Examensarbeten **2012:12**
Institutionen för skogens ekologi och skötsel

Tame animals in the wilderness
– livestock grazing around summer farms in Jämtland, boreal Sweden 1800-2011

Foto: Felicia Olsson

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Tama djur i det vilda – bete kring fäbodar i Jämtland från 1800-talet fram till idag

Felicia Olsson

Nyckelord / *Keywords:*
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Umeå, march 29th 2012.
Felicia Olsson

Sammanfattning

Landskapet med skog och myrar som omger de svenska byarna i södra norrland har för jordbrukarna varit av avgörande betydelse. I de skandinaviska fäbodsystemen har skogen och dess myrar med bete utnyttjats till sin fulla potential. Systemet bestod av fäbodar några kilometer från den större gården i byn, och boskapen betade i skogen runt fäboden. Djuren påverkar sin omgivning och betade skogar innehåller i allmänhet en högre biologisk mångfald än en obetad skog.

Det övergripande syftet med detta examensarbete är att förstå hur betande tamdjur kan påverka ett nordligt skogsekosystem under en längre tidsperiod. Det studerade systemet är Klövsjö socken, i sydvästra delen av Jämtlands län i Sverige och den studerade perioden omfattar år 1800 - 2011.

För att bestämma arealen betesmark för Klövsjö socken, har gamla fastighetsbeteckning handlingar och deras protokoll studerats, och området för byarnas betesmarker och skogar har beräknats. Siffror och statistik från tidigare studier har använts för att beräkna antalet boskap, tillsammans med nationella statistik. För att uppskatta djurtätheten har antalet boskap omvandlats till betesekvivalenter, baserat på djurens energibehov. Detta underlättar jämförelser över tiden utan att behöva ta hänsyn förändringar i djurarter och storlekar.

Mitt resultat visar att antal djur och djurtäthet (antal djur på ett visst område) har varierat genom tiden i Klövsjö socken. Toppen för högsta antal djur och högsta djurtäthet inträffade vid olika tidpunkter. Det högsta antalet djur var då getter och får var på sin topp och kor fortfarande ökade, men djurtätheten var som störst när antalet kor var på sin topp, eftersom de var mest energikrävande. På toppen av betesekvivalenter fanns det lite mer än 0,05 betesekvivalenter per hektar i Klövsjö socken. Idag skulle betestryck i Klövsjö by i 2011 vara 0,007 betande ekvivalenter per hektar om samma areal används som i på 1800-talet.

Flera studier visar att det moderna skogsbruket har lett till likåldriga, homogena skogar med en förlust av viktiga strukturer, som till exempel gamla träd. Men när man jämför strukturer såsom flerskiktade skogar och gamla träd inom det studerade området finns inga signifikanta skillnader mellan 1925 och 2011. En anledning kan vara att skogarna i Klövsjö år 1925 redan var mycket påverkade av mänskliga aktiviter som bränning, vedsamlande och bete och därför var skogen inte äldre. Det är också troligt att de redan hade påverkats av skogsindustrin i form av avverkningar.

Generellt har betade skogar en högre biologisk mångfald än obetade skogar. En orsak till detta är variation i strukturen inom betade skogar som skapas av olika arter av betande djur. Ett exempel är gradienterna i betesintensitet från den mer öppna fäboden mot de tätare skogarna.

Antalet fäbodar har minskat de senaste hundra åren. Om fäbodarna försvinner, så försvinner både kulturella och biologiska värden med dem. Moderna fäbodar står inför en hel del utmaningar, men min åsikt är att det skulle vara värt det för samhället att försöka bevara de aktiva fäbodar som finns kvar idag.

Längre svensk populärsammanfattning finns längst bak.

Abstract

The forest and mire landscape surrounding the north Swedish villages have been of fundamental importance through time for the farmers. In the Scandinavian summer farm system the forest and mire pasture was used to its full potential. The system consisted of smaller summer farms some kilometres from the main farm in the village, and were the livestock grazed in the forest around the summer farm. The livestock affect their environment, and grazed forests generally contain a higher biodiversity than an ungrazed forest. The overall aim of this thesis is to understand the impact of livestock grazing on a northern forest ecosystem over a long time period. The studied system is the parish of Klövsjö, in the south-western part of the county of Jämtland, Sweden, and the studied period comprises the period year 1800 - 2011.

To determine the pasture area for the parish of Klövsjö, old cadastral acts and their protocols have been studied, and the area of the villages´ grazing lands and forests have been calculated. Some numbers and statistics from previous studies have been used to calculate livestock numbers, together with National Statistics. To estimate the stocking density the livestock numbers were converted to grazing equivalents, based on the animals energy demand. This facilitates comparisons over time without having to consider changes in livestock species and sizes.

My result show that the livestock numbers and stocking density (livestock numbers on a specific area) has fluctuated through time in Klövsjö parish. The peak for highest livestock numbers and highest stocking density occured at different times. The highest livestock numbers were given when goats and sheep were at their peak and cows still increased, but the stocking density was at its maximum when cow numbers were at their peak, since they were the most energy demanding. At the peak of grazing equivalents there was a bit more than 0.05 grazing equivalents per hectare in Klövsjö parish. In contrast, the grazing pressure in Klövsjö village in 2011 would be 0.007 grazing equivalents per hectare if the same area is used as in the 19th century.

Several studies show that modern forestry has led to evenaged, homogenous forests and a loss of important structures, such as old trees. However, when comparing structures such as multilayered forest and old trees in the studied area, there are no significant differences between 1925 and 2011. One reason could be that the Klövsjö forests in 1925 was highly affected by human impact such as burnings, firewood collections and grazing and therefore the stands were not older. It is also likely that they already were affected by the forest industry in form of early logging.

Generally, biodiversity in grazed forests is higher than compared to ungrazed forest. One reason for this is the variation and heterogenity in structure within the grazed forest, created by the different species of grazing animals. Examples are the gradients in grazing intensity from the more open summer farm towards the denser forests and the openings, shrubs and full grown trees.

The number of summer farms has decreased. If the summer farms disappear both cultural and biological values will disappear with them. A lot of challanges faces the modern summer farms, but my opinion is that it would be worth it for society to try to preserve the lasting summer farms.

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1. Introduction

Summer farms (sometimes called shielings, Swedish: *fäbodar*) have existed in many parts of Europe, from Scandinavia to central Europe through the Alps and down to the southern parts such as Spain and Greece. The overall purpose of summer farms has been to more effectively use the pasture resource by letting animals also graze in more remote areas (Frödin, 1929).

In Sweden the summer farms were mainly connected to the forested northern parts of the country (Frödin, 1929; Larsson, 2009). The forest and mires outside the villages have been of big importance through time for people on the Swedish countryside. These so called "outlands" (Swedish: *utmarker*) were among other things used to get firewood and materials for agricultural tools, and also used as grazing lands (Levander, 1943). The Scandinavian summer farm system used the forest and mire pasture to its full potential. The system consisted of small farms some kilometers from the main farm in the village, were the livestock grazed in the forest around the summer farm (Levander, 1943). In the Alps the animals could graze different vegetation on different elevation and therefore summer farm grazing did not extend over such large areas as in Sweden (Larsson, 2009). Both summer farms in Sweden and the Alps were used during the summer, and this is how they differ from other similar systems in southern Europe (Frödin, 1929). Further south the livestock could graze all year around. The connection to a main farm was not as strong, since they moved to different pastures throughout the year (Frödin, 1929). In Sweden the livestock was stabled on the main farm during wintertime. The animals needed a lot of fodder to survive through the winter, and a lot of the farmer's effort during the summer was to collect this fodder (Frödin, 1929; Larsson, 2009; Gadd, 2011).

The origin of the Swedish summer farms is debated. According to John Frödin (1952) the summer farms occured when not enough pastures and haymaking areas was available throughout the year in the immediate vicinity of the farm or the village. This forced the farmers to move around to find suitable land to feed his livestock (Frödin, 1952). It was because of the summer farms that the farms could increase their livestock (Larsson, 2009; Myrdal, 2011). Others say that the summer farms were a form of marking a territory, claiming the area and its resources between the main farm and the summer farm (Karlsson et al., 2010). The land that was used for grazing was probably primarily the ecotone between the mire where hay was harvested, and the deep forest where the grazing was poorer. Alpine forests and herb-rich spruce forests were excellent grazing areas (Frödin, 1952). To improve grazing some areas were burned and trees were girdled (Levander, 1943; Frödin, 1952; Ericsson; 1997).

Livestock grazing in the forest was seldom in conflict with other uses of the forest. During the 19th century and especially during the 20th century, the forest industry grew, and timber became increasingly important (Kardell, 2004). In year 1857 a new law made it the duty of the livestock owner to herd or fence his animals, to make sure they did not damage the forest production (Kardell, 2008). Despite this, forest grazing continued (Axelsson Linkowski, 2009). The industrial time started around year 1870 in Sweden, and with this came fertilizers as well as direct breeding with heavier cattle that were able to produce more milk per cow. This increased the profit in terms of more hay on less land, and more milk with fewer cows (Morell, 2011). As an effect of this the summer farms became redundant in some areas, and during the 20th century they drastically decreased in numbers in Sweden (Kardell & Olofsson, 2000).

During the last century grazed forests have significantly diminished (Andersson & Appelqvist, 1990). Structures created in grazed forests are unique and can be of great importance for biodiversity. The continouos disturbance by mules and hooves anables many different plant- and fungispecies to coexist (Croneberg, 2001). Trees get space to grow big and with large, thick branches. Thick stems can later become hollow, which favours a lot of redlisted insects (Axelsson Linkowski, 2009). The degree of grazing pressure is important for biodiversity on a local level (Pihlgren, 2007). Grazing pressure is defined as the number of livestock on a specific area, and the vegetation production on that area (Dahlström, 2006). The livestock grazed at different places in different times of year, and the livestock density has probably varied a lot throughout centuries. A very high grazing pressure can impoverish the diversity rather than enriching it (Dahlström, 2006). Therefore it is important to understand how the grazing pressure has changed over time, and how this has affected the forest. Some key questions are the area used for grazing and number of livestock at different time periods.

1.1 Aim

The overall aim of this thesis is to understand the impact of livestock grazing on a northern forest ecosystem over a long time period. The studied system is the parish of Klövsjö, in the south-western part of the county of Jämtland. The result will be presented at different spatial scales from parish level down to farm level. The studied time period is determined to approximately the year 1800 until today to capture the peak of the summer farm system in the late 19^{th} century, as well as its downfall. Klövsjö parish and village is the location chosen to use as model, since there are historical records available of this place, and also the forest grazing has continued into our days.

The questions to be answered are:

- How large was the available grazing area in the parish?
- How many livestock were grazing in the forests in the parish of Klövsjö, and of what kind?
- How did the grazing pressure change during the studied period?
- How high was the historical grazing pressure in the parish of Klövsjö, compared to other parts of Sweden?

Based on these results I will discuss forest grazing pressure in relation to forest structural changes and biodiversity, as well as comparing the grazing pressure to wild moose populations of today.

2. Materials & methods

2.1 Study area

The parish of Klövsjö is located in south-western Jämtland, in central Sweden. The parish consists of the three villages Klövsjö, Kvarnsjö and Skålan (figure 1). Klövsjö is just next to the lake Klövsjön, which is located 440 meter above sea level (figure 2). The highest point within the parish is Klövsjöfjället, which rises 1 023 meters above sea level (Kardell, 2008). The precipitation is 800-900 mm per year, and the vegetation period is 140 days (Alexandersson & Eggertsson-Karlström, 2001). The mean forest production in Jämtland is 3.5 m^3sk/year (Swedish Forest Agency, 2011).

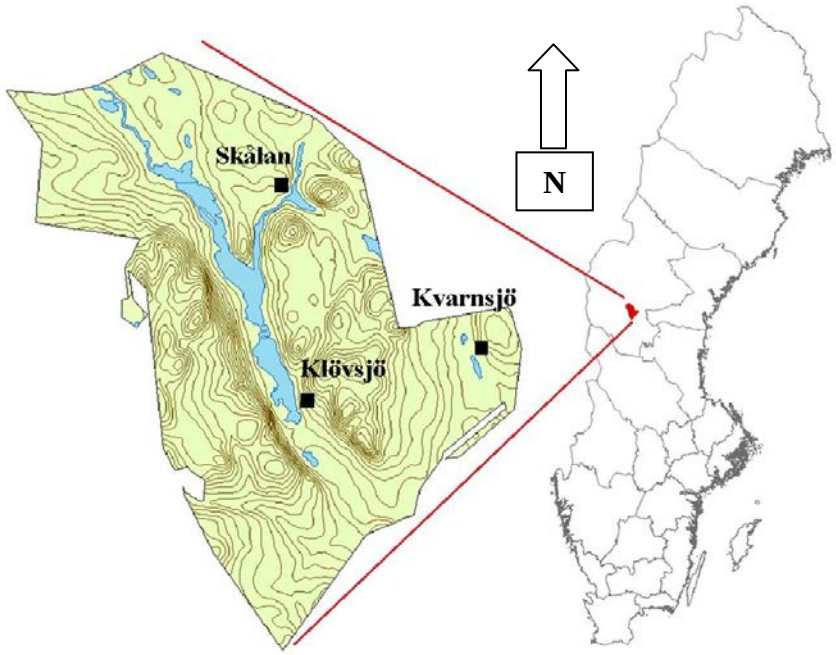

Figure 1. *The parish of Klövsjö located in the county of Jämtland in central Sweden. The three villages in the parish are Klövsjö, Skålan and Kvarnsjö.* © National Land Survey

Figure 2. *Klövsjö village with the lake Klövsjön and Klövsjöfjället in the background. Photo: Felicia Olsson*

2.2 Background on summer farms in Klövsjö

The agricultural economy in northern Sweden was based on livestock, unlike in southern parts of the country where agriculture was mainly oriented towards producing grains and cereals (Larsson, 2011). In the forested land of the northern parts of the country, more pastures were made available due to summer farms. This is one reason why people in northern Sweden could increase their livestock in the same pace as the population grew, unlike the southern parts where the higher population density required that more land was used for growing crops (Myrdal, 2011).

The concept of summer farms is variable both over time but also regionally. In this thesis a summer farms is defined as a small farm in a forest and mire landscape. It is connected to a main farm in or close to a village (Levander, 1943). During wintertime the livestock was stabled within the main farm, but during the summer it was herded around one or several summer farms. In Jämtland it was common to have two or three different summer farms (Kardell & Olofsson, 2000). One was used in early summer and another one in mid summer, and in late summer and beginning of autumn the livestock were taken back to the first summer farm, or even herded to a third (Levander, 1943; Kardell & Olofsson, 2000). Before Michaelmass at the beginning of October, the livestock was herded back to the main farm for the winter (Kardell & Olofsson, 2000; Axel Olsson, oral communication). The summer farms consisted of a main house for the herder, a stable/cowshed and some houses for refining milk products and store them (Larsson, 2009). Often one summer farm consisted of several smaller farms, and the area was shared by several farmers. This facilitated the work and decreased the costs for making roads and fences. Also the farmers could hire one or several summer farm maids jointly that could watch over all the animals (Levander, 1943; Larsson, 2011). The food for humans grew mainly around the farm in the village, where also some winterfodder for the livestock was collected. But much fodder was also harvested on meadows and mires close to the summer farms (Levander, 1943) (figure 3). Intentional flooding of meadows was a common way to treat the meadows to benefit the preferred sedges (Ullberg, 1933; Segerström & Emanuelsson, 2002).

Figure 3. *The summer farm Sandviksdalen in Klövsjö parish, 1965. The hay meadow is fenced to keep grazing livestock out. Photo: Einar Montén, Jamtlis arkiv.*

The herders were often young women. Besides herding the livestock they were supposed to milk the animals and make butter, cheese and whey cheese (Levander, 1943; Larsson, 2009). By refining the milk into these products it was easier to store and transport it back to the main farm (Larsson, 2009). To refine the milk a lot of firewood was needed (Ericsson, 1997) and this was often collected around the summer farms, during the herding (Levander, 1943). The main task for the herderers were to guide them to suitable grazing lands, to make sure they did not walk in to fields with growing winterfodder and also to protect them against dangers such as predators (Levander, 1943; Larsson, 2009). On the farms there were often different kinds of animals at the same time, usually cows, sheep and goats (Larsson, 2009). Cows and sheep preferably consumes grasses and leaves, while goats eat twigs and shrubs. Furthermore, their different sizes makes it possbile to utilize different types of terrain, meaning that they complement each other and and uses all of the available grazing (Ekeland, 1997).

In the middle of the 20th century the number of farms in Sweden was drastically reduced (Morell, 2011). There were many and complex reasons for this decrease were migration and the increased possibility to get a job in another sector with higher salaries had a strong impact. Also, the dairy production was becoming more industrial and it was difficult for small farms to survive the competition (Morell, 2011). The summer farms declined rapidly during this period (Larsson, 2009). One important reason for the very sharp decrease was that the system was based on cooperation, and when some farmers stopped using the summer farm it became very expensive for the remaining farmers to keep the summer farm system going (Larsson, 2009).

2.3 Forest pasture area

To determine the pasture area for the parish of Klövsjö, old cadastral acts (Swedish: *Laga skifte*) and their protocols have been studied (Swedish Land Survey SLS, cadastral acts), and the area of the villages´ grazing lands and forests have been summed. The cadastral acts for Klövsjö village were from the year 1842, Klövsjö outlands 1870, Klövsjö alpine outlands 1910, Kvarnsjö village and outland 1884 and Skålan village and outland 1895 (SLS). Old national statistics (BiSOS N) from the studied period have been rejected due to unreasonable figures and a lack of knowledge in how they were produced. The cadastral acts are executed on several occasions during the studied period, and summed into one pasture area used for all time periods. Despite this methodological problem this is the best estimate of grazing area which can be used. This is unfortunate, since this made it impossible to compare changes in pasture areas. The grazing pressure is now only based on the changing numbers of livestock on the same area.

The sum of the outlands includes forest, mires and other minor landcover types as well as some mires used for haymaking that were grazed after the harvest in the autumn.

2.4 Livestock numbers in Klövsjö parish, village and on farms.

Several studies of the summer farms have previously been performed in the parish of Klövsjö (Kardell & Olofsson, 2000; Kardell, 2008; Larsson, 2009), and some numbers and statistics from these studies have been used. National Statistics in the National Archives have also been used (table 1).

Table 1. *Different sources for livestock numbers and where they were found. BiSOS= Bidrag till Sveriges Officiella Statistik. SOS= Sveriges Officiella Statistik. SNA= Swedish National Archives. SLS= Swedish Land Survey.*

Year	Source	Area	Method	Found in
1772 – 1851 + 1915, 1927, 1951 and 1971	Probation rolls	Klövsjö parish	Average livestock numbers based on farm tax number	Larsson (2009)
1865 – 1905	BiSOS	Klövsjö parish	Direct application	Statistics Sweden
1935 - 1966	SOS, Jordbruksräkningen	Klövsjö parish	Direct application	Statistics Sweden
1807 - 1899	Probation rolls, cadastral acts, house cathetical rolls.	Klövsjö village	Average livestock numbers based on farm tax number, and average livestock based on people group.	Larsson (2009), SNA SLS
2011	Britta Hamrén	Klövsjö village	Direct application	Oral communication

Numbers from a doctoral thesis by Jesper Larsson (2009) were used for livestock numbers on parish level. These numbers include all livestock belonging to everyone that could have had animals in the three villages in Klövsjö parish. To fill gaps the statistics of livestock numbers in Conribution to Swedish Official Statistics (BiSOS N) and Swedish Official Statistics (SOS) have been used.

In order to quantify the livestock numbers in the village of Klövsjö, I used average livestock numbers from Larsson (2009). Larsson (2009) divided the farmers in Klövsjö parish into groups based on their farm tax number and searched in probation rolls to find out how many livestock each farmer had. In this way Larsson (2009) calculated livestock averages based on farm tax numbers in Klövjsö parish. By connecting these averages to the tax numbers of the farms in Klövsjö village, the amount of village livestock could be estimated. The tax numbers for each farm in the village was found in the National statistics and in cadastral acts (SNA, tax rolls). The tax numbers could change over time and as a result of homestead splitting, but the average livestock number was the same for the same tax number.

When calculating the number of livestock it is important to include people who did not pay taxes, such as crofters and cottagers. These people were often dependent on the farmers in the sense that they had to work for the farmers as payment for the tenancy. This group can otherwise easily be forgotten, since their individual animal holding could be small, though taken together they had many livestock during the 19th century (Larsson, 2009). To get appropriate averages the group was divided in two, one with cottagers, soldiers and craftsmen, and the other one with crofters. An average animal holding for each group was calculated from probate inventories of these people. A total sum of 42 probation inventories from the period 1830 – 1880 were used (SNA, probation rolls Klövsjö). Time was limited in this thesis so no more probation inventories could be studied, but the average numbers are reasonable. The same method is used by Larsson (2009) and Dahlström (2006). Both discuss that using this method to get avarage numbers may result in an overestimation of animal numbers. One reason for this is that wealthy people can be overrepresented in the probation rolls. Also the numbers of livestock can fluctuate during the lifetime of the people. The sum of people in the village from each group during different years was noted from house catechetical rolls and tax rolls (SNA, House catechetical rolls Klövsjö, tax rolls Klövsjö). To the average animal holding for the groups the sum of animals was added to the sum of the previously calculated average numbers from the farmers based on tax.

The number of livestock in Klövsjö village in 2011 came from Britta Hamrén (oral communication), and the numbers are based on applications for agri-environment payments. To get grants the livestock have to be by the summer farm for at least 2 months a year (Britta Hamrén, oral communication).

Since different livestock graze and affect the forest in differents ways, the proportion of horses, cows, sheep and goats were calculated by dividing the number of each animal with the sum of all animals each year.

I chose three individual summer farms for calculating stocking density (see figure 4). The first one of these summer farms were Storvallen, wich was choosen because of the find of a probation roll after the farm owner. The second one was Bräckvallen who was choosen because of the knowledge of present numbers of livestock there. The third one was Trättäng wich were choosen because of the record of the summer farm area and data of the summer farm owners. For livestock numbers on individual farms, I used probation rolls and catechetical rolls (SNA, probation rolls Klövsjö, House catechetical rolls Klövsjö). The number of livestock on Storvallen was found in the probation roll of Hans Hansson, who was the owner of that summer farm until 1874 (SNA, probation roll Klövsjö, 1874). House catechetical rolls were used to find out how many livestock owners that did not pay taxes, but could have used the land during Hans Hansson's lifetime. The calculated livestock averages for these people were used. In Trättäng the number of livestock was calculated by using Larssons (2009) average livestock numbers based on farm tax number, and also here house catechetical rolls was used to find out how many livestock owners that did not pay taxes but still could have used the summer farm. The same method was used for Bräckvallen. In Klövsjö village, the farms had a specific farm number (which was not the same one as the tax number). Homestead splitting gave several farms with the same number, and these farms often shared summer farms. For the farms with village farm number 2, livestock numbers were calculated using the farm average livestock numbers from Larsson (2009), and connecting them to farm tax numbers for year 1910.

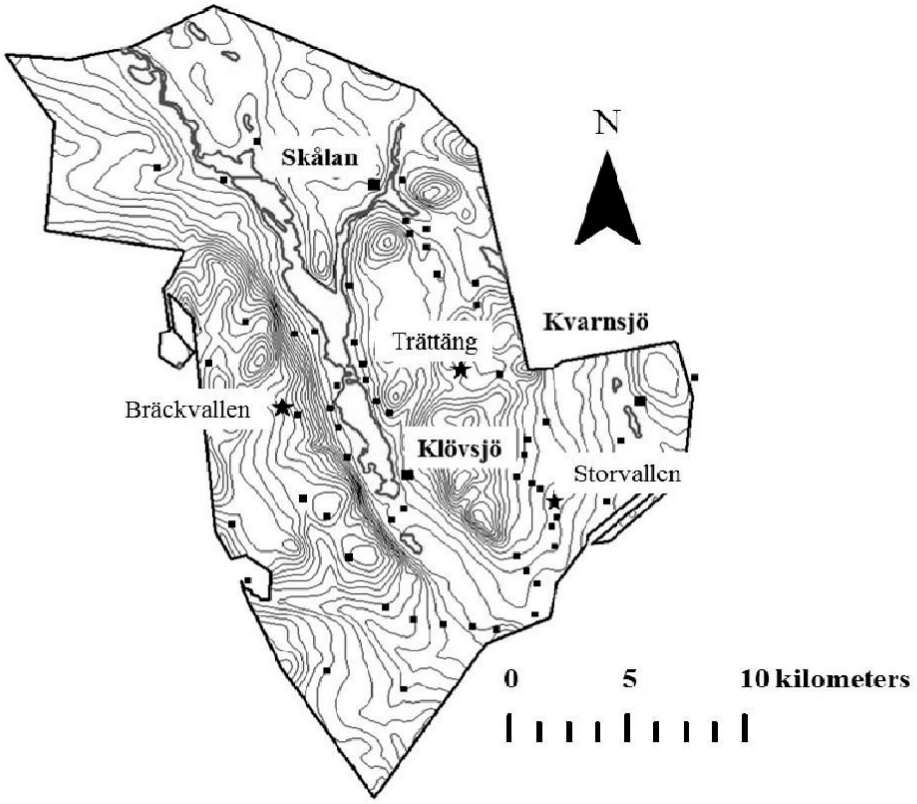

Figure 4. *Klövsjö parish during the period 1890 – 1910 with summer farms marked as small squares, and the individual studied farms Bräckvallen, Trättäng and Storvallen marked with stars. Approximately sketched after Kardell & Olofsson (2000).* © National Land Survey

2.4 Stocking density in Klövsjö parish, village and on farms.

Stocking density is the number of animals grazing on a specific area. The stocking density can be expressed in terms of number of livestock per hectare, or in grazing equivalents per hectare. The later is the definition used in this thesis. Grazing equivalents is the energy need (food demand) for different grazing animals calculated into the same unit. Reasons for using equivalents instead of livestock numbers are to facilitate comparisons through the studied time period without having to consider changes in livestock species, or changes in production per animal. To be able to make comparisons with Anna Dahlström´s (2006) numbers for southern Sweden her method to calculate the grazing equivalents was used. The conversion from number of animals into equivalents was done in several steps. First equivalents within the separate species (cattle, horse, sheep, and goat) based on an adult animals energy need was set. Then the adult animal was converted into an equivalent based on a grown cattle (see Appendix I). In this thesis the stocking density is based on changing numbers of livestock on the same area, since only one sum of pasture area in Klövsjö parish and village is used. This means that the grazing pressure could not be calculated, since the required data about changes in fodder availability were not obtainable.

The stocking density for individual summer farms was calculated by extracting data about the owner and pasture areas of the summer farms from the cadastral acts of Klövsjö outlands

1870 and Klövsjö alpine outlands 1910 (NLS). For the farms with village farm number 2, the sum of the outlands from cadastral act 1870 and 1910 was used to calculate the sum of pasture area (NLS). The stocking density was calculated using the average livestock numbers from Larsson (2009), and connecting them to farm tax numbers for year 1910 (SNA, tax rolls Klövsjö).

2.5 Forest stand structure

The National Forest Inventory started in the 1920´s, and was done in the county of Jämtland in 1925 (NFI). It was a total inventory of all forested land in Sweden, and the purpose was to get accurate estimations on the forest condition. The execution was 10 meter wide tax lines spaced 10 kilometres apart in Jämtland. The data was divided in plots; each plot was 2 kilometers long along the tax line (National Forest Inventory Board, 1932). All forest on both sides of the line was assessed with respect to site quality, stem density, age classes, and forest condition. Stem density was not classified in absolute numbers, but assessed in relation to the potential stem density according to the site qualities. Forest condition was assessed from a production point of view, with highest possible site production in mind. The stands were classified into three classes; satisfying, less satisfying and not satisfying. 16 plots on three tax lines in Klövsjö parish were used. From this data the forest structure was described.

The data showing the modern forest structure was collected in 2006 – 2010 by the National Forest Inventory. The execution was random plots with a radius of 7 – 10 meters. The plots are clustered along squares or rectangles with 300 – 1800 meters length. Within the plots the forest is assessed in respect to site quality, stem density, age classes etcetera (Swedish Forest Agency, 2011). Data from the county of Jämtland was used here.

3. Result

3.1 Pasture area

The parish includes the three villages Klövsjö, Kvarnsjö and Skålan, and the total available area of the forest and mire pasture for grazing livestock in the parish has been calculated to 38 329 hectares (table 2). The sum of the forest and mire pasture area belonging to the different villages varied from 4 413 hectares in Kvarnsjö, to 24 834 hectares in Klövsjö. The total land area of the parish was calculated to 41 623 hectares (no water or roads included), from the middle of the 19th century to the beginning of the 20th century.

Table 2. *Area of forest and mire pasture in hectare of the three villages in Klövsjö parish in hectare. Different cadastral acts established between 1842 - 1920 are used as sources (NLS, cadastral acts).*

Year	Source	Area	Area of forest and mire pasture
1842	Cadastral act	Klövsjö village	934,99 hectares
1870	Cadastral act	Klövsjö outland	13452,15 hectares
1884	Cadastral act	Kvarnsjö village	34,68 hectares
1884	Cadastral act	Kvarnsjö outland	4378,74 hectares
1895	Cadastral act	Skålan village	161,00 hectares
1895	Cadastral act	Skålan outland	8920,00 hectares
1910	Cadastral act	Klövsjö alpine outland	10447,00 hectares
Sum:			**38328,56 hectares**

3.2 Livestock numbers in Klövsjö parish, village and on farms.

The analysis of the number of livestock from Larsson (2009) and the official statistics (BiSOS N, SOS) in the whole parish of Klövsjö in the period 1772 – 1971 show that there were fluctuations in livestock numbers (figure 5). The studied period started with a steady increase in livestock numbers. There was a distinct peak of total livestock numbers in the middle of the 19th century, and after this there was a quick downfall which halted and increased slightly again in the turn of the century. This continued with a slower decrease of livestock until the 1950s when it decreased more rapidly once more.

In the beginning of the 19th century the number of goats and sheep well exceeded the number of cows in Klövsjö parish (figure 5). They reached a peak in the middle of the 19th century, but by the end of the century they were significantly lower in numbers. After the middle of the 20th century there were no goats at all left in Klövsjö parish according to the national statistics. The number of cows had a small decline in the late 19th century, but increased in numbers until 1915, when they start to decline and continued to do so during the 20th century.

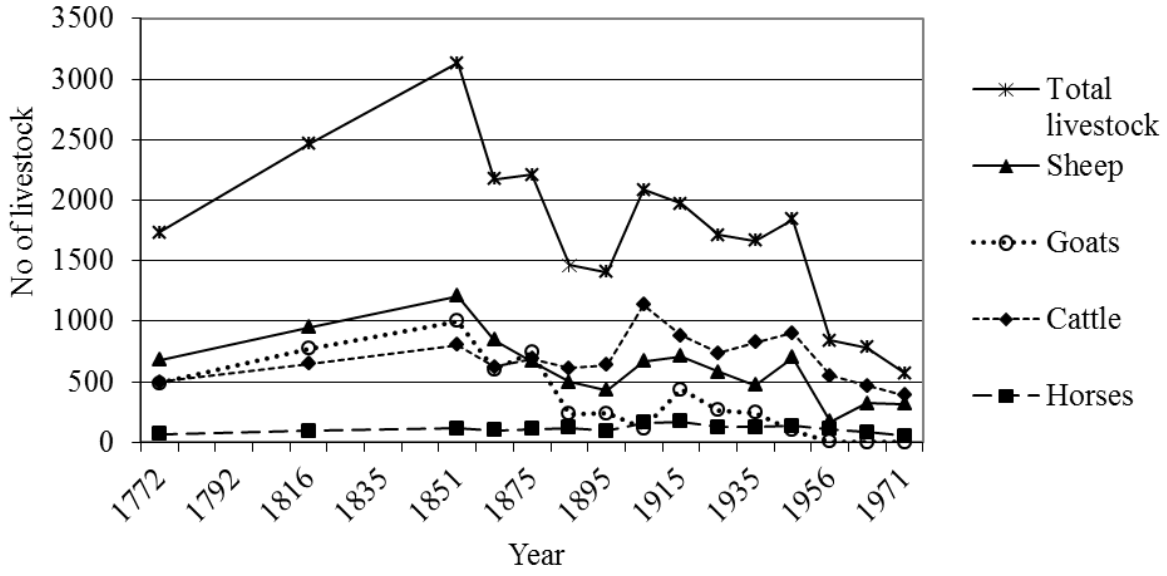

Figure 5. *Fluctuations in number of livestock in Klövsjö parish during the 19th and 20th century. Note that the graph is not linear (BiSOS N, 1865, 1875, 1895, 1905, 1915; SOS Jordbruksräkningen 1927,1935, 1944, 1956, 1966; Larsson, 2009, 1772, 1816, 1851, 1915, 1927, 1951, 1971).*

The analysis of the number of livestock calculated with farm tax number for Klövsjö parish from Larsson (2009) and linked to the the farms in Klövsjö village (SNA, tax rolls Klövsjö) showed a total increase of livestock in the period 1807 – 1899 in Klövsjö village (figure 6). During the studied period a weak peak was reached by the end of the 19th century after which the numbers slightly decreased. In Klövsjö village sheep and goats exceeded the number of cows during the whole nineteenth century, and the three livestock species increased and decreased about equally during the century. In 2011 there were 127 cattle, 27 sheep, 5 goats and 3 horses known to graze in the forests of Klövsjö village (Britta Hamrén, oral communication).

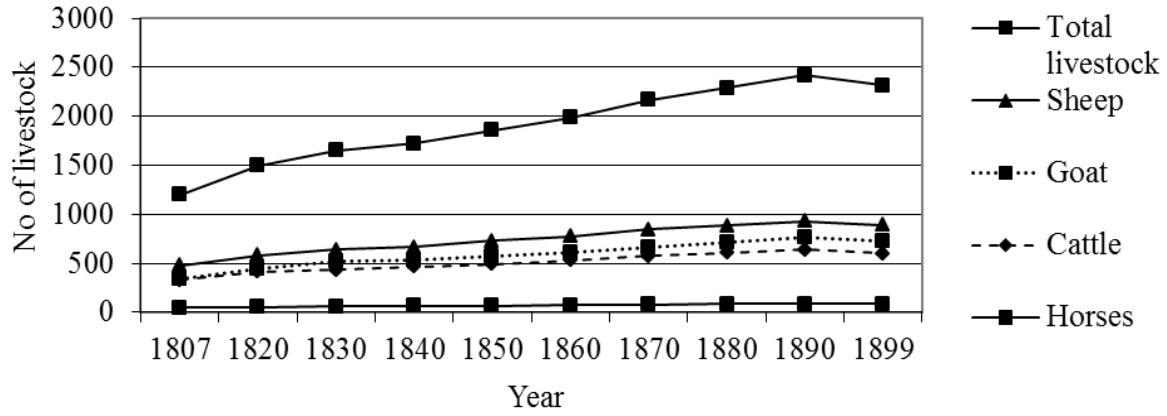

Figure 6. *Number of livestock in Klövsjö village between 1807 – 1899 (SNA probations rolls, house catechetical rolls, tax rolls; Larsson 2009).*

On the individual summer farms the total number of livestock owners on each summer farm ranged from 2 (Storvallen) to 23 (Bräckvallen), and the animals from 45 (Storvallen) to 419 (Bräckvallen) (see Appendix II). Today there are 25 cows on Bräckvallen (Axel Olsson, oral communication).

3.3 Stocking density in Klövsjö parish, village and on farms.

Stocking density as the sum of the grazing equivalents per hectare in the parish (based on the animals need for energy) in the period 1772 – 1971 followed the fluctuations of the total number of livestock. The difference is that the largest peaks occured at different times. The stocking density started with an increase until a small peak was reached 1851, to be followed by a downfall (figure 7). The livestock numbers for the parish peaked in the middle of the 19th century (figure 5), while the stocking density reached its highest peak in the beginning of the 20th century (figure 7). Thereafter the stocking density decreased during the whole 20th century with the exception for a few years during the 1940s (figure 7). In Klövsjö parish there were more fluctuations in stocking density, than for just Klövsjö village, but the values are similar (figure 7 and figure 8).

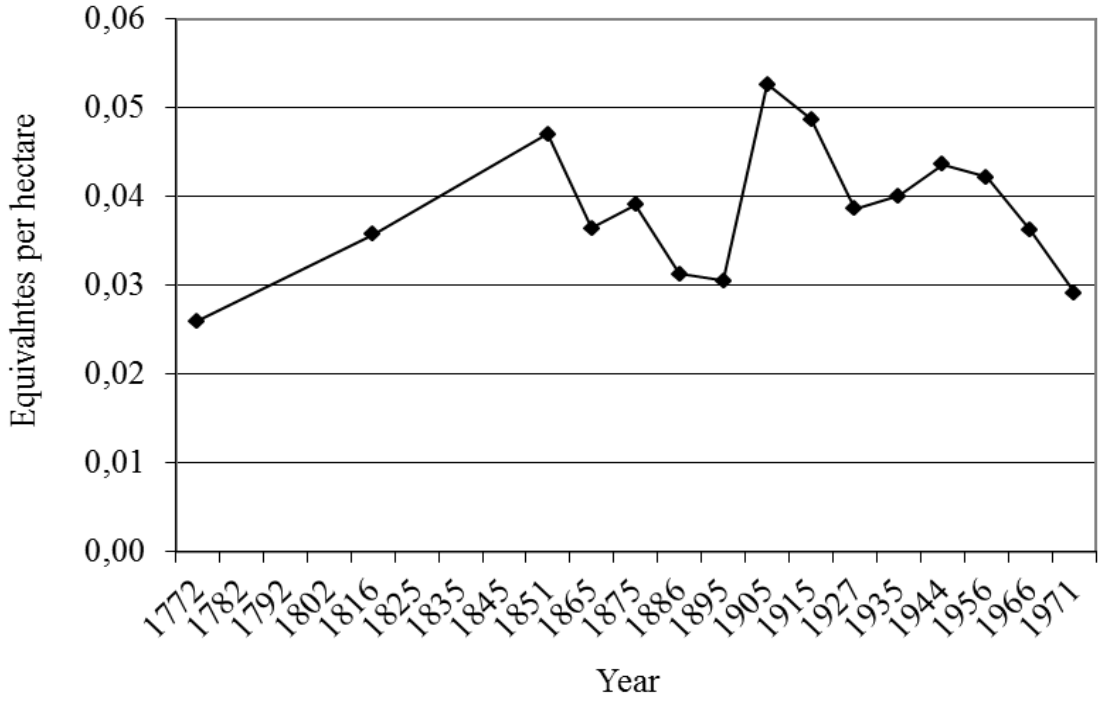

Figure 7. *Number of all livestock recalculated into grazing equivalents per hectare in the parish of Klövsjö, between 1772 – 1971. (BiSOS N, 1865, 1875, 1895, 1905, 1915; SOS Jordbruksräkningen 1927,1935, 1944, 1956, 1966; Larsson, 2009, 1772, 1816, 1851, 1915, 1927, 1951, 1971).*

The stocking density in the village in the period 1807 – 1899 follow the fluctuations of the total number of livestock. In Klövsjö village the grazing equivalents increased per hectare until 1890 where it reached a peak and slightly decreased until 1899 (figure 8). If calculating with the same forest pasture area as during the 19th century, the gstocking density in Klövsjö village in 2011 would be 0.0068 grazing equivalents per hectare (Britta Hamrén, oral communication), a much lower number than during the 19th century.

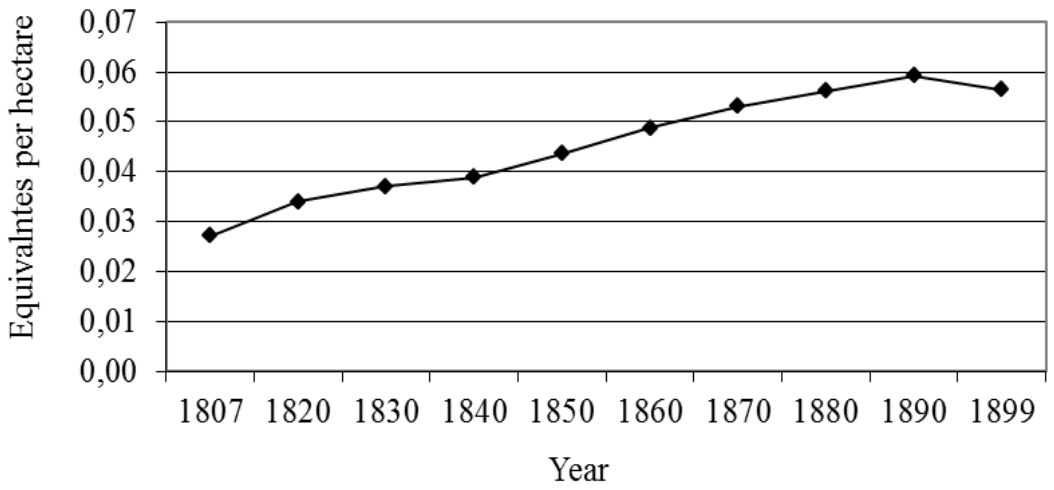

Figure 8. *Number of all livestock recalculated into grazing equivalents per hectare in the village of Klövsjö, between 1807 – 1899. (SNA probations rolls, house catechetical rolls, tax rolls; Larsson 2009).*

The proportion of livestock species based on stocking density in Klövsjö village was without large fluctuations between 1807-1899. The reason is the equal increase between the species until the end of the 19th century (figure 6). The species proportions in stocking density in the village were similar to the species proportions in the parish at the beginning of the 19th century (figure 9). But in the parish, the cows increased in proportion of grazing equivalents, at the expense of goats and sheep. The goats and sheep consistuted of nearly 40 % of the grazing equivalents in the beginning of the 19th century. When the goats disappeared in the middle of the 20th century, sheep alone represented 7 % of the grazing equivalents in the end of the century (figure 9).

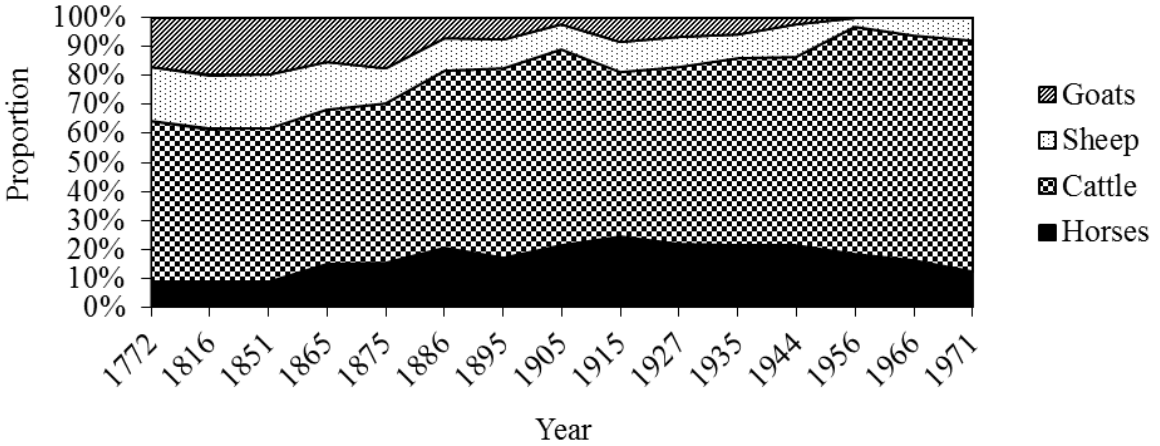

Figure 9. *Proportion of livestock species of grazing equivalents in Klövsjö parish, between 1772 – 1971 (BiSOS N, 1865, 1875, 1895, 1905, 1915; SOS Jordbruksräkningen 1927, 1935, 1944, 1956, 1966; Larsson, 2009, 1772, 1816, 1851, 1915, 1927, 1951, 1971).*

The stocking density on individual summer ranged from 27 (Storvallen) to 254 (Bräckvallen). Stocking density on each summer farm gave a very high grazing pressure (table 3), since the area surrounding the summer farm is very small. When calculating all outlands of the specific summer farm, the stocking density is still higher than the average stocking density for both Klövsjö parish and village. For the farmers with farm number 2, that had access to both

Trättängen and Bräckvallen, the sum of all outlands both on village land and alpine land gav a grazing pressure very close to average grazing pressure for Klövsjö village in the end of the 19th century.

Table 3. *Total grazing equivalents for each summer farm divided per summer farm area and outland areas for all farmers using the summer farm, to get the grazing pressure per hectare. Ha=hectares. The years within the brackets are the year of the data source.*

	Sum grazing equivalents	/ha summer farm	/ha outlands all farmers
Storvallen (1870)	27,25	13,62	0,09
Trättängen (1870)	219,58	4,79	0,2
Bräckvallen (1910)	254,25	60,68	0,19
Farms no 2 in total (1910)	144,45	-	0,06

3.4 Forest stand structure

The data from the National Forest Inventory show that in the 1920s there were several areas that had been clearcut, but still there were several stands with old forest (figure 10). Over 45 % of the forest in the parish of Klövsjö was by this time multilayered with cohorts of different ages within the stands. Most of these stands included a cohort older than 120 years. 19 % of the forest in Klövsjö was two-layered, and 26 % was multilayered (three cohorts or more).

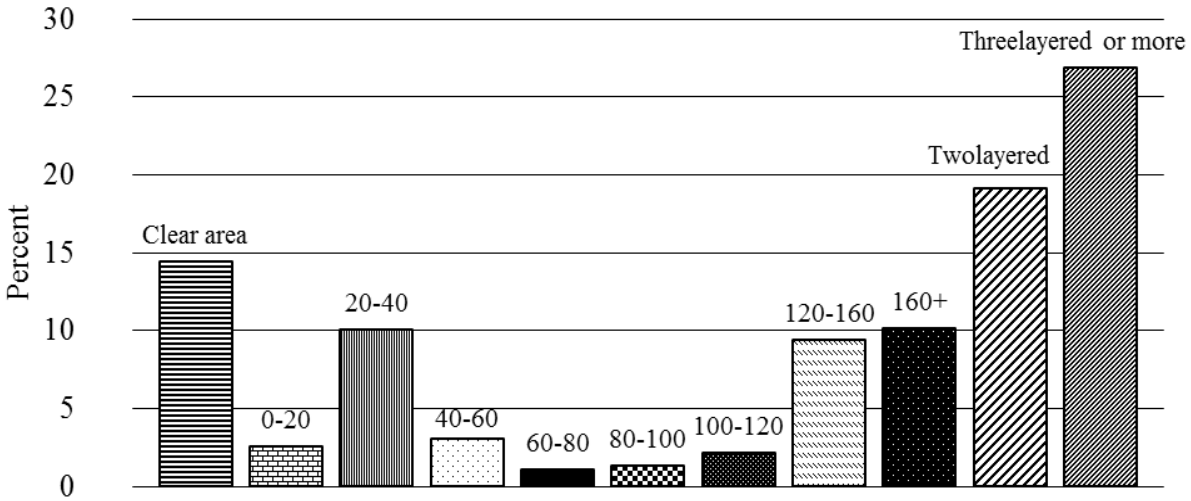

Figure 10. *Proportion of age-classes for all forest land in Klövsjö parish 1925. The stands are classified by age, and clear areas without growing trees and stands with different ages (two- and threelayered) (NFI).*

Stem density was not classified in absolute numbers, but assessed in relation to the potential stem density that could be possible according to the site qualities. Class 0.9-1 was the highest class and equals nearly fulfilled potential stem density. The mulitlayered forests were in general more dense, with 20 % of the stands in the highest stem density class, and the two-layered with only 3 % of the stands in the highest stem density class (figure 11).

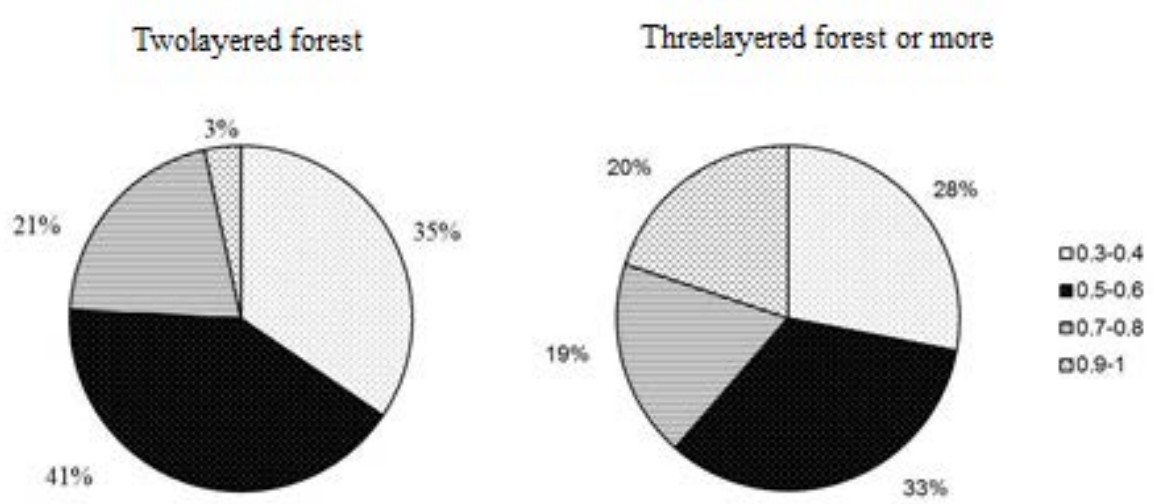

Figure 11. *Proportion of stem density classes of all two- and multi-layered forest in Klövsjö parish 1925 (NFI). Note that the numbers are relative to the possible stem density on the site (NFI).*

Of all forest land in Klövsjö parish, 15 % was clear sites without trees (figure 10), and 11 % had the highest stem density class (data not shown). The largest class was stem density class 0.5-0.6 with 32 % (data not shown). But if the clear stands without trees are overlooked in the calculations, the result is that of stem density classes with forest, 13 % belonged to the highest class. The largest class was also here stem density class 0.5-0.6, with 38 % (figure 12).

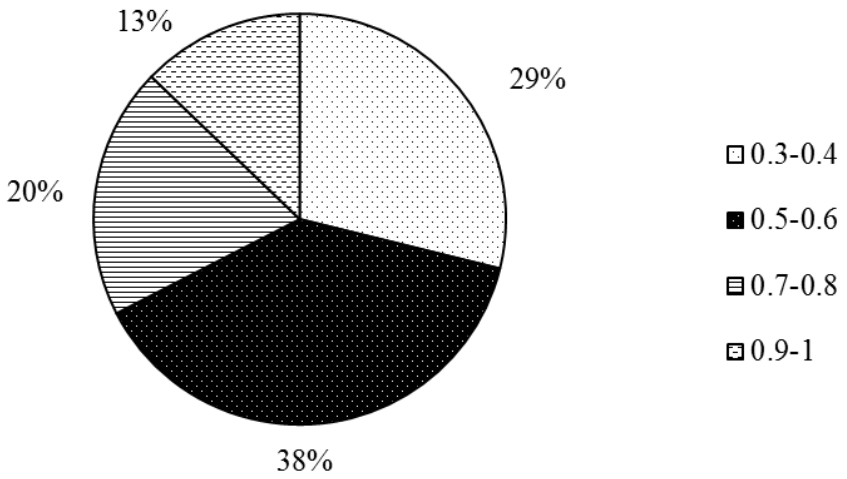

Figure 12. *Proportion of stem density classes of all forest in Klövsjö parish 1925. The two lowest classes regarded as clear sites are not included (NFI). Note that the numbers are relative to the possible stem density on the site.*

When looking at the estimated forest condition in relation to the site qualities, the older forest (120 years or older) had more stands that was considered “not satisfying” from a production point of view than when looking at all forest stands together (see figure 13).

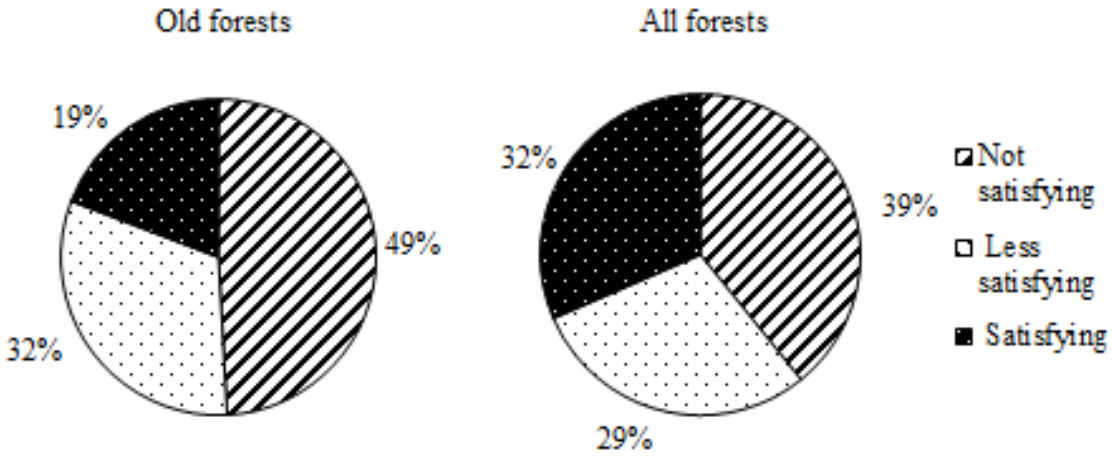

Figure 13. *Proportion of estimated forest condition of the forest in Klövsjö parish in 1925, divided between old forest and all forest (NFI).*

4. Discussion

4.1 Livestock numbers and stocking density

My results show that in the parish of Klövsjö a pasture area of 38 329 hectares (383,3 km^2), was available for grazing livestock (NLS, cadastral acts). The livestock numbers and stocking density fluctuated during the studied period. From 1800 to 1851 the livestock numbers in the parish increased (figure 5). This was probably due to the possibilites to keep the livestock on summer farms, thus increasing available forest pasture (Myrdal, 2011). The peak in livestock numbers occured in 1851 with 3000 animals (figure 5), and the peak in overall stocking density occured in 1905 with 0.05 grazing equivalents per hectare (figure 7).

The reasons for the peaks of livestock numbers and stocking density occurring at different times was because the cows increased until 1905, while the goats and sheep decreased after 1850. This gave the highest livestock numbers when goats and sheep were at their peak and cows still increased. But the stocking density reached its maximum when cows were at their peak, since they are the most energy demanding. A reason for the increase of cows during the 20th century was that more winterfodder could be produced on meadows and fodder crops were also grown on arable farmland. Manure and fertilizers were used on farmland which increased the yield of both animal fodder and crops for humans. The increase in crop yields cleared more land to be used for animal fodder (Morell, 2011). The cows increased in weight during the studied period as a result of direct breeding and therefore needed more energy. However, the fluctuations in stocking density (figure 7 and 8) are rather explained by the changes in livestock numbers (figure 5 and 6). The grazing equivalents in Klövsjö parish and village are calculated for the weights of *Swedish mountain cattle* which were and are a common race in the region. This race is a bit lighter than other modern milk cows of today, and produces less milk but do not need as much fodder (Hallander, 1989).

The reduction in goats and sheep were probably due to the international wool and cotton production, which outcompeted the swedish wool (Larsson, 2009; Morell, 2011). The pressure from the forest industry also lead to goats and sheep having to be controlled and herded to protect young conifer plants (Kardell, 2004; Kardell, 2008). After the middle of the 19th century the forest industry grew. The timber became more valuable (Kardell, 2004) and goats were heavily critized by the forest industry (Kardell & Olofsson, 2000; Kardell, 2004; Kardell, 2008; Morell, 2011). In 1857 there was a new law stating that livestock needed to be fenced or herded (Kardell, 2004; Kardell, 2008). The forests had been cut through several times (Östlund et al. 1997) so it was important to assure the regrowth of young trees and save them from the hungry livestock (Kardell, 2008). During the same period it became more and more difficult to find workers for herding. The summer farm herders were mainly women (Levander, 1943; Larsson, 2009), and before the 1940s more women than men in Sweden left agriculture for urban work (Morell, 2011). Also in the turn of the 20th century, many people emigrated from Sweden to USA (Morell, 2011; SNA house catechetical rolls Klövsjö). The forest grazing debate in Sweden continued. In 1903 there was a forestry law stating that regrowth must be assured (Kardell, 2004) and now the grazing really became an issue for the foresters (Kardell, 2004; Kardell, 2008). In 1933 a new law was initiated, saying that land fenced in the beginning of that year was not allowed for grazing cattle, but this also means

that land not fenced by this time was available for livestock (SVL 1933:269). This law is still legitimate. Later on, no further laws were needed since the livestock no longer grazed in the forest, which was probably mainly due to advances in economy and agriculture and not the restrictions in grazing (Kardell, 2004; Kardell, 2008).

Between the 1920s and 1940s the number of small-holdings rose in northern Sweden. After the second world war (ended in 1945) the number of farms in Sweden were drastically reduced (Morell, 2011). The reason for this decrease were the possibility for employment in other sectors, such as industry or forestry. At the same time the cattle were given more and better fodder and as a result the forest grazing lost importance (Morell, 2011). The dairy production became more industrial and it was difficult for small farms to survive financially (Morell, 2011). Also small farms were merged into larger ones (Morell, 2011). The breeding led to heavier animals with higher milk production; hence they needed fodder with higher quality than what the poor forest pastures could offer (Hallander, 1989). All these factors lead to fewer and fewer livestock grazing in the forest.

At the peak of stocking density in 1905 there were a bit more than 5 grazing equivalents per km^2, in the form of 3 cows and 4 goats and sheep (figure 7). There was 1 horse in 2 km^2. According to Ericsson (1997) there were 2 cows and 2 goats and sheep (3 grazing equivalents) per km^2 in the Särna-Idre area by the end of the 19th century, when calculating with a pasture area of 300 km^2 (no mires included). Särna-Idre is located in Dalarna south of Jämtland (Ericsson, 1997), and has a lower productivity than Klövsjö. The mean productivity for the Särna-Idre region is 2,4 m^3sk/year compared to 3,5 m^3sk/year in Jämtland (Swedish Forest Agency, 2011). Frödin (1925) calculated the pasture area for the summer farms in the region of Siljan to 2 961 km^2 (with no mires included) during the 19th century. Frödin (1925) concluded that 6 cows and 21 sheep and goats (13 grazing equivalents) grazed on each km^2. He also stated that most cattle grazed closer to the village, and that the summer farms furthest away from the main farm held nearly 6 cattle per each km^2. The region of Siljan is also located in Dalarna but with higher productitivity than Särna-Idre, with a mean productivity of 4,8 m^3sk/year (Swedish Forest Agency, 2011). It can be difficult to compare the stocking density in this way, since the available forest pasture is calculated in different ways between the three studies. For example both Frödin (1925) and Ericsson (1997) subtract 1/3 of the forest area assumed to be mires for haymaking, while these areas are included in the pasture in this study, since they were probably used for grazing after the harvest. The three areas have different productivity and are calculated for different times. Also different sources were used for the number of livestock in the areas.

In four parishes in south-east Sweden in the middle of the 19th century, the stocking density varied from 4 to 12 grazing equivalents per km^2 in different parishes (including meadows). If not including this land use in the pasture, the stocking density varied from 5 to 22 grazing equivalents per km^2 (Dahlström, 2006). Thus, the stocking density by the end of the 19th century was higher in southern Sweden than in Klövsjö parish, which was expected due to higher productivity (around 8 m^3sk/year) and population density in these areas. The population density could be 5 times higher in Dalarna and 20 times higher in southern Sweden than in Jämtland (BiSOS N 1850; 1900).

When looking at the stocking density for the individual summer farms there could have been over 250 animals on a summer farm (see table 2). Though the livestock grazed freely in the forest, herded by the summer farm maids to different, suitable pastures (Levander, 1943;

Larsson, 2009), the grazing pressure in the absolute vicinity of the summer farm must have been very high (figure 14).

Figure 14. *Cows and goats are herded to the pastures from the summer farm Sandviksdalen in 1959. Notice the bare hill in the backrground, probably due to grazing. Photo: Einar Montén, Jamtlis arkiv.*

Every morning and evening the cows were milked and every night all livestock were secured in the cowshed (Levander, 1943). This meant that the areas near the summer farm were grazed and trampled everyday on the way to or home from grazing in the forest. When looking at the forest pasture belonging to the individual farm owners of the summer farms, the stocking density was higher on this land than for all the available forest pasture in the parish (see table 2). This is a consequense of the fact that the stocking density for the parish is an average, and show that some areas contained a lot of animals, while some areas might not have been affected in the same way. The result for the different levels; parish, village and farm level is important to illustrate the different gradients in stocking density around the summer farms.

The livestock grazed all over the forest in Klövsjö since the parish had and has a common pasture right (Axel Olsson, oral communication). But then what stopped the farmers from getting a high number of cows? Probably it was the winterfodder who limited the size of the livestock (Larsson, 2009). There was not an endless resource of hay and leaves, and it also took a lot of time during the summer to collect all the fodder needed. There were also rules for

the summer farms, for example when you had to leave the village for grazing on the summer farm, and who had the right to which farms (Ullberg, 1933).

4.2 Forest structure

How the forest landscape was affected by the forest grazing depends on the stocking density and the vegetation production on the pasture area, thus creating the grazing pressure. Besides this a great deal depends on what kind of animals that were grazing. Different kinds of herbivores have different kind of plant preferences. Many factors affect the individual's choice for grazing, both on a small, very local scale and from a broader perspective. Examples of these factors can be social behaviours, energy demand, plant availability, location of water and shelter (Rook et al., 2004). Also the morphology of the animals is important. Larger cattle is more general in their grazing than sheep and goats, because the later has narrow mouths and can more easily be specific in their foraging. Therefore goats and sheep browse more on bushes for example, since they can choose to bite off the digestible part such as shoot, leaf or flower more precise than larger cattle (Rook et al., 2004). When cattle, sheep and goats graze together at one location, different livestock can use different plants and plant parts. They complement eachother and the pasture is very well utilized. Also goats that graze on bushes and small conifers keep gaps in the forest open for grasses to grow for larger cattle (Ekeland, 1997) (figure 15).

Figure 15. *Goats and cows grazing together. Photo: unknown, Photo library, Forestry Library, Umeå.*

There have been fluctuations between grazers and browsers in Scandinavia through history (Bradshaw & Mitchell, 1999). After the last glacial period there were a lot of grazers such as bison and auroch in Sweden, but when these species got extinct they were replaced by different browsing deer-species. A few thousand years ago the domestic grazing cattle were

very common in the forests, pushing away the wild deers. In Klövsjö parish the browsers goats and sheep decreased first from nearly 40 % of the grazing equivalents at the beginning of the 19th century, until the sheep alone consisted of 7% in the end of the century. The grazing cattle were now dominating the forest, with nearly 80 % of the grazing equivalents (figure 7). During the same time browsing mooses in Sweden were scarce because of the hunting (BiSOS Q, 1870). In Jämtland they were sligthly more than in southern Sweden, where they were nearly extinct. In the regions of Jämtland and Västernorrland (the region east of Jämtland) together, 194 mooses were shot in 1895 (BiSOS Q, 1895). At the beginning of the 20th century the moose was said to be increasing in Sweden and in 1905, the year when the grazing pressure peaks in Klövsjö, 183 mooses was shot in Jämtland/Västernorrland (BiSOS Q, 1905). These figures can be compared with the mooses shot only in Jämtland year 2010, which was over 12 000, showing that there are much more mooses in the forests of Klövsjö today than during the 19th century (Viltdata). In Klövsjö village there was in year 2011 a number of 127 cattle, 27 sheep, 5 goats and 3 horses that is known to graze in the forests (Britta Hamrén, oral communication). This is the sum of animals that farmers had reported when they applied for grants to have a summer farm and forest grazing, but there could be more animals (Britta Hamrén, oral communication). This number is much lower than the 2 500 livestock grazing in the forests of Klövsjö village in the peak in 1851, proving that once again the browsing deer-species are dominating the forests. All these fluctations in history between different kind of grazers and browsers in the forests of Klövsjö must have highly affected the forest structure.

Kardell (2008) followed some cows that grazed freely in the forest in Klövsjö during a sum of 15 seperate days between 1994 and 2005. The cows walked between 2.5 and 15 km around the summer farm and spent about 7-8 hours in the forest. Probably the herders herded the livestock about the same way as in earlier times. In Dalarna the forest pasture was divided into different areas, which were supposed to be visited during different times of the week, to make sure that no area was over-grazed (Levander, 1943). The cows were herded away from meadows and mires where the winterfodder grew, towards open areas in the forest that contained a lot of grasses (Levander, 1943). The forest was often burned or trees girdled to create these open areas for grazing (Levander, 1943; Frödin, 1952; Ericsson, 1997). This could have created the two-layered forests shown in figure 11 with the low stem density. Denser forests did not contain much valuable grazing (Frödin, 1952) and were therefore often just passed through, visited during heavy rains or to get away from troublesome insects (Kardell, 2008). According to the National Forest Inventory 19 % of the forest in Klövsjö was two-layered in 1925 and could probably have been used as forest pasture together with the 15 % of the clear areas without trees (figure 10) and other sparse forest stands. Half of the older forests in Klövsjö were not satisfying in their state production point of view (figure 13) and this could have been due to long-term grazing or the measures taken to create better pasture, such as burning or girdling in the past.

Kardell & Olofsson (2000) drew a circle on a map around each summer farm existing during the years 1890-1910 in Klövsjö parish. The circle had a radius of 4 km (the estimated walking distance for grazing livestock) to see how much area that in this time could have been affected by the forest grazing. This map shows that very few areas in the parish were not affected by grazing livestock. Most summer farms were located in the center of the parish, and very few were located in the alpine west and northern areas (figure 4). Perhaps these areas did not show a grazed forest structure, but it is likely that most of the forest was very affected by grazing. Ullberg (1933) wrote about a rule made by the village council year 1793 in Klövsjö village that an area was supposed to be protected from forest grazing and fodder collection. It was

still allowed to take out old, dry trees to use as firewood. The need to protect an area would suggest that nearly all forest were affected by the farmers and their livestock.

Today modern forestry with clear-cuts has been active in Jämtland for nearly 50 years (Kardell, 2004). In 1925 the multi-layered forests consisted of 45 % of all forested land in Klövsjö parish (figure 10). This can be compared to 33 % of multilayered forests in the county of Jämtland in 2011 (Göran Kempe, oral communication). The percentage of forest older than 120 years was more 20 % in 1925 in Klövsjö parish (figure 10) if calculating with the old multi-layered forest, to be compared to 25 % in 2010 in the county of Jämtland (Swedish Forest Agency, 2011). It is large differences in the size of the areas, so the comparison is not reliable. But still it is a bit puzzling. Several studies show that modern forestry has led to evenaged, homogenous forests and a loss of important structures, such as old trees (Berg et al., 1994; Hanski & Hammond, 1995; Östlund et al., 1997). However, the comparisons with the figures from the inventory done in 1925 in Klövsjö parish, and the statistics from the county of Jämtland today do not show this trend. One reason could be that the Klövsjö forests in 1925 were highly affected by human impact such as burnings, firewood collections and grazing and therefore the stands were not older. It is also likely that they already were affected by the forest industry in form of early logging. Although the stand age in these forest were not older than today, it is probable that the stands contained single trees much older than what can be found today. In 1925 15 % of the forest land was clear areas in Klövsjö parish (figure 10). In Jämtland in 2010 this per centage was 4 % (Swedish Forest Agency, 2011). This could also be an indicator for an open and much utilized forest structure in the 1920´s, and a denser forest with quick regenerations in the 21st century. A further indicator for this theory is figure 11 and 12, which show a high rate of stands with low stem densities in the forests of Klövsjö in relation to what could have been possible on the sites in 1925. 67 % of all forested land in Klövsjö parish in 1925 had just above half of the possible stem density or less (figure 12). The inventory is done so differently today from the 1920s, making no further comparisons in stem density or forest condition possible.

Ericsson (2001) called heavily exploited forests in the 19th century in Särna-Idre “pine-savannas”. These open forests with sparse, old pine trees are developed through fires (both antropogenic and natural), collection of fire wood, heavy grazing pressure and logging (Ericsson, 2001). The stocking density was lower in Särna-Idre than in Klövsjö, but the productivity is higher in Klövsjö. It is difficult to say if any areas in Klövsjö looked like these pine-savannas since we do not know anything about standing volume or stem density, just the relative stem density according to the Nation Forest Inventory (NFI). In the cadastral act some pieces of forest land were marked as “pasture” (NLS, cadastral acts). It would be very interesting to know what these pastures looked like. Were they grasslands in the forest landscape like modern pastures, or were they more similar to the pine savannas described by Ericsson (2001)?

It is reasonable to belive that the forest was intensively used in the vicinity of the summer farms, since the herds of livestock started and ended their grazing by the summer farm every day, and most of the firewood collection probably occurred near the summer farm (Levander, 1943). This could have created a gradient with highly exploited land around the summer farm towards more extensive use with denser forest further away (figure 16) (Dahlström, 2006).

Figure 16. *The summer farm Fallmoran in Klövsjö parish, 1916. Notice the bare boulders in the front, and the gradient towards denser forests on the hills in the background. Photo: unknown, Jamtlis arkiv.*

4.3 Biodiversity in grazed forests

A grazed forest is often a multilayerad forest, with old or dead trees, and grazed leaf and shrub vegetation (Axelsson Linkowski, 2009). The forest is often penetrated with a net of animal paths (Ljung, 2011). Studies with fossil pollen data show that there was a reduction in rare deciduous tree species when farming and forest grazing started in central Sweden, but on the other hand there is an increase in sedges, grasses and herbs, showing an alteration in vegetation which was probably partly due to the grazing (Segerström & Emanuelsson, 2002).

Generally, biodiversity in grazed forests is higher than compared to ungrazed forests (Croneberg, 2001). One reason for this is the variation and heterogenity in structure within the grazed forest (Axelsson Linkowski, 2009). An example is the gradients in grazing intensity from the more open summer farm towards the denser forests. A grazed forest also contains a structure with openings, shrubs and full grown trees (Axelsson Linkowski, 2009). Sunny openings in a sheltered location are benificial for some lichens, fungi, wild bees and bumblebees (Croneberg, 2001; Axelsson Linkowski, 2009). These opennings are created by the livestock holding the trees in check by browsing. The livestock also trample the ground, making open spots with exposed soil which are good growing spots for seeds (Croneberg, 2001; Axelsson Linkowski, 2009). The ground is also fertilized by dung but still with low nutrient concentration in the ground water because of the outtake of plant biomass. Also the turnover rate for litter is high (Croneberg, 2001). Grazed forest often contains a lot of old or dead trees (Croneberg, 2001), which are important for several species of invertebrates, fungi and lichens (Berg et al., 1994; Axelsson Linkowski, 2009). A shrub-structure can be good for biodiversity, since shrubs can act as reproductive refugees for plant species (Pihlgren, 2007).

Grazing intensity is an important factor when it comes to biodiversity. Too low stocking density makes it easier for some species to be dominant and to high stocking density makes it difficult for plant species to reproduce (Pihlgren, 2007). The grazing pressure by the summer farms was evened over large areas since the summer farm maids had divided the pasture near the farm into different areas, often one area for one day of the week. This made all land around the summer farm grazed equally (Levander, 1943) and gave the vegetation a chance to recover. Depending on what kind of structures and species you want to preserve, it could be necessary to have both grazers and browsers together in the pasture. Today the few livestock foraging in the forests are mainly grazing cattle. Also, there is much more moose in Jämtland than during the 19th century (BiSOS Q, 1870, Viltdata). They can create the resembling shrub structures as in a livestock-grazed forest (McInnes et al., 1992), and they can reduce the deciduous species (Abaturov & Smirnov, 2002). Even though they are all browsers, moose can probably not alone replace sheep and goats to preserve a traditional grazed forest structure, due to their different morphology and foraging behaviour. The population densities with moose would also need to be very high to get a grazed forest structure, which could increase the risk for serious traffic accidents (Ingemarsson et al., 2007). Also moose do not belong to any special farm but wanders free in the forest, making it difficult to direct the browsing to specific areas. The summer farm maids herded the livestock to different areas in different days of the week (Levander, 1943), which made it possible to direct and even the grazing pressure in the pasture.

4.4 A critical analysis of my historical sources

When using historical sources it is important to remember the strengths and weaknesses of these data. Lack of knowledge in how the data was produced is common, and it is always risky to use data in ways that was not intended in when producing it.

The available grazing area in the outlands of Klövsjö parish was calculated to 38 329 hectares. This area was assessed from cadastral acts from the middle of the 19th century until the beginning of the 20th century (see table 1). The cadastral acts were produced by the government in negotiations with the farmers as a basis for farm shifts. They are probably very reliable. The maps were created during different times, and it can be risky to sum the areas from them, since there may be changes in areas of different land uses. In Klövsjö parish there has been a lot of split homesteads through inheritance (Larsson, 2009), and this may have increased the areas of fields. According to Hansson & Persson (2007) Klövsjö village has not expanded much since the 1830s; instead the density of houses within the village borders has increased. The borders between Klövsjö village and the surrounding forests is exactly the same today as it was in the cadastral act from the 1840s, and the borders of the fields between the forest and the lake is about the same as today (Hansson & Persson, 2007). The conclusion is that though there may be changes in land use areas between the years, it would not have a large impact on the area of outlands available for grazing.

For the number of livestock in the parish, figures from Larsson (2009) were used together with official statistics (table 1). The latter numbers were rejected by Larsson (2009) due to lack of knowledge in how they were produced, but still used here not to get gaps in the data. After the turn of the 20th century the statistics got more reliable (SOS; Larsson, 2009). The probation rolls were produced after death to know the assets of the deceased, and it was important to get it right for the heirs (Dahlström, 2006; Larsson, 2009) and averages based on

this source is therefore the most reliable data. Many of the peaks and dips in number of livestock can be due to the different sources used. The numbers from the statistics is often lower than the numbers calculated by Larsson (2009), I therefore believe that the statistics show an underestimation. The result showing a large decrease in livestock after 1851 in Klövsjö parish can therefore be exaggerated. For example in 1915 there is a small peak in livestock numbers (figure 5) and this number is based on the numbers calculated by Larsson (2009). Another support for the statistics to be an underestimation is that the livestock numbers in the parish between 1851 - 1915 goes below the livestock numbers in the village during this time, which should be impossible (figure 5 and 6).

The livestock numbers for the village were calculated by averages based on farm tax number from Larsson (2009) and linked to the tax numbers of the farms in Klövsjö village (SNA tax rolls Klövsjö). This was combined with probation rolls (SNA probation rolls Klövsjö). A problem with this method is that tax numbers were not used in the same way after the turn of the 20th century, and therefore this analysis could not continue up to modern time. It would probably give better figures of livestock numbers if only probation rolls were used for the whole parish and village during the studied period, but this could not be done due to time constraints.

It can be very difficult to estimate the true number of livestock on each summer farm. The cottagers livestock was here included in the summer farm belonging to the farm that the cottagers had to work for, but their livestock could be on different summer farms. In the last cadastral act some of them got access to their own summer farms (NLS cadastral act, 1910). The farmers could also let livestock from other villages with less pastures graze on their land (Levander, 1943).

The stocking density might be both underestimated and overestimated in this study. The number of livestock was calculated per all available forested land. But much of this land could have been too dense forest to contain any valuable grazing, making the stocking density on the spots with a lot of herbs and grasses much higher. The grazing pressure could not be calculated since data about fodder production and availability in the pasture are lacking and are very time consuming to extract.

There are several gaps in the information of the forest structure. The inventories performed by the NFI might have too few plots in Klövsjö to get statistically reliable material and the data collection by NFI were primarly made to be used on a larger scale. The inventory was done by assessing the state of the forest in comparison with what it should be able to produce, which reflects the values of that time when timber quite recently had become valuable (Kardell, 2004). This makes it difficult to get a picture of how the forests in Klövsjö really looked in times of livestock grazings. The forest should still be affected by the grazing pressure peak in 1905 when the inventories were made, but we do not know how the structure changed when many goats and sheep disappeared from the agriculture. The forest landscape was highly affected by humans and their cattle, but in what way can be difficult to say. With more time for studies, it would be interesting to do comparisons with the forest structures in an even less populated areas (such as northern Sweden) as well as more densely populated areas (such as southern Sweden) during the first National Forest Inventories. It could also have been interesting to complement this with field studies of the current forest structure, to see what grazing structures are present today and what could be remnants from earlier grazing. A time consuming and difficult task, but very interesting, would be to try to estimate the landscape from cadastral acts (NLS). All land plots in these acts were valued with a

number on a scale. Perhaps these different values for forested land and grazing pastures could give an approximation of the utilization of the landscape.

4.5 Summer farms in the future

Many belive that summer farms are worth preserving for the future (Kardell & Olofsson, 2000; Ekeland, 2008; Rönnow, 2010; LIFE). The reasons for keeping the summer farms are the values of cultural heritage and biodiversity (Kardell & Olofsson, 2000; Ekeland, 2008; Rönnow, 2010; LIFE). The cultural heritage could be the buildings within the summer farm, as well as carved trees in the forest (Ljung, 2011). It could also take form in different kind of food, for example the cheeses made on the summer farms (figure 17). Different kinds of crafts were produced by the herders, and they sang special songs (Kardell & Olofsson, 2000).

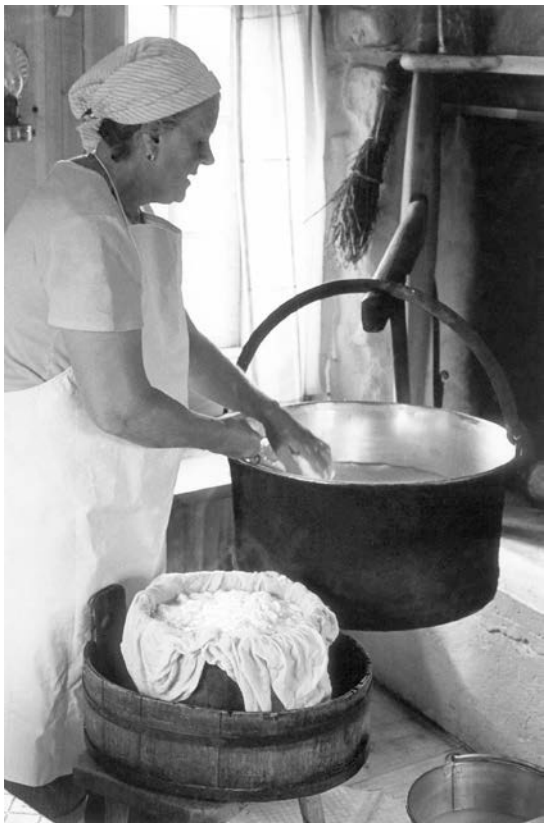

Figure 17. *Gölin Bredesen is making cheese in the summer farm Fallmoran in 1982. Photo: Ingela Bruce, Jamtlis arkiv.*

Many summer farms have livestock of old breeds that are unusual today (figure 18) (Olofsson, 2008; Rönnow, 2010). These breeds are adapted to their specific environment. They are often hardy and easily bred animals (Hallander, 1989). According to Hallander (1989) these old breeds is important to keep in the future since they have qualities that might be necessary in the future. Breeding of cattle is done to adapt the livestock to current demands and needs, however, no one knows what will be required in the future and therefore it is important to keep a diversity among livestock breeds (Hallander, 1989).

Figure 18. *Swedish mountain cattle, an old Swedish breed, grazing on a meadow in Klövsjö. Photo: Felicia Olsson*

The forest grazing has decreased drastically in Sweden during the 20th century, with negative effects for biodiversity (Andersson & Appelqvist, 1990). In the past there could be over 400 livestock animals on one summer farm in Klövsjö (see Appendix II). This can be compared to the total number of grazing livestock in Klövsjö forests of today which are 162 (Britta Hamrén, oral communication). Cows are the main livestock species, sometimes sheep but rarely goats (Britta Hamrén, oral communication). Grazed forests contain unique structures (Croneberg, 2001; Axelsson Linkowski, 2009). When cattle and browsers such as sheep and goats graze together they utilizes all of the pasture very well, and this increase the grazing pressure and creates the grazed forest structure (Ekeland, 1997). A heavy grazing pressure could either increase or decrease the vegetation biodiversity (Dahlström, 2006, Pihlgren, 2007). The species benefiting from the structures of grazed forests could probably survive in environments with different kinds of natural disturbances that are nowadays surpressed by humans, such as fires or floodings (Pykälä, 2000). Recreating these disturbances could save some species, but it would not save the other values connected to summer farms. Another issue to be addressed is the other historical uses of the forest. A lot of firewood was collected around the summer farms for the processing of milk to cheese; meadows were flooded to benefit the preferred plants etc. The disappearance of these human impacts has also impoverished biodiversity.

The biggest problem experienced by the modern summer farmers in Dalarna is the predators. To fence the livestock is not to have forest grazing on summer farms in the traditional sense, and to hire herders would be very expensive (Rönnow, 2010). In Klövsjö there is not as common with wolves as it is in Dalarna, but there are bears, wolverines and lynx (Anon, 2011). Another problem for modern summer farms is the difficulties to get profit. Lower grants would probably lead to a decrease in summer farms (Rönnow, 2010). These are important issues that must be solved for the summer farms to survive in the future. To profit from the summer farms some farmers sell cheese and perhaps this is an idea that could be extended (Kardell & Olofsson, 2000). Tourism is another often suggested solution for summer farms to survive (Kardell & Olofsson, 2000; Rönnow, 2010). Others believe that the line between culture reserves and nature reserves should be erased, and that more grazed forests should be included in some kind of reserve (Lindberg, 2008; Rönnow, 2010; Ljung,

2011). The grants should be larger to support and encourage the farmers that are still active with their summer farm (Lindberg, 2008; Ljung, 2011). I belive that a change is needed on a political level to make it profitable to run even a small-scaled farm. Locally produced provisions should be encouraged and life on the countryside should be supported with the amenities needed in a modern society, such as grocery stores, schools and hospitals. Life for a small-scale farmer should simply be somewhat facilitated, so that enthusiast that cherish the cultural and nature values can continue their work with livestock in the forest.

One thing is clear, the forest grazing has decreased very rapidly (Andersson & Appelqvist, 1990; Bradshaw & Mitchell, 1999) and the Swedish boreal landscape of today is homogenous (Östlund et al. 1997). Bearing in mind how common it has been with grazed forests in the past, and also looking at all the cultural heritage associated with summer farms, I belive we ought to try to preserve at least the few summer farms that are still active with forest grazing livestock.

5. Conclusions

The question posed at the beginning of this master thesis was how high the grazing pressure has been in the past in Klövsjö parish. This study is not meant to be an answer to how many livestock you should have in the forest to keep biological values. Both a high and a low grazing pressure can be good or bad for biodiversity (Dahlström, 2006; Pihlgren, 2007). It is important to remember the unreliability of using historical records for purposes that were not intended when the data was produced. This study was meant to give some comparable numbers, and to show how stocking density and livestock species has fluctuated through time in Klövsjö parish.

My result show that the livestock numbers and stocking density has fluctuated trough time in Klövsjö parish. The peak for highest livestock numbers and highest stocking density occured in different times, 1851 and 1905 respectively. The reason for the differing peaks is that the cows increased until 1905, while the goats and sheep decreased after 1850. This gave the highest livestock numbers when goats and sheep were at their peak and cows still increased. But the grazing pressure was at its maximum when cows were at their peak, since they were the most energy demanding.

At the peak of grazing equivalents in 1905 there was a bit more than 5 grazing equivalents per km^2 in Klövsjö parish. In Dalarna during the 19th century the grazing pressure varied between 3 grazing equivalents per km^2 in the Särna-Idre area, and 13 grazing equivalents in the Siljan-area (Frödin, 1925; Ericsson, 1997). In four parishes in the southeast of Sweden, the grazing equivalents varied from 4 to 12 per km^2 in different parishes in the middle of the 19th century, when including meadows in the pasture (Dahlström, 2006). These differences in stocking density are not surprising, since also the farmer density were different in different parts of the country. The population density could be 5 times higher in Dalarna and 20 times higher in southern Sweden than in Jämtland (BiSOS 1850; 1900).

According to the National Forest Inventory (NFI) much of the forests in Klövsjö parish were in a non-satisfying state in 1925. Today modern forestry with clear-cuts has been active in Jämtland for nearly 50 years (Kardell, 2004). Several studies show that modern forestry has led to evenaged, homogenous forests and a loss of important structures, such as old trees (Berg et al., 1994; Hanski & Hammond, 1995; Östlund et al., 1997). However, when you compare structures such as multilayered forest and old trees, there are no significant differences between 1925 and 2011. One reason could be that the Klövsjö forests in 1925 was highly affected by human impact such as burnings, firewood collections and grazing and therefore the stands were not older. It is also likely that they already were affected by the forest industry in form of early logging. Despite this it is probable that the stands contained single trees that were older than the oldest single trees of today.

When cattle and browsers such as sheep and goats graze together they utilizes all of the pastue very well, and this increase the grazing pressure and creates the grazed forest structure (Ekeland, 1997). Today the few livestock foraging in the forests are mainly grazing cattle. Also, there is much more moose in Jämtland than during the 19th century when they were nearly extinct (BiSOS Q, 1870, Viltdata). Browsing moose can also create forest structures of a livestock-grazed forest (McInnes et al., 1992). But moose can probably not alone replace

sheep and goats to preserve a traditional grazed forest structure, due to their different morphology and foraging behaviour.

Generally, biodiversity in grazed forests is higher than compared to ungrazed forests (Croneberg, 2001). One reason for this is the variation and heterogenity in structure within the grazed forest (Axelsson Linkowski, 2009). Examples are the gradients in grazing intensity from the more open summer farm towards the denser forests and the openings, shrubs and full grown trees (Axelsson Linkowski, 2009).

Historical sources can be unreliable since the data is used for other purposes than intended when produced. Many of the peaks and dips in number of livestock in my result can be due to the different sources used. The National Statistics (BiSOS N, SOS) show low numbers and is an unreliable source due to lack of knowledge in how they were produced. The averages based on probation inventories are probably the most reliable data. It can also be very difficult to estimate the true number of livestock on each summer farm. We cannot be sure where the livestock really grazed, if the cottagers had their livestock on the farm that the cottagers had to work for. My result show that stocking density in Klövsjö parish has significantly decreased during the studied period, but the effect of stocking density cannot be proved. The number of livestock was calculated per all available forest land. But much of this land could have been too dense forest to contain any valuable grazing, making the stocking density on the spots with a lot of herbs and grasses much higher.

With more time for studies, it would be interesting to do comparisons with the forest structures in an even less populated areas as well as more densely populated areas within Sweden during the first National Forest Inventories. A time consuming and difficult task, but very interesting, would be to try to estimate the landscape from cadastral acts (NLS). Perhaps the different values for forested land and grazing pastures in the acts could give an approximation of the utilization of the landscape.

The number of summer farms has decreased. If the summer farms disappear both cultural and biological values will disappear with them. A lot of challanges faces the modern summer farms, but in my opinion it would be worth it for society to put some time and money into it.

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7. Appendix

Appendix I.

Grazing equivalents
The formula used was as follows: 1 grazing equivalent = 0.9 cattle = 3.7 sheep = 2.9 goat = 0.48 horse.

The reason for 1 grazing equivalent = 0.9 cattle instead of 1 grazing equivalent = 1.0 cattle, which might have seem more logical, is that Dahlström (2006) did her calculations from the seventeenth century, so 1.0 cattle is equal to a cow from that century. Later on, breeding made the cows bigger (with higher milk production), so they demanded more energy. Hence, a cow in the 19th century needed more fodder, so 1 grazing equivalent = 0.9 cow.

The cattle energy need was calculated as follows: Metabolism = ((kg body weight)^{¾})* 0,5.

Changes from lighter cattle to heavier animals with higher demand for fodder occurred gradually. Since it is difficult to estimate how much heavier the cows get each year, it was simplified and a limit was set to 1850 when the breeding and importation of foreign cow breeds took off (Hallander, 1989). Another limit was set to 1950 when the cows were very similar to the cows of today (Hallander, 1989). The weight started with 175 kg in the beginning of the 19th century, and 1850 it was 200 kg and 1950 it was 450 kg (weights from Hallander, 1989; Kardell& Olofsson, 2000; Dahlström, 2006). Here *a Swedish mountain cattle* with today's weight of 400 kg was used, since they are the most common race on summer farms (Rönnow, 2010). This race differs from other cow races, in that they are a bit smaller, produce less milk and demande slightly less fodder (Hallander, 1989).

Horses are presumed to weigh about 250 kg at the beginning of the 1800´s and had the same weight trough the study.

The formula used for sheep was: Metabolism = (kg body weight) ^{¾} * 0,395. A sheep was estimated to the weight of 35 kg.

The formula used for goat was: Metabolism = (kg body weight) ^{¾} * 0,395. A sheep was estimated to the weight of 50 kg.

In this study the figures used is the numbers already calculated by Dahlström (2006). The only exception is when calculating for cattle, since the lighter *Swedish mountain cattle* are used as a model species here.

Appendix II.

Table 1. *The area of forest and mire pasture (outlands) belonging to each summer farm, and the sum of all the forest and mire apstures (outlands) belonging to the farmers connected to that summer farm. Also the sum of forest and mire pasture (outlands) for all farmers with farm number 2.*

	Area ha, summer farm	Outland ha	Source
Storvallen	2,0001	3,4678	Cadastral act 1870
Outland for all farmers on Storvallen		318,9350	Cadastral act 1870
Trättängen	45,8739	123,1776	Cadastral act 1870
Outland for all farmers on Trättäng		1121,6676	Cadastral act 1870
Bräckvallen	4,1950	205,7300	Cadastral act 1910
Outland for all farmers on Bräckvallen		1330,6600	Cadastral act 1910
Outlands for all farmers on no 2		2452,3276	Cadastral act 1870; 1910

Table 2. *Amount of livestock and livestock calculated into grazing equivalents that could have been grazing on the summer farm Storvallen. The sum of livestock and grazing equivalents is divided by the areas from table 1.*

Possible livestock on Storvallen

Farmers	**Cows**	**Horses**	**Sheep**	**Goats**	**Total grazing equivalents**	**Total livestock**	**Source**
Hans Hansson	6,00	1,00	11,00	3,00	13,32	21,00	Probation roll, 741109
Cottager Andersson	5,58	0,86	8,80	8,72	13,93	23,96	Average numbers
Sum	**11,58**	**1,86**	**19,80**	**11,72**	**27,65**	**44,96**	
Per summer farm					13,82	22,48	
Per summer farm outland					7,97	12,96	
Per outlands for all farmers					0,09	0,14	

Table 3. *Amount of livestock and livestock calculated into grazing equivalents that could have been grazing on the summer farm Trättäng. The sum of livestock and grazing equivalents is divided by the areas from table 1. The sum after the names are the farmers tax number.*

Possible livestock on Trättäng

Farmers	Cows	Horses	Sheep	Goats	Total grazing equivalents	Total livestock	Source
2 Zakris Kristensson, 25/32	9,10	1,50	14,30	11,50	21,96	36,40	Average tax-based numbers
2 Anders Norell, 25/32	9,10	1,50	14,30	11,50	21,96	36,40	Average tax-based numbers
2 Zakris Fjäll 25/64	9,10	1,50	14,30	11,50	21,96	36,40	Average tax-based numbers
2 Sven Göransson, 25/64	9,10	1,50	14,30	11,50	21,96	36,40	Average tax-based numbers
2 Matias Olofsson 25/32	9,10	1,50	14,30	11,50	21,96	36,40	Average tax-based numbers
Crofters/cottagers	45,50	7,50	71,50	57,50	109,78	182,00	Average numbers
Sum	**91,00**	**15,00**	**143,00**	**115,00**	**219,56**	**364,00**	
Per summer farm					4,78616381	7,934795167	
Per summer farm outland					1,78	2,96	
Per outlands for all farmers					0,20	0,32	

Table 4. *Amount of livestock and livestock calculated into grazing equivalents that could have been grazing on the summer farm Bräckvallen. The sum of livestock and grazing equivalents is divided by the areas from table 1. The sum after the names are the farmers tax number.*

Possible livestock on Bräckvallen

Farmers	Cows	Horses	Sheep	Goats	Total grazing equivalents	Total livestock	Source
7 Olof Sifvertsson 40/96	9,10	1,50	14,30	11,50	**21,96**	**36,40**	Average tax-based numbers
7 Jöns Sifvertsson 40/96	9,10	1,50	14,30	11,50	**21,96**	**36,40**	Average tax-based numbers
7 Sifvert Olofsson 40/96	9,10	1,50	14,30	11,50	**21,96**	**36,40**	Average tax-based numbers
7 Olof Olofsson 5/36	9,10	1,50	14,30	11,50	**21,96**	**36,40**	Average tax-based numbers
7 Olof Ersson 5/36	9,10	1,50	14,30	11,50	**21,96**	**36,40**	Average tax-based numbers
2 Johan Olofsson 25/384	9,10	1,50	14,30	11,50	**21,96**	**36,40**	Average tax-based numbers
2 Zakris Kristersson 25/64	9,10	1,50	14,30	11,50	**21,96**	**36,40**	Average tax-based numbers
2 Krister Kristersson 25/64	9,10	1,50	14,30	11,50	**21,96**	**36,40**	Average tax-based numbers
2 Olof Andersson Norell 25/32	9,10	1,50	14,30	11,50	**21,96**	**36,40**	Average tax-based numbers
Crofters/cottagers	27,8	2,15	32,8	28,19	**56,61**	**90,94**	Average numbers
Sum:	**109,70**	**15,65**	**161,50**	**131,69**	**254,21**	**418,54**	
Per summer farm					60,67159905	99,77115614	
Per summer farm outland					1,24	2,03	
Per outlands for all farmers					0,19	0,31	

Table 5. *Amount of livestock and livestock calculated into grazing equivalents that could have been grazing on all of the land belonging to the farms with farm number 2. The sum of livestock and grazing equivalents is divided by the areas from table 1. The sum after the names are the farmers tax number.*

Possible livestock for all farmers on no 2

Farmers	Cows	Horses	Sheep	Goats	Total grazing equivalents	Total livestock	Source
2 Johan Olofsson 25/384	9,10	1,50	14,30	11,50	**21,96**	**36,40**	Average tax-based numbers
2 Zakris Kristersson 25/64	9,10	1,50	14,30	11,50	**21,96**	**36,40**	Average tax-based numbers
2 Krister Kristersson 25/64	9,10	1,50	14,30	11,50	**21,96**	**36,40**	Average tax-based numbers
2 Olof Andersson Norell 25/32	9,10	1,50	14,30	11,50	**21,96**	**36,40**	Average tax-based numbers
Crofters/cottagers	27,8	2,15	32,8	28,19	**56,61**	**90,94**	Average numbers
Sum	**64,20**	**8,15**	**90,00**	**74,19**	**144,43**	**236,54**	
Per outlands for all farmers					0,058895058	0,096455287	

Svensk sammanfattning

Detta är en populärvetenskaplig sammanfattning. Större och fler figurer i färg finns i originalet.

Tama djur i det vilda – bete kring fäbodar i Jämtland från 1800-talet fram till idag.

Inledning

Utmarken har genom tiderna haft stor betydelse för folk på landsbygden. Där hämtade man brännved och material till redskap, och den användes även som betesmark. Att djuren betade i skogen var sällan någon konflikt mot det övriga nyttjandet. Men under 1800-talet och framförallt under 1900-talet växte skogsindustrin, och timmer blev allt mer värdefullt. År 1857 blev det boskapsbondens plikt att hägna eller valla sina kreatur, detta för att skydda skogsproduktionen. Skogsbetet fortsatte dock även efter detta (Axelsson Linkowski, 2009).

Fäbodar finns i hela Europa, från Skandinavien, via central Europa med alperna, ner till södra Europa som Spanien och Grekland. I alperna är fäbodväsendet liknande det i Sverige, den största skillnaden är att betesmarkerna inte är lika vitt utbredda i alperna, där man använder de olika vegetationszonerna för bete, som ges av höjdskillnaderna i bergen. På vintern måste man stalla djuren vid hemgården, och detta ger en stark koppling mellan fäboden och hemgården. Mycket av böndernas sommararbete går åt till att samla in allt foder som behövs för att djuren ska kunna klara vintern. Detta behövs inte i södra Europa där djuren kan beta ute året runt, och ständigt flyttas mellan olika betesplatser.

Enligt John Frödin (1952) uppkom fäbodväsendet i Sverige då tillräcklig mängd bete och slåtter inte fanns tillgängligt i gårdens närhet för hela året, utan bonden fick flytta runt för att finna lämpliga marker för att försörja sina djur. Det var med hjälp av fäbodarna som gårdar kunde öka sina djurbesättningar (Larsson, 2009). Enligt andra källor grundades fäbodarna för att markera revir och hävda marken med dess resurser mellan fäboden och gården. Fäbodar är i första hand en norrländsk företeelse, och fäbodväsendet södra utbredning vid 1800-talets slut sammanföll till stor del med limes norrlandicus (Larsson, 2009). De marker som nyttjades var huvudsakligen gränsmarken mellan myren där man slog vinterbete, och den tätare skogen där betet var fattigare. Fjällskogar liksom högörtsrika granskogar erbjöd bra bete. För att få fram bra bete brände man skogen, och när svedjandet avskaffades ringbarkade man träden (Frödin, 1952).

Betad skog är en av de naturtyper som minskat mest i Sverige under de senaste hundra åren. Strukturerna som skapas av skogsbete är unika och kan vara viktiga för biologisk mångfald. Den kontinuerliga störningen av bete och tramp gör att fler växt- och svamparter kan konkurrera om växtplatsen. Träd friställs och bildar grova och knotiga grenar och grova stammar som senare kan bli ihåliga, vilket gynnar flera rödlistade arter av insekter. Boskapsspillning i skuggade och fuktiga miljöer är viktiga substrat för vissa numer ovanliga svampar (Axelsson Linkowski, 2009). Graden av betestryck är viktig för dynamiken av biodiversitet på lokal nivå. Djuren betade förr på olika ställen olika tider på året, och troligtvis har även mängden betesdjur varierat genom århundraden. Ett för hårt betestryck under lång tid kan utarma biodiversiteten snarare än förstärka den (Dahlström, 2006). Av bland annat dessa skäl är det mycket viktigt att förstå hur skogsbetet både påverkat skogen och hur det har

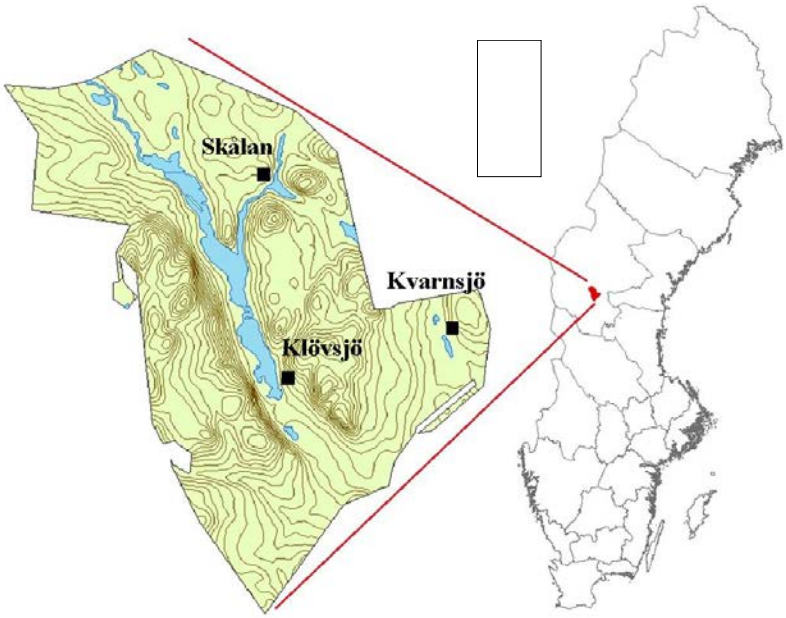
förändrats över tiden. Viktiga frågor att studera är djurtätheten och hur stora delar av skogarna som utnyttjats för skogsbete.

Syfte
Det övergripande syftet med detta examensarbete är att analysera skogsbetets omfattning och förändring över tid i en jämtländsk socken i ett längre tidsperspektiv. Det område som jag kommer att arbeta med är Klövsjö socken och den studerade tidsperioden sträcker sig från ca 1800 till idag.

Frågeställningar
- Hur många djur och av vilken typ betade i skogarna kring Klövsjö?
- Hur stor areal skogsmark har funnits tillgänglig inom socken vid olika tidpunkter?
- Hur har betestrycket förändrats inom socken under den studerade tidsperioden och hur kan skogarna ha påverkats av detta?

Utifrån resultaten kommer jag diskutera betestryck i relation till skogsstruktur, biodiversitet och dagens älgstammar.

Material och metod
Studieområdet
Klövsjö socken ligger i sydvästra Jämtland, i centrala Sverige. Den består av de tre byarna Klövsjö, Kvarnsjö och Skålan (se figur 1). Klövsjö ligger precis bredvid Klövsjön, som ligger 440 meter över havsytan (se figur 2). Socknens högsta punkt är Klövsjöfjället, som reser sig 1 023 meter över havet. Nederbörden är 800-900 mm per år, och vegetationsperioden är 140 dagar (Alexandersson & Eggertsson-Karlström, 2001). Medelskogsproduktionen i Jämtland är 3,5 m^3sk/år (Skogsstyrelsen, 2011).



Figur 1. *Klövsjö socken ligger i Jämtland i centrala Sweden. De tre byarna är Klövsjö, Skålan och Kvarnsjö.* © Lantmäteriet

Figur 2. *Klövsjö by intill Klövsjön med Klövsjöfjället i bakgrunden. Foto: Felicia Olsson*

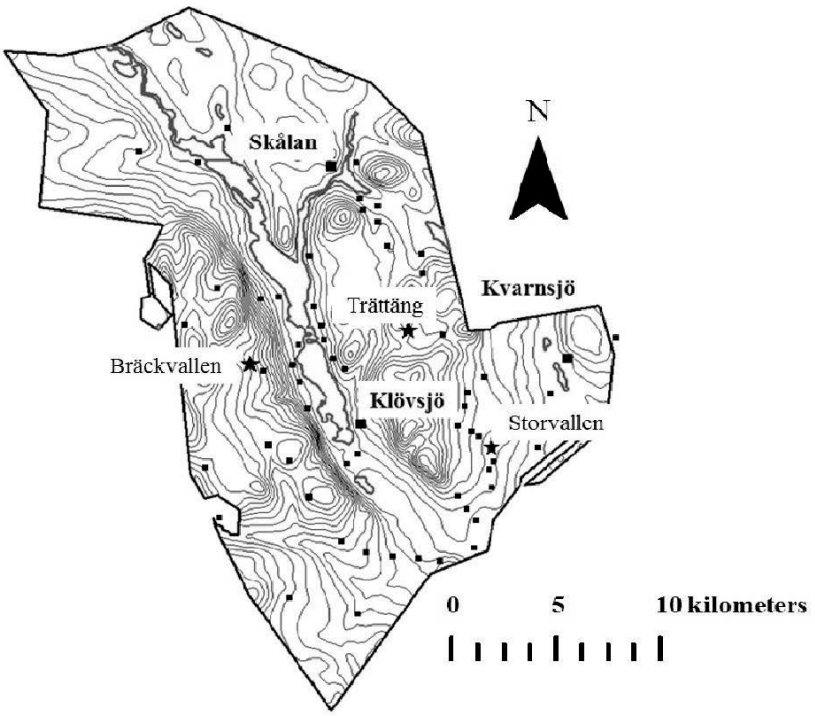
Metoder

För att ta reda på hur mycket skogsmark som funnits tillgänglig för bete har jag studerat kartor och protokoll från Laga skiftes-kartor. Laga skifte har genomförts olika år för olika delar av socknen. Data från dessa olika kartor har slagits samman till en summerad areal av skogsbetesmark.

Uppgifter om antalet boskap i hela Klövsjö socken under studieperioden har jag bland annat fått från Larsson (2009). För att ta reda på antalet djur i Klövsjö by har jag använt Larssons (2009) medelvärden för gårdar i Klövsjö socken, och kopplat dessa medelvärden till gårdsstorleken på gårdarna i byn. För att få reda på hur många djur de obesuttna (torpare, backstugusittare osv) hade, har jag undersökt flera boupptecknin gar efter personer tillhörande dessa grupper, och räknat ut egna medelvärden. Boupptecknin gar uppförda under 37 år undersöktes, och antalet upptecknin gar som medelvärdena baseras på är 42.

Djurtäthet innebär antalet djur per hektar, eller antalet betesekvivalenter per hektar. För att ta reda på betestrycket ska även vegetationsproduktionen tas med i beräkningen. I denna uppsats används betesekvivalenter per hektar för att uttrycka djurtäheten. Betesekvivalenter innebär att den energi varje djur behöver, dvs. foderbehovet, räknas om till samma enhet. En betesekvivalent är lika med energibehovet för ett vuxet nötkreatur. En get är lika med 0,3 betesekvivalenter, eftersom de behöver en tredjedels foder av en ko. Fördelarna med denna metod är att det går lätt att jämföra betestrycker över tid oavsett förändringar i boskapssammansättningen eller djurstorlek.

Undersökningen har utförts på tre nivåer; sockennivå, bynivå och fäbodnivå. De tre fäbodar som valts ut bland andra för att titta närmare på är Bräckvallen, Trättäng och Storvallen (se figur 3).



Figur 3. *Klövsjö socken år 1890 – 1910 med fäbodar markerade med små fyrkanter, och de individuella fäbodarna Bräckvallen, Trättäng and Storvallen markerade med stjärnor. Ungefärligt tecknat efter Kardell & Olofsson (2000).* © Lantmäteriet

För att få en uppfattning om skogsstrukturen har jag analyserat historiska skogsdata, bland annat uppgifter från den första riksskogstaxeringen i Jämtland, 1925. Detta var en linjetaxering. Skogstillståndet inventerades genom att uppskatta bonitet, stamtäthet, åldersgrupper, vegetationstyp och skogstillstånd. De flesta variabler uppskattades genom att jämföra hur skogens såg ut i relation till hur den borde kunna se ut om högsta möjliga produktion uppnåtts.

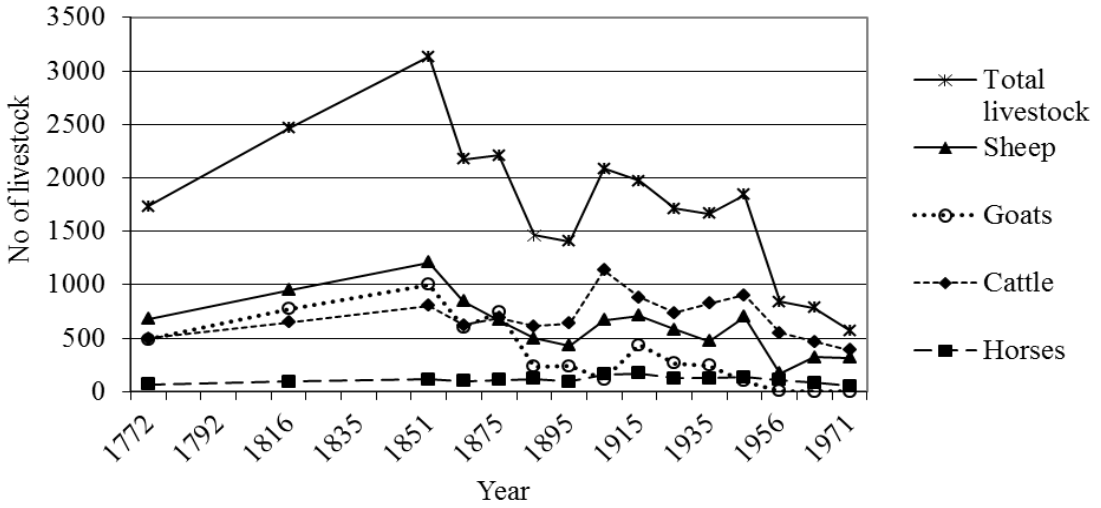
Resultat

Skogsbetesareal

Summan av sockenarealen utan sjöar och vägar inräknade är 41 623 hektar. Av detta är skog som kan ha använts för bete 38 328 hektar.

Antal boskap

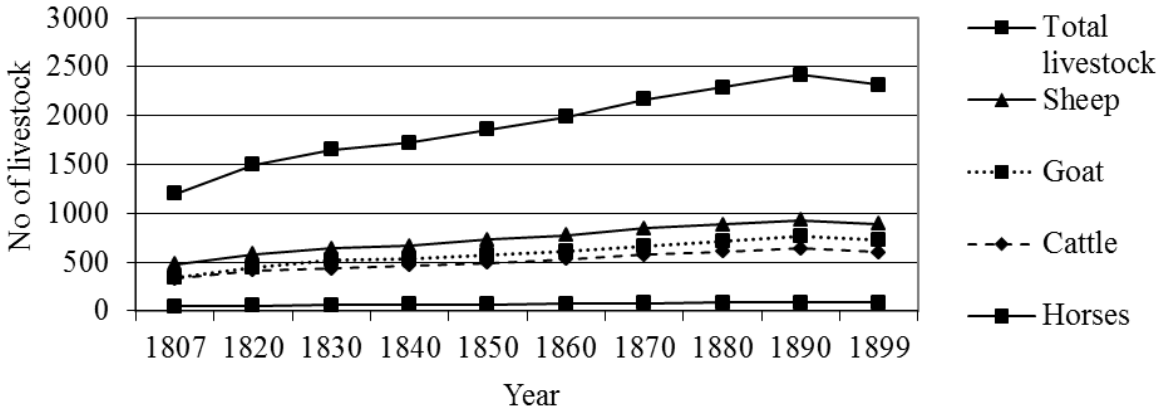
Antalet boskap har fluktuerat i Klövsjö socken mellan 1772-1971. Perioden startade med ett stigande antal boskap fram till 1851, för att sedan sjunka. 1905 blir det återigen en liten topp och efter det var nivå mer stadig fram till 1956, då antalet boskap sjönk återigen. I början av studieperioden är får och getter vanligast. Dessa småkreatur sjunker dock efter 1851, men var fler än korna fram till 1875. 1895 börjar korna öka rejält i antal och är därefter alltid fler än småkreaturen (se figur 4).



Figur 4. *Antal boskap i Klövsjö socken mellan 1772 – 1971 (BiSOS N, 1865, 1875, 1895, 1905, 1915; SOS Jordbruksräkningen 1927,1935, 1944, 1956, 1966; Larsson, 2009).*

Antalet boskap i Klövsjö by stiger stadigt mellan 1807-1899, förutom en svag topp 1890 och en lika svag minskning av boskap till 1899 (se figur 5).

2011 fanns det 127 nötboskap, 27 får, 5 getter och 3 hästar som betade i Klövsjö skogar, som det sökts bidrag för (Britta Hamrén, muntlig kommunikation).

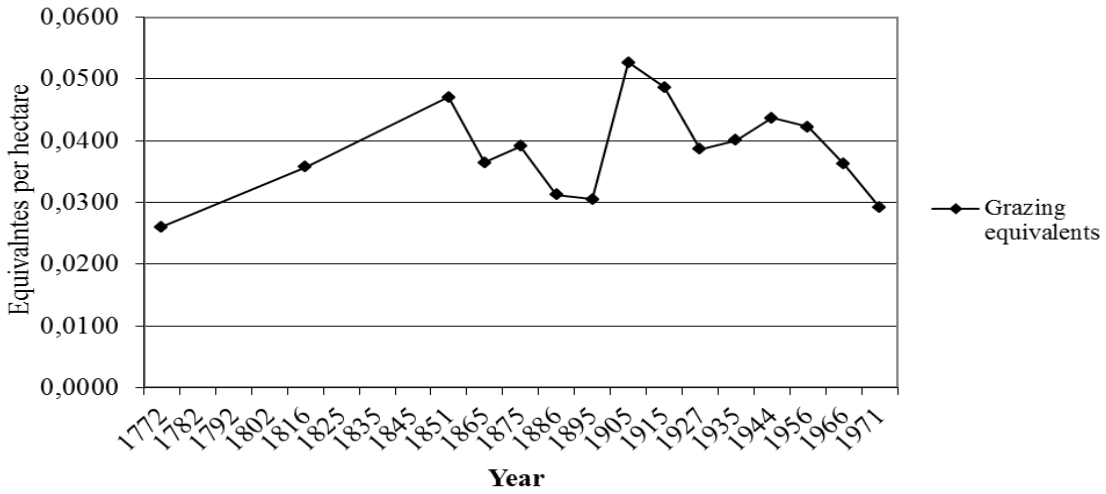


Figur 5. *Antal boskap i Klövsjö by mellan 1807 – 1899 (boupptecknings*ar*, husförhörslängder; mantalslängder; Larsson 2009).*

På de individuella fäbodarna varierade antalet boskapsägare från 2 (Storvallen) till 23 (Bräckvallen), och antalet djur från 45 (Storvallen) till 419 (Bräckvallen). Idag finns det 25 kor på Bräckvallen (Axel Olsson, muntlig kommunikation).

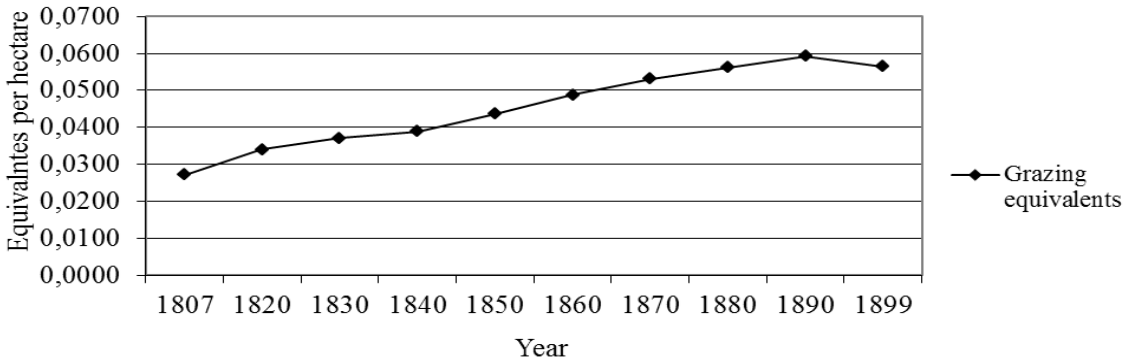
Djurtäthet

Djurtätheten i Klövsjö socken fluktuerar mellan 1772-1971 precis som antalet boskap. Skillnaden är att den högsta toppen av djurtäthet nås 1905 (figur 6), till skillnad från antalet boskap som nådde sin topp 1851 (figur 4).



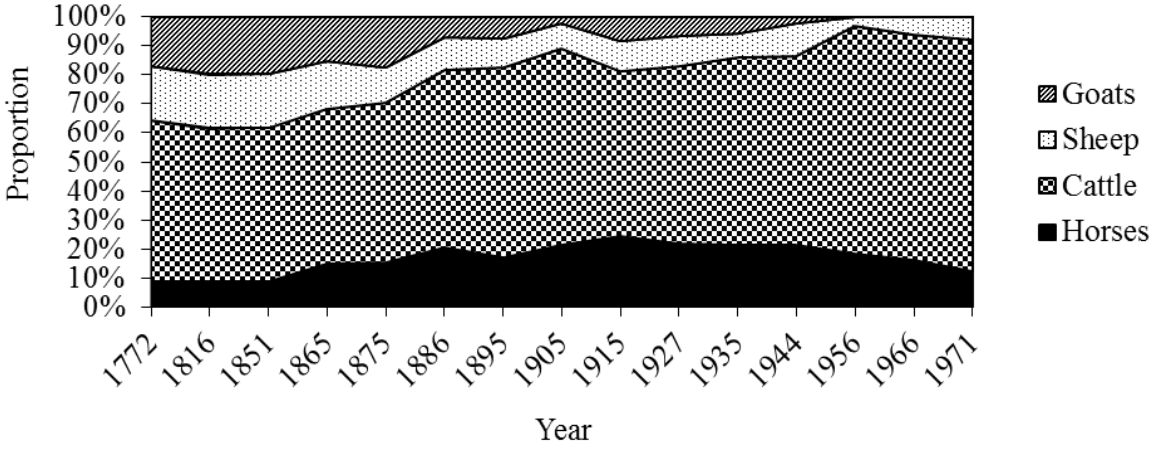
Figur 6. *Boskap omräknat till betesekvivalente per hektarr i Klövsjö socken mellan 1772 – 1971.*

Djurtätheten i Klövsjö by mellan 1807-1899 följer samma mönster som antalet boskap. Om man med samma betesareal som tidigare, för de djur som går på skogen i byn 2011 skulle betestrycket bli 0,0068 betesekvivalenter per hektar.



Figur 7. *Antal boskap omräknat till betesekvivalente rper hektar i Klövsjö by mellan 1807 – 1899.*

Beräknar man proportionen av de olika boskapssorterna av det totala antalet betesekvivalenter under studieperioden i socknen, ser man tydligt hur nötboskapen ökar i antal samtidigt som småkreaturen minskar. På 1950-talet försvinner getterna helt och i slutet av studieperioden består fåren ensamma av 7 % av alla betesekvivalenter i socknen.



Figur 8. *Proportioner av boskap av betesekvivalenter i Klövsjö socken mellan 1772 – 1971.*

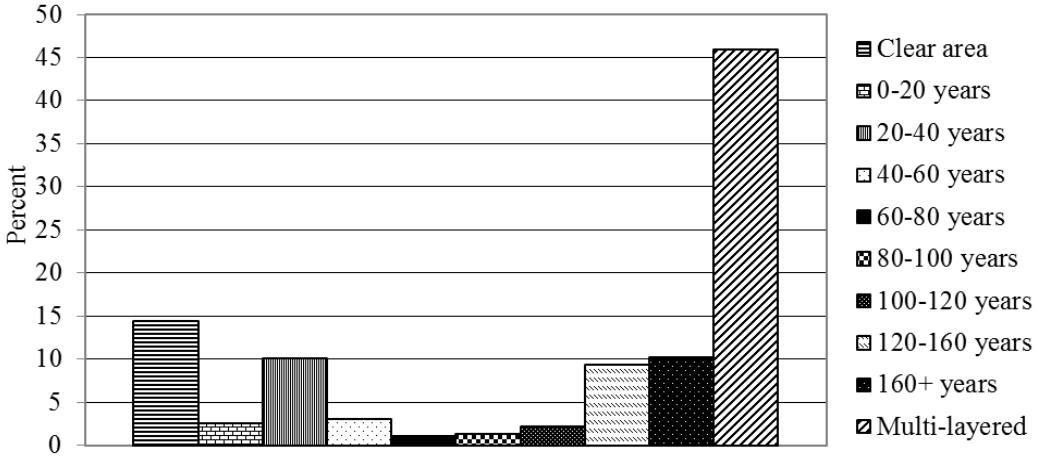
Resultatet för djurtätheten på de individuella fäbodarna visar en mycket hög djurtäthet endast delat på arealen fäbodmark, eftersom detta är små arealer. Delar man däremot antalet betesekvivalenter på arealen utmark för alla bönder som har djur på fäboden, blir djurtätheten lite mer realistiskt men fortfarande högt. Detta beror helt enkelt på att djurtätheten som är beräknat för socknen och byn är medelvärden (tabell 2). Beräkningarna för de gårdar som har gårdsnummer 2 i Klövsjö, blir betestrycket 0,06 vilket är detsamma som djurtätheten i Klövsjö by år 1890 (figur 7).

Tabell 2. *Totalt antal betesekvivalenter för varje fäbod, delat på areal till fäboden samt arealen utmark för alla bönder som använde fäboden, för att få djurtätheten per hektar.*

	Summa betesekvivalenter	**/ha fäbod**	**/ha utmark för alla bönder**
Storvallen (1870)	27,25	13,62	0,09
Trättängen (1870)	219,58	4,79	0,2
Bräckvallen (1910)	254,25	60,68	0,19
Farms no 2 in total (1910)	144,45	-	0,06

Skogsstrukturen

Data från Riksskogstaxeringen visar att 1925 så var flera områden kalhuggna, men det fanns fortfarande områden med gammal skog (se figur 9). Över 45 % av skogen i Klövsjö socken var vid den här tiden flerskiktad med olika åldrar inom beståndet (se figur 9), och de flesta av dessa bestånd innehåll skikt med en ålder på över 120 år. 19 % av skogen i Klövsjö tvåskiktad, och 26 % var flerskiktad (tre ålderskikt eller fler).



Figur 9. *Proportion av åldersklasser för all skogsbeklädd mark in Klövsjö socken 1925 (Riksskogstaxeringen).*

Grundytan var klassifierad i absoluta siffror utan uppskattade i relation till den potentiella grundytan som kunde varit möjligt utifrån ståndortens egenskaper. Av all skogsmark i Klövsjö socken, var 15 % kala ytor (figur 9), och 11 % tillhörde den högsta klassen av grundyta. Den största klassen var klass 0.5-0.6 med 32 % (ej redovisad data). Men om de kala ytorna inte räknades, visade resultatet att 13 % av den skogsbeklädda marken hörde till den högsta klassen. Den största klassen var även nu grundyteklass 0.5-0.6, med 38 % (figur 10).

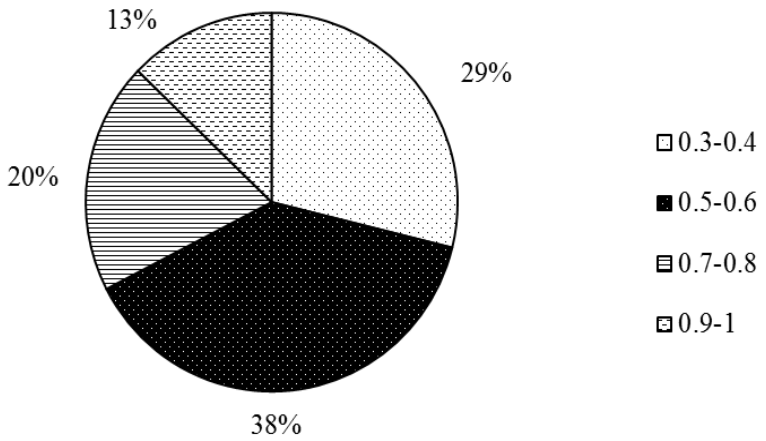
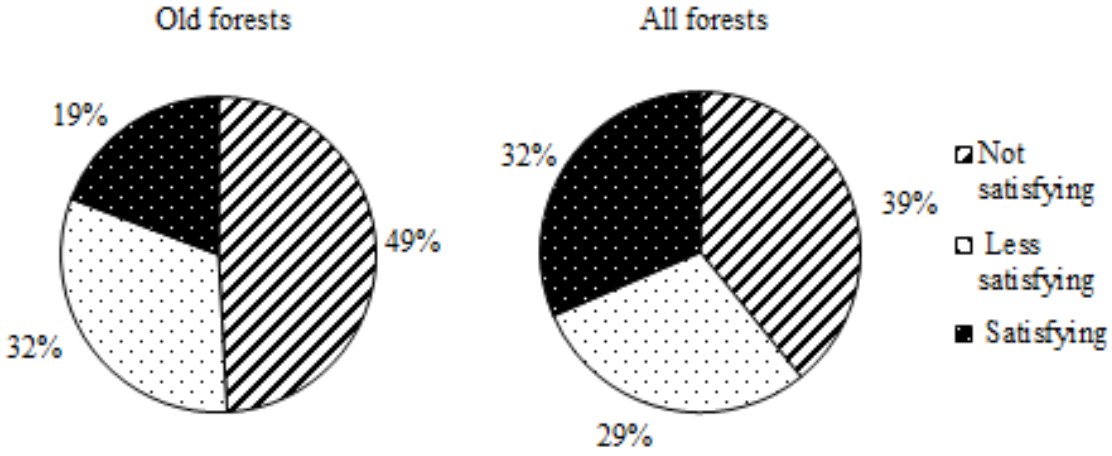


Figure 10. *Proportion av grundytan uppdelat på klasser av alla bestånd i Klövsjö socken 1925. De två lägsta klasserna som består av kal mark är inte inkluderade (Riksskogstaxeringen). Notera att siffrorna är relativa till den potentiella grundytan bserat på ståndortsegenskaper.*

När man ser på det uppskattade skogstillståndet i relation till ståndortsegenskaperna, så hade den äldre skogen (äldre än 120 år) fler bestånd som angetts som “ej tillfredställande” än om man såg till all skog i Klövsjö socken (figur 11).



Figur 11. *Proportion av uppskattat skogstillstånd i relation till det möjliga skogstillståndet baserat på ståndortens egenskaper i Klövsjö socken 1925, uppdelat på äldre skog (äldre än 120 år) och all skog (Riksskogstaxeringen).*

Diskussion

Antal boskap och djurtäthet

Mina resultat visar att i Klövsjö socken finns det en betesareal på 38 329 hektar (383,3 km^2) tillgänglig för boskap (Lantmäteriet). Antalet boskap och djurtäthet fluktuerade under studieperioden. Från 1800 till 1851 ökade antalet boskap i socknen. Anledningen till det här var troligen möjligheten att kunna hålla boskap på fäbodarna (Myrdal, 2011). Toppen i djurantal skedde 1851 med 3000 djur, och toppen i djurtäthet på betesarealen skedde 1905 med 0,05 betesekvivalenter per hektar. Anledningen till att topparna är under olika år beror på att korna ökade fram till 1905, medan getter och får minskade efter 1850. Detta gör att antalet djur är som flest när getter och får är på sin topp och korna ökar, medan det är flest betesekvivalenter när korna har sin topp, eftersom det är de som kräver mest energi.

Minskningen i getter och får kan ha berott på ökad internationell konkurrens i ullproduktion, samtidigt som bomull kom in på marknaden. Under denna tid blev skogen mer värdefull, och satte skogsindustrin stor press på att få bort getterna från skogen, eftersom man ansåg att de åt upp skogsföryngringen. 1933 kom en ny lag som sa att mark som vid den tiden var stängslad fick man inte valla djur på, men detta betydde samtidigt att ostängslad mark var fri (SVL 1933:269).. Denna lag gäller än, då nya lagar inte var aktuellt eftersom djuren senare betade på stängslad hagmark med rikt bete.

Vid toppen av betesekvivalenter 1905 fanns det lite mer än 5 betesekvivalenter per km^2, i form av 3 kor och 4 småfäkreatur. Det fanns en häst på 2 km^2. Enligt Ericsson (1997) fanns det 2 kor och 2 småfäkreatur (3 betesekvivalenter) per km^2 i Särna-Idre området i Dalarna i slutet av 1800-talet, när man räknar med ett betesområdet på 300 km^2 (utan myrar). Frödin (1925) kom fram till att 6 kor och 21 småfäkreatur (13 betesekvivalenter) betade på varje km^2 i Siljansområdet i Dalarna. Siljanområdet har högre bonitet än Klövsjö, men Särna-Idre har lägst bonitet. I fyra socknar i sydöstra Sverige så varierade betesekvivalenterna från 4 till 12 per km^2 i mitten av 1800-talet. Den högre djurtätheten i södra Sverige var väntad eftersom boniteten och befolkningstätheten var högre i söder.

Skogsstrukturen
Hur skogsstrukturen påverkas av bete beror bland annat på vilken typ av djur som betar och hur många de är, liksom vegetationsproduktionen. Olika betesdjur föredrar att beta olika växter. Kor föredrar att beta gräs, liksom får. Getter å andra sidan föredrar att beta ris och buskar. Storleksskillnader bidrar också till att djuren betar på olika vis och olika växter (Rook et al., 2004). När denna boskap betade tillsammans kring fäbodarna kunde betestrycket bli väldigt högt, eftersom djurslagen kompletterar varandra och kan utnyttja betet i möjligaste mån (figur 12).

Figur 12. *Betande getter och kor. Foto: okänd, Bildbanken, Skogsbiblioteket, Umeå.*

För att skapa bete åt fäboddjuren brände man skog eller ringbarkade träden (Levander, 1943; Frödin, 1952; Ericsson, 1997). Detta tillsammans med införandet av rationellt skogsbruk kan vara orsaken till de dåliga stamtätheterna och de dåliga skogstillstånden som syns i figur 10 och 11. Tät skog innehöll inte mycket värdefullt bete, utan det var snarare de bestånd med låg stamtäthet som utnyttjades tillsammans med de 15 % av kalmark (figur 9).

I Jämtland idag är endast 4 % av skogsmarken kalmark (Göran Kempe, muntlig kommunikation). Detta är troligen ett resultat av dagens lyckade föryngringar och täta skogar. Andelen äldre bestånd i Klövsjö socken var inte mycket högre än andelen i Jämtlands län idag. Detta kan bero på att landskapet redan under 1800-talet var påverkat av skogsbruk och bete. Det är också troligt att de äldsta träden i beståndet under 1800-talet var äldre än de äldsta träden i dagens bestånd.

Genom historien har det varit skillnader i andelen buskbetare och gräsbetare. För några tusen år sedan trängde människans djur undan buskbetande hjortdjur från de svenska markerna. Under 1800-talet var älgarna i Jämtland väldigt få på grund av jakten (BiSOS Q, 1870). 1905 sköt man 183 älgar i Jämtland och Västerbotten (BiSOS Q, 1905). Detta kan jämföras med att man 2010 sköt cirka 12 000 älgar i Jämtland (Viltdata). 2011 fanns det i Klövsjö by 127 kor, 27 får, 5 getter och 3 hästar som betade i skogarna (Britta Hamrén, muntlig kommunikation). Det är stor skillnad mot de 2 500 tamdjur som betade kring Klövsjö by vid toppen 1851.

Dessa fluktuationer mellan olika sorters betande djur och antalet djur måste ha påverkat skogsstrukturen i hög grad.

Biodiversitet i betade skogar
Generellt sett är biodiversiteten högre i en betad skog än i en obetad (Cronebarg, 2001). En anledning till det här är de olika strukturer som bildas i en betad skog. Det skapas luckor i den annars täta skogen(Axelsson Linkowski, 2009). Soliga öppningar i en skyddad miljö kan gynna lavar, insekter och svampar (Croneberg, 2001; Axelsson Linkowski, 2009). Klövar kan trampa fram fläckar med bar jord, vilket blir grogrund för frön. Taggiga buskar kan ge skydd åt växter som ananrs lätt blir nedbetande, och därför kan en buskig miljö gynna biodiversiteten (Pihlgren, 2007). Biodiversiteten är beroende av betesintensiteten. För högt betestryck kan minska biodiversitet, liksom för lågt då vissa växter blir dominerande.

Källkritik
Det är viktigt att komma ihåg styrkor och svagheter när historiska källor används. Det kan vara riskfyllt att använda data i andra syften än de det producerades för.

När Laga skiftes-kartorna tillverkades var det väldigt viktigt att få alla arealer rätt för att förhindra orättvisa vid skiftet. Enligt Hansson & Persson (2007), har Klövsjö by nästan samma bygräns som på 1840-talet, eftersom det huvudsakligen skett hemmansklyvningar inom byn. Detta gör att de arealer jag använt i arbetet stämmer även om samma areal används under hela studieperioden. Det kan emellertid vara svår att veta hur stor skogsareal som verkligen utnyttjas som bete. Den mesta skogen kan ha varit för tät för att erbjuda bra bete, och betet kan då ha koncentrerats till vissa luckor i skogslandskapet.

Antalet djur från den officiella statistiken är väldigt osäkra siffror eftersom det är okänt hur dessa siffror togs fram. Troligen är bouppteckningar en betydligt säkrare källa. Bouppteckningar upprättades efter dödsfall, och för arvingarna var det mycket viktigt att dessa stämde. Att bara använda bouppteckningar i ett såhär omfattande arbete skulle dock bli mycket tidskrävande.

Det finns flera luckor i informationen om skogsstrukturen. Provytorna från inventeringarna av Riksskogstaxeringen kan ha varit för få för att användas på en såhär liten skala. Flera variabler blev endast uppskattade vilket har försvårat en jämförelse med det nutida skogstillståndet.

Fäbodar i framtiden
Det finns flera anledningar till att bevara fäbodar in i framtiden (Kardell & Olofsson, 2000; Ekeland, 2008; Rönnow, 2010; LIFE). Biodiversiteten i betade skogar har redan nämnts. Förutom detta finns det flera kulturella värden, såsom mat (t.ex. ost), hantverk och sånger (Kardell & Olofsson, 2000). En annan anledning kan vara att de flesta fäbodar har traditionella lantraser. Dessa kan vara värda att bevara för att upprätthålla en diversitet även inom boskap, då man inte vet vilka egenskaper som kommer efterfrågas hos djuren i framtiden (Hallander, 1989).

En sak är säker, skogsbetet har minskat drastiskt (Andersson & Appelqvist, 1990; Bradshaw & Mitchell, 1999) och det svenska skogslandskapet är idag homogent (Östlund et al. 1997). Med tanke på hur vanligt det har varit med skogsbete, och även de övriga värdena kopplade till fäbodar, anser jag att de få aktivar fäbodar som finns kvar idag borde finnas kvar i framtiden

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