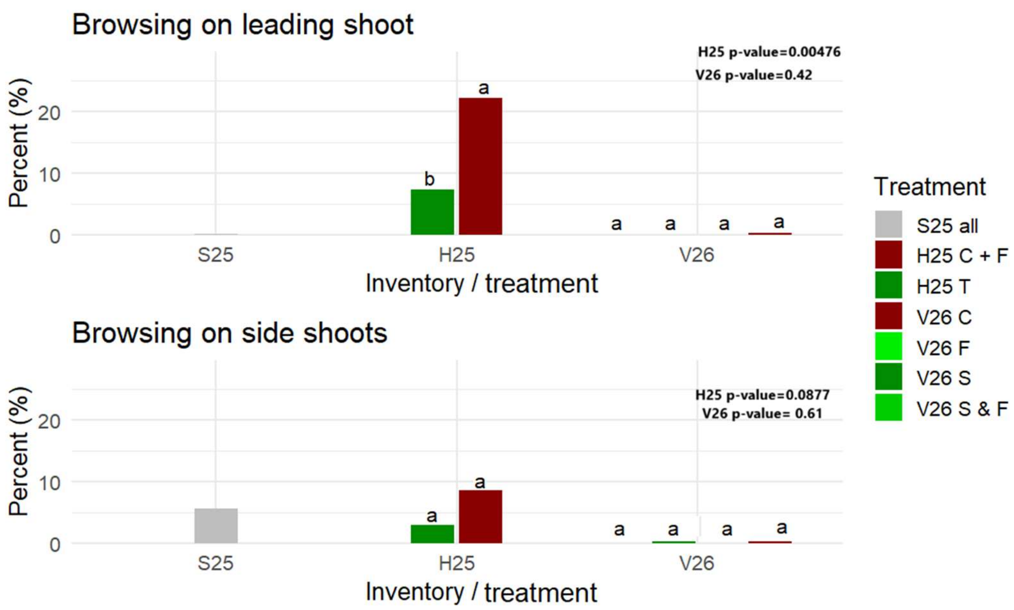

Figure 8. Mean browsing on top shoots (upper panel) and side shoots (lower panel) during the inventory times of summer 2025 (S25 grey), fall 2025 (H25) and spring 2026 (V26). Dark red "control" (C) / untreated in fall 2025 (H25 C), light green "fall" (F) treatment, medium green "spring and fall" (S & F) treatment, dark green "spring" (S) treatment as well as treated in fall 2025, letters showing results of the Tukey tests. P-values in written in the graph.

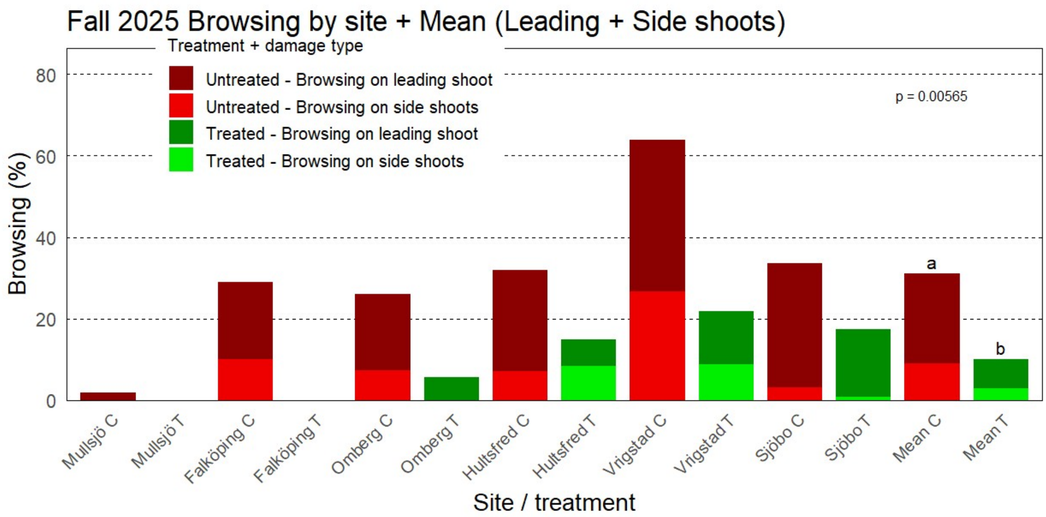

Figure 9, Fall 2025 browsing on leading shoot and side shoots in the treatments. Dark red Browsing on leading shoots, light red browsing on sideshoots for Untreated (H25 C), Dark green Browsing on leading shoots, light green browsing on sideshoots for treated (T), letters showing results of the Tukey tests. P-value 0.00565, F-value 21,499, residuals 5. Means, H25 C 23.56, H25 T= 8,24.

Trico treated seedlings had higher percentage of dead tops in the fall inventory than untreated seedlings, but the difference was not statistically significant (Fig 11) (p=0.268). The amount of dead tops was not statistically significantly different between treatments in the spring measurement (p=0.3074), see means in appendix B.

The proportion of poor form in the spring measurement was relatively similar across treatments and no statistically significant difference between treatments were found (Fig 12) (p=0.8973). Although the overall means were similar, there was considerable variation between the different areas. For example, around 70% of F in Sjöbo showed poor form, whereas only about 20% of C in Falköping had poor form. A form of 2 or above was counted as poor for the tests and graphs, see means in appendix A. For pairwise and mean values for spring 2026 see appendix A.

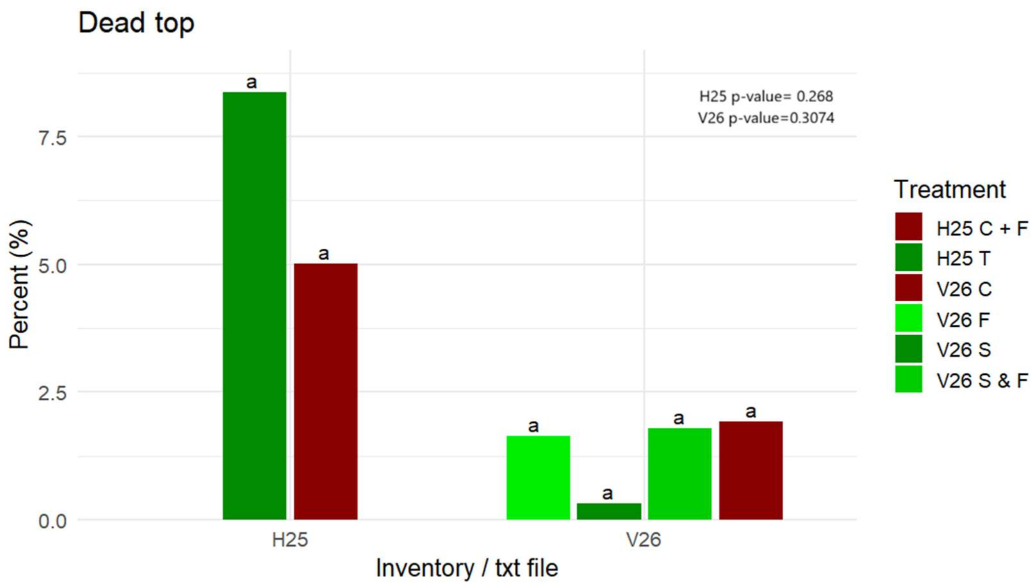

Figure 10. Dead top/ top shoot wilt in the inventory periods of fall 2025 (H25) and spring 2026 (V26), dark green S and T showing treated in the spring of 2025, dark red untreated (control spring 2026 and fall and control fall 2025), light green F (treated fall 2025) medium green S & F (treated in both fall and spring) letters showing difference from Tukey tests. Fall: p-value 0.268, F-value 1,552, residuals 5. Spring: p -value 0.3074, F-value 1.31, residuals 15.

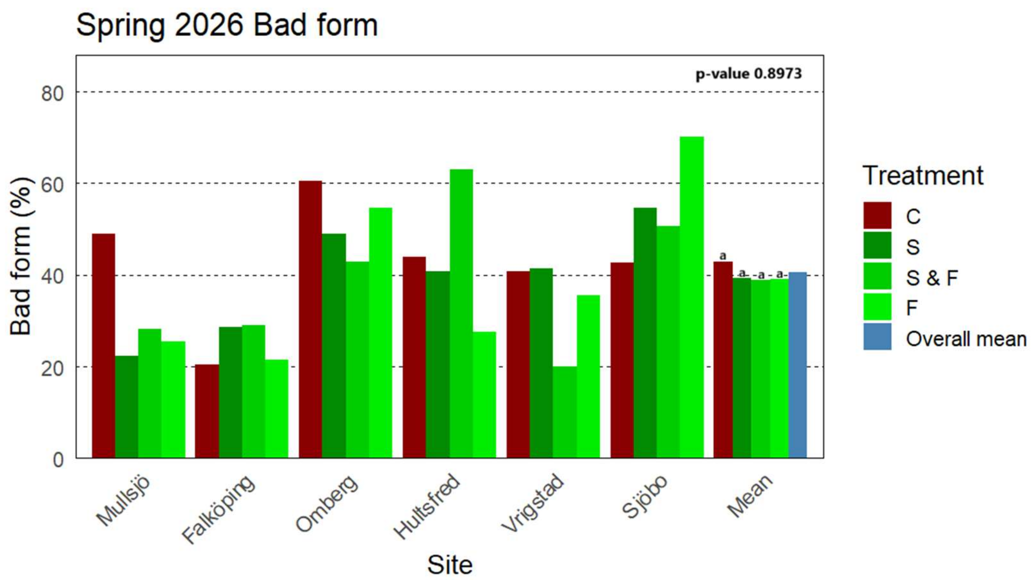

Figure 11. Form of the birch seedlings in inventory time of spring 2026, red is C "Control" treatment, dark green is S "treated with Trico in Summer/spring 2025", medium green is S & F " treated with Trico in both spring and fall" and light green is F "treated with Trico in fall 2025", light blue is the overall mean, letters showing difference from Tukey tests. P-value 0.8973, F-value 0.2, residuals 15.

As expected, there was no coverage of Trico in the C-treatment (figure 13). F and S & F had above 80% of seedlings in the Trico coverage to a sufficient degree. The S-treatment had close to three equal parts of Trico coverage classes, present but insufficient, and no coverage, yet somewhat less in the Trico sufficient category. There was also some difference between the Trico status in the different areas (appendix P). For pairwise and mean values for spring 2026 see appendix A.

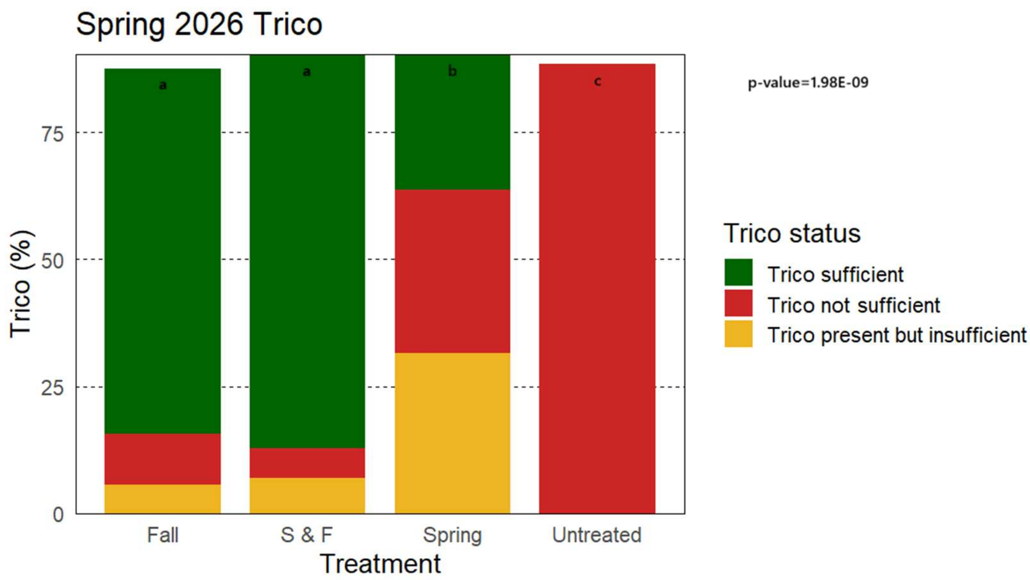

Figure 12. Trico cover on the different treatments and mean Trico cover over the whole experiment. Red is no Trico on plant, yellow is inadequate Trico coverage, green is approved Trico coverage, Fall (F), Spring and Fall (S & F), Spring (S), Untreated (C). letters showing difference from Tukey tests.

Severe damage differed statistically significant between H25 C and H25 T in the fall inventory (p=0.00392) but there was no significant difference between the treatments in the spring inventory (p=0.1141) (fig 14). Overall, for summer 2025 and spring 2026, severe and deadly damage was relatively low, with the highest being C in spring 2026 of around 6%. For pairwise and mean values for spring 2026 see appendix A and fall 2026 appendix B.

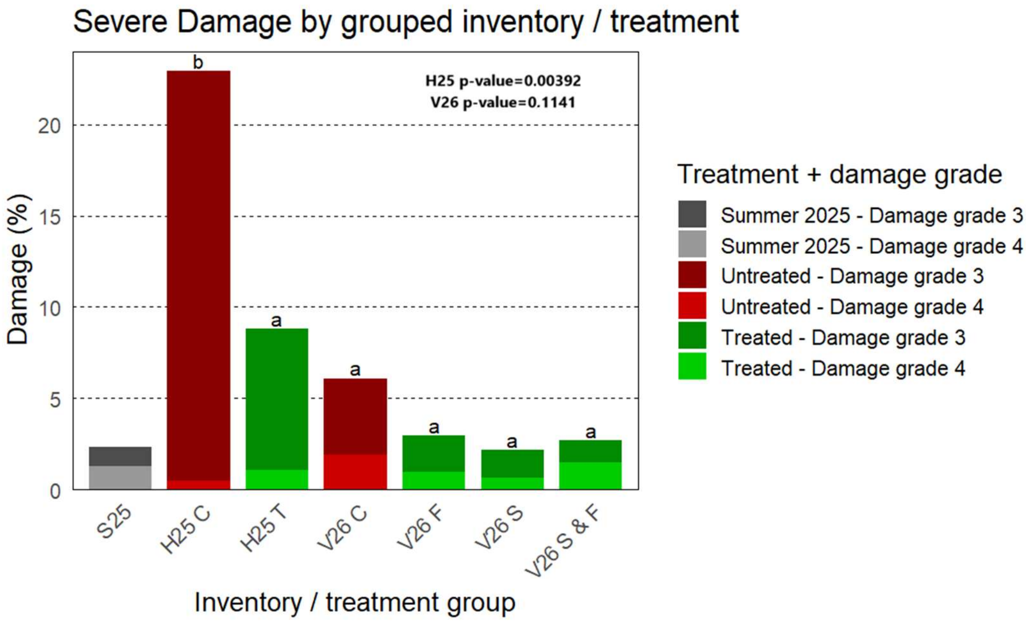

Figure 13. Severe damage over the different inventory periods S25 (summer 2025), H25 (fall 2025), V26 (spring 2026), dark red is untreated grade 3 "Severe damage more than a year growth inhibition" and light red is untreated grade 4 "Deadly damage", dark green is treated grade 3 "Severe damage more than a year growth inhibition" and light green is treated grade 4 "Deadly damage", dark grey is summer 2025 grade 3 "Severe damage more than a year growth inhibition" and light grey is summer 2025 grade 4 "Deadly damage", letters showing difference from Tukey tests.

Generally, for spring the damage types did not differ between treatments (figure 15, top), with dead top, fungi, other mammal damage (mostly vole) and unknown having no statistical difference and pine weevil not being present. There was a lot of hare damage on C, but it was mainly from Hultsfred control treatment (appendix D).

For fall 2025 the differences between the treatments have already been presented previously with browsing damages (figure 9 and 10). Other than this there were no statistical differences between H25 C and H25 T. For the summer 2025 inventory (appendix E) it will have to be looked at more as a whole as the treatment of the plants was done simultaneously as the inventory. There we see damage from unknown at around 12%, side shoot browsing at around a mean of 5% and pine weevil damage of around 4%. We can also see some drought damage in Mullsjö and Falköping and some hare damage in Hultsfred. There is also a clear difference between locations with amount and type of damage.

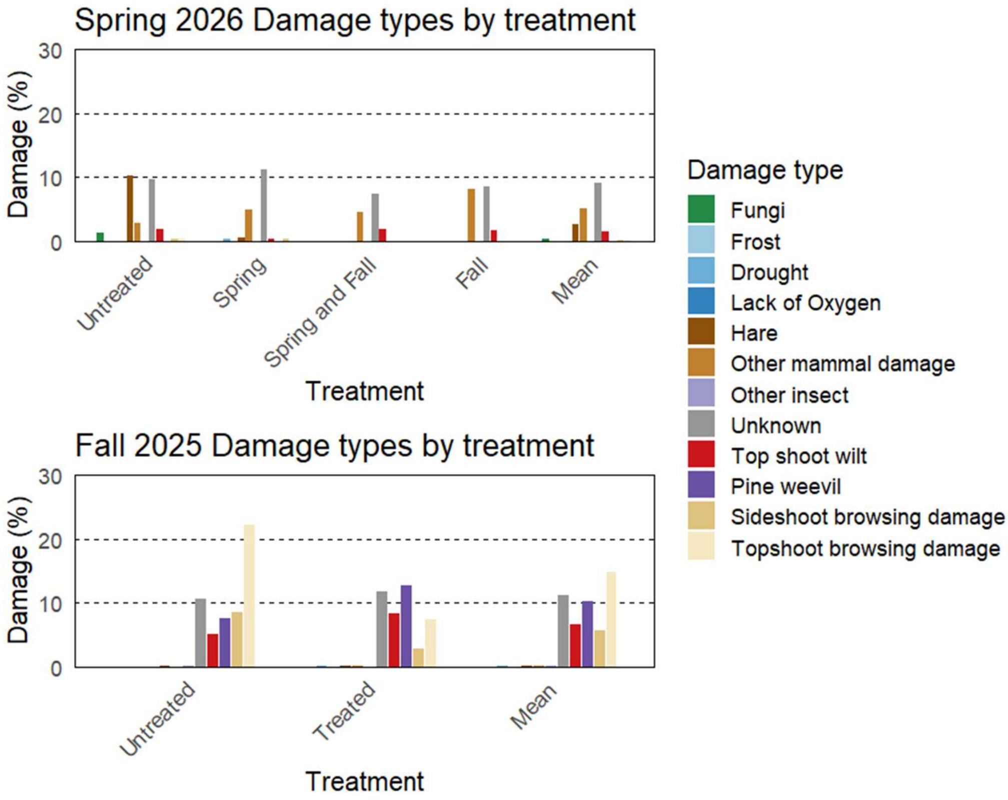

Figure 14. Damage types per treatment and mean spring 2026 (top), damage types per treatment and mean fall 2025 (bottom), green is fungi, blues are abiotic damages (light blue frost, medium blue drought, dark blue lack of oxygen), browns are mammalian damages (dark brown Hare, light brown other mammal damage, tan is sideshoot browsing damage, beige is top shoot browsing damage), purples are insect damage (light purple other insect, dark purple pine weevil), grey is unknown and red is top shoot wilt.

Generally, it appears that cervids do not avoid specific plots when they are sprayed with Trico (Fig 16). The mean number of moose and red deer pellets per ha is low and evenly distributed. Small deer (fallow and roe) showed variation in presence in the different treatment areas but were most abundant in S which is likely due to the large number observed in Omberg (Appendix F), where feeding stations were located close to the plot. The sites showed considerable variation in animal presence, with Vrigstad being the only site where moose were found within the plots. Omberg had a high number of small deer pellets and had high animal activity. Sjöbo, Omberg, and Falköping had some presence of red deer, which was not observed at the other sites. The age of the faecal matter did not differ between the treatments. No certainly fresh faecal matter was found for moose.

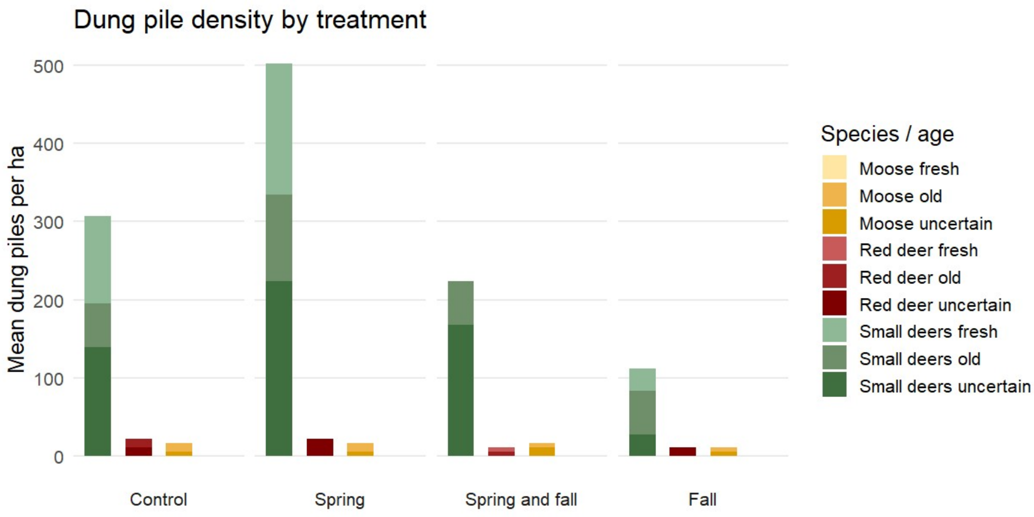

Figure 15. Mean number of faecal dung piles in the different treatments per ha, Small deer's (roe and fallow deer) (green), Moose (gold) minimum 10 pellets, red deer (red) minimum of 20 pellets. Fresh faecal matter lighter colour, old faecal matter medium, uncertain age faecal matter dark.

4. Discussion

The results show that Trico worked as a browsing repellent against cervids for summer browsing. The study showed that there was no observed browsing during late fall and winter and therefore there was no need for repellents. Trico cover was sufficient in the spring inventory for seedlings treated in the fall but not for seedlings treated in summer only which indicates that fall treatment may be active during next summer. Further research needs to be done on this. In this study Trico showed to not influence on form and other damages.

4.1 Browsing Results

Trico has been proven to work on pine in Sweden, with a decreased amount of browsing on the treated pines during fall (U. Nilsson, personal communication). This has shown to be true for this experiment as well. As there were significantly less browsed top shoots on treated birches in the fall inventory.

There was no significant difference between the treatments on survival, height or form. The survival could perhaps be explained by the damages not becoming severe enough from browsing. Sisenis et al (2016) found that heavy browsing caused high mortality, this could indicate that there was not as heavy browsing in our experiment compared to their study. Previous studies have shown that only browsing over longer periods of time have caused a decrease in survival, and even heavy browsing did not affect the survival of birch in the short term (Zvirgzdins et al., 2025b). Therefore, our result seems to correlate with other studies. There is also a difference between the areas, with some being more browsed than other. Comparing appendix F with figure 10 we can see some correlation with the amount of faecal matter found and the amount of browsing in the fall with Mullsjö having very little faecal matter found and very little browsing in the fall.

When birches are browsed it can be expected that the seedlings produce fewer long shoots but more branched shoots (Bergström & Danell, 1987) which is measured as poor form in our experiment. This was not specifically observed between the treatments. However, this is still the first year of treatment thus seedlings may still die, and the seedlings will grow after browsing making the effects on poor form more visible. Therefore, further research is needed to see if it has a lasting effect over the years.

According to Díaz-Yáñez et al (2017) moose browse more on birches in summer compared to winter. This fits well with the results from my study showing almost no browsing damage in the spring inventory and clear browsing damage in the summer and fall inventories. Yet as it is a limited number of sites this may differ in other areas.

Difference in height was observed after a year, but this was not statistically significant. Although this difference may be related with the browsing observed in the fall inventory, which had significantly more browsing on H25 C (F and C combined) compared to H25 T (S and S & F combined), the seedlings did not grow after the fall inventory due to it being winter. This combined with minute browsing during the spring inventory probably made it so that the former browsed seedlings showed this height difference. There was a large difference between the heights on the different sites, this could be because of many factors such as site recovery, provenance and growth phenology (Zvirgzdins et al., 2025b). But also site properties because nutrient- and water availability is important for seedling growth (Danell et al., 1985). These factors could be very important in influencing the growth and browsing pressure.

4.2 Cervid factors

Cervids did not seem to avoid Trico treated areas in winter and early spring (as indicated by the cervid index figure 16), but they seem to have been influenced by the presence of Trico in the growing season. The fall inventory showed less browsing observed on H25 T compared to H25 C. As the index was not done in fall, this study cannot say that this influenced their movement through the plots in fall, but their movement seems to have been unaffected in the spring inventory. Yet it is suggested that Trico has had a repelling effect on Cervids elsewhere, where untreated pines in an area of Trico treatment were less browsed compared untreated pines in control (U. Nilsson, personal communication). There can be many reasons for the observation of cervids not avoiding the Trico treated areas in the spring and winter. This could for example be habituation and degradation of the treatment, but it needs to be studied further.

There is also a presence of all Cervids over the study sites, but to a different degree (appendix F). There is also a presence of all cervids in the regions but to different degrees with Jönköping and Västra Götaland having more moose compared to the other regions, Östergötland having a quite even spread of cervids and Skåne having the fewest observed cervids per hour (Naturvårdsverket., n.d.) (Viltdata., n.d) (appendix G and H). Therefore, one cannot say that a specific cervid caused damage instead they must be grouped when looking at the results.

4.3 Trico

From the spring inventory one can see that Trico did not stay on for a full year to a sufficient degree and future recommendations would be to spray it yearly. Trico did not seem to cause bad form on the seedlings in spring but there was a difference in dead top for the fall inventory. Here it seemed that more of the Trico treated seedlings had a dead top, yet this was not observed in the spring inventory. What would have caused this needs to be studied further.

In other studies where Trico was tested on ornamental yews in the New York in the United States, they found that Trico protected the yews for about 3 months in winter (Curtis & Eshenaur 2022). In this experiment no browsing difference (due to there being almost no browsing) was found in winter but this is probably rather an observation of cervid behaviour rather than if the Trico was effective or not. Yet my study also indicates that the treatment was at least effective for 3 months (June to October) and perhaps even more depending on the exact date they were treated and later inventoried. Note that this is a comparison of a different species in a different climate, but the winter temperatures are comparable (Weather spark, 2026) (Appendix I).

Economically it could be defendable to treat birches with Trico in areas with high browsing. It is most likely not economically viable to treat the seedlings twice (S & F), rather it is more important of the treatment time. Further studies could be done to see if the fall treatment is effective in the following summer months and at what threshold the browsing pressure needs to be for Trico to be economically viable.

4.4 Other damage

In the spring inventory a lot of vole damage was found, and some but very few deer fraying (fejning) on the birches. In Hultsfred there was also a lot of hare damage.

The vole damage has been found in other studies, where they specifically eat on young seedlings and mainly in winter (Borowski., 2007). Yet the amount of vole damage varies a lot and have many factors such as population cycle (high or low) and other food sources in the area (Borowski., 2007). Birch is generally not a preferred species for voles (Borowski., 2007). Therefore, the amount of vole damage may be correlated to food sources and population cycles of the voles.

Hare damage was almost only recorded on the untreated saplings, yet as this was only observed in one area, one cannot say that Trico influenced hare browsing. One possible explanation could be that the hare has its nest close to the C plot in Hultsfred as hare damage was registered on the seedlings in the C plot in the summer inventory as well (appendix E).

There was quite a lot of stem breakage but due to the cause of this being unknown they were put into the unknown category. The cause of this is something that could be interesting to investigate further in another study, as this study cannot prove anything more than the observation of this type of damage.

Unknown damage, other mammal damage, pine weevil damage and abiotic damages were not affected by the Trico treatment and was somewhat evenly spread throughout the treatments. This is not unexpected as the Trico treatment is supposed to repel browsing and not specifically anything else.

The amount of pine weevil damage may be surprising. Yet other studies have found that this is also a problem for birch (Kaya et al., 2026). The study by Kaya et al (2026) have shown birch is a species that pine weevils feed on, even when conifers are available. Comparing the results from this study to the results by Kaya et al (2026) we can see that there is less pine weevil damage on the seedlings in this experiment (Kaya et al., 2026). A possible solution to this problem could be coating of the seedlings using Hylonox as it has been proven to be effective against pine weevils (Kaya et al., 2026).

4.5 Site

The sites differed quite a lot for each treatment. According to Díaz-Yáñez et al., 2017 some of the most important factors for browsing is tree density, structural heterogeneity of the basal area, stand size, altitude, previous treatment, slope, site index, species diversity and percentage of pine (Díaz-Yáñez et al., 2017) and for our experiment the availability of birch in browsing height. Density, structural heterogeneity of the basal area and stand size should be about the same for all the treatments, but altitude, previous treatment, slope, site index, species diversity and percentage of pine would be very difficult to compare in this experiment. Though when the fieldwork was being done several of these factors were noticed, with different stands being close by woodland in some areas (Omberg) and others being more open (Mullsjö), some having a lot of different species inside the stand (Sjöbo) and others having less (Mullsjö) and the occurrence of pine with Vrigstad having a pine plantation next to it. This is something that also was noticed in the experiment by Curtis & Eshenaur (2022) where they found that environmental factors were different between the different treatment areas which made it difficult to predict browsing pressure. Other noticeable differences were from previous treatment of the stand. It would also have been interesting to compare site index of the different sites, but they were not available. At some plots there were feeders right next to the plot and hay, others had semi-busy roads next to them, hiking trails were present in one of the plots and houses were in some cases right next to the plot.

4.6 Limitations

There are some limitations to this experiment, as mentioned in the results there is only one replicant for each area making it unreliable to test site effects. Due to there being such a difference between sites it would also be an advantage to have more sites, and it could also be an advantage to replicate the treatments for each site, yet this would require a larger treatment area.

Another limitation to this experiment is that it is only looking at southern Sweden, from Sjöbo (latitude 55°) Falköping (latitude 58°). We could expect some differences in cervids if we were to make these experiments further north, with lower red deer, fallow deer and roe deer populations further north (Zvirgzdins et al., 2025c). Therefore, the browsing must be assumed for all the cervids, even though they have different diets, with roe deer and moose being more specific browsers and fallow deer and red deer being more generalist (Zvirgzdins et al., 2025c). Damage by other cervids than moose is more relevant in southern Sweden compared to northern Sweden (Pfeffer et al., 2021). Therefore, one could expect a difference in browsing in northern Sweden compared to Southern and perhaps see better how Trico affects moose behaviour.

The index made for faecal matter is somewhat weak, as it is just a count of faecal matter within the circular plots. This only shows the presence of the different cervids in the circular plots and treatment areas and should only be read as such. They indicate that either cervids have been present or not but cannot confirm feeding behaviour nor species specific browsing.

Due to some of the variables being depending on the observer there can be observer bias. Severity of damage and stem form are the main variables that can be affected by this. But due to there being clear visual as well as written instructions on how a birch would look/ the thresholds of the damage, it is believed that the subjective effect is limited.

A limitation to the Trico treatment is that it is needed to be applied in dry weather conditions (U. Nilsson, personal communication). Weather being at times unpredictable as well as the distance between the plots makes it so that all the treatment areas were not treated at the same time. Yet it is believed to be treated at close enough times for a good comparison to be made.

4.7 Future studies

Future studies should include better ways of applying the Trico. They should study more of when the best time and how long the Trico is still effective.

4.7.1 Application

For future studies methods of application should be studied. One thing that could be interesting to see is if dipping the seedlings before planting is more effective, or would it be cost inefficient as they get more Trico than needed.

Further in time when the plants have been planted another method of applying could perhaps be used, for example spraying the plants with drones. Drone technology advances maybe it would be more cost effective to use drones.

4.7.2 Long-term treatment

For the future of this experiment, one should look at how browsing would be affected by spraying Trico on previously browsed plants. Also, if Trico is still effective if it's not visible and if the plants treated in fall are effective in the following spring. This could be done by splitting up the plots into 2 and not spraying one of the plots.

4.7.3 Future applications

Trico could perhaps be very useful in continuous cover forestry and forestry methods where a single tree is the focus. Applying Trico would protect the specific seedling from browsing and would likely be easier and cheaper than fencing. Another use could be in areas where browsing pressure was thought to be a non-issue but has appeared to be an issue and would be a quicker solution than fencing. In areas where fencing is not possible, Trico could also be a good solution to protect the seedlings against browsing on other species that are even more susceptible to browsing, such as oak, sallow and rowan.

5. Conclusion

To conclude this study showed that Trico has worked as a browsing repellent against cervids during the growing season, as treated birch seedling had significantly less top shoot browsing in the fall inventory. In contrast almost no browsing was found in the spring inventory suggesting that there was no need for a repellant during the winter to early spring in these areas.

Trico cover was sufficient in the spring inventory for seedlings treated in the fall. However, it was not for seedlings treated in summer only. This indicates that fall treatment may be active during next summer, but further research needs to be done on this.

Trico did not appear to influence survival, height, form and other damages during the spring inventory. Yet there was somewhat more wilting top shoot on the treated seedlings in the fall inventory, however this was not statistically significant. This is something that should be studied further.

Trico seems to be a viable alternative to fencing in areas with high browsing pressure. However, as this experiment was only targeted in southern Sweden and had somewhat few sites it should be studied further to make exact recommendations for treatment.

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7. Popular science summary

The dominating productive tree species in Sweden is Norway spruce and Scots pine (SLU, 2023). This poses a problem as Sweden is only relying on two species, thus creating a higher risk if one of them would become unable to grow in Sweden. Having a third species would spread this risk. The third most common species in Sweden is birch (SLU, 2023) and would be a good option as the third productive tree species. Yet birch has problems with browsing, and if there is heavy browsing over a long time the time it takes to the harvest can double (Sisenis et al., 2016).

Sweden has 4 main species of deer, moose, red deer, fallow deer and roe deer, which have different browsing behaviours ((C) Zvirgzdins et al., 2025). Moose behaviour mostly browse birch in summer (Díaz-Yáñez et al., 2017).

Fencing is an option for protecting the birches, but it is expensive and often expensive maintenance ((A) Zvirgzdins, A., 2025). Therefore, to make birch a more viable productive species one could use browsing repellents.

Trico is a browsing repellent made up of sheep fats that creates an odour that deters deer's (Dehmani, 2025). It is applied by spraying the plants and has shown to be effective for at least 3 months (Curtis & Eshenaur, 2022).

This thesis tests the effectiveness of browsing repellents on birch seedlings overtime against some of the most common species of deer in Sweden.

The methods for testing were inventories of damage on 6 sites in southern Sweden. The Trico was applied in 4 treatments, control treatment, treated in spring, treated in fall and treated in both spring and fall. An index of faecal matter was also done to see if the deer avoided areas with Trico.

The experiment found that most of the browsing was done in the fall and there was a significant difference between the untreated seedlings compared to the treated seedlings. As most of the browsing was found to be in the fall, the most likely time for the effective application of browsing repellent would be in spring. Double application of the repellent did not differ in its effectiveness compared to the application in fall.

The importance of this study is that it found that Trico was effective, and it found that it was effective for birch and it was effective for a year in southern Sweden.

For the forest owner this means that Trico is a viable alternative to fencing, yet it is important that the Trico is applied in the right season.

Due to it also showing to be effective on birch, birch also becomes a better alternative overall as one does not need as high establishment and maintenance cost with fencing.

8. Appendix

Appendix A. Table over Anova tests done in Spring 2026 (V26) and fall 2025 (H25), Bold letters showing statistical significance ($p \leq 0{,}05$), and no significance in italic.44

Appendix B. Table over Tukey tests done in fall 2025, Bold letters showing statistical significance and no significance in italic. Difference in group shown with different letters in Tukey group. 45

Appendix C. Table over Tukey tests done in spring 2026, Bold letters showing statistical significance and no significance in italic. Difference in group shown with different letters in Tukey group. 45

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Appendix E. The damage types in inventory time of summer 2025, green is fungi, blues are abiotic damages (light blue frost, medium blue drought, dark blue lack of oxygen), browns are mammalian damages (dark brown Hare, light brown other mammal damage, tan is sideshoot browsing damage, beige is top shoot browsing damage), purples are insect damage (light purple other insect, dark purple pine weevil), grey is unknown and red is top shoot wilt.........................46

Appendix F. showing how mean amount of pellets/mounds per m^2 in the different Treatment areas and treatments, Roe deer (beige) fewer than 45 pellets but more than 45, Moose (gold) minimum 10 pellets, fallow deer (green) more than 45 or more than 10 if it is known it is “fallow deer, Red deer (red) minimum of 20 pellets. Fresh faecal matter lighter colour, old faecal matter medium, uncertain age faecal matter dark. 47

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Appendix H. Showing the number of traffic related accidents with the four main cervid groups in the whole of Sweden from 2019-2025, gathered from Naturvårdsverket (n.d.). Trafikolyckor med klövvilt. Available at: https://www.naturvardsverket.se/data-och-statistik/vilt/trafikolyckor-klovvilt/ (Accessed: 5 February 2026). 48

Appendix I. Yearly temperature changes comparing Jönköping (purple) and New York (green) Weather Spark (no date) Comparison of the average weather in

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Appendix J.Map over Sjöbo treatment area. 50

Appendix K. Map over Omberg treatment area. 51

Appendix L. Map over Mullsjö treatment area. 52

Appendix M. Map over Hultsfred treatment area. 53

Appendix N. Map over Falköping treatment area. 54

Appendix O. Map over Vrigstad treatment area. 55

Appendix P. Trico status by treatment area. Green sufficient, red insufficient, yellow there but not to the right degree. 56

Appendix A. Table over Anova tests done in Spring 2026 (V26) and fall 2025 (H25), Bold letters showing statistical significance ($p \leq 0{,}05$), and no significance in italic.

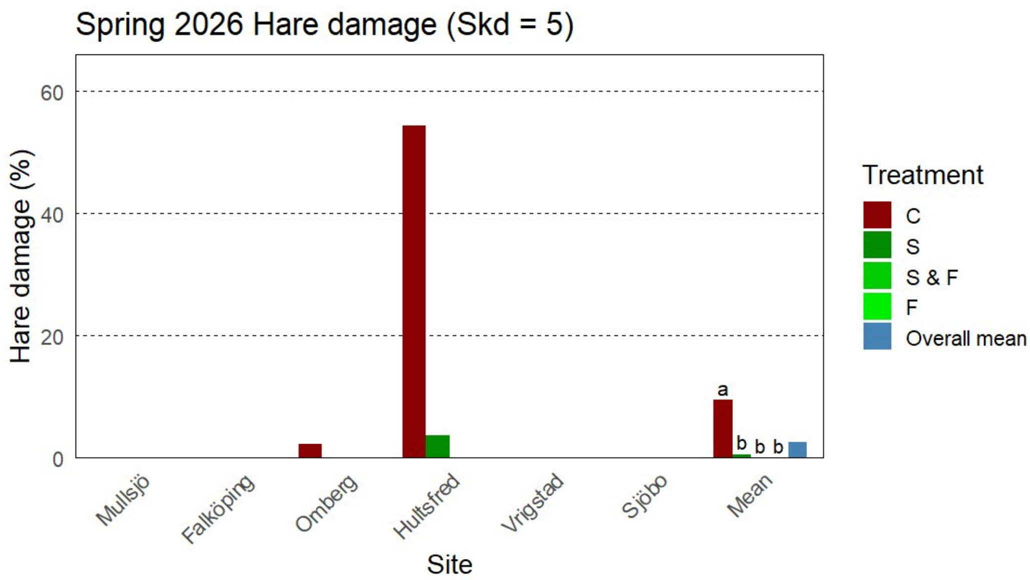
Analysis	Treatment	Treatment p-	F	Residual	Residual mean sq
H25 ANALYSIS – LEAD SHOOT BROWSING OR	**1**	**0,00392**	**25,5**	**5**	**24**
H25 ANALYSIS – LEAD SHOOT BROWSING	**1**	**0,00476**	**23,3**	**5**	**29,1**
H25 ANALYSIS – SIDE SHOOT BROWSING	*1*	*0,0877*	*4,49*	*5*	*23*
H25 ANALYSIS – LEAD SHOOT OR SIDE SHOOT	**1**	**0.00565**	**21,5**	**5**	**32,8**
H25 ANALYSIS – SEVERE DAMAGE	*1*	**0,00392**	*25,5*	*5*	*24*
H25 ANALYSIS – DEAD TOP	*1*	*0,268*	*1,55*	*5*	*27,02*
H25 ANALYSIS – SNYT	*1*	*0,552*	*0,41*	*5*	*217*
H25 ANALYSIS – FUNGI		*na*			
H25 ANALYSIS – HARE	*1*	*0,932*	*0,01*	*5*	*0,23175*
H25 ANALYSIS – OTHER MAMMAL	*1*	*0,363*	*1*	*5*	*0,05985*
H25 ANALYSIS – UNKNOWN	*1*	*0,765*	*0,1*	*5*	*43,18*
V26 ANALYSIS – HEIGHT	*3*	*0,065809*	*2,96*	*15*	*38,7*
V26 ANALYSIS – SURVIVAL	*3*	*0,276*	*1,42*	*15*	*24,23*
V26 ANALYSIS – LEAD SHOOT BROWSING	*3*	*0,42*	*1*	*15*	*0,112*
V26 ANALYSIS – SIDE SHOOT BROWSING	*3*	*0,61*	*0,63*	*15*	*0,2314*
V26 ANALYSIS – LEAD SHOOT OR SIDE SHOOT	*3*	*0,61*	*0,63*	*15*	*0,2314*
V26 ANALYSIS – SEVERE DAMAGE	*3*	*0,1141*	*2,35*	*15*	*9,354*
V26 ANALYSIS – DEAD TOP	*3*	*0,3074*	*1,31*	*15*	*5,542*
V26 ANALYSIS – FORM	*3*	*0,8973*	*0,2*	*15*	*132,4*
V26 ANALYSIS – TRICO	**3**	**1,98E-09**	**79,3**	**15**	**120**
V26 ANALYSIS – SNYT		*na*			
V26 ANALYSIS – FUNGI	*3*	*0,42*	*1*	*15*	*4,383*
V26 ANALYSIS – HARE	*3*	*0,373*	*1,12*	*15*	*116,2*
V26 ANALYSIS – OTHER MAMMAL	*3*	*0,352*	*1,18*	*15*	*24,86*
V26 ANALYSIS – UNKNOWN	*3*	*0,46226*	*0,9*	*15*	*41,15*

Appendix B. Table over Tukey tests done in fall 2025, Bold letters showing statistical significance and no significance in italic. Difference in group shown with different letters in Tukey group.

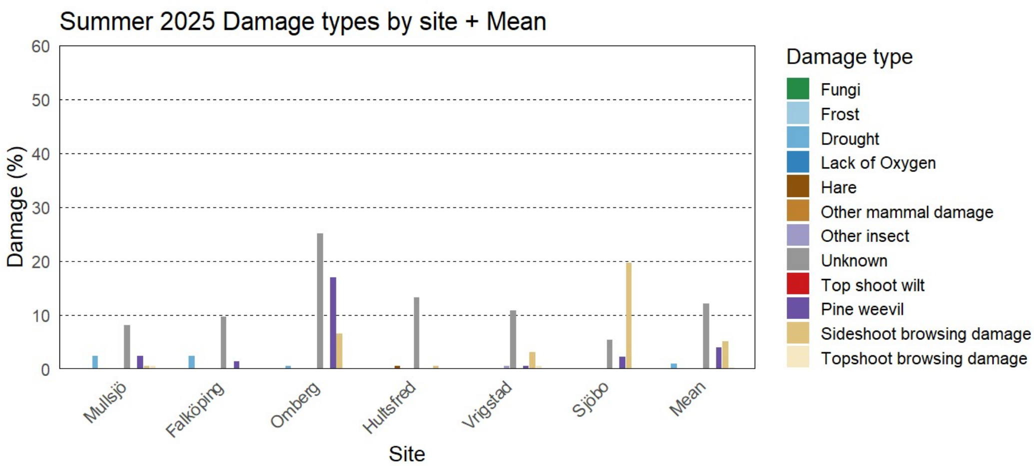
Analysis	Treatment	Mean	Significan
H25 ANALYSIS – LEAD SHOOT BROWSING OR SEVERE	Untreated	22,84	a
	Treated	8,54	b
H25 ANALYSIS – LEAD SHOOT BROWSING	Untreated	22.02	a
	Treated	6,98	b
H25 ANALYSIS – SIDE SHOOT BROWSING	Untreated	8,86	a
	Treated	3	a
H25 ANALYSIS – LEAD SHOOT OR SIDE SHOOT BROWSING	Untreated	23,56	a
	Treated	8,24	b
H25 ANALYSIS – SEVERE DAMAGE	Untreated	22,84	a
	Treated	8,54	b
H25 ANALYSIS – DEAD TOP	Treated	8,77	a
	Untreated	5,04	a
H25 ANALYSIS – SNYT	Treated	13,24	a
	Untreated	7,82	a
H25 ANALYSIS – FUNGI	Untreated	na	
	Treated	na	
H25 ANALYSIS – HARE	Treated	0,19	a
	Untreated	0,17	a
H25 ANALYSIS – OTHER MAMMAL	Treated	0,14	a
	Untreated	0	a
H25 ANALYSIS – UNKNOWN	Treated	12,15	a
	Untreated	10,96	a

Appendix C. Table over Tukey tests done in spring 2026, Bold letters showing statistical significance and no significance in italic. Difference in group shown with different letters in Tukey group.

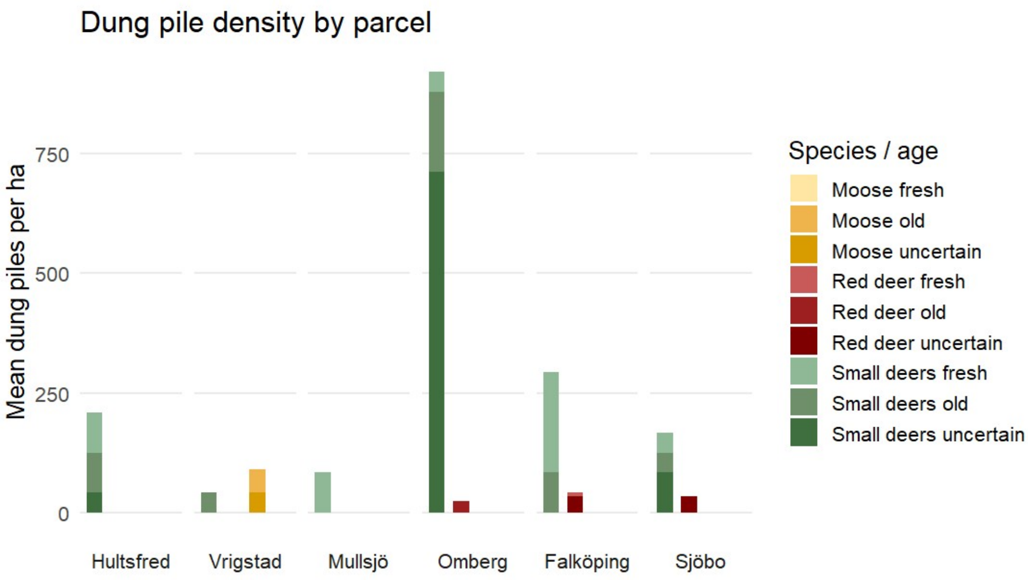
Analysis	Treatme	Mean	Significa
V26 ANALYSIS – HEIGHT	Trico spring	68.33	a
	Trico	67.48	a
	Control	60.36	a
	Trico fall	60.36	a
V26 ANALYSIS – SURVIVAL	Trico	94.66	a
	Trico spring	93.91	a
	Trico fall	90.22	a
	Control	90.13	a
V26 ANALYSIS – LEAD SHOOT BROWSING	Control	0.27	a
	Trico spring	0	a
	Trico fall	0	a
	Trico	0	a
V26 ANALYSIS – SIDE SHOOT BROWSING	Control	0.27	a
	Trico spring	0.26	a
	Trico fall	0	a
	Trico	0	a
V26 ANALYSIS – LEAD SHOOT OR SIDE SHOOT BROWSING	Control	0.27	a
	Trico spring	0.26	a
	Trico fall	0	a
	Trico	0	a
V26 ANALYSIS – SEVERE DAMAGE	Control	6.59	a
	Trico	3.37	a
	Trico fall	3.04	a
	Trico spring	2.25	a
V26 ANALYSIS – DEAD TOP	Trico	2.46	a
	Control	2.41	a
	Trico fall	0.91	a
	Trico spring	0.26	a
V26 ANALYSIS – FORM	Control	44.93	a
	Trico spring	41.71	a
	Trico	41.17	a
	Trico fall	40.1	a
V26 ANALYSIS – TRICO	Trico	88.73	a
	Trico fall	79.34	a
	Trico spring	60.75	b
	Control	0	c
V26 ANALYSIS – SNYT	Control	na	
	Trico spring	na	
	Trico fall	na	
	Trico	na	
V26 ANALYSIS – FUNGI	Control	1.71	a
	Trico fall	0	a
	Trico spring	0	a
	Trico	0	a
V26 ANALYSIS – HARE	Control	9.49	a
	Trico spring	0.62	a
	Trico fall	0	a
	Trico	0	a
V26 ANALYSIS – OTHER MAMMAL	Trico fall	8.02	a
	Trico spring	5.12	a
	Trico	5	a
	Control	2.63	a
V26 ANALYSIS – UNKNOWN	Trico spring	12.58	a
	Control	9.32	a
	Trico fall	7.45	a
	Trico	7.17	a



Appendix D. Hare damage of the birch seedlings in inventory time of spring 2026, red is C "Control" treatment, dark green is S "treated with Trico in Summer/spring 2025", medium green is S & F " treated with Trico in both spring and fall" and light green is F "treated with Trico in fall 2025", light blue is the overall mean, letters indicating results from Tukey tests.



Appendix E. The damage types in inventory time of summer 2025, green is fungi, blues are abiotic damages (light blue frost, medium blue drought, dark blue lack of oxygen), browns are mammalian damages (dark brown Hare, light brown other mammal damage, tan is sideshoot browsing damage, beige is top shoot browsing damage), purples are insect damage (light purple other insect, dark purple pine weevil), grey is unknown and red is top shoot wilt.



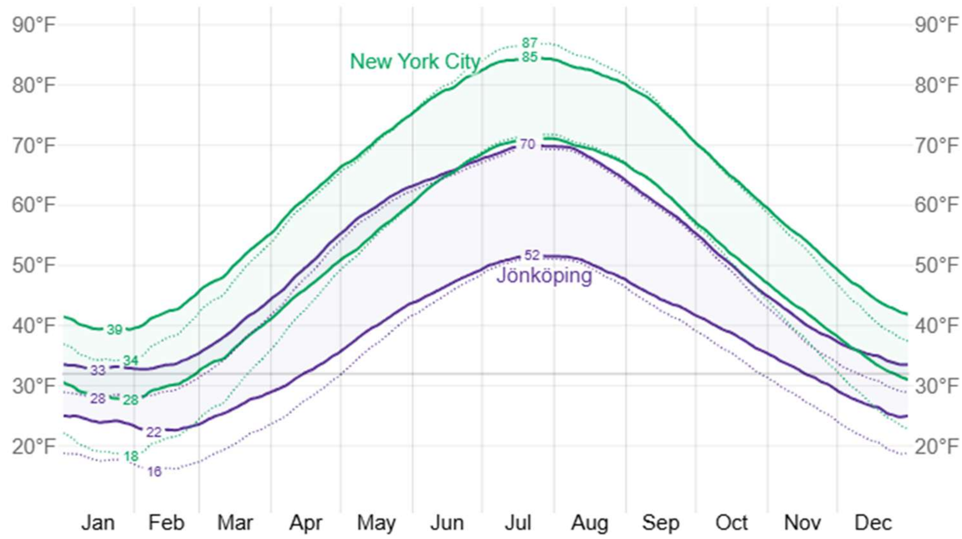
Appendix F. showing how mean amount of pellets/mounds per m^2 in the different Treatment areas and treatments, Roe deer (beige) fewer than 45 pellets but more than 45, Moose (gold) minimum 10 pellets, fallow deer (green) more than 45 or more than 10 if it is known it is "fallow deer, Red deer (red) minimum of 20 pellets. Fresh faecal matter lighter colour, old faecal matter medium, uncertain age faecal matter dark.

Appendix G. Showing the amount of seen cervids per county per observed hour in the year 2025, gathered from Viltdata (n.d.). Statistik. Available at: https://rapport.viltdata.se/statistik/ (Accessed: 5 February 2026).

Place	Animal	year	total h	number obs	Obs / h
Jönköping	Moose	2025	132506	12026	0,0908
Jönköping	Red deer	2025	143466	79	0,0006
Jönköping	Fallow deer	2025	143466	69	0,0005
Jönköping	Roe deer	2025	143466	78	0,0005
Östra Götaland	Moose	2025	154692	6915	0,0447
Östra Götaland	Red deer	2025	156104	2133	0,0137
Östra Götaland	Fallow deer	2025	156161	2169	0,0139
Östra Götaland	Roe deer	2025	156115	976	0,0063
Västra Götaland	Moose	2025	232639	20081	0,0863
Västra Götaland	Red deer	2025	233686	990	0,0042
Västra Götaland	Fallow deer	2025	233686	375	0,0016
Västra Götaland	Roe deer	2025	233686	513	0,0022
Skåne	Moose	2025	68381	2784	0,0407
Skåne	Red deer	2025	69460	24	0,0003
Skåne	Fallow deer	2025	69460	115	0,0017
Skåne	Roe deer	2025	69460	114	0,0016

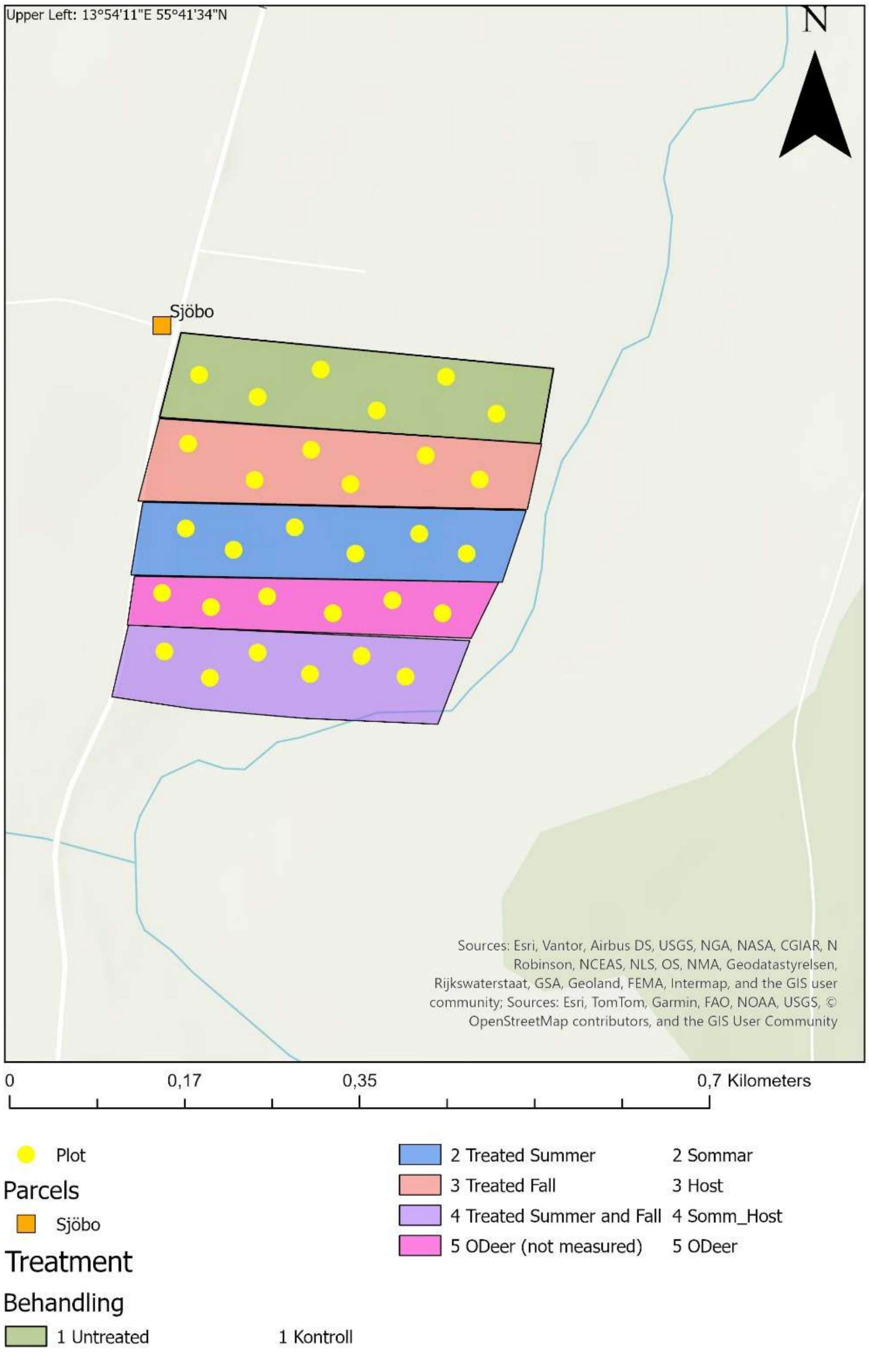
Appendix H. Showing the number of traffic related accidents with the four main cervid groups in the whole of Sweden from 2019-2025, gathered from Naturvårdsverket (n.d.). Trafikolyckor med klövvilt. Available at: https://www.naturvardsverket.se/data-och-statistik/vilt/trafikolyckor-klovvilt/ (Accessed: 5 February 2026).

Year	Fallow deer	Red deer	Roe deer	Moose	Total per year
2019	4508	457	44975	6485	56425
2020	4592	419	43548	5550	54109
2021	4705	466	49606	6638	61415
2022	5417	440	47690	5665	59212
2023	5790	506	49820	6185	62301
2024	6126	443	51550	6550	64669
2025	6537	449	50638	6251	63875
Total	37675	3180	337827	43324	422006
Average	5382	454	48261	6189	60287



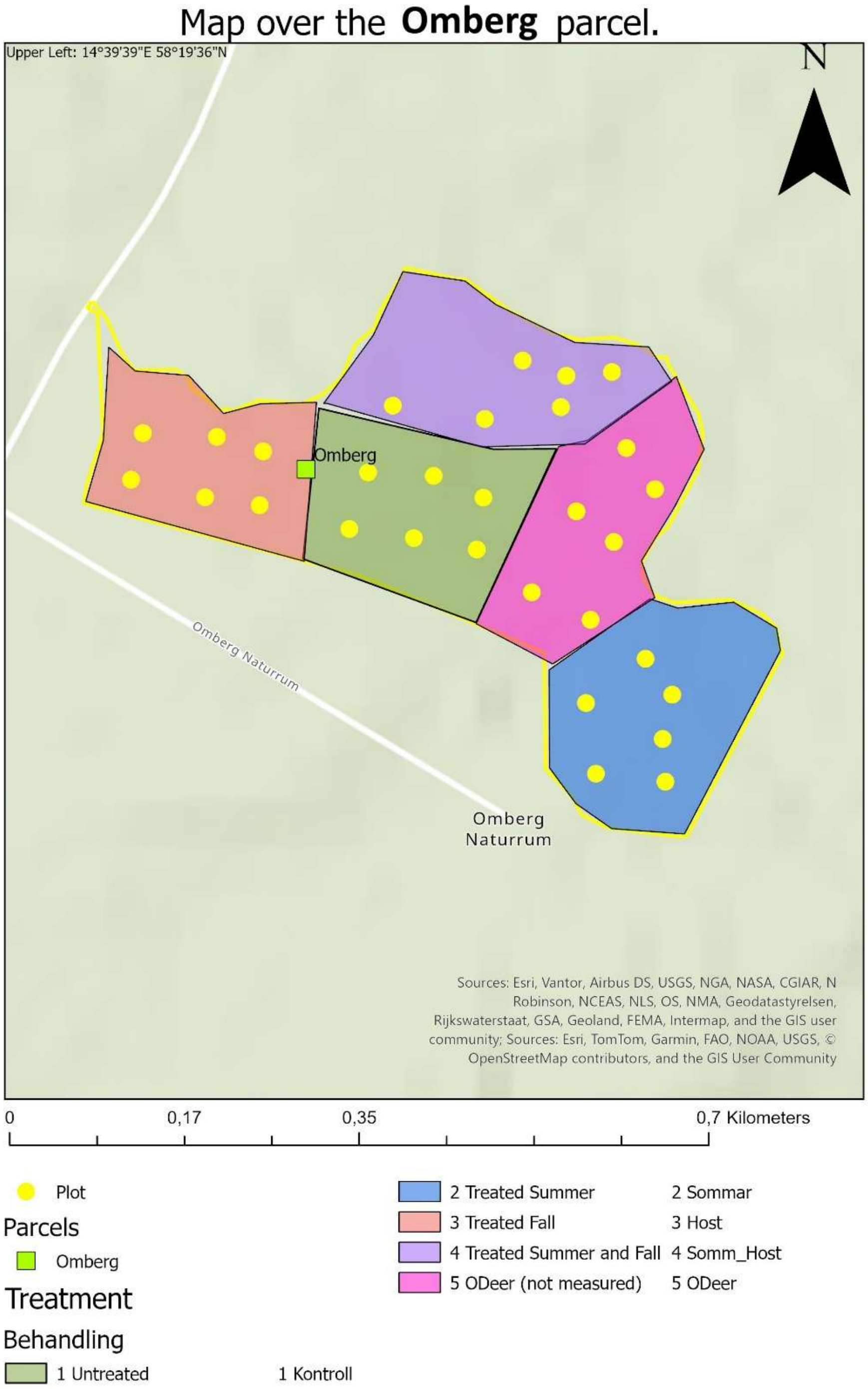
Appendix I. Yearly temperature changes comparing Jönköping (purple) and New York (green) [Weather Spark](#) (no date) Comparison of the average weather in Jönköping and New York City. Available at: [Weather comparison page](#) (Accessed: 15 May 2026).

Map over the Sjöbo parcel.



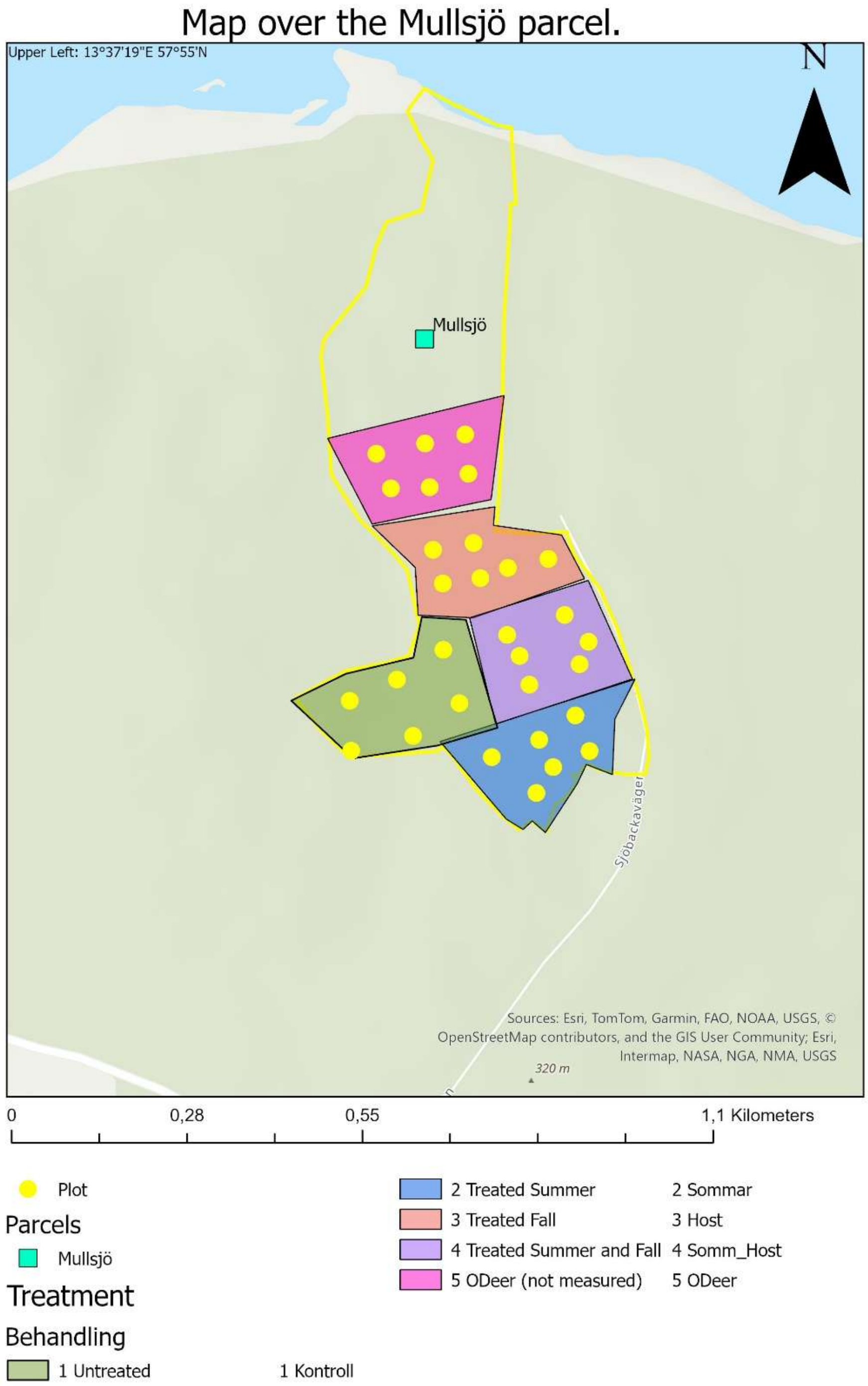
Description: Map over parcel, colours showing which treatment was done, first English name then Swedish.

Appendix J.Map over Sjöbo treatment area.



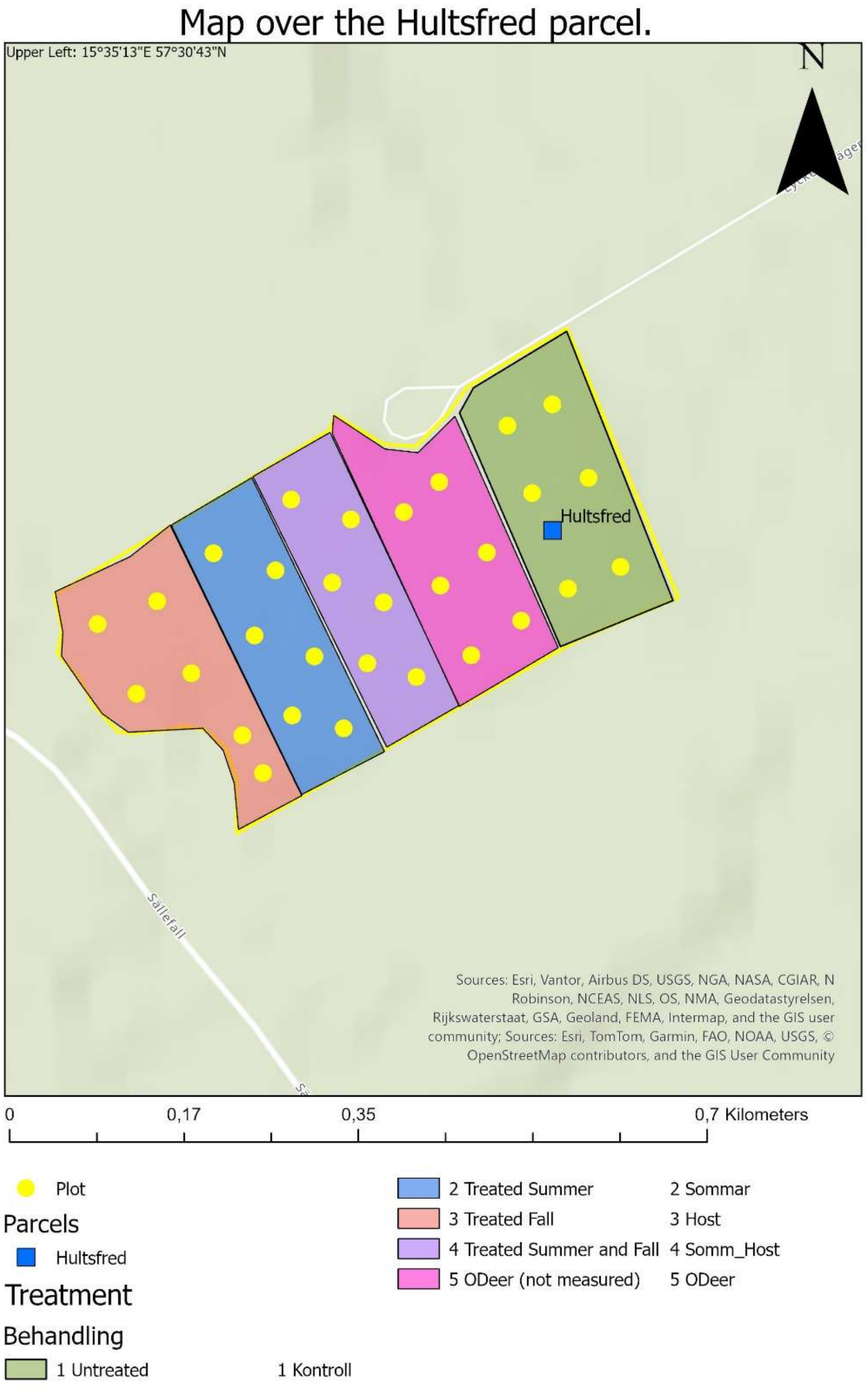
Description: Map over parcel, colours showing which treatment was done, first English name then Swedish.

Appendix K. Map over Omberg treatment area.



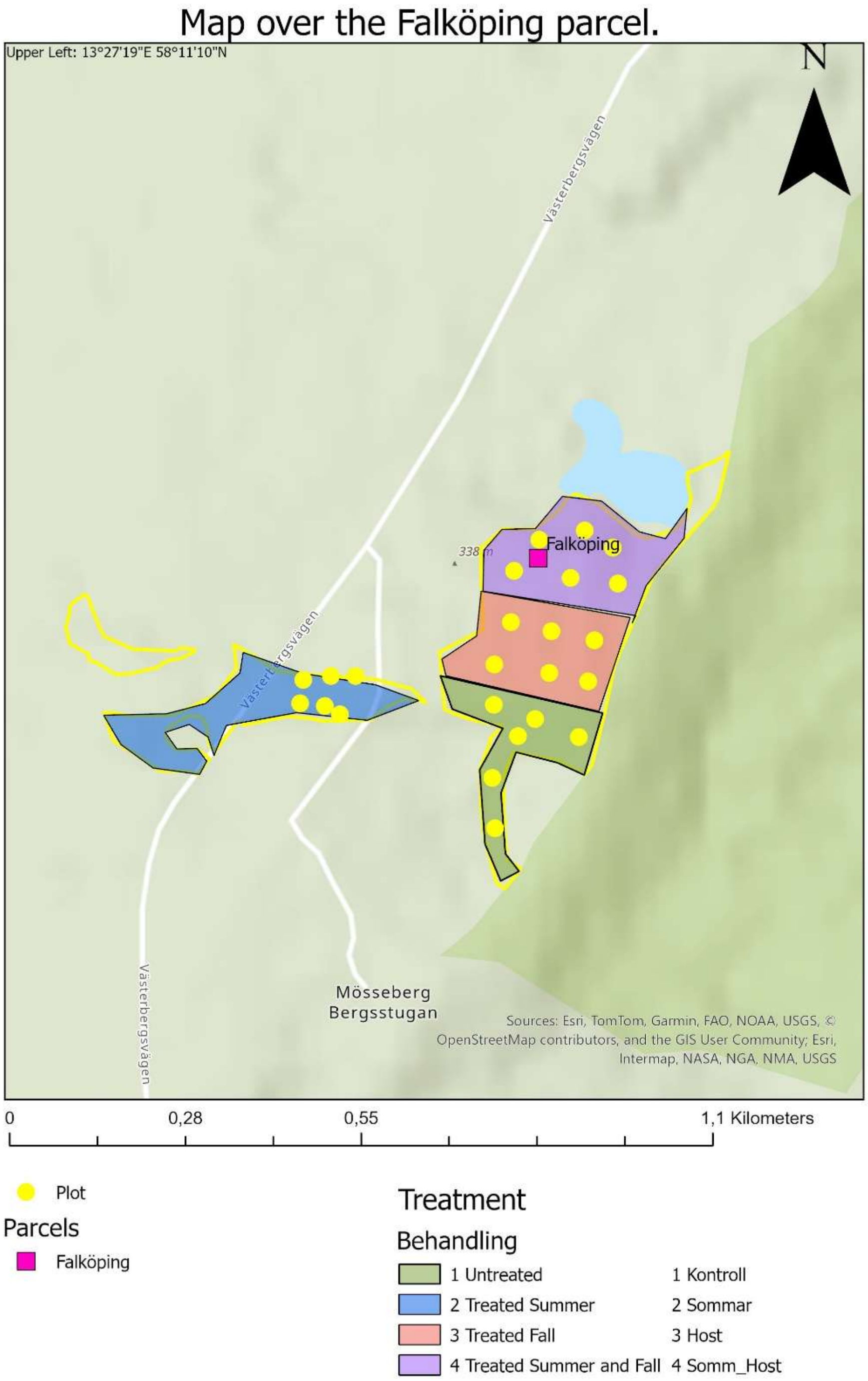
Description: Map over parcel, colours showing which treatment was done, first English name then Swedish.

Appendix L. Map over Mullsjö treatment area.



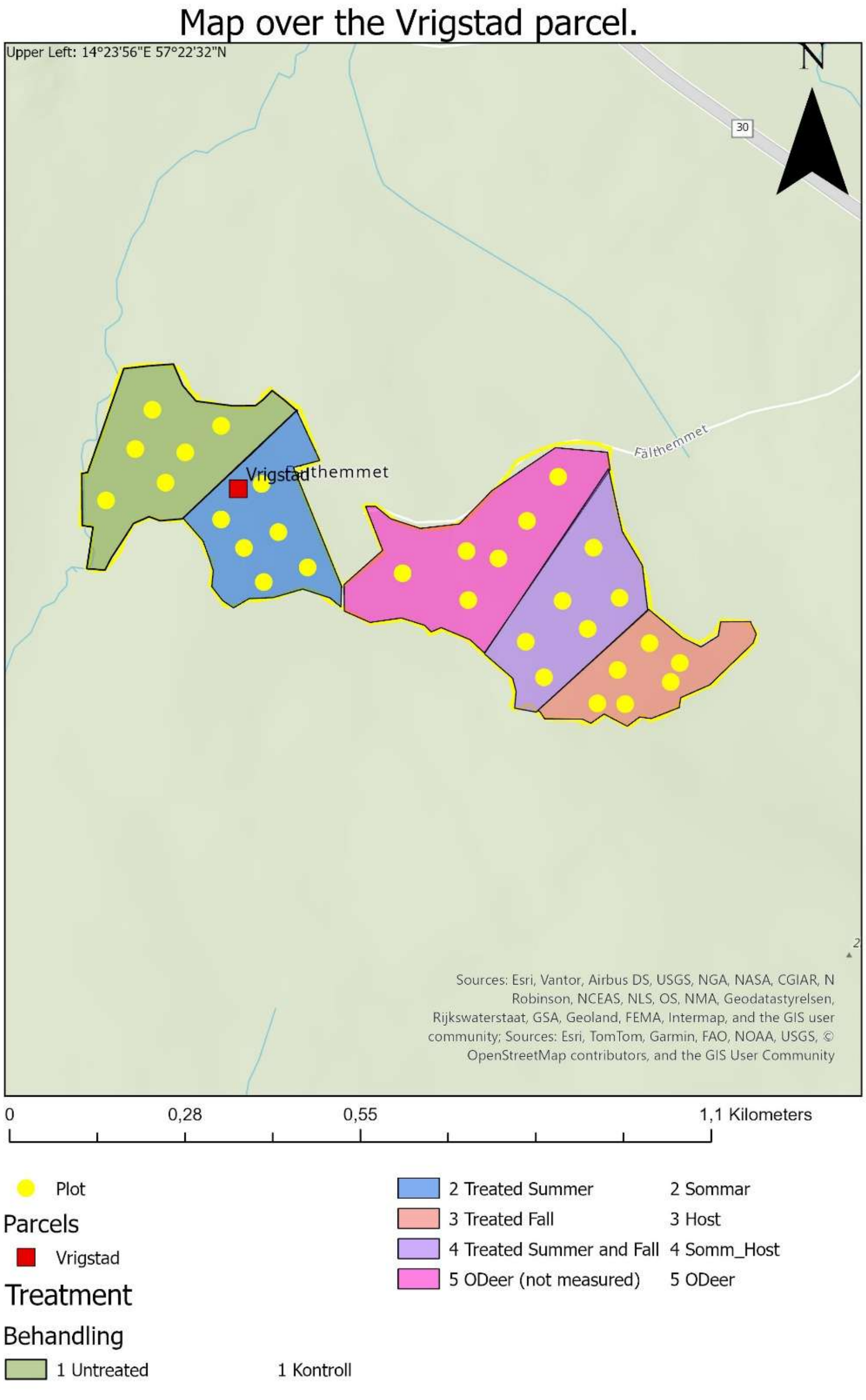
Description: Map over parcel, colours showing which treatment was done, first English name then Swedish.

Appendix M. Map over Hultsfred treatment area.



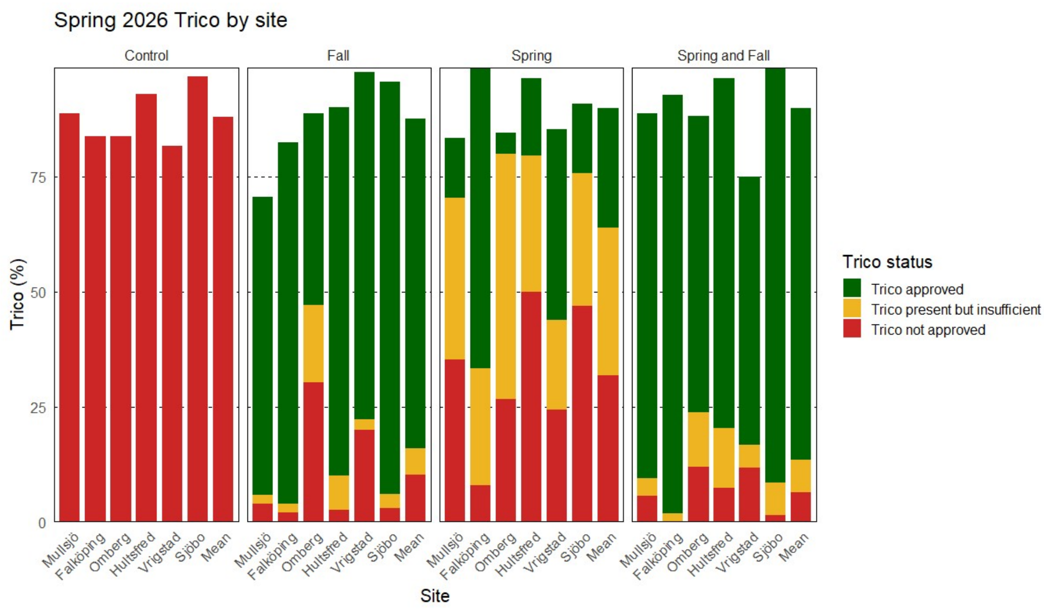
Description: Map over parcel, colours showing which treatment was done, first English name then Swedish.

Appendix N. Map over Falköping treatment area.



Description: Map over parcel, colours showing which treatment was done, first English name then Swedish.

Appendix O. Map over Vrigstad treatment area.



Appendix P. Trico status by treatment area. Green sufficient, red insufficient, yellow there but not to the right degree.

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