“It’s the machine’s fault”:

An ethnographic study of the domestication of Swedish production forests

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Abstract

This thesis explores different ways of relating to forests, and thus also different types of forestry. Starting with the Swedish forest industry one which is characterized by the planting of forests at the expense of natural regeneration, thus making Sweden the fifth country in the world in terms of planted area the study then examines different forests. This study is conducted with qualitative methods and by “following the seed” looks at various actors’ interests and potential flaws in the venture of planting forests. Different possibilities of doing forestry are explored in the thesis through letting modern forestry meet local forest-owners as well as a seed-collecting practice in central Sweden.

These processes are explored by understanding the forest as an assemblage of historical decisions, species and human interests, tracing relations and powers within and beyond forests from a more-than-human perspective. Forestry emerges as an attempt at domestication of the forest and the thesis explores how it goes wild, as well as the meeting of modern industrialism and science with other world views, values and practices.

This allows for an alternative understanding of forests, forestry beyond industrialism and modernity, and what sort of futures we might have living together with forests.

Keywords
Anthropology, domestication, forestry, nature’s work, reforestation, assemblage

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1. Introduction

1.1. Background

Forests are a topic that one should tread lightly on. The enormous diversity not only of ecological types of forests but also of human relationships to forests make them a highly contested resource in many places. While it is a resource for some, it is a home for species and humans all over the world. When I talk about forests in this thesis, I will be clear with what type of forests are discussed.

In this study I am interested in why Swedish production forests are planted instead of naturally regenerated and what difference it makes. As about half of total Swedish forest land is planted, I argue that Sweden presents a particularly good example through which we can look at questions of nature/culture and wild/domesticated forest.

As anthropology is currently engaged in the plantation, with some scholars suggesting the term for the present era to be the plantationocene (Haraway et al. 2016), I have found it interesting to think of how the Swedish planted forest relates to the relationships which constitute the plantation. Andrew Mitchell has called the Swedish forest a garden (2018) which might entail extending the domestic space to include the forest as part of the controlled domus. Since the area of study also refers to the domestication of plants (Scott 2017; Seshia Galvin 2018; Swanson, Lien, and Ween 2018) I have found it fruitful to look at the literature of domestication to help me understand what is currently happening in the Swedish forest.

How to define forests is a contentious issue. To give an example, forests are generally defined in terms of land use. With such a definition, forests do not necessarily need to include trees, for example a recent clear cut in Sweden. At the same time, trees in urban areas are generally not categorized as forests even though they can be very old. With the use of remote sensing satellites for measuring land cover, disputes have emerged regarding what is meant by the term forests. The Food and Agriculture Organisation (FAO) base their definition on land use which includes land on which trees are present or on which the trees can be expected to reach a hight of at least 5 meters and a canopy cover of 10 per cent (FAO 2020a:20). Even though plantations are generally not regarded by lay-people as forests, these are included in the FAO definition.

In Sweden, the discussion of what counts as a forest has been ongoing, and is complicated by the fact that forests are semi-natural in the sense that they resemble natural forests when they are mature. Often, forests are managed so hard that they are cut down before their intended

rotation time is reached. No forest is natural in the sense that it is without human interference. As the era of Anthropocene suggests, human is now the dominating force on the planet and human disturbance is everywhere (Swanson 2018). There are however forests that are different to degree of human control and this is what this thesis will discuss by looking at how production forests are regenerated in Sweden. The forests which I visit in this thesis are patches of the productive forest land which covers 50 per cent of the land area of Sweden. What I do in this study is following the seed, to bring into focus how the Swedish forest is in essence made.

1.2. Relevance

Recently forestry has been heavily debated in Sweden. Environmental interests have revealed the industry as unsustainable. The European union has under the LULUCF regulation (one of the ways that climate mitigation is dealt with in the union) started to ask its member states to preserve carbon stocks in forest and agriculture. Sweden, with a big part of growing forest of Europe is expected to take part in this responsibility.

At the same time, a specific type of forestry is being challenged on how it is degrading biodiversity within the forest. It is argued that clear-cutting should be changed to more of continuous cover forestry, that is keeping a certain degree of the ground covered by vegetation all the time instead of leaving the ground bare (Felton et al. 2019). For a large part of Swedish forestry this would entail a major shift. Continuous cover forestry is said to not work with pine trees, give more transportation emissions and be not economically practicable. It is also said to threaten the moose population by not providing enough small leaf trees to eat during summer.

1.3. Aim

This thesis intends to explore how seeds and plants are dealt with in Swedish industrial forestry. It inquires into how some small-scale forest owners are thinking about regeneration of their forests and asks what role the forest seed has in their idea of their forest. As natural regeneration is decreasing, this is the context I place the study in. What are the implications for Swedish forests that they are not naturally regenerating?

For anthropology, the thesis brings in the perspective from Swedish forests to the debate of human made environmental change in the era that has been called the Anthropocene. I position my study in dialogue with authors that have discussed domestication and the

plantationocene as I argue that this study can contribute to knowledge about our shaping of the environment.

1.4. Research questions

My initial research questions were, how do forest owners view the practice of saving their own seed? How does it relate to the wider politics of forest reproductive material and forestry? As I started my fieldwork, I found very few people saving seeds while I instead found out about of the industrial seed saving and debates about forest regeneration. As many people had views of these practices my questions became; What are the different perspectives and practices on seed saving and what does this tell us about Swedish forestry and its future? What are the possible more-than-human forest policies and practices that we can learn from the examples that I found in my field?

1.5. Short description of method

What initially motivated me to conduct this study was to explore the forest seed as essentially entangled with clear-cutting practices. The seed is where it all starts. I have over two months of fieldwork during the autumn of 2021 in Sweden followed the forest seed.

My intent has been to dive into the issue of forestry as it is being debated but with a different type of focus. By following the forest seed (Marcus 1995), I have tried to get closer to the anticipation as well as the material base of scientific forestry. I have followed the seed and plant as it is engineered as a commodity in breeding and produced in seed orchards. Further I have been following it in the hands of forest owners who are planning for regeneration of forests. Finally, I have looked at how the industry's final use of forests as a resource for sawn products and pulp, which in turn informs the breeding goals.

For the topic of this thesis, I have made use of Swedish official statistics and statistics delivered to FAO to interpret what is happening with regeneration of forests in Sweden. Regular reports from The Swedish Forest Agency and grey literature from the Forestry Research Institute of Sweden have also been important sources for getting to know the field and expanding the ethnographic present (Aull Davies 2008).

While Sweden stretches from a nemoral zone dominated by deciduous trees to a sub-alpine zone dominated by birch trees and shrubs, the forest landscape I visited contains boreal and hemi-boreal forests dominated by spruce and pine with some deciduous trees. The forests I have visited are owned by small-scale owners rather than industry owners. They reside

primarily in the county of Värmland in mid-western Sweden. When I say forester, I refer to people working with forest but not necessarily being a forest owner.

1.6. Terminology

My field is full of a certain type of terminology which can be hard to grasp. It was hard for me to enter the field and I already had a previous understanding that I do not expect the reader to have. I here want to give some key concepts for the reader to enter the field.

In this thesis, production forests refer to the productive forest land which covers 50 per cent of the land area of Sweden. Productive forest land excludes formally protected areas such as forests owned by the state in the sub-alpine region, nature reserves as well as forest land impediments where forest grows so slow it is not economically viable to grow forest. This amounts to around 20 million hectares of forest land. When I say industrial forestry, I refer to the practices of the forest industry which is operating in the productive forest land and is dominating Swedish forestry but is not in total control.

In contrast to deforestation which is removal for other land-uses and afforestation which is establishing forests at land which previously had other uses such as agriculture - reforestation refers to land-use change of replacing previous forest with new forest. There is natural regeneration that doesn't involve *skogsodling* or silviculture. Silviculture refers to seeding and planting and are types of artificial regeneration.

Within silviculture, there are two main categories of forest seeds: stand seeds (*beståndsfrö*) and orchard-seeds (*plantagefrö*). Stand seeds are seeds which are gathered from felled trees during harvest. These seeds can be local in the sense that they are used at the same site as they are gathered. They can also be imported from a place nearby or even from other countries. Orchard-seeds are produced in seed orchards, domestic or foreign.

I have used the term "genetically bred seed" for seeds that are selectively bred. In the field it was common to talk about this as "improvement". How this breeding is done will follow below but it is important to say from the start that this is not GMO in the sense which the reader may be used to. It is rather a controlled mix of two parent trees, much like breeding is done in animals. All orchard seeds are genetically bred.

Genetic variation or genetic diversity is the biological diversity which exists within species. Population genetics have argued that the need for preservation of diverse populations is a

necessary part of preserving genetic variation within species. Genetic variation can be estimated by several different methods.

1.7. Disposition

First, I provide an overview of Swedish forestry and the actors involved. Then follows a comparison with FAO statistics of how Swedish production forests are regenerated as well as a historical background to understand how the need for forest seed was dealt with by Swedish forestry.

Chapter one takes on the question of forest tree breeding and seed production by following the seed from how it is conceived by plant breeders to planted in a seed orchard to multiply. I base my research on interviews with researchers and other employed professionals in the breeding and seed production as well as several meetings in which I attended. I think of forests as an assemblage and use domestication as the primary theory to understand what is going on in the field.

In Chapter two I go out in the forest to describe different ways that forest regeneration is done. The plant figures in several of the sites but I also follow the idea of natural regeneration. The chapter deals with the idea of work. I see the process of regenerating a forest as both human and non-human work depending on cheap enough labour and energy to keep costs low and nature's work to regenerate. I interview forest owners to see what their ideas of regeneration are. Here I introduce more pieces of the forest assemblage to place the forest owner within a context where the choices are limited and affected by other forces.

In Chapter three I finish with an idea of searching for the seed saver within Swedish forestry. In the two preceding chapters the seed saving is done industrially by seed production or naturally by natural regeneration but here the small-scale seed saving is in focus. Here I tell the story of The Woodland Cemetery in Stockholm and a forty-year-old history of a concern for regeneration which made seed saving an avenue of future adaptation. I also discuss forest owners who have chosen to or considered saving their own seed as an alternative to using orchard-seeds.

2. Background

2.1. Political economy

Sweden is often depicted as a country in northern Europe where the forests are vast and wild animals roam freely. These images are used regularly by tourism organisations to promote Sweden as a stark contrast to the deforested European continent. Here, where trees are abundant, it is joked that in the Netherlands, every tree has its own name. Such notions are important now that Swedish politicians feel the European Union is encroaching on the competence of member states.

There are primarily two processes of establishing the amount of forest land in Sweden. The first defines it according to FAO which exclude urban forests and include land which could support trees to a cover of 10 per cent with minimum 5 meters height. This is a land use definition. The other one is land cover which includes urban forests and excludes land without trees such as clear-cuttings (SCB 2020). In this thesis I use the land use definition as I discuss production forests and the practices of reforestation.

Forest land covers around 70 per cent of the land area in Sweden. This amounts to 28 million hectares where 22 million is classified as production forest that is outside formally protected areas and impediments (Skogsdata 2021). Additionally, 2 million hectares is voluntary set-asides or consideration patches (SCB 2020) making 20 million hectares available as what is called forest available for wood supply (FAWS). Around 50 per cent of the land area in Sweden is devoted to production forest. (Black-Samuelsson et al. 2020)

The total annual felling amounts to around 80 million cubic meters of wood measured in m3sk. Around half of the annual felling is made into sawn products and pulp. Some losses occur and part of it is used for bioenergy like heating the industry itself (Skytt, Englund, and Jonsson 2021). The amount of annual felling provides an indicator for governing forestry. Some scenarios of a climate neutral Sweden, with heavy demand for bioenergy, point to the need for 110 million cubic meters by the end of the century. Currently, a project to raise the volume from forestry calls for 20 million cubic meters more by 2050. To increase the

production, some of the intended actions are more breeding of seedlings, fertilizers in the forest and actions against forest pathogens[1].

Data on total final felled area annually has been fairly constant since 1955 at 200 000 hectares (Skogsdata 2021:161). Even though the area of final felling has remained rather constant, the volume has risen considerably from 50 m3sk to 80 m3sk today. The growth in production is said to be because of improved seeds, but also regular forest management and thinning (Skogsdata 2021:93).

Typical forest management in Sweden works by bringing in bred forest reproductive material, seeds or plants. This is then often planted by entrepreneurs that hire workers for the job. The same workers are hired again for cleaning undergrowth after 5-10 years and then machines are brought in to do thinning operations one to three times in a stand to make space for the harvester and the trees to grow. Then a final felling is made and the cycle repeats with the new plant. The number of years this process takes is called the rotation time. This is the way of scientific forestry and has been all but perfected over the last one and a half centuries. The machines have been introduced in the last 50 years. The rotation times currently vary between 55-100 years for different species and different latitudes. Not everyone, however, likes that, some prefer close to nature forestry.

2.2. Actors

Forestry governance in Sweden is multi-layered. The base for legislation is the forestry act. The latest major revision of this legislation was made in 1992 when environment and production were newly considered as two equal targets. The environmental legislation does not directly apply to forestry since forestry has its own legislation. Some European Union legislation, primarily the Birds and Habitats directives are core legislations that influence forests as habitats for protected species. As mentioned above, European Union climate legislation is increasingly growing as a factor influencing Swedish forestry (Sotirov, Winkel, and Eckerberg 2021).

[1] https://via.tt.se/pressmeddelande/88-atgarder-ska-oka-tillvaxten-i-skogen-med-20-procent?publisherId=415163&releaseId=3268257 Accessed 2022-05-23

The Swedish Forest Agency is the government authority responsible for ensuring the forestry act is followed. The decisions that involve forests as habitats are generally under the oversight of Swedish Environmental Protection Agency but the Swedish EPA has generally few legal instruments that influence how forestry is done. The EPA is however often responsible for forests outside of the production forest.

The governance is to a large extent based on voluntary measures. Since 1990 a main stakeholder has been consumers who have influenced forestry by certification. Forest owners often choose to certify their production according to set environmental and social targets. The Forest Stewardship Council, FSC is the biggest grouping. The development of certification together with placing power in the hands of the forest owners meant that the Forest agency was given a different role, shifting from managing forests as they have done previously, to governance and oversight.

The ownership of forest land in Sweden is a mix of individual owners who control half, privately owned companies that own a quarter and other owners - which include the state, municipalities and the church - that own a quarter (Skogsdata 2021). The group of individual owners consist of about 310 000 individuals of which 60 per cent are men with a mean age of 61 years. There is an overall trend of forest owners getting older and fewer in number. In 1999 there were about 350 000 individuals with a mean age of 55 years. Another trend is that a few owners are buying up forest land and becoming larger owners with the group that is owning more than 100 hectares growing (SCB 2021a). 8 per cent of the individual owners own more than 100 hectares, making them still quite unusual.

In the two other categories, private companies and public owners, 90 per cent own more than 1000 hectares. When individual owners are often dependent on associations or timber buyers to manage their forests, private and public owners instead often manage their land themselves and hire workers when needed. The companies are not only owning forest, but also sawmills, pulp and the paper industry. The industry is a major provider for export revenues and still a big employer.

Finally, some words on the knowledge production surrounding Swedish forestry. As James Scott (1998) argues, the forestry scientific community contributed to a great deal to making forests an important state interest towards the end of 19th century. The simplification of forests into production forests happened in Sweden as well. I mention two institutions that have been formative which are present in my fieldwork.

The Swedish University of Agricultural Sciences, (SLU) has since 1977 been home to scientific forestry but the institutional history goes back to 1828 (Eliasson and Törnlund 2018:250). Here, basic research of forestry is done. At the Skogforsk, the Forestry Research Institute of Sweden, a lot of the applied research about forestry is done. The institute is funded by the forest industry through a share of timber revenues as well as with an annual grant from the Swedish state. It is a hybrid organisation that also sells reports to specific projects and is today home to the breeding program that is one of the main themes in the thesis.

2.3. Sweden is a special case in regeneration of forests

In terms of countries with the greatest amount of planted forest area[2], Sweden ranks fifth in the world. (Black-Samuelsson et al. 2020:58). But when it comes to the percentage of total forest land that is planted, Sweden ranks the first. According to the FAO, forests are categorised into naturally regenerating forests and planted forests. The first category is sub-divided into primary forests and other naturally regenerating forests while the second category is sub-divided into plantations and other planted forests (FAO and UNEP 2020:15). It is as "other planted forests" that Sweden reports it's planted forest. While plantations are well covered by anthropologist, Swedish planted forests are not that well written about.

According to FAO, 7 per cent of the world's forests are planted which amounts to 290 million hectares. Other planted forests amount to a total of 159 million hectares where Sweden has 14 million hectares (FAO 2020b). This is a considerable increase since 1990, when Sweden reported 8 million hectares. Half of Swedish forest land is today planted compared to 93 per cent of the worlds forest. (FAO 2020a).

These numbers refer to stand origin and don't say anything about the size of the felled forest land that is annually regenerated naturally or with planting. In Europe, Sweden was the country that regenerated the biggest share artificially - 83,4 per cent with planting or seeding - in 2015, followed by Finland. In terms of area this amounted to 135 000 hectares annually (Forest Europe 2020:298). The trend has clearly been more planted forest land rather than natural regenerated forests.

[2] Non-naturally regenerated forest, that is including plantations or other planted forest.

Researchers debate whether this should be a sign of worry. Naturally regenerating forests generally contribute more to biodiversity and provide a more varied set of values than planted forests according to FAO (2020a:27). These ideas were part of what I wanted to understand in this thesis.

2.4. Historical background to the field

To be able to make my point about different outcomes of forest regeneration I first need to give a background to where Swedish forestry originates. Then I will provide the background of forest breeding.

Forest historians Per Eliasson and Erik Törnlund think of the environmental history of Norrland as two timber frontiers, the first in the end of 19th century and the second in mid-20th century. The first timber frontier was driven by demand for timber. Since infrastructure was insignificant in northern Sweden, the first timber frontier removed the old and big trees, some as old as 500 years and then the ones that could carry its cost for transportation to markets. Capitalists made profits by exporting this timber to England. (Eliasson and Törnlund 2018).

Towards the end of the 19th century, the importance of forest seeds increased in Sweden. The practice of dimension felling that had been dominating northern Swedish forestry since the mid-1800s provided challenges as the regeneration didn't happen. Regeneration of forests, or sustainability of forest resources, had been a state interest for many centuries but it is not until the turn of the century that the regeneration of forest land with silviculture first became Swedish law. This applied first to the island of Gotland in 1874 and was soon followed by the sub-alpine region and then all forest land in 1903 (Eliasson and Törnlund 2018). Eliasson and Törnlund discuss the idea of *skogsodling*, literally forest cultivation as a metaphor that resonated well with Swedish peasants that had been raised in a farming society.

It is here that the second timber frontier is triggered by the idea of a need for proper regeneration to deal with inconsistent growth. The remaining trees were removed and used in the booming paper and pulp industry. The increasing urbanisation combined with rationalisation led a great deal of farmland being abandoned and this continued for the whole century. This farmland was often converted into forests, leaving old villages abandoned and a regionalisation followed where state presence was diverted to bigger cities at the expense of former villages and towns.

The forestry debate has moved back and forth between ideas of natural regeneration together with dimension felling or taking out certain trees (*blädning)* to the idea of clear-cutting with

the use of artificial regeneration. The duty to care for reforestation was prioritized by the state and in the mid-20th century what was considered proper reforestation seems to be artificial rather than natural regeneration. Here, the epoch of artificial regeneration starts in especially large-scale forestry. (Eliasson and Törnlund 2018:268)

With artificial regeneration being established, the first generation of genetically bred forest seeds grown in seed orchards was soon to make its entrance in the forest. In the introduction of a Governmental report from 1972 it was stated that bred forest seeds provided the least controversial way to increase the production from forests (Statens Offentliga Utredningar 1972:9). The whole report has the uncanny appearance of state improvement that was very much a signature of Swedish society at this era.

Towards the end of the century, the genetically bred seed had made its entry into Swedish forests and replaced stand seeds and natural regeneration. Over the last twenty years, the use of genetically bred seeds has increased from 40 to almost 100 per cent. The Swedish forestry agency has stated that this does not help the variation of Swedish forests (Skogsstyrelsen 2017).

2.5. Methods

I have for some years been interested in Swedish forestry. My previous fieldwork was among forest researchers and one point stuck with me then. Is a forest with less genetic diversity more prone to damage than a diverse forest? An interlocutor posed the core question, that most people are in favour of mixed forests, but on what level should we mix? The question is if the intended mix on a landscape level that is expected by a mixed group of ownership is sufficient, and if that is contributing to mixed forests. Or should mixed forests be on the local level? Can it in that case be planted? Or is it even on the genetic level that the mix is needed?

This fieldwork was conducted primarily during the autumn of 2021 over November – January. It started out as a quest to look for seed savers in the Swedish forest. I decided, based on previous literature studies that there is enough written on seed saving in farming, but I lacked the perspective of Swedish forestry. If there were forest owners saving their own seed, I thought that maybe they would see it as an act of resistance to the industrial forestry, akin to how seed saving has been written of when it concerns crop seeds. For the large part, I didn't find these people, apart from one who I detail in chapter three. Instead, I found a part of the forest industry that is responsible for saving seeds.

All in all, I conducted eight recorded interviews and seven other interview situations of minimum one hour in duration where I decided to take notes instead of recording. The intention of this method was to elicit more honest responses. I also made participant observation at a regional office of a major forest company and worked with horse in the forest together with a forest entrepreneur. The forests owners I visited resided in Värmland, two in Södermanland near Stockholm, one in Medelpad and one in Västmanland. All were rather small-scale owners and not the forest industry. The choice of these forest owners was determined by availability and access.

Eight interviews were made with forest owners or primary managers of forests. Four of these interviews were made in the same forest the interviewee owned and/or managed. I was influenced by what Jo Lee and Tim Ingold call walking ethnography (Lee and Ingold 2006). . The other four were made at the kitchen table of the forest owner or by phone. One of the phone interviews was complemented by photo elicitation, with pictures chosen by the forest owner that he sent me to show and tell me about his forestry. All my interlocutors have been given pseudonyms to protect their anonymity.

As mentioned above, 60 per cent of forest owners are male and their mean age is 61 years old. The forest owners I interview in this study are however only male and between 50-90 years old. Even though this is the typical forest owner in Sweden there are still a considerable group of women and younger owners. The results in this thesis should be viewed with this in mind.

Generally, the quality of the data shifted depending on how it was procured. I learnt more by being in the forest but those interviews were also made in the beginning of the fieldwork. This is evidenced by how many misunderstandings occurred in the beginning. I thought that a dead spruce tree was a larch tree and misunderstood that a shot calf was not a previously owned domestic one but a moose. The interviews over phone provided a great degree of detail as well but were limited by being unable to see the type of forest that the interviewee managed. The photos that one forest owner sent me helped a great deal with understanding the context that he was in. The interviews on the phone still provided enough data to be reliable for the purpose of my analysis.

Seven of the interviews and the participant observation were made with a group of people which I term forest researchers and forestry professionals, including staff at Swedish Forest Agency, Skogforsk – the Forestry Research Institute of Sweden, the certification organisation

FSC, a plant nursery, employees at a major forest company, a contractor working in the forest with horses and a wood measurer.

Apart from this I participated in around ten seminars of the topic, both online and on-site, some of which also allowed me an opportunity to mingle afterwards with the participants.

Following the seed - and the plant

The seed is where it all starts. They carry the memory of the places they have grown and when they sprout the seed has genetic information that will prepare it to the specific site (Rezvani 2021). In this thesis I trace the seed in and out of different sites where it is selectively bred, prepared and planted. The seed continues it life as a seedling and is then becoming the trees that form Swedish production forests. Thereby, as I followed the seed, I also follow the plant. While the seed is in focus in chapter one and the plant is in focus in chapter two, I will sometimes use it interchangeably.

In 2020, more than 400 million forest seedlings were produced and sold in Sweden (SCB 2021b). I decided early on in my fieldwork to follow the two coniferous species Norwegian spruce, *Picea abies* and Scots pine, *Pinus sylvestris*. I based this decision on the fact that they were the most important economically. Of thirty species of forest trees that exist in Sweden, these two amounts to 41 per cent and 39 per cent of the standing volume in the production forest respectively (Black-Samuelsson et al. 2020:7).

It is a challenge to follow two species instead of one but it has worked because in my field they are often dealt with in relation to each other. Where pine grows, spruce should not grow and vice versa. Other species of forest trees have surfaced in my fieldwork but it is mainly spruce and pine that are talked about. Another focus on deciduous trees or the introduced tree *Pinus contorta*, would have yielded other results and led me to different forests. The contorta tree is for example encroaching on natural reserves and damaging Sami livelihood by not providing feed for reindeers. Such a study would drag other perspectives in.

My fieldwork consisted of multiple “field-sites”. These are sites I considered as having potential to follow the forest seed through (Marcus 1995). Initially I wanted to conduct fieldwork at the sites where forest seeds where bred, grown and planted. As this turned out to be hard to do, I instead turned to search for forest owners where I was expecting seed collection but I found something else. I found traditional ways of doing forestry that negotiated the modern and industrial. Therefore, I included this aspect in my research. My further search for seed saving led me to the material in chapter three. All this then provide the

base from which I discuss different forests and different futures of more-than-human forests and forestry.

My idea was to place the forest seed in the centre of a tangled web, to see what is foregrounded. Having followed the forestry debate for a long time, I had previous knowledge of what is discussed.

Method discussion

I have tried to keep the seed in focus by working with the question of seed saving, imagined by me as a relationship between the human and the seed. This foregrounding of the plant seen through humans is, however, a challenge. Multispecies ethnography is an emerging field that is grappling with questions like these. When reading how John Hartigan tries to interview a plant (Hartigan 2017) I come to recognize how connected and infused we are with the knowledge of experts. In Hartigan's account, it is the classifications and language from the Flora which make him able to relate to the plant. In the same vein, I have needed to fall back onto foresters' way of relating. Forestry, and specifically scientific forestry has its beaten track of reading forests and this is what I rely on together with the ways of knowing from forest owners. To find new ways-of-knowing the plants, multispecies ethnography is promising but this thesis has not made use of their methods.

Following the seed had some other problems outside of theory as well. Since my fieldwork was conducted over the autumn and winter months it was necessarily influenced by the work that is done over winter in forestry. Planting is not one of them. Therefore, there is an obvious gap in my study about the work of planting the seedlings. It is a well-known phenomenon that migrant labour is necessary for the forest industry to keep costs low enough to get the profit going[3]. The forest industry has been flagged as one of the industries that are of high risk of exploiting migrant workers[4]. Even though important for an analysis of Swedish forest assemblage, in the rest of this thesis the work of migrants is not included.

[3] Röstlund, Lisa 2021. Migrantarbetare berättar: Vi utnyttjas av skogsbolag. Dagens Nyheter https://www.dn.se/sverige/migrantarbetare-berattar-vi-utnyttjas-av-skogsbolag/ Accessed 2022-06-02

[4] https://www.av.se/globalassets/filer/nyheter/lagesrapport_2020_det_myndighetsgemensamma_arbetet.pdf Accessed 2022-06-02

In hindsight, by following the seed I didn't get to hang around with people so much. Instead, I visited some forest owners only once, conducted interviews with people working with the seeds and read a lot of governmental reports. In one sense this gave a broad view but what is lacking is a more in-depth knowledge of what happens at various sites where the seed and plant is made. What might be noticed by the reader is that I haven't been able to visit the seed facilities that figure in chapter one. I had originally planned to conduct fieldwork at these various sites where the seed is in a sense made but it proved too difficult to gain entry. One reason for this is that a lot of time went into understanding the process of seed production and where it is made so that by the end of fieldwork, I started to understand where to go and what to ask to see.

All in all, the method of following the seed had primarily three upsides. One was that it did bring into light, as I had imagined, the thinking of future. By asking about the seed and what is planted it is possible to get a glimpse of the anticipated future of Swedish forestry. Two, it was engaging for my interlocutors to talk about forest regeneration. Third, it brought into light a lot of different processes in a similar way to how Marcus (1995) talks about the method. The purpose of following a thing is about orienting oneself within a complex world, something to hold on to.

When I conclude, this is very much an open-ended study. So much more could be done with regards to the historical development of forests seeds, imported seeds and breeding in combination with Swedish early 20th century history of colonisation and eugenics to name one thing. Within the field of environmental history, a lot of interesting things could and should be done. And as mentioned, since I didn't follow the seed during spring months, this method might have been even more suitable for a longer fieldwork.

2.6. Theoretical orientation

Domestication

Domestication is the idea that throughout history, humans have taken animals and plants into the home, the domus, and enlisted them as servants for the exchange of care and nutrients. The domestication of wheat is said to have made people sedentary and created hierarchies. But the narrative of domestication has been critiqued as privileging an idea of human mastery over nature (Dooren 2012) and as a single event happening to one species at a time, suggesting that we stopped domesticating species because we ran out of them (Tsing 2018).

Over the recent years in anthropology, the more-than-human turn have included other species and lifeforms into anthropological analysis. By thinking of the proliferation of wheat, from he wheat's perspective, it has led some to argue for a view of co-domestication, that other species have domesticated humans equally as we have them or at least that agency is distributed, where some have more control but no one is in control (Dooren 2012). James Scott was influential in challenging the idea of domestication as a single event and suggests that domestication should be viewed as a process of adapting the environment to human needs. He postulated the idea that agriculture was around long before humans became sedentary, creating cities and hierarchies. His conception of domestication is as a process that hasn't ceased to do its work on the environment (Scott 2017).

Domestication has two main definitions in the Merriam Webster dictionary. First, "the adaptation of a plant or animal from a wild or natural state (as by selective breeding) to life in close association with humans" and "the process of adapting someone or the state of being adapted to domestic life" (Merriam Webster n.d.). The first of these is a definition where the controlled breeding is key, the second is where the domesticate is brought into the human domus. Also worth noting, is that what is domesticated - is that which was once wild or natural. Here the term points to how it has almost been used instead of the nature/culture dichotomy as what is wild is outside the domus where human culture originates (Swanson 2018).

Since anthropology has been questioning such dichotomies, the pair wild and domesticated has been under just as much scrutiny. James Scott asks, when did plants become domesticated? Was it when we tended to wild plants, preferred such seeds that didn't disperse immediately or when humans planted seeds in a cleared seed bed? His definition is that it is a process that is on-going. And the alterations of landscapes started with fire (Scott 2017).

By thinking of domestication as a process of a relationship between humans and their environment, it has led some scholars to think of domestication as something akin to learning to live together with the non-human world. In the work of Marianne Lien (2015), the process of domestication is open-ended and she argues that we should see it not as an ordering device to differentiate between nature and society, but as a concept we can use to inquire into ways of living together with other species. To do this, domestication need to be understood as a process that can take many different forms.

This is an understanding of domestication that Anna Tsing has trouble with. For her, domestication shouldn't remove human control. She states that practices such as learning to live with other species, for example the popular concept of rewilding, should not be seen as domestication (Tsing 2018). Domestication, she argues is a concept entangled with progress and capable of making invisible certain interspecies relationships. To explain what she means, Tsing brings up interspecies relationships with chickens, pigs and fruit trees among Meratus people. These cannot be seen as domestication precisely because they are marginal, she argues. They are not infused with capital and progress.

The multispecies ethnography can be thought of as a way of thinking outside domestication, but as pointed to above my methods have not been adapted to learn from the perspective of the plant. I will however try to include as many lifeways as possible in what I term the forest assemblage, more on that below. What I will try to do in this thesis is to think of the Swedish production forest as domesticated in the sense that Tsing suggest above, as a progress concept. I also think of it through the effects domestication of forest has on landscapes. By thinking of forest through a progress concept, I understand that there are risks of me contributing to making invisible certain interspecies relations, but I will try to use it as a critique. Let me give some more examples of how domestication has been discussed.

In Heather Swanson's reading of the work of Marienne Lien, Swanson argues that we should view domestication with an attention to space and talk about the geographies of domestication. In Lien's work on domesticated salmon, she argues that domestication is taking place in different ways at smolt production facilities, hatcheries and grow-out site (Lien 2015:168). This is similar to how I will think of the domestication of forest trees at seed orchards and plant nurseries.

With the geographies of domestication, Swanson also talk about the effects that these sites have on surrounding landscapes. In the case of domesticated salmon, there has been instances of "genetic incursion" by domesticated salmon on wild populations. "Through alterations of both genetics and early rearing environments, hatcheries have remade Pacific salmon bodies and their rhythms." (Swanson 2018:145). Similar concerns are present in the case of bred forest trees in Sweden. Since spruce and pine cross-pollinate by wind, this creates a mixture that might have unexpected results. Swanson ask what we can make of the term domestication when, in one way the domus, under anthropogenic change is everywhere. What Swanson does, is follow the effects of domesticated salmon by suggesting we pay attention to landscapes. With such attention, political economy is put inside domestication, the feed for

the farmed salmon is included in the product (ibid.:155). This is the domestication I will turn to in chapter one.

What if we put landscape change in the centre of domestication stories, Swanson suggest, and explore how domestication can be seen as not a relationship between human and a single kind of species, but as a "reconfiguration of multispecies assemblages" (ibid.:151). The forest assemblage is something that I will develop below and use throughout the thesis.

As Swanson argues, this could first be interpreted as a broad view of domestication, but it is rather a quite specific way of viewing effects of domestication. I agree with her that such a view carries potential for more powerful forms of critique. Paraphrasing Swanson, the changes we see in forest landscapes are materially tied to the production of forest seedlings. (cf. Swanson 2018:151) This leads Swanson to argue that domestication can be seen "as a process of disorientation". By removing or disrupting ties to the landscape, the domus is made central to the worlds of non-humans (Swanson 2018:152).

The forest as a garden

Apart from agriculture, cultivation of crops and in my case, forests seeds, seeds are also important in gardening. Within gardens, nature is highly controlled but at the same time imbued with a certain kind of agency. Bhatti and Church (2001) write that gardens can be seen as a microcosm for studying human-nature relations and how they inspire people to create order or reconnect with nature, highlighting how peoples' different views on the relationship to nature is enacted through gardening. Even though gardens are far from what is usually understood as nature, they argue that as sites for everyday interaction the garden provides a place to study how humans learn to develop readings of nature. I want to stick to the point of how we can learn about nature from gardens. Much like gardens we can think of Swedish forests as an anthropic, domesticated space with highly controlled breeding, but with a lingering impossibility of total control.

Andrew Mitchell (2018) writes of the Swedish forest as a garden in his work on the wolf. The wolf roams in the garden and is consequently highly controlled. The analysis is based on the idea that Swedes use the forest for mushroom picking, hunting and recreation and that one's own garden seldom has fences against the forest, is therefore can be seen as an extension of the garden (ibid.:15). I want to continue this idea of the forest as a garden, thereby placing forests within the domus by showing how the Swedish forest to a large degree is the result of a controlled breeding.

Since natural forests are often thought of as lacking human disturbance, the result has often been to deny people entry to protected areas. The thinking of primary forests risk making invisible the intentional use of forests by Sami people. The purpose is to be able to differentiate between cultural use of forest pre-industrial epoch and the highly controlled nature of the Swedish forest. As many others have shown, when Columbus landed on the shore of Americas, the landscape he encountered was seen as wilderness even though it had been cultivated by humans for ages (Mastnak, Elyachar, and Boellstorff 2014).

Anthropocene or the plantationocene

Bengt Karlsson has been key in working with bridging political ecology and more-than-human directions of thought (Karlsson 2015, 2016, 2021). The plantation has surfaced as a site worthy of such studies. Scholars that discuss plantationocene think of it as a defining feature of our time (Haraway et al. 2016). As four crops provide more than half of the caloric consumption (Scott 2017:23), the plantation is becoming increasingly a condition of the world. Up for debate is the liveability in the plantations, the ruins of the same and whether the practice of writing about species assemblages lack the political perspective (Hornborg 2017). Also, whether it places the plant in the centre as white scholars seem to more easily relate to animals and plants than racialised plantation workers (Davis et al. 2019).

Sophie Chao (2018a) writes about how the oil palm exist on the plantation without any commensality with the wider ecosystem. Instead, the palm is there for an extractive industry. Chao shows how in the Marind worldview, the oil palm doesn't have any friends. She points out that while love and care is common in the multispecies literature, some people grapple with the violent unloving of some species. Chao doesn't stay so much on the question of domestication but she writes that domestication is the flip side of wildness, that the Marind pity the oil palm that has become domesticated and lost if "wildness".

The question is if Swedish forests are crops or wild trees. There could in this sense be affinities with anthropological research on agricultural crops (Seshia Galvin 2018). As with crops, trees are cultivated for harvest. Trees growing together also form habitats for other species. It is as forests we usually think of biodiversity, as a space for other species. What I intend to do is to think of how these trees come together to form habitats. By thinking of the biography of the trees, I hope to shine some light on the domus of the Swedish forest.

Work

Traditional understandings of economics tell us that it is the three production factors of land, labour and capital that produce value. In a classical Marxian understanding, profit is produced by capital owners paying workers less than the value they produce. This is usually termed the exploitation of the surplus value. Land, or the environmental inputs such as natural resources are merely acted upon by capital and workers.

Often, critique has been directed towards Marxism for not giving nature value. That is often countered by saying that what Marx did was to show how capitalism doesn't value nature. Marxism is as such not an idea of how the world should be, but a description of the world as it is under capitalism.

As the debate between Marxist geographer Erik Swyngedouw and ecological economist Georgis Kallis show, the question for Marxists is very much about keeping the theory of labour constant. It is what counts as Value that Kallis and Swyngedouw debate, where the latter states that Value in a Marxist sense is what is produced by human labour on nature. There is no question that bees produce something we term as valuable but it is not Value in Marxian sense. If so, the proposition that surplus value is created only from the exploitation of workers don't hold. (Kallis and Swyngedouw 2018)

Anna Tsing's thinking is that natural resources as raw material cannot be taken for granted any more (2015:62). She suggests we include the concept of salvage accumulation, salvage referring to rescuing something and playing with the Marxian concept of savage accumulation, how capitalism started with the enclosure of commons. Tsing define salvage accumulation as how capitalism translate values that are produced in non-capitalist arenas into capital that can be accumulated (ibid.). The term refers to the value or "free work" that nature provide such as ecological processes outside the farmer's control. What Tsing does is stating that there has been a generative process that has produced things we call valuable that capitalism is turning into process by salvage accumulation.

This literature branches out in the discussion on biocapital (cf. Helmreich 2008) and I leave the fundamental questions of if nature produce value or not to instead turn to what geographers Lowe Börjeson and Tola Gemechu Ango (2021) argues is the need to see landscapes as products of both work of people and work of nature. As they argue about the quality of landscapes producing ecosystem services, I take their work to be important to point to how a view of non-human work leads to an idea of landscapes as a socio-natural

assemblage where humans are living with nature. The perspective of living-with has further influenced my thinking in this thesis of landscapes as sites of biodiversity rather than biodiversity being contained in nature outside production landscapes. The work of people and the work of nature are all parts of the forest assemblage.

Forest Assemblages

Both Anna Tsing (2015) and Julie Guthman (2019) have made use of the assemblage as a tool in their analysis. Anna Tsing has in her work used the concept of assemblages to point to how different lifeways come together in a patch. Her description of assemblages are "open-ended gatherings". Her use of the concept is place-centred (Tsing 2015:292n8) as it focuses on how species and things come together in a place, at whatever scale and sometimes influence each other. This influence can range from mutualistic, symbiotic to parasitic. Sometimes they just co-exist (ibid.:22).

To further define the concept, she uses the prefix of polyphonic, as it refers to different voices that build up the classical music of the fugue. These voices interact and at some points produce new harmonies. In a telling section, she refers to that all species shape their habitat, beavers create dams and trees shed leaves that together with soil life make humus. The different world-makings of multispecies can in the same sense as polyphonic voices become happenings. Different from a gathering, happenings is when the multi-species worlds, rather than just existing parallel become more than the sum of its part, for better or for worse (Tsing 2015:23). In production forests, humans are the dominating force but this means that humans need to make space and adapt to other multispecies world makings that are going on.

In Julie Guthman's work on the Californian Strawberry industry (2019), she tells us about how the Strawberry in California has long been sheltered from pathogens using soil fumigation, a technology which disinfects the soil and kills all soil life. The development of soil fumigation massively simplified strawberry breeding by removing resistance as a goal for plant breeders. It later became clear that the chemicals used for fumigation either depleted the ozone layer or created adverse health effects of surrounding areas and made workers ill. The breeding of strawberries has bitten its tail and is stuck in a situation of too little resistance breeding. Such cases have been present before in many cultivars.

Julie Guthman's use of assemblage is to understand how strawberries are the result of a certain arrangement of inputs to a system, where one thing changes, it sends ripple effects through the whole system. Guthman seems to agree with Anna Tsing in how assemblages are

helpful to study more-than-human worlds and political economic forces together. In this sense, assemblages are just as much of a method as theory. Geographers Paul Robbins and Brian Marks (2010) also highlight that the history of the concept of assemblage seems to come from a need to reinsert the material or natural conditions into social science after a period of strong focus on social constructions.

For my purposes, assemblages provide a framework for thinking of what is shaping forests as few forests today are free from human impact. The term assemblages make it possible to highlight different lifeways that are meeting and shaping forests, both human and non-human. I use the term forest assemblage to describe forests as a process in becoming. The forest is here home to multiple lifeways. Human ideas of forests are also multiple but by discussing it as assemblage I highlight that there are other species that are affected by human choices and that it can be made differently.

In my example the moose, the hunter, the forest owner and pine forest are a prime example of such a happening produced by open-ended gatherings in forest assemblages. Their coming together happened when an increase of clear-cutting forestry gave the moose a great amount of food. Today, the young pine has so much potential future value that it needs to be fenced from moose and those moose are even culled. The seedling is steering action in a tangled web. Other examples in my field are how the mechanical forest harvester has created a certain type of forest practice and species composition.

This way of looking at the plant as one melody among others points to a challenge of putting the seed in centre of the study. The seed is only a temporary centre and part of the species division of humans. I am also not schooled in ecology or botany and my descriptions of assemblages will be lacking the multitude of connections that exists within the forest. There are many things that I only hint on in the ethnography. Storms are taking down forest, mycorrhiza is providing the plant with nutrients and water in exchange of sugar, especially important in harsh soils. The soils themselves are results of ten thousand years of decomposing litter and deadwood.

As I use forest assemblage, I am aware that I cannot describe all lifeways but it can instead be used as a platform to build common knowledge. I am in favour of a bridging of social science with natural science to understand pathways to a sustainable society. By pathways I am referring to the increasing discussion of socio-economic pathways (SSP) within sustainability science. Even though this thesis does not aim to discuss the SSP's directly, I acknowledge that

all pathways include goal-conflicts and these need to be understood on the ground. When studying forests, what natural science needs is to understand people and power and what social science need is to understand biological processes and “social” behaviour of other species than humans.

As pointed to above, by enlarging the concept of the social to include interactions between non-human species and things, we can with assemblages look at holisms. With the caveat that I might have misunderstood some ecological processes, what follows below is my interpretation of what is going on in the Swedish production forests.

3. Chapter 1: From seed to plant

3.1. Breeding

> *"When I say, below, that "domestication is a progress concept," I'm not trying to criticize the trope; I'm trying to see how progress becomes inscribed into interspecies relations." (Tsing 2018:282)*

Breeding basics

Genetically bred seeds dominate the regeneration within production forests in Sweden (SCB 2021b). Around 85 per cent of the forest land was artificially regenerated with a mix of almost exclusively genetically bred seeds (Forest Europe 2020:298).

As with all statistics, the production of it is narrow and one obvious class to notice is that this is data on percentage of regenerated forest land refers to final felled area. It is not including protected areas or unproductive forest land. As will become clear, this means that the data can be interpreted as not all encompassing. Some people point out that regenerated area is not totally dominated by bred trees or that the area outside production forests of 8 million hectares is enough to keep genetic variation intact. As a reminder, Sweden has 28 million hectares of forest land, 20-22 million hectares counting as production forest out of which 14 million hectares is planted forest. The question is, does the large-scale planting of bred seedlings affect Swedish forests?

When the first seed orchards were established in Sweden in 1949, it was made with gathered parent trees, called plus trees. These had been selected from fine examples of natural stands and the selection was based on characteristics deemed valuable at that time. These characteristics were to a large degree the same as they are now. The general breeding goals are to improve production goals while maintaining wood quality (Black-Samuelsson et al. 2020:59). The parent trees are made into a controlled crossing and the offspring is made into vegetative cutting which is planted into seed orchards.

The breeding is divided into sub populations based on temperature and photoperiod. The strategy is called multiple breeding population strategy. For *Pinus sylvestris* there are 24 breeding populations, each consisting of 50-60 clones making the selection of plus trees that is used in Swedish breeding to more than 1000 parent trees. Roughly the same amount of parent trees has been used for the breeding of *Picea abies*. Some additions have been made over the years as well. (Black-Samuelsson et al. 2020:60) From these around 2000 plus trees,

which is more than I initially though, a big part of Swedish forest is made. But let's not get to the point too quickly.

I have not managed to get hold of the official breeding strategy, but during my fieldwork an employee at the Forestry Research Institute of Sweden said that there are three overall targets for the breeding which are given equal weight. Preparation for future climate change, preservation of genetic variation and increased value production.

The common way of measuring outcome for breeders is genetic gain. Genetic gain refers to the increase in production created by selective breeding compared to the parent trees population. After combinations of different plus trees are made, these are tested to see which performs the best. These are then made into the new parent trees and are used as the selection base for the next generation. This way, each generation is producing a genetic gain of around 10 per cent. One generation of forest tree breeding currently take around 20 years, so this is a slow process and very different from breeding of agricultural crops. But in terms of outcomes from breeding, we can already see results. The fourth generation which is just making its way into the market, has reached 25 per cent increase of productivity (Black-Samuelsson et al. 2020:59). As we will see, the increase in productivity might have unintended consequences in less resistance or reduced genetic variation.

First, I will use my ethnographical material to place the question of breeding within the concern for the future of Swedish forests. By breeding for improvement, I mean that breeding is projected to solve some key issues of Swedish forestry. In this chapter, I will regularly return to the idea of domestication. My core question is, can a forest tree be domesticated? And if so, can a forest?

Breeding for improvement

I connected to a recorded seminar about plant breeding. It was the 11th of October and the recording was from the 5th of May[5]. The topic of the talk was how to adapt Swedish forestry to climate change. Climate scenarios show an increase in temperature with increasing periods of drought, risk a repeat of the warm summer of 2018 and the succeeding spruce bark beetle

[5] https://www.ksla.se/aktivitet/skogstrads-och-vaxtforadlingens-roll-i-klimatpolitiken/ Accessed 2022-05-10

attacks on the forest. There is also increased risks for heavy rainfall and less days with sub-zero temperatures. All this is affecting Swedish forestry.

At another online conference[6] titled trees for the future, the issue of substitution of fossil fuels were on the agenda and new flows of value such as biochemicals were discussed as potential goals for breeding. An often talked about substitution is when timber is replacing concrete and steel in building construction. Even though houses have been built in timber structures for centuries the type of building that is done today necessitates the invention of CLT wood, glued together wooden planks.

The machine that makes glued wood is also favouring a far spacing between tree branches. A researcher working on the value chains in forestry was at the conference talking about this development in combination with a machine that is removing the branches in the sawn timber. These branches are weak points but when removed and glued together the boards are stronger. A result he said, is that the distance between branches become a substantial value increase in sawn timber, amounting to 4 euros more per centimetre, so valuable that it could be a characteristic that breeders could promote.

My point in this and the next chapter is that the machine is shaping the looks of our future forest. I intentionally use the machine in a broad sense, not a specific machine but instead I am pointing to industrial technology. Not only has the machine potential esthetical ideas of the industrial trees, but glued wood has also replaced the need to old growth forests, as will be seen in chapter two. This seems to have the unintended effect that the market and money for old growth timber has disappeared.

The ideas that plant breeders used to discuss the potential future tree I have decided to group in what I call the ideotype of the plant (cf. Chao 2018b). There are many ideas of what the plant is supposed to fulfil. Carbon lock in, drought tolerance and preserved genetic variation. During my whole fieldwork, more ideas of what the ideotype is supposed to solve emerge.

There is a trilling degree of anticipation involved in forest tree breeding. As many pointed out during my field work, what differs with forest trees from agricultural crops is the rotation

[6] https://vimeo.com/search?q=nordgen%20temadag Accessed 2022-05-18

time. This has implication both for how fast the breeding can move, making the genetically bred seeds of forest trees in Sweden only on their third or fourth generation. This is of course nothing in comparison with old, domesticated crops as corn and wheat. But the temporal conditions also create the need for breeding for trees which are vital over 50-100 years. It is here that climate change has complicated things a lot.

Genetic variation

Biological diversity exists on three levels with ecosystem diversity, species diversity and genetic diversity. Overall, biological diversity is seen as an important pool of resilience to a changing climate. As Sweden has moved from natural regeneration forwarding their local genetic material, to a practice of planting genetically improved seedling, we should ask what this entails for the resilience of Swedish forests. It has been argued that genetic variation is an understudied part of global environmental governance for biological diversity and recently calls for such indicators within global governance have surfaced (Hoban et al. 2020). In Sweden, a monitoring program has been suggested which should include monitoring of forest trees (Posledovich, Ekblom, and Laikre 2021). The authors rightly point to the fact that genetic variation is not independently monitored to any extent when it comes to forest trees in Sweden.

Let me first recap an interesting discussion from my first days of fieldwork, I will keep the names out since it is not important. So, one plant breeder asks another plant breeder, doesn't the European Union see genetic diversity in a natural forest perspective? The goal must be, says the plant breeder to another plant breeder, that we can at fast pace adapt the plant reproductive material we use in the forest to adapt to a changing climate. Also, isn't it raising genetic diversity when we use material that are gathered from many sources?

The other plant breeder answers, well, depends on how you look at it. It could be deduced that if you use plant material gathered at many sites you get an increase in the genetic variation at the local level, at the sites of the genome which you look at. But it could also be interesting to look at the landscape-level, since 50 per cent of the Swedish forest are production forest it is a societal interest of what happens with it. I hope that there is researcher's listening to this that might think more about it.

Well, I got puzzled at least. It seems unclear what type of genetic variation is deemed valuable. These levels are used by scientists in the forestry sector to designate between effects

on different levels. The landscape level is ambiguous since it can mean both mean a cartographical class like Värmland, and the more lived landscape in the sense of a village.

It is vital to discuss genetic variation as a common pool resource that should not be drained. The risk is high that a repair of genetic diversity in forest trees might be very hard to do due to their long generations. That such work of reinserting genetic variation in forest was confirmed by the current head of breeding for forest trees during an online seminar.

It is without doubt that the domestication of crops has contributed to a narrow base of genetic diversity in many crops. In the case of Julie Guthman's example of strawberries, this has made the contemporary Californian strawberry plant dependent on chemical inputs. Her work makes use of the assemblage to point to how a crop is genetically improved to fit within a system, often with inputs owned by the same company that which owns the breeding stock. (Guthman 2019)

Let me take another example of how the idea of wild forest and domestication are put to use in my field. As one of the plant breeders discussed above in relation to the potential for climate adapted seedlings, the idea is that with cuttings or the technology called somatic embryogenesis[7], the time from conceiving of the ideoplant to production is shortened. The idea of cloned forest trees is put forward by these plant breeders as a quick way to adapt to changing conditions because of climate change.

One researcher presenting at an online conference was playing with a scenario where 1-8 million hectares forest land would be replaced with spruce clones. I will not evaluate the scenario other than saying that currently we have laws against such practice. The interesting thing was that the researcher was using natural regenerated forests as a background where the natural genetic variation would be conserved. The natural forest with natural regeneration was here seen an infinite source of genetic variation. Such a discourse separates nature from culture and is a break with ideas of seeing production forests as part of biodiversity.

On one level, the notion of timber forests is a forest which is there to fulfil certain human needs and it is also bred to fulfil these needs better. From this situation, wild things happen,

[7] Somatic embryogenesis is a technology of in-vitro cloning of Norwegian spruce to cut the time of production by removing the need for seed orchards. Instead, the offspring of two parent trees is to be cloned in laboratories.

like forest pathogens and a process of wild undergrowth that can be both left for fire protection or feed for browsing[8] animals or removed. The natural regeneration within a planted forest is a resource which foresters can point at to say that the forest is not at all controlled.

To understand this, I think we need to scale what nature is. Below, by focusing a bit closer on pollen contamination of seed orchards, I show that nature can in one way be threatened by seed orchards and seed orchards can also be contaminated. The permeable border between wild and domesticated is there. It points to different ways of seeing nature, one is a view that it is under huge anthropogenic pressure and another is that it is still wild nature out there.

I think it is helpful to think of discourse formations. What we have is an idea of domestication and one of precaution. In the discourse of domestication, there is nothing stopping humans from adapting the environment. As Karen Rader has shown, genetic engineering has been made into just another type of domestication in certain biotechnological discourses, thereby naturalizing it (Rader 2007:184). Even though most researchers would argue against the notion that there is untouched nature out there, the term "natural" is often used to describe that which is deemed valuable and uncontroversial.

Limits to breeding

As I have shown, there is a great interest in what breeding can solve. But even though the issues of resistance to pests and drought are a concern for the breeding strategy, there are many caveats that surface in the field. The most immediate one is that there is no replacement for good forest management. One researcher who answered a question regarding the potential for more drought resistant spruce said that most central is the idea of the proper tree on the proper soil. Spruce should grow where the ground is wet enough and pine belongs on arid ground. Such an inflection is very important to not try to improve something which should rather be solved with proper management.

If drought resistance would be included in the breeding programme, it could however be conflicting with other goals. At a conference I brought up this question and as an answer I heard that there is a type of reverse breeding in which the practice is to breed for resistance.

[8] Browsing is what herbivores in the forest do when they feed on leaves.

By choosing those plants that do well against a pathogen or insect, you forward the genome that should be better adapted. To what degree this is done, is outside my knowledge but it was stated more than once that such a practice was possible when dealing with many breeding goals.

The practice of resistance breeding is also dealt with through a series of ways of ranking the presence of genes that are responsible for less tolerance against a pathogen. With root rot, scientists can estimate the relationships between the presence of genes inflicting root rot in different populations and genes favouring growth, density or other more conventional breeding goals. Such studies can present negative correlations or positive correlations and are important to evaluate the potential of resistance breeding.

The conference, "Trees for the future", had the framing that breeding for growth might create less dense and less stiff timber logs. This unintentional result was confirmed by my interlocutor Bert who is employed by one of the official agencies and is working with forest reproductive material. Other participants during this conference also brought up the issue of lower density in timber.

Bred trees might have other problems as well, some still only emerging or still unknown. A question that surfaced during the time of field work was the issue with resin top disease in the north of Sweden. A solution has been suggested to thin the existing seed orchards to get rid of clones that are most susceptible to the fungus[9]. This was confirmed by the same interlocutor above, Bert. As this is an emergent problem it seems rather unclear what is driving the outbreak. It has been suggested that it is an unintentional result of less resistance because of breeding for growth[10]. Another concern is that double top shoots occur frequently in spruce, seemingly without explanation (Black-Samuelsson et al. 2020:59).

Even though we cannot know for sure what has created the double top shoots in spruce or resin top disease, there are reasons to believe that a lower genetic diversity of forest trees, created because of breeding with a narrow goal of economic value production can be creating a situation of more susceptibility to pests. If not today, then maybe in the future. This is the

[9] https://www.skogsstyrelsen.se/globalassets/om-oss/rapporter/rapporter-2021202020192018/rapport-2019-10-multiskadad-ungskog-i-vasterbottens-och-norrbottens-lan.pdf Accessed 2022-06-02
[10] https://www.slu.se/forskning/kunskapsbank/inst.mykopat/torskate-i-sverige/ Accessed 2022-05-10

whole purpose of keeping genetic diversity intact. It is however hard to confirm that it is only because of breeding that this lower resistance is happening. As important is climate change and management techniques in forestry.

Finally, even though plant breeding can include many variables in the selection, growth is the primary goal. A critical plant breeder I met said “we don’t breed for conviviality with squirrels”. The bred seedling is also supposed to fit within an assemblage of soil scarification, planting, forest hygiene and management. The bred plants will be different than natural trees.

3.2. Seed orchards and plant nurseries

Pollen contamination

There are circa 200 seed orchards in Sweden. The first seed orchard in Sweden was established in Värmland in 1949 (Almqvist, Wennström, and Karlsson 2009). This is the world first seed-orchard for forest trees I hear. In a seed-orchard a bred tree is placed and left to grow. These trees are open-pollinated and set seeds after about 20 years. The cones are then plucked and left to dry by the owner of the seed orchard. Orchards was originally owned by the state but is now owned by the industry in interest groups.

The forest tree breeding selects two individuals that present good characteristics which are then crossed with controlled mating. The pollen is injected into the flower and the resulting offspring is cloned and put to grow in seed orchards. Many clones are used and a representative selection of parental pairs is used to preserve all genetic diversity. When these clones set seeds, they have been pollinated by pollen from the seed orchard as well as outside pollen. This also creates genetic variation that legitimates the seed production. With removed pollen contamination, genetic variation and therefore one core aim of the breeding programme would change.

The management of a border involves keeping things separate, it is sometimes however unclear what it is that needs protection. An interesting example of this happened when I asked Ted, a researcher at the Forestry Research Institute of Sweden, about if pollen from genetically bred trees would risk contaminating the surrounding natural forest. This was something I had read in a report from the forest agency (Skogsstyrelsen 2017:32). He was initially unsure what I meant but answered that he doesn’t know and that usually he is concerned with the opposite, to protect seed orchards from contamination from pollen of the surrounding natural forest.

In a list made by the forest agency together with other stakeholders, both the forest industry and nature organisations, it is mentioned that a practice of tenting the seed orchards would increase production. The purpose would be to keep the genetic gain from the controlled mating without pollen contamination from sources outside the seed orchard[11]. This does however have potential bad effects on genetic diversity (Black-Samuelsson et al. 2020:39).

My point is that in the field, the idea of natural and domesticated trees is present. The border is erected as a comparison to make sense of the idea of genetic diversity. The natural forest is by some thought to be at risk because of a high use of genetically bred forest reproductive material. By others it is rather a question of purifying the domesticated material and protect it from natural sources of contamination, for the purpose of genetic gain.

Nursing the plant

Maria shared her screen in our video-call on Zoom and said that unfortunately she can't send me these pictures. What I saw was an aerial view of the plant nursery she has been working at. In her words, it is like a factory. Niklas used the same words when I first asked him if I could be enrolled as an intern the plant nursery. My interviews with Maria and Niklas are the closest I got to the plant factory where the seedlings are made. There are around 20 of these sites spread out in Sweden. I don't think they are more secretive than any other business but private business is different from public science which is relatively easy access for an anthropologist.

The plant nursery is an industrial area almost with production lines, Niklas told me. Regularly it's only three people and one boss employed there and what I would do, hanging around there seemed not so suitable. The idea develops instead to that I should accompany Niklas to the plant nursery to see how it works but during the time of my fieldwork it was not realised. I sensed a bit of reluctance to accept me.

There might have been other reasons, as Niklas was one of the first people I talked to, he was the one telling me that there is a difference between seed orchards and plant nurseries. The

[11] https://wwwprod.skogsstyrelsen.se/globalassets/om-oss/pagaende-projekt/hallbar-okad-tillvaxt/lista-88-atgarder.pdf accessed 2022-06-02

challenge of starting this fieldwork was that it required a great amount of orientation before I could find out what was interesting to me.

Niklas continued and told me the history of producing seedlings. Over the years the practice of producing the seedlings had been a headache for plant producers. In the 1980s, the change from plants dug up from the ground to plants in pots created the enormous problem of root bound trees that you could push and they would fall. The history is full of other problems that plant breeders learnt thorough practical trial and error.

Phenology for example which concerns ecological timing in plants. An internal clock learned by the plant by the duration of light called photoperiod, prevents foresters from moving seeds from northern provinces to southern ones. During a mingle after a meeting about the future of Swedish forestry, I met a woman working with bioeconomy who suggested we could maybe bring seeds from Germany since they would be adapted to the higher summer temperatures that are anticipated from climate change. Such an assisted migration is not possible, however. It was already tried during the 1800s. To survive as a plant, you need a clock correctly set for the climate and light levels. This is what complicates the climate adaptation of plants, the temperature is changing but the photoperiod is not.

When Niklas was telling me about this, he mentioned a report in the news from Umeå about a birch tree that was in green growth in the middle of winter. In the report, a scientist from the Forestry Research Institute of Sweden said that the birch was brought in from far south, from Poland. The tree mixed up the environmental cues and didn't know how to behave. Two children that were interviewed were calling it the magical tree, it seemed to have superpowers.

I didn't dare to ask Niklas about the ethnicity of the workers but I have a concern that this might also be part of why I am not allowed to come to the plant nursery. A year prior my study, some of the migrant workers working within forestry have spoken up about their precarious situation. When I checked the collective agreement between the union and employer organisation in the forestry sector, I saw that a planter and a plant nursery worker was paid about the same hourly wage of 120 SEK, about 12 euros an hour. This was what I had on my first summer job as a sixteen-year-old so it's a small wage and I can imagine that the work force represents it.

When the forest seeds arrive to the plant nursery, they have been sorted according to weight and size and been x-rayed for insects that can live inside the seeds. The seed that has been

conceived and cared for at the Forestry Research Institute of Sweden is ending up in pots at twenty different plant nurseries. Niklas stressed the idea that ideally plants should grow uniformly, otherwise they will shade each other. I understand that sorting by size and weight helps with that.

The seeding in pots is often done in the spring and towards the summer the small plants are trained for the latitude with shade-nets and tents that fool the plant into thinking it is night-time. Then they go into dark rooms with below zero temperature to imitate winter, causing them to go into hibernation until the next spring. With such environmental cues, together with proper genetics from the seed orchard that have gone into the seed, the plants are trained for the environment where they will end up.

Yearly, Sweden produced about 400 million of these small seedlings which is quite astonishing in my mind. These plants are expected to live on up to at least 60 years. It is here that value is a bit of a strange word to speak of. When I asked Maria why this part of the forest industry is so scarcely written about, she replied that she believes it is because of the limited value from sales. Björn however, who is working with the seed preparation at the Forestry Research Institute of Sweden is stating the opposite, that there exists a huge amount of value in the seeds and plants. It came up when he said that a thing not many people know is that pine seeds have culinary qualities. As he made sure to tell me they don't walk around and chew on the seeds at the institute, he said the seeds are the condensed value of the future forest. Such a value is slippery and necessitates long time planning which individual companies are rather bad at. As told above, the Swedish state realised this and have been working to make sure the production forest is being replaced with proper regeneration to provide for future generations.

3.3. Same thing as throwing out seeds in the forest

Niklas said that what they do in the plant nursery is only helping nature on its way. By taking seeds, planting in pots and planting the seedlings, Niklas meant that the same process is happening in the forest. Here he was, in the same sense as others, naturalizing the process by saying it is nothing different from how a seed is grown in the forest.

As I have shown, there is a large degree of control in the process that is not captured in Niklas' statement. The primary difference is that the seeds that are used for plant production are selectively bred to enhance production values. In this sense it could be argued that the

plant production is tied into the industry of plant breeding. There seems to be less of a point of cultivating plants with regular seeds.

Also, the plants are seemingly not always surviving. In the fieldwork I came across people who believed that moose preferred plants that have been bred and cultivated in plant nurseries over naturally regenerated seedlings because they have a higher content of carbohydrates. As I am finishing this thesis, the Forestry Research Institute of Sweden has just published a report stating that at least 20 per cent of planted seedlings don't survive more than three years.[12]

So, can we speak of the domestication of Swedish production forests after the advent of genetically bred forest seeds? The definition of domestication often includes the necessary condition that domesticated species cannot reproduce outside human control. If they do, they are wild. With such an understanding of domestication, forests are not domesticated. Forest cannot be said to be dependent on humans for their survival. Still, there is no question that the plant material of the Swedish forest is in a process of domestication by being subject to heavy human adaptation through controlled breeding. But even though it seems possible that breeding might affect the genetic composition of the surrounding forest, it is hard to argue that forests are domesticated. Partly this has to do with the fact that a forest is an entity that is more than a single species of trees. Forests involve other lifeways.

To a certain degree, there might be possible to put forward an argument that a production forest, to deliver what humans want from that forest, necessitates human cultivation. The planted forests are also subject of heavy simplification by soil scarification and sometimes improvement measures as fertilizers. This type of forest could be said to be more domesticated than others. But when humans don't take care of forests, forests care for themselves.

What I instead suggest is in line with the authors I have discussed above that domestication is a "reconfiguration of multispecies assemblages" (Swanson 2018:151). With Anna Tsing's words as an entrance to this chapter, I have here described how domestication as a progress concept has become inscribed in the forest-human relationships in Swedish production forests

[12] https://www.skogforsk.se/nyheter/2022/plantdod-stoppas-i-stort-forskningsprojekt/ Accessed 2022-05-19

(cf. Tsing 2018). Domestication is not a state which the forest or the forest seed can be in, it is rather a degree of domestication that is the result of the above-mentioned conditions of forest tree breeding with certain defined breeding goals. These are political in the sense they can be changed by humans.

As Anna Tsing (2015:23) has stated, the planted tree has a relative, a wild seedling that is different in that it is not planted. By paying attention to forest assemblages, we can focus on different type of forests. This difference I believe is productive to shed light on. One of the most interesting differences that is suggested by my material is the concept of genetic variation that has been discussed above. As said above, Swanson (2018) has raised concerns for the way that domestication has ripple effects on landscapes, and in consideration of the fact that production forests cover half the land mass of Sweden, this is a concern that plant breeders should take into account.

4. Chapter 2: From plant to priced timber

When my grandma turned 90, I met with a cousin of my dad, Barbro. During our dinner out, me and Barbro talked about how Swedish agriculture is struggling and we decided I would come and stay with her for a while to learn more of how it works in Värmland. I knew already that I planned to conduct a fieldwork about forestry, and I thought that this was a good opportunity to get in contact with some forest owners.

A month later I was on the morning train to Karlstad. After changing to a second train, I was at the station. Barbro showed up in her two-seat Renault Kangoo van. I threw my bags in the back and jumped in. We hadn't decided exactly how long I would stay but Barbro had already booked quite a lot of meetings for me. We got to know each other by choosing where and what to shop for dinner, our socialist upbringing seems to have ensured that we both preferred Coop besides ICA.

It was as we tried out our interest in how to shop most environmentally friendly. At first, I read it as Barbro wanted to be nice to me. I am used to people showing their courtesy to me by discussing food choice when hearing about my vegetarianism and membership of the green party. I soon however came to see this as true interest from Barbro's side. Her knowledge shines when we come to the dairy section. Barbro has worked as a milkmaid before and she doesn't like the idea of paying more for lactose free products. Cream fraiche is naturally lactose low she said, this was new knowledge for me. I later check and it seems to be the case. I had of course no idea how cream fraiche is made.

In this chapter I to visit forest owners' own ways of knowing to understand how forestry is done and what role the spruce and pine seedlings play in regeneration of the forests. It is arranged to cover the life of the tree from planted in the forest to harvesting for the market.

4.1. Planting forests

Selecting type of regeneration

The seemingly total demand for more pine forests is challenging the numbers of moose. As Andy put it, the question is how to regenerate forest in these times of climate change and many herbivores. This question also resonates with the worry that forest breeders feel when anticipating the future. In this section I will tell of how the forest owners I met and talked with viewed and practiced regeneration of their forests.

Evert picked me up by the bus stop and we went towards his forest. At a turn I saw what I though was a larch tree at the side of the road. During winter, larches shed their needles and

become brown, as opposed to spruce and pine that stay green. We had already spoke a bit of what choice Evert had made for the regeneration of the forest after his spruce bark beetle attack. I knew that he had chosen larch on one part of it, so that was what I wanted to bring up in the car but what I pointed at was apparently a dead spruce tree. I should have known better and we joked about it.

What I entered was a completely different forest to what I saw when I was there two years prior. The dead trees had been removed and the area was no longer the deep forest it was before. A structure on the ground, where he had intended to build a cottage for his son was almost the only thing that made me accept that I had been in this forest before.

After the spruce bark beetle attacks in Sweden over the last few years, which originated from a combination of some hot years without rainfall and the wrong trees in the wrong place, the forest owners including Evert needed to find a way of replacing the forest with new forest. He had recruited his timber buyer, one of the big forest companies in the region and when the harvester arrived one early morning he had gone down to meet with the driver. It was lucky he did, because Evert's idea was to save as many trees as possible and only remove the dead spruce trees. The harvester was thinking economically and had prepared for planting spruce. Instead, Evert preferred seed trees as the primary method. This is one type of natural regeneration in which you leave pine trees that can re-seed themselves. Together with other trees that grow spontaneously, Evert will get a mixed forest of different species and ages. That is what he was hoping for.

Bit by bit, I have come to learn more about what possible ways there are to regenerate forests in Sweden today. As the previous example shows, there is a need to consider regeneration when the harvest is planned. As such, this chapter is not limited to the regeneration phase but drags into the analysis both the management regime of forestry today, and the political economy of ownership together with market demands. What regeneration is happening is conditioned both by a forest assemblage where breeding and management are key components, but also the formative decisions of forest owners and the work of nature. All parts of the assemblage.

Seed trees are one way of caring for the regeneration of forests and it is rather common with the forest owners I meet during my fieldwork. It is classified as natural regeneration and sometimes it is used together with minor soil scarification. This is what Rickard did on his clearing.

Rickard is the relative of a friend and has worked his whole life for a timber company. It is only in the last 20 years as retired that he has bought some forest land to manage. Rickard is 75 years old and owner of 12 hectares of forest land. We walk up to one part of his land where he has tried out natural regeneration. Contrary to Evert, he didn't leave seed trees, only some birch trees for tree retention, but a storm had knocked them down. Rickard had already been there to bring it down with his small and old tractor. Rickard was instead primarily relying on the surrounding forest as seed trees. A novelty that he did, however, was that he had taken his small excavator up to scratch the surface and remove some undergrowth where the seeds could get a head start. It seemed to have paid off because we could now see small pine trees growing in the mineral soil.

I had up until this point been very sceptical of soil scarification. As a large-scale practice, it is often the case of harrowing the forest floor to turn the grasses and leave bare soil to plant into with the undergrowth as compost to provide some heat and nutrition for the growing plants. This harrowing can dig half a meter deep trench across the forest and damage sites of cultural heritage. When used in reindeer herding areas, the conflict is also even clearer since reindeer lichens are removed.

The practice of Rickard was however very different from my previous understanding of soil scarification. Many of my interlocutors used a small-scale soil scarification to remove small patches of growth to seed or plant. This is a big difference and means it is sometimes hard to understand what type of practice is referred to.

Another strategy is of course planting. As has been made clear above, planting is currently totally dominating in Swedish forestry. Among the forest owners I met however, they all used some combinations. I asked them if they had bought plants and many had done so at least a few times. Evert told about his larch trees, Jakob about his Contorta, Arne about a specific type of birch tree called Maser birch. The spruce and pine plant seemed quite invisible when I come to think of it. As stated before, this might be because of a seasonal bias in the fieldwork. Also, since I made use of my relative, I made contacts with forest owners that were in the forest as a pastime, rather than for pure economical interest.

When I asked Arne if he has ever bought seedlings, he said that there has been no need to do that. Since he is using a horse to drag trees out of the forest you get natural scarification of the soil and seeds that lay dormant will grow to new trees. He called it "to help nature". After all, the squirrels are not that effective and only drops seeds here and there, he said. After a small

detour when he told me that he used to shoot squirrels in his young years, he told me that you don't need to care too much about planting or sowing, nature is sorting it out. This could be called natural regeneration but it doesn't fit with how I had come to understand it through the literature since it is rather no measures. Arne didn't tell me that much about how he harvested his trees but if it was quite small-scale, there was no need for planting or sowing. The idea that forest just grow back if it is handled with care and not made to produce too fast was growing in me when I spent these days in Värmland.

Olof is a rather large forest owner with a bit more than 100 hectares and the forest we visit is one part of it. He has never been able to make a living from his forest but has been doing it as a pastime. What is special with him is that he has a big interest in draught horses and has kept with some old ways of doing before the advent of the machines. He has instead worked full time on a regular job at a sawmill.

The forest is high up on a hill and we need to drive at least fifteen minutes on a dirt road from the main road to get here. The ground at the clearing is mostly covered by a grass, I'm not sufficiently botanically educated to know what species, but this is a quite common view of the felled areas I visit during my stay in Värmland. The piled-up stones, thousands of them point to how people living here made their livelihood primarily from grazing animals. The dirt layer is too shallow to support anything else. I had started to learn to differentiate between ground for spruce and ground for pine trees, a basic distinction of suitable habitat for forest trees used by my interlocutors and this was typical for the conditions for pine. The interview was made as we walked across his patch of forest and I used a recorder in my pocket and my camera to snap some pictures.

The cleared area was less than four hectares, a reasonable but also commonly sized clearing the size of around eight football fields. Olof said that previously there had been mixed forest here. His strategy for regeneration here is planted spruce bought through a company, but they are few in numbers. There are some small pine saplings peeking through the thick undergrowth. He has also chosen to leave seed trees but as he is very protective of the sites of heritage that are on his ground, he doesn't like soil scarification.

We had, up until arriving to the clearing talked, about how Olof preferred to use natural regeneration. He said that the plants you buy sometimes are brought up abroad or in southern Sweden, far away from the conditions which are needed here in his forest. On top of that, the soil is so scare that a planted seedling might not make it. He was also very sceptical about the

practice of planting vast areas of spruce; they are all eaten by the spruce bark beetle he said. Still, funnily enough, Olof seemed a bit puzzled when he saw that he had planted spruce at this clearing and asked himself why he chose spruce. All in all, the regeneration was pointing towards a mixed forest once again.

What is natural regeneration

There can be many reasons for choosing natural regeneration, I learn over the course of fieldwork. For Olof it is primarily the low cost. He is also knowledgeable and the primary worker in his own forest, much like Evert, Rickard and Arne as well. In terms of harvesting, everyone hired a timber company for such and some also paid for plants and planting. Only Rickard and Evert specifically said that they had planted themselves.

But the amount of work that the forest owners I interviewed did, is quite different from how many small-scale owners operate who often hire a timber company to fully manage the forest. Around a third of the forest owners today are not living close to their forest, and if they do, they may have inherited the forest while they work as a dentist. For forest owners like my interlocutors, that are competent in forestry, they don't have any trouble to come up here and take care of any fallen trees after a storm. Leaving seed trees is therefore possible and insignificant in cost compared to buying in seedlings and labour.

This is maybe why the question of who does the planting was not discussed with my interlocutors. It is maybe seen as any other service the company provides. When I asked why they didn't buy the service it was rather cost than moral reasons behind their decision. In the same vein, the forest owners were often not satisfied with the amount of economic gain they got from their forest, at least that was how they talked about it. I didn't inquire into specifics of timber deals but my impression is that to be able to make something to live off as a forest owner, you need to operate at the bigger scale.

Apart from the low cost, both Olof and Arne do however use the word natural at some points in our interview to describe their way of caring for the forest. Natural is both present in their way of speaking but also in the category that forest statistics is using which is natural regeneration.

Natural regeneration is something separate from artificial regeneration, the use of seeds for sowing or seedlings for planting. Still, natural regeneration has many human elements that is contributing to helping nature with the regeneration, as has been made clear. Most primarily is the use of soil scarification which can be included under the rubric of natural regeneration.

Also leaving seed trees is conditioned by first removing forest but leaving trees some for continuation, a human impact of the landscape.

In the statistics there is another category termed “no measures”, in which nothing is done to promote growth of new forest. This category seems strange and here it is probably wise to ask that if one doesn’t do anything after a clearing, why would you report that?

One reason that natural regeneration is decreasing might be that the forestry act calls for suitable regeneration so that the number of trees is sufficient after a set number of years, depending on the conditions of the patch. Olof commented on this when I asked about regeneration and said that the forestry agency wouldn’t let the forest owners do how they please. He said, they call him up and demand that he makes sure the ground is covered by new forest within a certain number of years. Instead of developing this further he pointed to the edge of the small road we walked on and said this is where he shot his last calf. I interpret this as a domesticated cow and only show more of my city dwelling ignorance.

Jakob is a bigger than average forest owner in Medelpad with around 200 hectares. Instead of travelling we decided to conduct an interview over phone with the use of photo-elicitation so he could show me how his forest looks like. He described himself as a forester trained in self-sufficiency instead of production. This, he meant, had implications for how he manages his forest.

The first time we spoke he said that he also had planted contorta, an introduced tree. When I asked him in our follow-up interview about this, he said that this was the only suitable regeneration technique, but it is only a small patch and he wouldn’t do it again. I understand that the first time we spoke he read me as an environmentalist and wanted to challenge my views. He, like many other forest owners, need to combat a prevailing idea that they are destroying the forest and when he said he uses contorta it is to explain that the decision is his.

Likewise, he also made sure to tell me about how planted trees don’t create tightly controlled forest, contrary to what they say in the news. He said that even if you plant, during thinning you decide the forest you will keep for the future. He also said that the conditions on the ground steer the scarification machine, so the plants are not planted in line with each other all the time. I took this as well to be a discursive sign to distant himself from his idea of my idea of forestry but also stating that the timber fields are not as uniform as they say.

This is not to say that I didn't get a good picture of how Jakob prepared his forests. Partly he was very sceptical of the use of heavy machines. He also told me about how a patch of very natural regeneration happened. Just beside where he had planted contorta, there had been a fire which burnt the pine trees. Some died, but more importantly, when the undergrowth burned it made room for natural regenerated pine trees. He said that you never burn anymore, you don't dare but this was the most natural way of regeneration.

The idea refers to what I also encountered in the field, a defence of clear-cutting because it mimics the disturbance regime of forest fires, which are common in the Scandinavian environmental history. By stating that clear-cuttings are like fires, the forest industry can compare it to a natural disturbance and hence clear-cuttings are made natural. The real difference between a fire regime and clear cutting is that the flames only burn three meters up the pine, which makes them survive and reproduce by self-seeding in the exposed mineral soil. This is what had happened for Jakob.

All these five forest owners were rather small-scale, apart from Olof and Jakob who reside in the middle. Even though they use natural regeneration it doesn't contribute so much to the overall statistics where it is the forest companies that are the big players. At the company I later visit, plants were the main option of regeneration.

4.2. Working forests

Replaced by the machine

Beata's house is on the opposite side of the lake to Barbros, they are almost neighbours. The house is built with trees she has felled at the property. The horses are Ardenner, a landrace breed, and this is how Barbro and Beata know each other. Both as neighbours and as colleagues working with horses. Beata was cheerful from the start; her voice was amusing since it's so soft in an environment where strong horses and a diesel truck on idling made me expect something else.

While Beata packed her big truck, Barbro and I went into the stable to say hello to the two horses. Steam from their noses rose inside the wooden stable. It was still dark outside because we would leave before seven. Me and Barbro led the horses on board the truck and secured them. Then we fetched the equipment we needed for the day, a *rullebör*, a wagon that can hoist tree trunks. Connected to the horse as a cart it makes for an appropriate equipment to drag logs out of the forest this part of early autumn. If the ground was frozen and had been covered with snow, we might have chosen a sledge instead.

Working with a horse has obvious advantages compared to heavy machinery. It is low impact on the ground which is the primary reason why Beata had been hired. The customer was the bishop of Karlstad who was clearing a rather wet area with deciduous trees from spruce trees. The purpose was to promote the values from the deciduous trees and open for more light to come down to the forest floor. When Beata told me this, she referred to how important it is to care for the mycorrhiza, the life below ground.

Beatas dog greeted me happily when I jumped into the truck and he sat close, leaning towards me throughout the whole trip to today's workplace. When I ask Beata about why she chose to work with forestry, she told me how she like her work and life to be beautiful, that there is no point of having a work life where you cannot work with people and enjoy it.

We met with a younger Norwegian woman who were working the other horse. Me and Beata worked with the black one. It was hard, I had never worked with horses. She said that it's a lot to think about. Up until that point I had been directing my questions more towards issues of sustainability. I interpreted that as a way of bringing me back from thoughts to practical matters. When the sun rose over the area, the church bells rang and steam from the horses rose against the sun. It was magical and held a certain aesthetics which a machine could not produce.

As Olof who chose to work with forest because of his interest in horses, Beata did the same. This is not the only things she does, however. She mostly did forestry during the winter and gardening as well as home keeping during the rest of the year. During lunch, Beata said that we need to limit greed in the forest, that biodiversity is more important. When Barbro arrived, she was quick to point out that Beata is not carful with her body. There is a proper technique to handle the logs and use the counterweight for leverage. Beata was working more with shear strength. This is also part of the reason why people and horses has been replaced by big machines.

Olof had another idea of the machine. When Olof said he is not sure why he chose spruce, what does that mean? Does it mean that today when spruce is more often discussed, it is shameful to plant spruce? Just before Olof said this, we had discussed how spruce is a problem; still Olof has planted it, and he is not sure why. When we sit down to have some coffee later, Olof told me that the machine is responsible for the fact that we have so much spruce in Sweden. He said that the machine cannot remove branches from other major forest trees like pine and birch and that this has made it more profitable to plant spruce.

Machine is a word that has deeper meaning. Olof uses it as a term signifying the harvester, the big machines that are used today in forestry. I however become intrigued and see it as a broader term signifying the forest industry, including the breeding of forest trees and the mechanisation leading to labour opportunities disappearing from the countryside. Taken together with what he said before that he is not sure why he chose to plant spruce – the machine has influence on this forest owner in Värmland.

The moose in the room

"We cannot look away from the moose in the room" - A researcher paraphrasing the saying about the elephant on a meeting about forest damages and management strategies.

My first interview in Värmland was with Barbro's 72-year-old neighbour. Arne told the story about how for some years in his earlier career it was stipulated in the forestry act that forest owners should remove deciduous trees from the forest floor.[13] It was believed by scientific forestry and state foresters at that time that pine trees grew better if they did not need to compete with other trees. Arne met with a state forester who told him to do so as well, but Arne refused. He told the forester that they could conduct a trial, removing the deciduous undergrowth from one patch and leaving it on the other. The forester agreed. When they came back, all the young pines had been eaten by browsing wildlife at the patch with no deciduous trees, while they were left unharmed at the patch where Arne had decided how to do it.

This story tells me two things. I can't look away from the fact that this is quite typical of how a forest owner sees state policies. The story is instrumental in illustrating how a governing state will never understand how forestry works, and that it is better if forest owners are left to decide themselves. And in many stories from this time, the state forestry of Sweden is notorious for not listening to forest owners' ideas. But the story was also interesting in the sense that it conveyed an understanding of browsing that I could not get in any other way.

On Olof's clearing, small pines and slightly bigger spruce trees were growing amongst the grasses on a seven-year-old clearing and Olof pointed to some shrubbery that I hadn't paid

[13] "Röjningsplikt" was in the Swedish forestry act between 1979 and 1993.

attention to. This is very important, he said. The shrubs had been eaten by deer or moose and should be saved. When herbivores browse, they prefer the same shrubs next year. Me and Barbro were both keen on understanding something new and told Olof of what Arne had said the day before about how he had saved deciduous trees as well. This way, leaving food for the moose is generally talked about as a good way to make the moose less interested in the small pine trees.

To contrast this with scientific forestry, I also attended a meeting during my fieldwork directed towards forest owners interested in discussing how to succeed in growing pine trees[14]. The digital evening was made for us to understand more about these interactions between food for herbivores and the potential of growing pine. The presentation was about how to keep pine trees alive by providing enough feed for herbivores. Here, the general strategy that was suggested was to use soil scarification to get more growth of deciduous trees. The downside of this is that bilberry bush is removed for many years to come, contributing to both less winter feed for herbivores and less socially valuable forests.

It is in my interview with Andy, in the end of my fieldwork that I understand that the number of moose has been rising together with a certain type of forest management practices. The moose is very much a part of the industrial forestry. The young pines have been great food for the moose and now when pine is the tree that many forest owners want instead of spruce, then the moose has become an obstacle. He said that maybe it is at a reasonable number now. The number of shot moose peaked at 180 000 per year in the beginning of the 1980s, before going down and hovering around 100 000 for many years. Today the number sits at 80 000. But as Andy, who is ecologically trained told me, the culling is not the only thing that is influencing the numbers. The warm summer is also making the moose having a harder time to survive in Southern Sweden.

Moose and pine forest have an interaction with humans, and the number of moose culled each year is both a valuable game for hunters but also an expectation from forest owners and industry to keep the damages from moose to forests at bay. A family of moose can park at a clear-cutting and be satisfied with the young pine shoots for a whole summer. Even though it

[14] https://gronamoten.agrovast.se/kalender/framtidens-resilienta-skogar-tallodling/ Accessed 2022-05-21

is hard to establish correlations, it is generally regarded as a fact that the clear-cutting has provided a lot of food for the moose. Andy is linking the shifting numbers of moose with how the forest management has developed. There are rather intricate interplays he said and joked that as a biologist he should know everything.

It is here that I believe that the assemblage is useful to point to what type of forest management Sweden currently has. The interaction between humans, pines and moose are what Anna Tsing has called a happening. The multispecies world-making of human production forest provided a lot of food for the moose that exploded in numbers with the entry of clear-cutting. Today as planted forest is replacing natural regenerated forest, there is less food and the browsing damages are increasing for production forestry.

4.3. Selling forests

At a company

Martin picked me up outside Barbro's house in his car. We got a good connection from the start. I feel it might have resulted from Martin's critical attitude towards how forestry is done these days but he was also very easy to talk to. Martin started working as a manual labourer in forestry during his youth and is still in the same company with only some years to go before retirement. In his job as a planner, he is responsible in laying out the route that the harvester will take in forests the company own and make sure any sites of natural or cultural value is protected with precautionary measures. Together with the timber buyers, who buy and plan forest that individual forest owners sell, these two flows of own forest and bought forest is sending the timber on in the organisation to harvest, which in turn is delivering timber to the company sawmill and paper industry.

When he showed me the map of northern Värmland which he was working with, a number on each patch of forests was showing how old the forest was. The numbers all showed that the forest was around 50 years old. Scattered here and there were patches with red lines around them, indicating a key biotope[15] and voluntary set asides. Martin told me that those had been agreed to be protected with the certification. He was currently under pressure to find more forest to protect but there were not much to find. Martin said it was too bad that the law

[15] Nyckelbiotop is a term in Swedish forestry currently contested but refers to an area with high ecological value.

enforced clearing of badly regenerated forests during the 1970s, the second timber frontier as I talked about in the background above. Imagine what fantastic forests we could have had, he said, if they were protected then.

As he was lacking forest that are old enough and because he as pressured to keep the flow of timber constant, he was forced to plan for harvesting of non-mature forest. He was feeling it was such a waste that these forests were not left to mature. They were well taken care of and could easily been left to grow for longer. Therefore, he was also under the impression that the forest was driven too hard today.

During the half a day that I hang out at the office, I met timber buyers and one young man responsible for placing the order on what machines would be used for the timber harvest. The ones that were responsible for the regeneration were not at the office but I learnt that this company had chosen not to use seed trees. Martin told me that this was because they had the experience that the pines fell during storms and created problems. Other companies do however use seed trees so there are probably economic reasons why this company didn't want seed trees.

Pricing for the market

At the end of the supply chain are the industries that need a steady supply of timber. To get to know the conditions I went to a sawmill to talk with Samuel who was working as a wood measurer. The position is responsible for unbiased grading of the quality of the timber to set the price. At this sawmill, they specialise on the Home-Depot type of market. After a printed A4 with the measure-order was given to Samuel, a driver in a wheel loader stacked the logs on an infeed table from which the logs were fed in on a conveyer belt and then Samuel's work began. As we sat down, and I heard the belt starting, I felt that this is the sound of industrial Sweden. The buttons had that characteristic "click" that early digital machines had and the conveyer belt produced a steady rhythm. Samuel was positioned in a chair with many colourful buttons. Every log was given a classification, spruce or pine and then a class one, two, three or four. Four is bad, one is the best. To be a class one log, the log needs to be straight to give good output of sawn boards, without branches that make knots on the final boards and reasonably dense.

This classification sets the price that the forest owner is paid. It's here I see that classification matters. Samuel said that in recent years the 50-year-old plantations of spruce are coming in, partly from the company I visited the day before, are on the verge of being too low density.

These logs are on the verge of being classified as *vrak*, meaning it does not fulfil the set rules of the pricing. By balancing on the edge, the "company wood", which Samuel said they derogatory call it, the company can make profit while losing some logs that are not dense enough to be able to withstand the forces involved in construction timber.

On the other end of the scale, some timber is coming in that is very dense, indicating that it is also very old. Samuel said he was sad to see those logs because they shouldn't have been cut. He is in favour of letting more old growth forest stand. As this sawmill don't have a premium segment for timber, it doesn't help to know that the oldest and biggest trunks are too big to handle in the sawmill and instead they are turned into plywood for walls. The nicest timber should in Samuel's opinion instead of being turned into tables and doors like in the old days, not end up behind some wallpaper in a newly constructed house.

Samuel is a forest owner as well. When I asked him what is important for him, he was clear that he like natural forests and providing for ecosystem services. As a small forest owner that prefer being in nature, he is fine with managing his forest just for natural and recreational values.

Samuel's position is the shape where Swedish forestry needs to fit in. His classification systems steers pricing in the forest and affects how the forest owners prefer to manage their forest. Like Samuel said, some of the big companies are balancing on the edge between fast grown timber with too few growth rings meaning the wood is too weak to use for construction. It's here that straight wood is rewarded and some old growth ends up as plywood. Uniformity does its work from one end of the production line.

5. Chapter 3: Reorient forestry

At the Woodland Cemetery the pines are creating the impression that you are in a room with pillars. It's a religious experience and tightly resonates with the Swedish idea of nature as a holy place. I have always loved the place and I took the opportunity to include it in the fieldwork. The concern for forest pathogens is real and since some years a regeneration work has been on going to spread the risks by making sure there are successor trees moving in under the big pines. Pine is however a tree which loves sunlight. To provide for the regeneration, Otto, the responsible for trees at The Woodland Cemetery and his predecessors have needed to fell some of the pines and thereby create openings in the crown cover. In the openings, light can shine down, and pines has been planted in groups of three.

But Otto was facing some problems when I visited him just before Christmas of 2021. Not primarily the concern of forest pathogens and climate change but the handling of failed regeneration. While we moved around with his iPad where he had a map of the recent years planting, he told me that almost 50 per cent of the planted pines were dying. It was unclear why but the establishment might be affected by bad plant material, low light levels, stress from planting or the earthing up of tombs. After all, at this cemetery the roots of the trees are regularly cut. The trees which didn't make it were ten years old when they were planted. The idea is that they are strong and healthy and can adapt to the new place but it didn't seem to be the case. Previously smaller trees had been planted and those seemed to have managed better.

5.1. Seed savers of forest seeds

When I set out on fieldwork, I had in mind to look for seed savers within Swedish forestry. I had been reading the literature about seed saving in crop production and gardening, and I was anticipating finding something common to this in Swedish forestry. There is a strand of resistance to state control and bureaucratic enclosure over seeds that is common in the anthropological literature (Rezvani 2021). The literature of seed banks has also shone light on the fact that seeds cannot be saved outside of culture (Lewis-Jones 2019). By highlighting biocultural diversity, anthropologists have sought to point to how intertwined life is (Haider 2021).

In 1908 the Swedish parliament introduced legislation that made it possible for school children to participate in sowing and planting three days per year (Holmberg 2005:19). In the beginning of the 20th century, it was often the work of women and children to pick cones in the forest. These cones where then prepared into seeds for forests in the home or at seed preparation facilities. In the 1960s there were more than thirty seed preparation facilities

spread over the country (Statens Offentliga Utredningar 1972). The regional or state forest organisations were responsible for the gathering, preparing and handling seeds for forestry up until 1993 (Holmberg 2005).

As time progressed, modernity removed the practice of picking cones in the forest and as with all things during this era, rationalisation consolidated the thirty seed facilities into two sites. I am not sure how common it was to save one's own seeds but the picking of cones was probably done as an extra labour outside of the farms and the seeds were sold to a forest company or the regional forest organisations.

It has been hard to access this era through my fieldwork but Evert remembered that his wife, Linnéa once said that her mother used to pick cones for money. Linnéas father worked as a forester and as Evert is born 1939, Linnéas mother and father was probably born around the year of 1910. Evert said they worked a lot in the forest and that Linnéa's mother picked cones. He is not sure if it was spruce or pine and we come to talk about this because I ask if he has considered picking cones.

My questions sparked some interest in him, he seemed to be quite bored and lacking things to do, so this could be an activity, saving some seeds and then seeding them. When Evert said he considered saving some seeds, it is a bit like how August thought about it. I talked to August over the phone and took notes instead of recording. He is 88 and the oldest of all my informants. When I asked him about seed saving, he told me that he had tried it out but it was almost as though he was a bit shy to tell me about it.

He said it was almost twenty years ago, maybe thirty. It was done after a clearing, when the pine trees lay on the ground and it was only a few hours work to pick the cones in a bucket. Then he dried them and gather the seeds that fell from the cone. At that point in time, he had a neighbour that had invested in a machine to do it.

When I asked him why he saved seeds he first stated that his main reason was only to try it out, artisanal seed saving he calls it. At that time, there wasn't genetically bred seeds. He compared it with today and said that these days, you can get 20-25 per cent improvement with the bred seeds. Still, seed saving is possible to do today, to buy less of the improved seeds and top up with as much of the local saved seed. The improved seed should grow faster and outcompete the local seed. I asked why one would do that and he said it could be about cost. The improved seed are expensive, about 12 000 SEK per kilo and you need about 300 grams

per hectare. In his view it's still not worth it, the price would need to be four times more expensive for it to be worth the time to save his own seeds.

When I asked August about genetic variation it is not the idea of favouring local genetic material that is on his mind. It is rather the idea of letting one specific forest live on. He would never do it with spruce, but he might consider a beautiful pine stand. That would be because of purely emotional ties, he said. August was saying that his grandchildren are not really at the age where they have opinions regarding how he cares for his forests, but if one of them, one day would come up to him and ask why he is removing the nice forest, that would be a reason to save the seeds. He is very much aware that since pollen from other pine trees would have contributed to the mix, the pine stand wouldn't live on totally but some of the qualities might be forwarded. He said that then you could point at the forest and say, this is the second generation of my pine forest.

To save seeds, the forest owner needs to have a use for the seeds. As we saw in chapter two, there are many ways to regenerate a forest. August's practices are very much in line with how Evert and Olof are leaving seed trees, even planting some spruce to create mixed forests. But he is also topping up with pine seeds to increase the chance that some trees survive browsing animals. With this strategy of regeneration, he is ideally left with a mixed stand of forest. For August, the saving of seeds would replace his need to buy those seeds.

To make saving your own seed worthwhile, there should be some advantages over planting or natural regeneration. Sowing as regeneration is a technique which is a bit more demanding. If as Evert, you choose natural regeneration you often do it instead of planting to save some money and time. Sowing is a middle way and not so many people would consider it.

But saving seeds is not the only way of forwarding the local provenience of the forest. The use of seed trees and natural regeneration is the shorter route and August was highlighting that genetic diversity is important why he was using the seed trees. When I pushed him on seed saving would contribute to the diversity, he instead switched the level of biodiversity and started, rightly so, talking of why planting is bad for species diversity. You cannot plant a mixed forest; it is too complicated to handle multiple trees and you wouldn't pay to go out two times in the same forest he said.

When I ask if it is something he wants to add he said that he would like to get the message out that sowing is a very safe method of regeneration. His reason is that the roots go down much

deeper over the season, compared to when you plant seedlings. He has made his own trials on this and was really convinced. That is what matters most, he said, you should write it!

As August is an ambassador of a different type of forestry that uses sowing instead of planting, he is in a sense preparing the ground for a type of forest regeneration that is very different from the conventional package of soil scarification and planting of bred spruce seedlings. Andy, another forest owner that has devoted his life to forests was finally the proper seed saver I found.

First time I spoke to him he was suggesting that there are people out there that save seeds because they have seen how their parents did it and got a nice result. By referring to them as a kind of dying group, he was suggesting that this was a common practice before. As I pointed to at the beginning of this section, it is hard to track the historical practice of seed saving in Swedish forestry.

Andy said he wants to do forestry as close-to-nature as possible. When I comment that other people in my fieldwork, like Arne were keeping with close-to-nature forestry by dragging out the trees by horse and making room for the seeds in the ground to grow, Andy told of a neighbour that has made a conventional clear-cutting but kept seed trees. He is however unsure if that would be enough with the browsing from moose and roe deer. Because of the moose he uses his own seeds to top up to handle browsing. In this sense, he has a similar understanding of forest regeneration as August.

Andy seems to condense a lot of the findings I have gotten in the field. He said the bred spruce produce low quality of the timber. He links monocultures of bred spruce with a high risk of the spruce bark beetles. He said that spruce is so easy to regenerate naturally that it is rather the pine he is saving seeds from. What makes Andy different from others however is his specific concern with the orchard seeds. According to him, it is the industrial ideas that govern forestry in Sweden. The flow of timber needs to continue he said and the seeds are made to grow faster. Andy is concerned that other characteristics are lost when production goals are forwarded in the breeding process. At the time when we talked, I wasn’t aware that almost 100 per cent of pine seeds are orchard seeds. That is why he saved his own seed.

In a way, Andy confirms what this study set out to reveal. He is wary that the breeding goals are conflicting. In his case, even though he is to a large extent like August, I interpret that the act of not using genetically bred seeds is a move away from industrial forestry to something else. What that is, might not be known yet.

Why I found Otto at the Woodland Cemetery was because I was on the lookout for seed-saving. In a book on urban trees, I found that there was a variety of pine named after the woodland Cemetery[16] and I quickly learnt that the seeds at the cemetery were saved from the trees to give life an opportunity to live on at the site. Otto is only two years into his position, and he didn't know that much about the decision to use local genetic material for the regeneration. He did however bring some documents that were documenting the decision of using local genetical material. In 2008, Stockholm City Museum decided that genetic material from the site should be used for regeneration at The Woodland Cemetery. The document stated that there are moral reasons for saving seeds at the Woodland Cemetery.

Before we said merry Christmas and goodbye, Otto told me that research collaboration is important for him. He pointed to the famous *Almhöjden* and said that they have a programme to vaccinate *Ulmus glabra* from Dutch elm disease, in collaboration with scientists. Knowing what is going on should decide what to do he said.

5.2. Close-to-nature forestry

I set out to search for the practice of seed-saving to a large degree because I believed it to be more close-to-nature. When I conducted my fieldwork, the debate in Swedish forestry was to a large degree about the straight rows of planted forest with clear-cutting opposed to a more close-to-nature forestry. The straight rows were in Swedish referred to *virkesåkrar* or timber fields. It is very much this idea of the timber field, or plantation that I sense that forest owners such as Arne and Olof distance themselves from when they speak of their forest practices as natural in chapter two. As was made clear, the word natural does not however mean that they wouldn't use plants or clear-cuttings.

The concept of close-to-nature forestry is rather new and came into my knowledge through the European Union's forest policies calling for it. There seems to be lacking an accepted definition of it but one way in which it is being implemented within Swedish forestry is as continuous cover forestry or *hyggesfritt skogsbruk* which would translate to non-clear-cutting forestry. All of these are similar but continuous cover forestry doesn't allow for ground

[16] https://eplanta.com/uploaded/Vaxtbeskrivningar2020/Pinus_sylvestris_FK_SKOGSKYRKOGARDEN_E.pdf Accessed 2022-05-23

without trees while *hyggesfritt* is a definition that fixes the largest possible clearing to be 0,25 hectares.[17]

Close-to-nature forestry is thought to be a type of forestry that works with nature. Here clear-cuts which have been favoured by Swedish forestry for more than a century are challenged. In a close-to-nature forestry, the *skogsodling*, that is externally produced seedlings, might not have a place. The planted forest might be left to natural regeneration instead. This potential shift is highlighted in a yearbook of the Swedish association of forest breeders, noting that this is an ongoing development[18].

To counter this, there seems to be a strategy to brand *hyggesfritt skogsbruk* as the Swedish way of doing close-to-nature forestry. The acceptance of genetically bred seeds within *hyggesfritt skogsbruk* is a bit unclear. In the fieldwork, a forest researcher suggested bred material could be used in this type of forestry. When the question came up, I raised the point that it might detract from other breeding goals. A researcher was then suggesting that the breeding can also be reversed and it is possible to select away individuals in the breeding population which shows signs of susceptibility to certain pathogens. The idea of using bred plant material might conflict with another goal of close-to-nature forestry.

The core question for scientific forestry to answer might be the one that the plant breeder put in chapter one, what are the landscape effects on genetic diversity by the big increase of artificial regeneration with genetically bred seeds? FAO states that 93 per cent of forests are naturally regenerating and points to the fact that generally they contain more values, social and ecological, than planted forests. The forest agency writes that naturally regenerated forests can be seen as more aesthetically pleasing than artificial regeneration (Skogsstyrelsen 2017:29).

I can't go into this debate in detail as it is outside my field of study but I have found it helpful thinking of forest breeding as domestication. When Heather Swanson talks about the genetic effects of planted salmon, she is referring to risks that the planted salmon is not only

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[17] https://www.skogsstyrelsen.se/globalassets/om-oss/rapporter/rapporter-2021202020192018/rapport-2021-8-hyggesfritt-skogsbruk---skogsstyrelsens-definition.pdf page 51 Accessed 2022-06-02
[18] https://skogstradsforadling.se/wp-content/uploads/2021/05/A%CC%8Arsbok-2020.pdf page 16 Accessed 2022-05-13

damaging the salmon we term wild, but she is also directing our gaze towards the landscape effects of the feed for the farmed salmon (Swanson 2018:155).

Anna Tsing and James Scott, put forward multispecies ethnography as an alternative to the concept of domestication. By this, they choose a vocabulary that is less influenced by ideas of progress. I sympathize with that but want to make sure we don't lose track of who is formative of the multispecies assemblage. Humans have the potential now to homogenize the world. The type of forestry that is suggested with soil scarification and clear cuttings, short rotation times and selective breeding might result in a less adapted forest for the future. This will also remove social value from the forest such as bilberries and aesthetical values. Even though there is a multispecies assemblage there are still politics here. I have seen it as my goal to map out these actors and lines of lifeways in the forest.

5.3. Future more-than-human forest policies

As forests are changing, so are the numbers of moose and maybe wolves as well. The close-to-nature forestry should in my opinion promote the forest as a habitat for other species as well as production interests. What this would entail for the numbers of moose is unclear. Many said that clear-cuttings and moose are made together and I see their point that clear-cuttings provides a lot of fodder. Also, even though levels of moose are going down, the damages are still high on pines pointing to other browsing animals entering the stage.

There are also problems with the plants. The Forestry Research Institute of Sweden is worried that plants die in the forest. At the Woodland Cemetery 50 per cent of the plants do not survive. I ask if mycorrhiza might be what the trees are lacking, the fungus threads that live with the roots of the pine underground. Otto said he believe that a tree which is brought up on the site is better suited that brought in plants. Andy is worried that important characteristics are lost during breeding and prefer the local seeds. August, like Otto, suggests that the seed, even if he use the bred seeds, are doing much better in adapting to the site than the plant.

As I have shown, humans are the dominant force in production forests. Our choices effect the lifeways of other species but these species are also part of the game by engaging in the forest assemblage. I suggest that we discuss forests and the future policies for them under the term of more-than-human forest policies. By more-than-human I refer to that there are other species than only us humans to take care of in these times. I have chosen the term because I believe we currently have a hard time to give power to other species like some have suggested

to give rights to nature. I believe it is we humans that have led us to this situation and it is up to us to solve it with. These forest policies are a human responsibility.

Andy said in our interview, the question is how to regenerate forests in these game rich and climatic changing times. Climate change is affecting Swedish forestry in multiple ways. As summers get longer, the spruce bark-beetle can reproduce over two generations instead of one. The decreasing number of winter days is also making sensitive forest lands hard to reach as the ground is not frozen and cannot carry heavy machines.

As the temperature zones are changing, the photoperiod which plants are used to stay the same. There is no solution in bringing seeds from a warmer climate to grow in the warming sub-arctic climate. What is needed is response. The question is what is most suitable. In chapter one, the plant breeders had their idea of making a system of clonal forestry that can provide new plant reproductive material to a new climate in a short time frame. What the plant breeders are doing is seeking to increase options, while also increasing the control and domestication of forests.

Andy is cultivating another type of forest, prioritizing pines that have grown on the site before industrial forestry put the spruce tree there. By using a low-tech response, he thinks of himself as a steward of the patch that he is managing. Thinking into the future, he can only base his decisions on what he knows. What we know is that genetic diversity will be important as a pool of resource to take from to meet new climatic conditions.

Leila Rezvani makes note of what Eduardo Kohn writes, that a species adaptation to the environment is a dialogue between the species and its environment as a meaning-making communication that is remembered in the seed. Rezvani continues saying that this adaptation can only survive if some plants are able to reproduce and set their seeds. (Rezvani 2021)

Such an understanding of “seed saving” in forestry today necessitates a deep time understanding. In this deep time, it is not about us and our use of forest trees today, but that of continuation of the life of the tree. When the perspective changes to deep time, the question is political in the sense that a few plant breeders’ decisions shouldn’t steer the industry in directions that might have such unforeseen consequences.

The breeding strategy, the choosing characteristics should be more visible. First because the future forests have a huge effect on the landscape. As production forests cover half of Sweden’s land area there are reasons to raise to overall biological diversity of Swedish

production forests. This implies to all land uses, agriculture to urban land and here I find the concept of “living with” helpful. Such a perspective turns the question of biodiversity somewhere - to biodiversity here. Second, genetic variation should not be "used up", as in previous breeding programmes during modernism. Even though agricultural seeds have been selectively bred and even subject of GMO technology, forests seeds in Sweden are in many people’s mind, nature. As made clear by forest researchers in chapter one, there is not as easy to backcross genetic diversity into forest seeds if it is lost.

But, as things are now, many things are with regards to the forest tree breeding not that bad. The Swedish state is engaged in the breeding and is creating a base for political discussions of forest tree breeding. The breeding stock is not essentially made a private good and the forest breeders are having preserved genetic variation as a goal. My main goal with this thesis has been to provide a window into this, what I would say, unknown but political field of forest genetic resources.

6. Conclusion

In this thesis I have been interested in what it means that half of Sweden's forest land are planted rather than naturally regenerated. By thinking with scholars in the plantationocene literature about domestication and work of nature I have tried to answer the questions of what the different perspectives and practices on seed saving are and what those can tell us about the Swedish forestry and its future. Also, in the thesis I have asked what are the possible more-than-human forest policies and practices that we can learn from these examples that I found in my field.

Chapter one provided a lens into the industrial seed production and the selective breeding of forest trees that forms the base for Swedish forestry. The idea in the first chapter has been to try a line of thought about the Swedish forest as domesticated. By showing how researchers debate what should be understood as proper genetic diversity I suggested that the question about control of nature is a question of values rather than a scientific question. The adaptation of future forest to climate change has multiple options, where increased control through adoption of a system of breeding of forest tree clones are one.

As the example with pollen contamination suggested, the plants are not kept pure and the outcome of the controlled breeding seems unable to answer. However, I suggest that domestication can be viewed as a change of interspecies relationships.

Chapter two inquired into what happens with the seeds and plant when they end up in the hands of small-scale individual forest owners. Different ways of forest regeneration were described from the perspective of these forest owners. What the material is suggesting is that forest owners are to a large degree in the hands of other actors when making decisions of regeneration. The title of the thesis, "it's the machines fault" refers to how one forest owner told me that the harvester can only manage to remove branches from Norwegian spruce while birch and big pines need other techniques. This he suggested might be the reason why Sweden has so much spruce forest outside its natural habitat. When I searched for different ways of doing forestry, I met forest owners who preserved old ways of doing forestry by engaging with it as a past-time outside of their breadwinning work.

As I use forest assemblage to gather different lifeways in the forest, both human and non-human, the moose provide an example on one type of happening in the words of Anna Tsing, were the planted pine forest make the moose population flourish. After visiting a company

and a wood measurer I also saw that the forest that is currently cut down is neither old nor dense but grown so fast that it sometimes is useless for sawn products.

In chapter three, I discussed the seed savers I found in my field who were saving forest seeds because of economical, emotional or moral reasons. It was done at the Woodland Cemetery who had a decision made for them to use local genetic resources rather than bred seeds and by one forest owner who didn't want to have bred pine that might lack out on other characteristics. The local forest seed was according to him good enough and resonated with his way of being a steward of his forest. Furthermore, the chapter looked at how the definition of close-to-nature forestry might allow for artificial regeneration or genetically bred seeds. I ended my exploration of Swedish forestry by discussing some possible future more-than-human forest policies.

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