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Attitudes to conserving biodiversity and the experienced possibilities and challenges

A case study with individual forest owners in Sweden

Master's thesis in Industrial Ecology

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SUMMARY

Forests provide welfare to Sweden in many aspects, but the national goals for biodiversity conservation in these forests are not met. Individual forest owners are part of the solution, as they have the power to manage their land. The purpose with the case study was to investigate individual forest owners' attitudes to biodiversity conservation in forestry and their perceived possibilities and challenges. A qualitative method was used with semi-structured interviews together with a literature search. The interviews were done with 30 individual Swedish forest owners, owning five to more than a thousand hectares. A conceptual framework was used to understand preconditions for behavioural change to solve environmental problems. The three most frequently mentioned possibilities were: taking general nature considerations in forestry, using continuous cover forestry (CCF) methods, and small-scale forestry as it is seen as an enabler for biodiversity. The three most frequently mentioned challenges were: lack of profitability when enhancing biodiversity, damage from elk and deer, and being afraid of having too much biodiversity. More than half of the forest owners believe biodiversity conservation is important. Most forest owners are willing to use CCF methods, to a varied degree, but experience difficulties to implement these. Only a few think that laws, regulations, and certifications work well for biodiversity conservation in Sweden, and the majority are afraid of losing ownership rights if authorities find high levels of biodiversity in their forests. There might be a potential to strengthen the acceptance of structural measures for biodiversity conservation, such as regulations, if more respect is paid to individual forest owners' attitudes.

Keywords: Biodiversity, Forest, Forestry, Forest owner, Sweden, Sustainable forests, Possibilities, Challenges, Attitudes.

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Glossary and abbreviations

Glossary

Listed are translations of words used in Swedish forestry. This list is meant to facilitate understanding of the different terms used for Swedish readers.

English	**Swedish**
Consideration areas	Hänssynsytor
Continuous cover forestry	Hyggesfritt skogsbruk
County Administrative Board	Länsstyrelsen
Forest stand	Bestånd
Ground preparation	Markberedning
Harvest	Avverka
Nature conservation agreement	Naturvårdsavtal
Overgrowth	Igenväxning
Patch cutting	Luckhuggning
Processing	Förädling
Protected areas	Formellt skyddad skog
Protected biotope area	Biotopskyddsområde
Rotation forestry	Trakthyggesbruk
Seed-tree stand	Fröträdsställning
Selection cutting	Plockhuggning
The Species Protection Ordinance	Artskyddsförordningen
The Swedish Forest Agency	Skogsstyrelsen
The Swedish National Forest Inventory	Riksskogstaxeringen
Voluntary set-asides	Frivilliga avsättningar

Abbreviations

CCF	Continuous cover forestry
FSC	Forest Stewardship Council
PEFC	Programme for the Endorsement of Forest Certification
SEO	Swedish Environmental Objective

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1 Introduction

The vital contributions to people from biodiversity, and thus from nature, are being deteriorated worldwide (IPBES, 2019). The World Economic Forum (2022) declares that biodiversity loss is the third most severe risk on a global scale over the next 10 years. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (2019) states in their latest report that "Biodiversity – the diversity within species, between species and of ecosystems – is declining faster than at any time in human history" (p. 10) and that the extinction rate has never been higher over the past 10 million years. The drivers of biodiversity loss[1] hinder sustainable development, and therefore IPBES calls for changes that enables a shift towards drivers that support biodiversity (IPBES, 2019). According to IPBES (2019) the goals for achieving sustainability and sustainable use of nature cannot be met by current trajectories and therefore transformative change are called for. As land use is a direct driver to biodiversity loss and forestry occupy vast land areas, it is important to conserve biodiversity in forests, a task which involves forest owners.

The Convention on Biological Diversity (CBD), which is the first global agreement for biodiversity from 1992, is signed by 196 parties, and is where Sweden's goals for conserving biodiversity originates from (CBD, 2022; Secretariat of the CBD, 2000; Sveriges miljömål, 2022). The aim of the convention is to globally agree on sustainable use and conservation of biodiversity (Secretariat of the CBD, 2000). Sweden has formal responsibilities to safeguard biodiversity since the ratification of the convention in 1993. More recently, EU decided on the *EU Biodiversity Strategy for 2030 - Bringing nature back into our lives*, which set an ambitious strategy to stop the loss of biodiversity. In addition, the *New EU Forest Strategy for 2030* (European commission, 2020; European commission, 2021) include a goal to formally protect 30% of EU's land and sea area and to promote forestry management methods that conserve and restore biodiversity. Management methods that create uneven-aged and continuous-cover forests are favoured in the strategy, in combination with actions that create more varied and resilient forests. Some actions noted in the *New EU Forest Strategy for 2030* are mixed-species forests adapted to natural conditions, increase of deadwood, and regulation of wildlife densities. According to 1§ Swedish Forestry Law (SFS 1979:429), the forest is an asset and a renewable resource that shall be cared for, so it yields a good return at the same time as biodiversity is conserved. Since the revision of the Swedish Forestry Law (SFS 1979:429) in 1993, with the aim to improve biodiversity conservation within forestry, some positive trends are seen (Andersson et al., 2019; Kyaschenko, 2022). Still, it is uncertain if the conservation measures taken are enough to protect biodiversity in the long-term.

Currently, the Swedish Environmental Objective (SEO) *Sustainable Forests* is not achieved, as the goals for biodiversity conservation are not met (Sveriges miljömål, 2022). Individual forest owners are part of the solution to reach the objective, mainly due to the land they own and the freedom to choose forestry management methods. *The Swedish Forestry Model* (Lindahl et al., 2017) depends partly on individual forest owners' conservation actions as they collectively own almost 50% of Sweden's productive forest land (Skogsstyrelsen, 2021a). Current research suggests there might be a limit to volunteerism when conserving biodiversity in Swedish forests, and that *The Swedish Forestry Model* prioritize the economic aspect of sustainability (Danley et al., 2021; Lindahl et al., 2017). As Sweden, EU, and IPBES call for change, it is important to understand the attitudes of Swedish individual forest owners regarding biodiversity and forestry, as they have the power to influence the conservation of biodiversity for almost half of the productive land area in Sweden (Andersson et al.,

[1] There are both direct and indirect drivers to biodiversity loss. The main direct drivers listed by IPBES (2019) are changes in land and sea use, direct exploitation of organisms, climate change, pollution, and invasion of alien species. Changes in land use and exploitation of organisms are drivers mainly connected to forestry. Indirect drivers listed by IPBES (2019) are production and consumption patterns, human population dynamics and trends, trade, technological innovations and local through global governance.

2019; European commission, 2020; European commission, 2021; IPBES, 2019; Skogsstyrelsen, 2021a). More specifically, it is important to understand individual forest owners' attitudes towards biodiversity as such, relevant laws and regulations, and the fixes that can be implemented within forestry to conserve biodiversity, such as continuous cover forestry (CCF) methods.

1.1 Purpose, aim, and research questions

The purpose was to investigate individual forest owners' attitudes to conserve biodiversity in forestry. The aim was to explore forest owners' perceived possibilities and challenges to enhance biodiversity in their forest and to investigate individual forest owners' attitudes regarding using continuous cover forestry (CCF) methods[2], and regulatory measures for biodiversity. A conceptual framework of three types of fixes for solving environmental problems was used to understand the preconditions for behavioural change and to relate the interviewees attitudes to potential fixes. The findings can for example be of use for forest owner associations, for companies in the forest industry or for authorities to better navigate the attitudes in policy making.

Research questions:

1. What are the individual forest owners' attitudes to conservation of biodiversity?
2. What are the individual forest owners' perceived challenges to enhance biodiversity in their forest?
3. What are the individual forest owners' perceived possibilities to enhance biodiversity in their forest?
4. What are the individual forest owners' attitudes to continuous cover forestry methods?
5. How do individual forest owners perceive biodiversity conservation in Sweden today, specifically concerning laws, regulations, and certifications?

1.2 Delimitations

Geographical boundaries were set to Sweden and the interviewed stakeholders were individual forest owners, henceforth called forest owners. The interviewees had to own at least 5 hectares of forest land to participate in the study. In the interviews, no other environmental issue was investigated except biodiversity. The effectiveness of different measures to enhance biodiversity was not taken into consideration in the analysis.

1.3 Structure of the report

After this *Introduction* explaining the topic studied and the aim of the study, comes a *Background* chapter containing information from the literature search on biodiversity, forestry, laws and regulations, Swedish forest owners, measures to conserve biodiversity, current research on forest owners' attitudes, and the importance of three types of fixes to enable behavioural change: cognitive, technical, and structural. The following chapter on *Method* describes how the case study, analysis and the literature search were conducted. Chapter 4, *The participating forest owners*, shows the characteristics of the interviewees and connects to chapter 5, *Findings*, where each sub-chapter answers each of the research questions. This is followed by a *Discussion*, which is divided into sub-chapters on different topics. The report ends with chapter *7, Conclusions and recommendations*, which provide a synthesized insight to the findings and suggests how to make use of them.

[2] CCF methods has different definitions depending on the context (Hertog et al., 2022; Skogsstyrelsen, 2022g). In this study a wider perspective on the definition of CCF methods is used including management systems that create uneven-aged forests and/or continuous-cover forests and/or clear-cut free forestry, and methods such as seed-tree stand, patch cutting and selection cutting.

2 Background

The decline of biodiversity is of societal concern, which has been known for some time (Chapin et al., 2000; IPBES, 2019). The nonlinearity of consequences and the uncertainty of the impacts of biodiversity loss make the issue highly complex, and the irreversibility of extinctions make it alarmingly serious. The losses of species directly reduce the diversity and availability of for example food, genetic resources, and materials. This is of immediate societal concern from an anthropocentric point of view as we lose precious assets that could have been a part of building the welfare for people. It is also of societal concern from a biocentric point of view if organisms die that are assigned an intrinsic value by some. Moreover, the loss of biodiversity is of societal concern because we rarely know in advance which species, genetic variation and diversity of ecosystems and habitats that are of value to future generations, and more so given climate change and other environmental challenges ahead.

In this chapter, several topics relevant to the study are presented starting with facts on biodiversity in Sweden, a brief review of laws, regulations and certifications, data on Swedish forest owners and theory on what is needed to create behavioural change to solve environmental problems. The chapter ends with measures that can be done to enhance biodiversity in forests and current research on forest owners' attitudes relating to forestry and biodiversity.

2.1 Biodiversity in Swedish forests

During the last decades the Swedish forestry regime has effectively intensified the growth and outtake from the forest, and this has affected biodiversity (Hertog et al., 2022; Larsson et al., 2011; Naumov et al., 2018). Since the Swedish National Forest Inventory [3] started collecting data in the 1920s the total stock of growing trees has increased with 106% (SLU, 2021). Meaning that all Swedish forest owners, from public to private owners, have in the past ~90 years effectively increased the volume of trees in Sweden. Which is positive in economic aspects, as the forest sector have increased the Swedish raw material assets. Forestry affects welfare in different ways. It provides us humans with material and products, which are important for the Swedish welfare such as paper, construction wood, biofuels, chemicals, and textile fibers (Lindahl et al., 2017). In addition, the Swedish forestry sector employs around 70 000-120 000 people (SOU, 2020). Nevertheless, some forestry methods such as large clearcuts affect ecosystems and biodiversity in the forest negatively (Eide et al., 2020; Larsson et al., 2011).

According to the latest report from the Swedish Species Information Centre at the Swedish University of Agricultural Sciences (SLU Artdatabanken) that evaluates species of animals, plants, fungi and algae in Sweden and their relative risk of going nationally extinct, many species are threatened, and the reasons why varies (Eide et al., 2020). A species is added to the red-list if they are assessed to be nationally extinct, critically endangered, endangered, vulnerable, near threatened or if there is a data deficit. Around 62 000 species are known in Sweden today, and approximately 21 700 of these are assessed (SLU Artdatabanken), of those are 21,8% red-listed. An increase of 11% of red-listed species are noted from 2015 to 2020. The increase is larger than the increase of assessed species, which is 0.5% between 2015 and 2020, which means that the increase in red-listed species is not because more species are assessed. Of the assessed 10 000 species living in the forest landscape, 2000 forest living species are red-listed.

Eide et al. (2020) shows that there are many reasons to diminishing populations of species but one of the largest influences are human activities. Diminishing populations of a species is an indicator when assessing if a species is at risk to be extinct. The two main drivers to diminishing populations in

[3] The Swedish National Forest Inventory is part of Sweden's official statistics. Its main purpose is to describe the state and the changes in Sweden's forests.

Sweden are harvest[4] and overgrowth[5], where it is shown that more than 1 400 species are largely negatively affected by harvests. If species that are somewhat negatively affected by harvest are included the number of species increase to around 1 800. The reason why harvest affects forest living species negatively is primarily because they need continuity in the forest and many species have difficulties surviving the phase after the harvest when the preconditions they need to live disappear (Eide et al., 2020; Savilaakso et al., 2021). Older trees are cut down and specific types of dead wood cannot be created, and these conditions can be difficult to recreate in conventional rotation forestry. In addition to harvesting and overgrowth, there are several other factors that have an impact on species populations. Some examples are grasslands that are no longer grazed, or afforested grasslands, increased nutrient load, intensified agriculture, drained wetlands, land exploitation for construction, and climate change impacts.

Despite the current loss of species and habitats and that the SEO *Sustainable Forests* has not been achieved, there are still some positive trends. Since the revision of the Swedish Forestry act in 1993, more consideration and actions for biodiversity has been taken (SFS 1979:429; Kyaschenko, 2022; Lindahl et al., 2017). It is also shown that the amount of dead wood, deciduous trees and older trees are increasing in Sweden (Andersson et al., 2019; Kyaschenko, 2022; SOU, 2020). According to the previous in-depth assessment of *Sustainable Forests,* the development of the environmental status varies depending on the time frame of the analysis (Andersson et al., 2019). With the base year being 2019, the environmental status is neutral in short-term (10 years), because there is both negative and positive aspects. In the medium-term (10-20 years), the development of the environmental status is assessed to be positive as Andersson et al. (2019) acknowledge that environmental considerations have been taken in the past and more is believed to be taken in the future and the effects of these measures are believed to be seen in within 10-20 years. It is added that the status is positive as long as the ambitions known in 2018 and the measures taken, continues to be strengthened and further developed and practically applied. In the long-term (more than 30 years), the development of the environmental status is believed to be unclear, because there are uncertainties on how species respond in the long run to measures taken and how the ecosystem will be affected in a longer period of time. There are also significant uncertainties if the actions taken to reduce the loss of biodiversity will be enough and if more actions will be taken in the future (Andersson et al., 2019; Kyaschenko, 2022).

2.2 Laws, regulations, and certifications

According to Swedish law, there are different regulations that need to be considered in forestry, but still forest owners have significant freedom to decide how they want to manage their forest (Skogsstyrelsen, 2021b). The 1§ Swedish forestry law (SFS 1979:429), states that Swedish forest owners shall value timber production and biodiversity conservation equally. An important part of Swedish forest policy strategy to achieve the SEO *Sustainable Forests*, is that forest owners are expected to voluntarily take actions to conserve biodiversity in their forest (Danley et al., 2021). Within the regulations, forest owners are expected to take own responsibility for managing their forests sustainably, which includes both production and environmental matters (Skogsstyrelsen, 2021b). For example, forest owners can take further measures for biodiversity conservation through forest certifications and voluntarily set-aside forest land (Skogsstyrelsen, 2022a; Skogsstyrelsen, 2021c).

There are specific laws regarding forestry that strictly needs to be followed. Forest owners in general, need to send in a notification before they harvest forest, and afterwards they are responsible for regenerating new forest. The forest cannot be harvested before it has reached a certain age, the age depends on the type of forest, but it varies between 45 to 100 years. There are also limits on how big areas that can be harvested. Furthermore, there are specific protective measures that need to be taken

[4] Final harvest of timber.
[5] Overgrowth of open landscaped that hold different biotopes.

against insect pests and regulation concerning biodiversity protection (Skogsstyrelsen, 2020). In forestry, you legally need to make sure that you do not harm officially protected species according to the Species Protection Ordinance (2007:845), which is the Swedish implementation of the EU directives on species and habitat protection from the Birds directive (2009/147/EC) and the Species and Habitats directive (92/43/EEG) (Naturvårdsverket, 2022a). In certain cases, taking measures are required by the regulations to safeguard species from being negatively affected. Examples of measures are avoiding forestry during sensitive periods, saving specific trees and in some cases adjusting or avoiding forestry practices. The knowledge to make sure that officially protected species are not negatively affected by forestry lies with the forest owner according to the Species Protection Ordinance (2007:845) (Skogsstyrelsen, 2021d; Skogsstyrelsen, 2022b).

Forest with specific values for biodiversity can legally become protected areas, through creating for example a nature reserve, protected biotope area or nature conservation agreement. Protected areas are considered an important tool to achieve the SEO *Sustainable Forests* and there is even a national strategy on how to prioritize when creating these (Skogsstyrelsen, 2022c; Skogsstyrelsen, 2022d). The protected areas are expected to be safeguarded for a foreseeable future and forestry practises or other activities that can be harmful to the values that are being protected are strictly forbidden. When the decision is made to create a protected biotope area or a nature reserve, the forest owner gets a financial compensation, as a lump sum, that corresponds to the property's reduced market value with an addition of 25%. Furthermore, the forest owner still owns the land and in a protected biotope area, hunting is still allowed. The right to manage the forest, however, does no longer belong to the forest owner, but to the authority protecting the area. In the case of the nature reserves, state authorities can also buy the total ownership of the land if the forest owner prefers that (Skogsstyrelsen, 2022e; Naturvårdsverket, 2022b). According to The Swedish Environmental Protection Agency (Naturvårdsverket, 2022c) and The Swedish Forest Agency (Skogsstyrelsen, 2022e), there is usually a dialog and an agreement between the forest owner and the state authority when it is suggested to create a protected area. A nature conservation agreement is another tool for conserving biodiversity. In this case, the forest owner and the state authority agree that the forest is to be managed in a specific way during an agreed period of time. The forest owner is financially compensated and neither the ownership of the land or the hunting right is affected (Skogsstyrelsen, 2022f).

In voluntarily certified forests through either FCS or PEFC, further considerations must be taken for biodiversity conservation compared to ordinary regulations (PEFC, 2017; FCS, 2020). Examples of additional considerations needed if you are certified with PEFC are to have a certification-adapted forestry plan, promote deciduous trees, and if you own more than 20 hectare of productive forest land you will need to set-aside at least 5% of productive land. If you are certified with FSC you will for example be required to conserve key biotopes or areas with high values of biodiversity, without getting further monetary compensation.

2.3 Swedish forest owners and their forestry methods

In 2020, there were 313 084 individual forest owners in Sweden and together they owned about 48% of the productive forest land (Skogsstyrelsen, 2021). The gender distribution is presented in Figure 1. The average forest land owned by forest owners is 30 hectares and the median is 12 hectares. The number of forest owners in different size classes varies, as can be seen in Figure 2. The distribution of productive forest land owned by forest owners are somewhat evenly distributed among the four regions, with Götaland having the largest share, as can be seen in Figure 3. The distribution of number of forest owners in each region shows that there are more in Götaland and Svealand than in North and South Norrland, as can be seen in Figure 4.

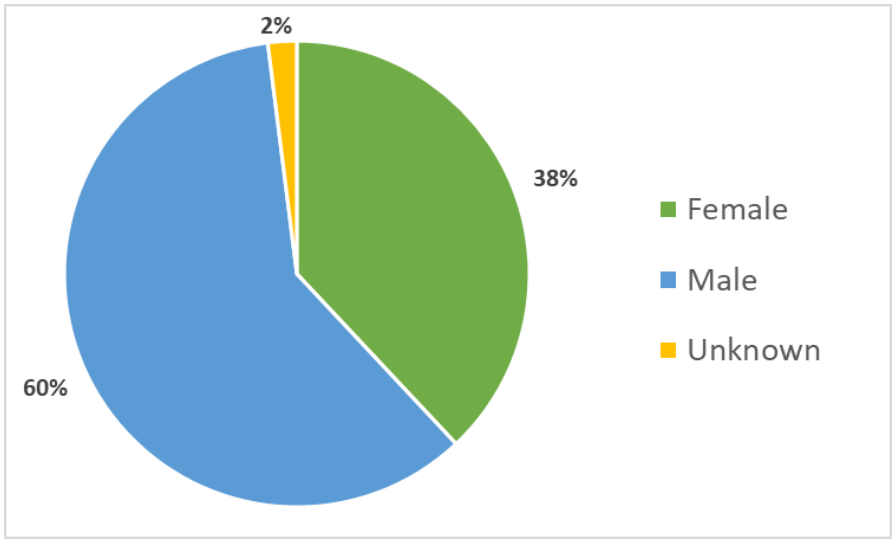

Figure 1 Official statistics of gender distribution of Swedish forest owners (Skogsstyrelsen, 2021).

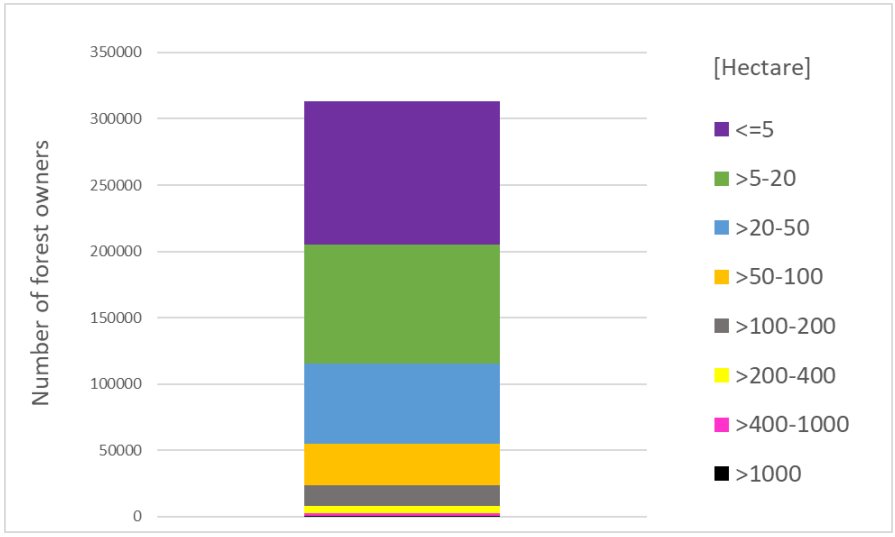

Figure 2 Number of Swedish forest owners separated by the different size classes [hectares] ranging from <=5 to >1000 hectares, year 2020. Official Swedish statistics (Skogsstyrelsen, 2021).

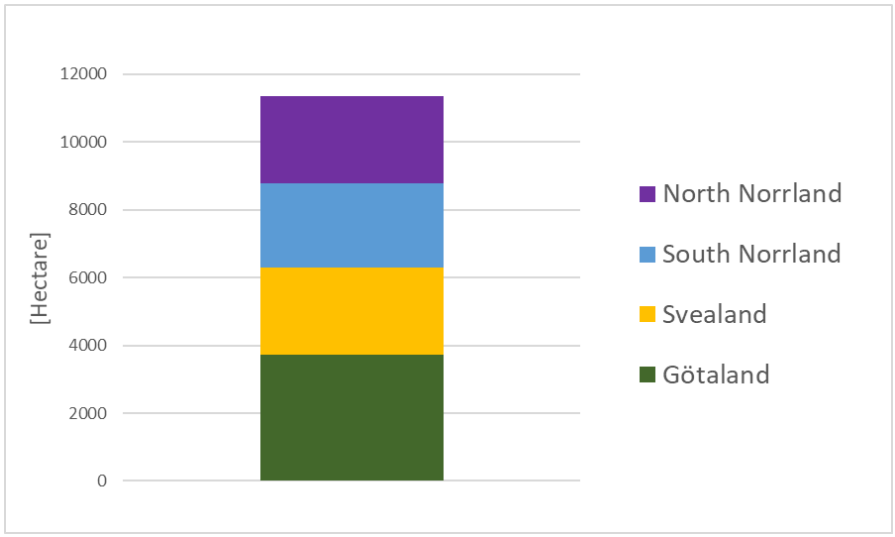

Figure 3 Area of productive forest land [1,000 hectares] for forest owners per region, year 2020. Official Swedish statistics (Skogsstyrelsen, 2021).

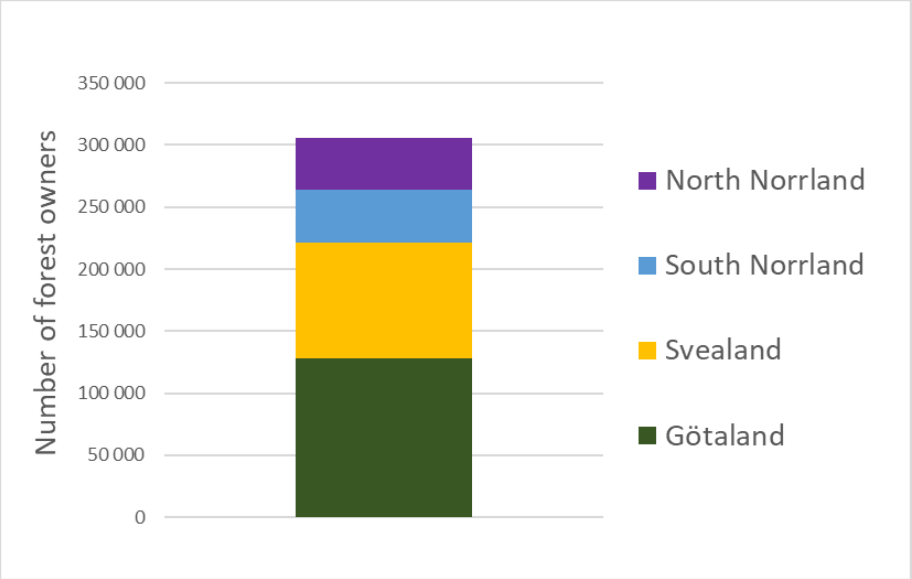

Figure 4 Number of forest owners in each region, year 2020. Official Swedish statistics (Skogsstyrelsen, 2021).

Statistics on forestry methods used in Sweden are not easy to find. Rotation forestry is said to be used on up to 95% of productive forest land, in Sweden (Dahlberg, 2011) and is described as the most frequently used conventional method (SOU, 2020). The method has been used since the1950s and have been optimized for high yields (Lindahl et al., 2017). CCF methods are used to a much smaller extent, approximately 1-5% of produced volume comes from these methods (Hertog et al., 2022).

According to the survey Skogsbarometern, forest owners have many different goals with their forest and varying financial dependency of their forest (Ludvig&CO, 2021; Skogsbarometern, 2021). Most of the participants in that survey stated that they did not depend on the forest financially and only 7% stated that their main source of income was from forestry. The values that the owners appreciated, except production of wood products, were hunting and recreation (58%), while some said they did not know (22%) and the rest stated tourism, wind power, or other.

2.4 Attitudes and behavioural change

Navigating environmental attitudes by Heberlein (2012) describes three fixes that are needed to enable behavioural change when solving environmental problems such as the loss of biodiversity: *technological*, *cognitive*, and *structural fixes*. Heberlein (2012) argues that knowledge on human attitudes is key when trying to fix an environmental problem and that all three types of fixes usually are demanded simultaneously to successfully solve the problem. A technological fix can be a forestry management system as CCF, or changes to the already applied forestry management system such as increasing dead wood, having more mixed species stands[6] or letting trees grow older before harvest. However, technological fixes are only a solution if there is a willingness to use them. A cognitive fix is often achieved by changing human behaviour with information and knowledge. Danley et al. (2021) argues that forest owners who are willing to take measures for biodiversity and believe it is important are more likely to be receptive to cognitive fixes. Changing believes and attitudes are not easy and that is why structural fixes also are an important tool. The purpose of the structural fix is that it "changes the social environment that influence what people do" (Heberlein, 2012, p.6). Examples of structural fixes are laws, regulations, and voluntary agreements such as certification schemes.

Heberlein (2012) argues that behavioural change can happen through changing attitudes with cognitive fixes, but it is fairly unusual, and a way forward is more often to navigate with attitudes in mind. Attitudes can change, but usually it takes time, and the outcome is somewhat unpredictable.

[6] A forest stand that contains several types of trees.

Only relying on attitudes to solve an environmental problem will most likely fail, as sometimes people say they have a certain attitude but behave the opposite. A positive attitude and knowledge regarding an environmental problem is most likely important to be willing to take actions to solve it, but not automatically a proof for a specific pro-environmental behaviour (Deutscher, 1966; Heberlein, 2012; Kühl et al., 2009). There is also a difference in attitudes, beliefs, and opinions, where attitudes tend to be stable whereas opinions and beliefs can change more quickly. Heberlein (2012) uses a river metaphor, where attitudes are like large rocks in the river with a potential to wreck the boat (the change) on the journey along the river. Instead of going blindly down the river not knowing where the rocks are, it is better to open the eyes and navigate around the rocks. This is a metaphor for the potential to also use the knowledge on attitudes when designing effective technological and structural fixes instead of only trying to change people's attitudes with cognitive fixes, as it is difficult and usually takes long time.

Behavioural changes are most likely to be needed, if any change regarding the conservation of biodiversity in forestry is going to happen. Change will probably not occur if we continue to do the same thing and just hoping for change to happen. Likewise, biodiversity will not be conserved or even increased just because humans value the existence of it, but, valuing biodiversity appears to be one part of the solution for behaviour change (Heberlein, 2012).

The knowledge regarding the three fixes is used as a theoretical framework in this study and are hereby called the TCS framework, where TCS stands for Technological, Cognitive, and Structural fixes.

2.5 Measures to enhance biodiversity in forests

To enhance biodiversity in Swedish forests and to achieve the SEO *Sustainable Forests*, actions need to be taken (Sveriges miljömål, 2022). Measures that can be applied are for example, to use CCF methods instead of rotation forestry, increase the rotation length between harvesting especially in forests with high ecological values and/or increase the diversity of tree species e.g., through planting more broadleaf trees in forest stands[7] (Danley et al., 2021; Naturvårdsverket, 2022d). Consideration within forestry is also an important measure to enhance biodiversity, which can for example involve leaving dead wood or sparing a variety of habitats and trees (Sveriges miljömål, 2022; Skogsstyrelsen, 2021e). Conserving biodiversity through official protection areas and voluntary set-asides are also crucial measures (Naturvårdsverket, 2022e).

Applying CCF methods instead of rotation forestry has proven to have ecological benefits for biodiversity (Hertog et al., 2022; Savilaakso et al., 2021). In general, CCF methods enable a more continuous tree cover, which is especially important for certain sensitive species, such as soil fungi, lace lichen, ground lichen, mosses, birds, and different insects (Hertog et al., 2022; Dahlberg, 2011). Increased cover of lichen also favours for example reindeer. CCF methods are also significant tools when wanting to maintain high values in nature while still managing the forest (Dahlberg, 2011; Savilaakso et al., 2021). When avoiding rotation forestry, nutrition is more likely to stay in the ground, which decreases the risk of polluting watercourses (Skogsstyrelsen, 2022h). However, using CCF methods can also increase the risk of storm damages and damages when driving machines in the forest.

According to the Swedish Forest Agency (2022i), only a limited amount of land is appropriate for CCF methods, and they claim these methods can only work as a complement to rotation forestry. Considering this, and that CCF methods are currently used on a very small scale, it is still important to take and develop consideration to biodiversity within rotation forestry (Dahlberg, 2011).

[7] A smaller area of forest that is typically uniform in type of habitat, tree species, and sometime in age.

2.6 Research on forest owners' attitudes

In this chapter previous research about forest owners' attitudes towards biodiversity conservation and regulatory measures are presented as well as suggested limitations with *The Swedish Forestry Model*. Furthermore, this chapter explores previous research on ownership structures.

2.6.1 Forest owners' attitudes to biodiversity

Forest owners have many different attitudes and beliefs regarding forestry and biodiversity, focusing both on production and environmental considerations (Eriksson & Klapwijk, 2019). Nordén et al. (2017) suggest that forest owners have a stronger orientation towards production, but also indicates that there is a demand for biodiversity conservation. This is somewhat consistent with the respondents in the study by Danley et al. (2021) where 73% thinks that the current level of protected forests in Sweden is sufficient or too much, whereas 9% thinks that Sweden needs to protect more forests, and the remaining had no opinion.

2.6.2 Ownership structures and small-scale forest owners

Nobel prize winner Elinor Ostrom concluded by observing the world that neither the state nor the market is far from the best manager to natural resource systems (Ostrom, 1990). Instead, a more successful and sustainable ownership structure, discovered by Ostrom, may be communities of individuals that by themselves structure the governance of a resource, thorough institutions unlike the state or the market.

Globally, forest owned by the state faces challenges with both profitability and adapting to local demands (Sterner & Coria, 2012). These challenges are commonly connected to the ownership structure of vast forests and the lack of knowledge of forest areas. Instead, local managers are seen to have better knowledge and control of forest areas and are better at adapting the management depending on local circumstances in the forest compared to the state. Therefore, small-scale private ownership is suggested to be a better management option than the state, but also compared to larger private companies.

2.6.3 Limit to volunteerism

Relying only on cognitive fixes might not be enough to conserve biodiversity, and currently it is suggested there is a limit to voluntarily biodiversity conservation within *The Swedish Forestry Model* (Lindahl et al., 2017). The same is suggested by Danley et al. (2021), that biodiversity conservation done voluntarily are at is limits and further actions are needed to achieve the SEO *Sustainable Forests.* When assessing the land area of voluntary set-asides[8] and consideration areas[9] it shows the areas are comparable with the amount of land conserved as protected areas[10], which also demonstrates the current importance of voluntary measures by forest owners to conserve biodiversity (SCB, 2022).

2.6.4 Acceptance to stricter structural fixes

Research by Danley et al. (2021) suggest that most forest owners do not want more regulatory measures to conserve biodiversity. The study made by Danley et al. showed that slightly less than two thirds of their responding forest owners did not believe that more legislation from the government is a good measure. Still about 30 % were not against more legislation to conserve biodiversity. Furthermore Koskela & Karppinen (2021) shows that more forest owners are motivated by flexibility and by being included in decision making, and less motivated by restrictive methods. Similar, little more than 60% of the respondents in the study by Danley et al. (2021) disagreed or strongly disagreed

[8] Voluntary set-asides are a biodiversity conservation measure that forest owners can do (SCB, 2022).
[9] Consideration areas are smaller areas with e.g., standing trees left at harvesting or dead wood. The purpose is to spare habitats for some species until new forest has grown (SCB, 2022). Its either done voluntarily or according to the Swedish Forestry Law (SFS 1979:429).
[10] Protected areas are a collective term for different ways to formally protect forest land, which are determined by laws and regulations (SCB, 2022).

that the government should do more to protect the environment through legislation, thus restricting the free choice of individuals. In contrast, little more than 25% of the respondent agreed or strongly agreed that the Swedish government should protect more forest through legislation. In addition, research by Lindahl et al (2017) describes a neutral attitude towards more structural fixes, with those strongly against or in favour of stricter structural measures being a minority.

2.6.5 Financial support and acceptance to biodiversity conservation

A Finnish study made by Koskela & Karppinen (2021) shows that in general there is more willingness to implement measures for biodiversity conservation if financial support is given. This is also discovered by Horne (2006). Boon et al. (2010) suggest that monetary values are not the only thing that decide forest owners' motivation to conserve biodiversity. Furthermore Koskela & Karppinen (2021) suggest that measures to enhance biodiversity that has less impact on forest owners' property rights were found to be more motivating for forest owners.

2.6.6 Forest owners being afraid of losing ownership rights

Research from Hertog et al (2022) explains that forest owners can be afraid of having too high levels of biodiversity. Because in this case their forest can become of interest for authorities to officially protect and then forest owners do not have the same property rights as before. A consultant of CCF methods state in Hertog et al (2022) "Some forest owners are afraid to use CCF, because then their forests can happen to become so valuable that they become key biotopes, and then they're not allowed to harvest anymore at all." (p.8).

3 Method

The method used for the qualitative case study was conducted in four main steps. The first step was to collect background information through a literature search and meetings with an expert on biodiversity. The second step was to get in contact with forest owners and book and plan the interviews. The third step was to conduct the interviews. The last and fourth step was to analyse the answers from the interviews.

3.1 Background information

The background information was used to help formulate the research questions and to design the interview guide, and it consisted of a literature search and meetings with an expert on biodiversity. Literature on forestry, biodiversity, and how to solve environmental problems were collected. The search was done in course literature from the master program Industrial Ecology, Chalmers library search engine, and Google scholar. The main search words used in the search engines were: forest owner AND biodiversity, forestry AND biodiversity AND Sweden, forest management AND biodiversity AND Sweden, biodiversity AND Sweden, and biodiversity. Four online meetings were held with an expert on biodiversity in the forest landscape. During these meetings, valuable information on both biodiversity and forestry was obtained.

3.2 Getting in contact with the interviewees

There were three methods used to get in contact with forest owners. The first and main method was by collaborating with forest owner associations. Five forest owner associations were contacted via email and phone calls and were asked to collaborate by sharing contact information of forest owners. The contacted forest owner associations were selected based mainly on geographical location, so that it would be a regional diversity from north to south. One forest owner association was selected because it differentiates from the more conventional associations, this association aims more towards utilizing more alternative values from the forest. Three forest owner associations chose to collaborate in this study.

A registration form was made, which the forest owner associations sent out to a selection of forest owners to register interest to participate in an interview. The registration form contained information about the study, the purpose of the interview, and how the data was to be handled according GDPR. The information gathered from the registration form was name, email, telephone number, gender, and how many hectares of forest they own. Mellanskog sent the registration form to 1500 of their forest owners, the selection was randomized with forest owners spread all over their region in Svealand. Skogens mångbruk shared the registration form to their members through their Facebook page, which at the time had 897 followers. Södra sent the registration form to 36 of their chairmen at Södra, they had the opportunity to further send it to elected representatives at Södra's 36 different forestry areas. In total 22 forest owners agreed to participate in an interview through the registration forms sent out by the forest owner associations.

The second method used to get in contact with forest owners was to reach out to personal contacts that own forest or might know someone that owns forest. In total seven agreed to participate in an interview through this method. The third method used to get in contact with forest owners, was to write messages on Facebook to people that were members in Facebook groups related to forestry. In total one person agreed to participate in an interview through this method. All participating forest owners received an email with the same information about the interview and the case study after they registered interest or agreed to participate.

3.3 The interviews

The primary data to the case study was collected in the 30 qualitative semi-structured interviews. The interviews were held in Swedish, and took place through video and audio meetings, except two interviews that were held on telephone. The length of the interviews was 30-120 minutes each. All

interviews were audio recorded and the interviews were anonymized, by coding the names of the interviewees. A structure for how to execute the interviews was prepared in advance through an interview guide, created with the support of the expert in biodiversity. As the interviews were semi-structured, the main questions in the interview guide were open-ended with follow-up questions. The structure of the interview guide was based on the research questions. For more details see the interview guide in Appendix A, and deeper descriptions of the questions asked in the interviews in Appendix B. When the interviews were held, a neutral approach was considered from the interviewers to minimize transferred bias to the interviewees. Sometimes when an answer was not fully understood by the interviewers, the interviewee was asked to verify a correct interpretation.

3.4 Analysing the interviews

The method for analysing the data from the interviews was based on an inductive approach, inspired by Yin (2003) and Gioia et al. (2021). The recorded interviews were initially transcribed by using the transcription function in Word 365, followed by a correction, and rewriting by the authors. As the purpose of the transcripts was to find data easily, details added in the transcript were restricted to stronger reactions such as irony, anger, laughter, strong emphasis on certain words or if there was a longer pause after a question. In the transcripts, specific sections, or sentences of value for answering the research questions, were also marked with colours.

The TCS framework presented in chapter *2.4 Attitudes and behavioural change* was used to understand preconditions for behavioural change to solve environmental problems. The analysis of the interviewees' answers was connected to the TCS framework, firstly to the research question on using CCF, which connected to technological fixes. Secondly to the research question on regulatory measures for biodiversity, which connected to structural fixes. When answering the research question on the interviewees' attitudes to biodiversity, the willingness to conserve biodiversity was also investigated, which connected to cognitive fixes. The last two research questions were connected to the interviewees perceived possibilities and challenges to enhance biodiversity in their own forest, and the answers were connected to attitudes to either of the three fixes, or incentives that motivates or demotivates the interviewees to enhance biodiversity. The connection between the research questions and the TCS framework was a basis when analysing the interviews and was used to structure and discuss the findings. Moreover, the connection is also demonstrated in the interview guide, see Appendix A.

To further structure the findings, different categories and themes were created to sort the attitudes from the interviewees. For two of the research questions three categories for each question were induced describing the most significant attitudes, see Table 1 and Table 2.

Table 1 Describes the induced categories for attitudes towards conservation of biodiversity. These categories were developed after the interviews and relates to the most frequently occurring attitudes. The interviewees were categorized depending on their answers from the interview.

Research question	**Induced categories**		
Forest owners' attitudes to conservation of biodiversity:	The status of biodiversity in Swedish forests are fine as it is.	Conserving biodiversity is important, but production is more important.	Biodiversity must be better conserved and increased.

Table 2 Describes the induced categories for attitudes towards CCF methods. These categories were developed after the interviews and relates to the most frequently occurring attitudes. The interviewees were categorized depending on their answers from the interview.

Research question	**Induced categories**		
Forest owners' attitudes to CCF methods:	Negative to CCF methods.	CCF methods could work in some limited areas.	Positive to CCF methods.

For the remaining research questions, themes were created to condense frequently occurring attitudes of the interviewees. The different themes were discovered through an inductive approach when analysing the interviews. Notes were added during the transcription on reoccurring attitudes and experiences related to the research questions. The themes evolved over time during the analysis. For example, "Afraid of having too much biodiversity" was created as a theme, describing a perceived challenge to enhance biodiversity. In the end, when the characteristics of the interviewees were to be summarized, some gaps in the data were found. This missing information was gathered via email asking for clarification on characteristics such as whether their forest is certified with PEFC and/or FSC.

4 The participating forest owners

The interviewed forest owners were portrayed using the following characteristics: location of their forest, owned forest in hectare, gender, members in a forest owner association, and goal with their forest. The choices were based on existing statistics and literature. These can be compared with the characteristics of all Swedish individual forest owners presented in chapter *2.3 Swedish forest owners and their forestry methods.*

The gender distribution of the interviewees can be seen in Figure 5, and was 53% male, 43% female, one interview was held with a female-male couple.

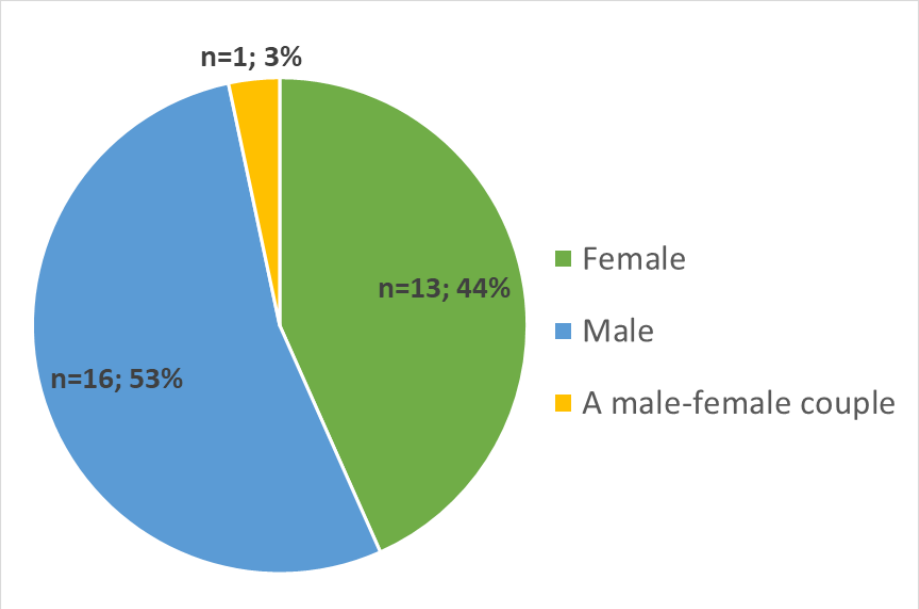

Figure 5 Gender distribution of the interviewees.

The interviewees' goal with their forest varied, as can be seen in Figure 6. Of the interviewees 73% (n=22) state many different goals ranging from hunting and recreation, to cultivating certain trees or creating certain habitats that they enjoy. Many of the interviewees also state that they care for the forest for future generations and wants to hand over a forest that is in better shape in the future to the young of today. All the 73% state that they manage their forest in some way to yield an income, and the perceived need for economic return varied among them from covering the expenses to the need for some return of investments. Further, 20% (n=6) state that the main goal is to manage the forest with a focus on maximizing economic return by managing the forest to yield as much timber and pulp wood as possible. However, all of them state that they care for the environment, enjoy nature, and take consideration within their management practices. Lastly, 7% (n=2) state that their main goal is to conserve the forest for recreational purposes and for the benefit of biodiversity. These did not actively manage the forest to harvest timber but state that some measures are done sometimes, but not for the purpose of income, but to create a natural forest for that location.

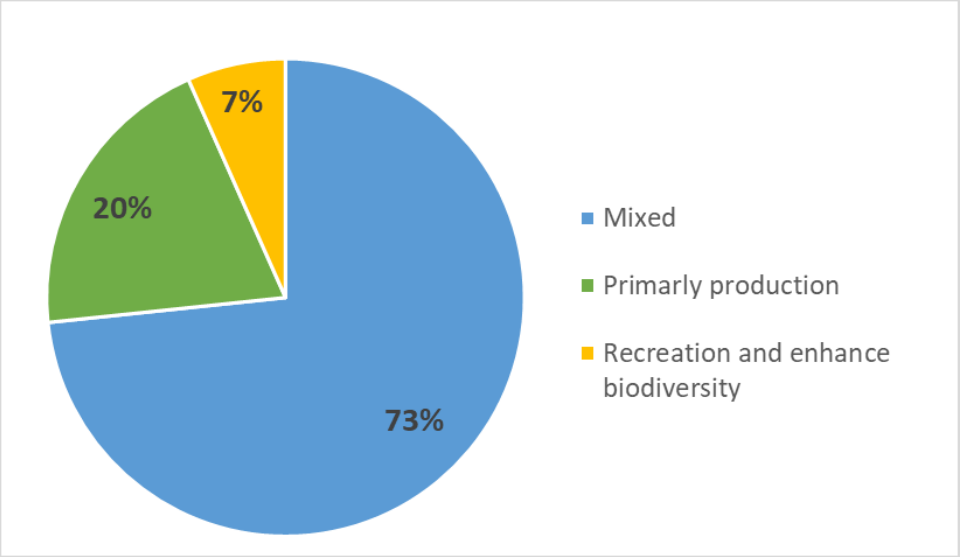

Figure 6 Shows the three different goals the interviewees have with their forest.

In Figure 7 the representation of different size classes among the interviewees are shown. The average size class in this study is 185 hectares and the median size class is 87 hectares.

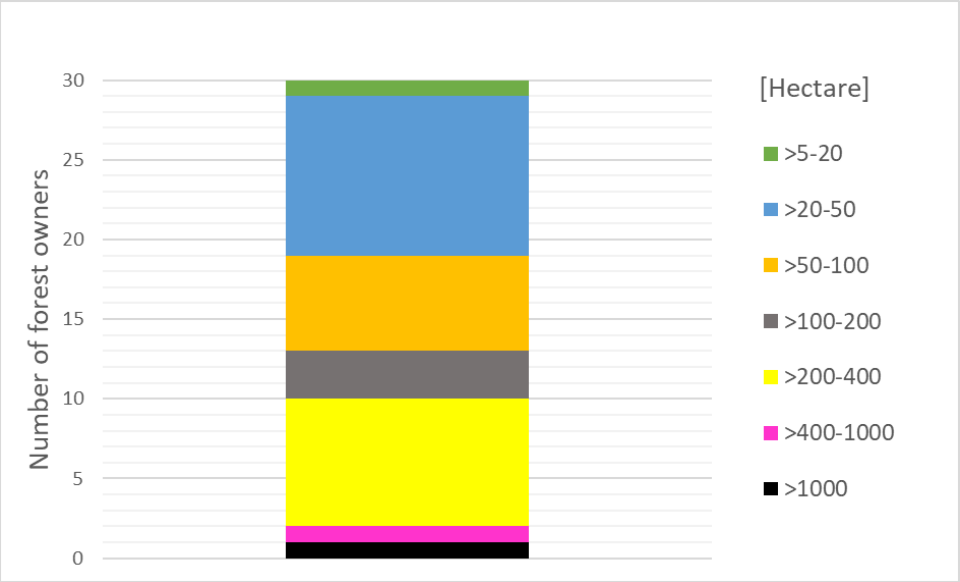

Figure 7 Number of interviewees separated by the different size classes [hectares] ranging from <=5 to >1000 hectares.

In Figure 8 the geographical representation among the interviewees is shown. Four interviewees own land in two places, hence the total number in Figure 8 is 34. In Figure 9, the owned land area for all the interviewees is shown and classified with regards to which region it is located in.

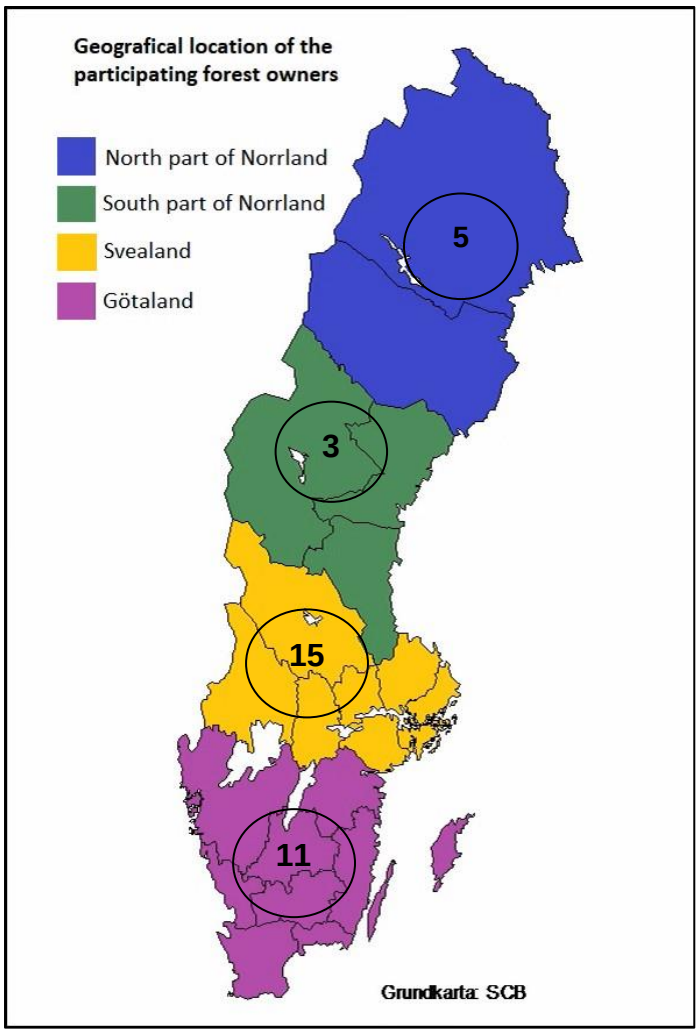

Figure 8 Geographical location of the forests owned by the interviewees.

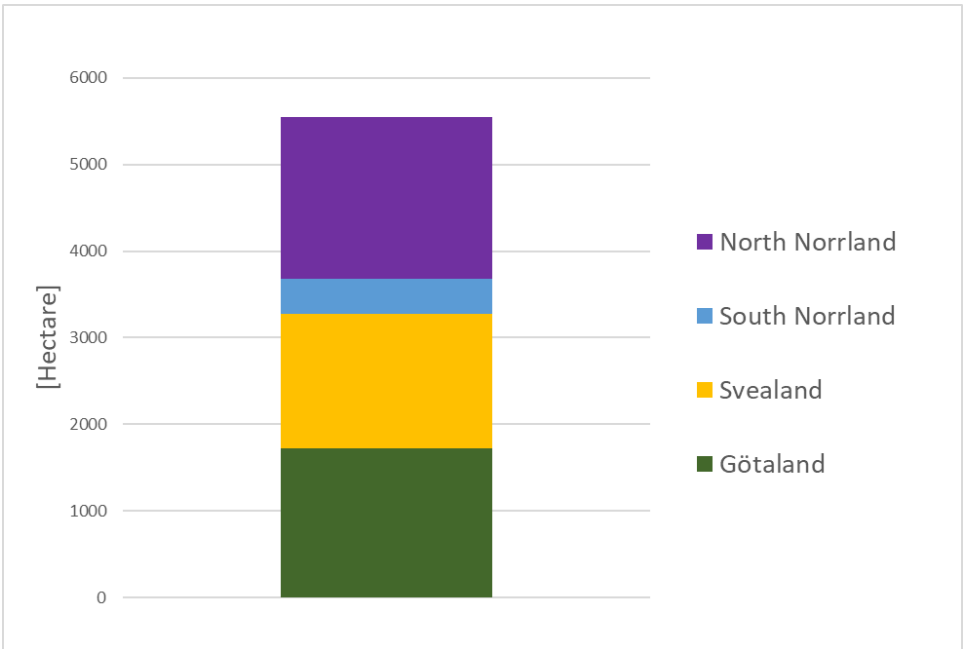

Figure 9 The interviewees owned land area in each region [hectare].

Many interviewees state that they are a member in a forest owner association. Almost all (n=28) of the interviewees state that they are a member in a forest owner association such as Södra, Norra skog Mellanskog or Skogens Mångbruk. Only a few (n=2) states they are not a member in a forest owner association.

More than half of the interviewees (n=18) state that they are certified according to either FSC or PEFC or both, a third (n=10) state that they are not certified and only a few (n=2) states that they do not know or are unsure. The reasons why or why not to be certified varied. Some felt that being certified was not really an option as if not, it would be very difficult to sell the timber. Others thought it was good to be certified as they got extra revenues when selling the timber. One forest owner shared that it was not necessary to certify the forest as the owner has no intention to harvest and sell it.

5 Findings

In this chapter, the findings from the analysis are presented. Starting with the attitudes to conservation of biodiversity, continuing to the perceived challenges and possibilities to enhance biodiversity and on to the attitudes to CCF methods. Lastly, the findings on how the interviewees perceive biodiversity conservation in Sweden today related to laws, regulations, and certifications are described, and the correlation between attitudes to biodiversity and being afraid of having too much biodiversity. Quotes are used throughout the chapter to demonstrate and deepen the understanding of the interviewees' attitudes and opinions. The quotes are translated from Swedish by the authors.

5.1 Attitudes to conservation of biodiversity

The results in Figure 10 describes the interviewees attitudes to conservation of biodiversity.

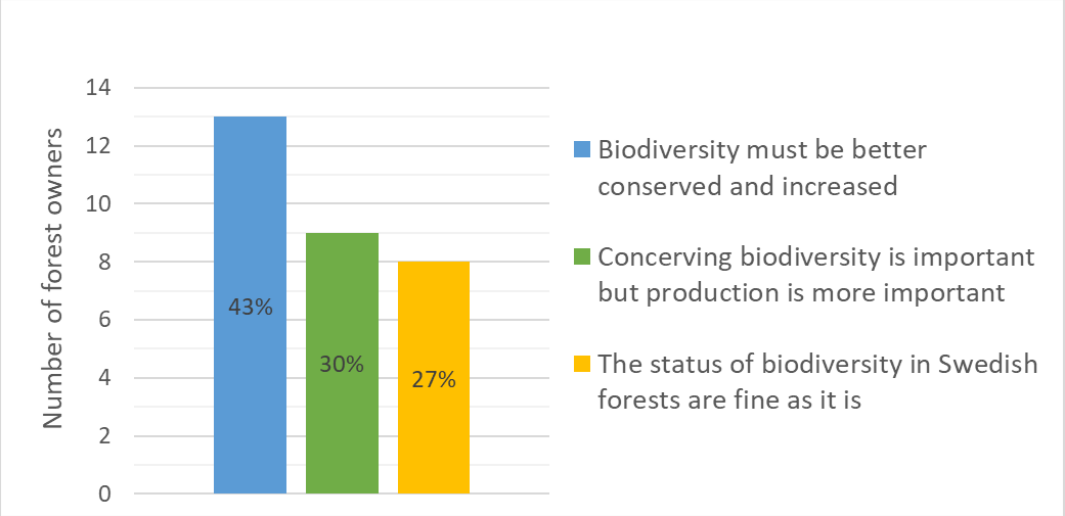

Figure 10 The interviewees attitudes to conservation of biodiversity. The bars show how many of the interviewees that are categorized to a specific attitude.

Of the interviewees, 43% (n=13) believe **biodiversity must be better conserved and increased** in Swedish forests. Some think the level of biodiversity is good in their own forest but needs to increase overall in Sweden. These interviewees in general believe that rotation forestry with large harvest areas is a key issue to the loss of biodiversity and believe things need to be done differently to conserve biodiversity.

> *"I do not think we understand what we do if we destroy the entire ecosystem called forest. I do not think mankind understands what it leads to. We think we stand above it, separated from nature in some way, but I do not think it really works that way. So, it [biodiversity] must absolutely be increased!" (S19)*

Of the interviewees, 30% (n=9) believe **conserving biodiversity is important, but production is more important**. These interviewees in general express they want to conserve biodiversity but not if it compromises too much with their forestry production and their profitability. Arguments such as, not in my backyard occurred, and biodiversity in Sweden was deemed important but if negative effects would threaten their own forest, they rather have less biodiversity. Negative effects could be connected to bad profitability or the fear of losing the ownership right to their forest.

> *"As long as the profitability is bad for the forest owner, I do not think it [biodiversity conservation] will work and I think the profitability will affect biodiversity preservation. It is more challenging to improve biodiversity if the profitability of the forest is bad. So, I think it is very important to have a focus on that." (S06)*

Of the interviewees, 27% (n=8) believe **the status of biodiversity in Swedish forests is fine as it is.** They do not see a need to conserve more and all express to value forest and nature dearly. Some of the interviewees in this group do not think that biodiversity is threatened and that it is okey if some species go extinct as new species arise in their place. They describe the natural balance of individuals and species and their tendency to self-regulate over time. They believe that forestry has an impact on biodiversity but do not see this as a problem, as they think the measures that are taken today ensures and maintains a good level of biodiversity.

> *"I don't see that there is a lack of biodiversity from my perspective, more like the opposite. That it [biodiversity] is increasing." (S24)*

5.2 Perceived challenges to enhance biodiversity

The findings show that the interviewees see a variation of challenges to enhance biodiversity, and most are connected to economy and profitability as can be seen in Figure 11.

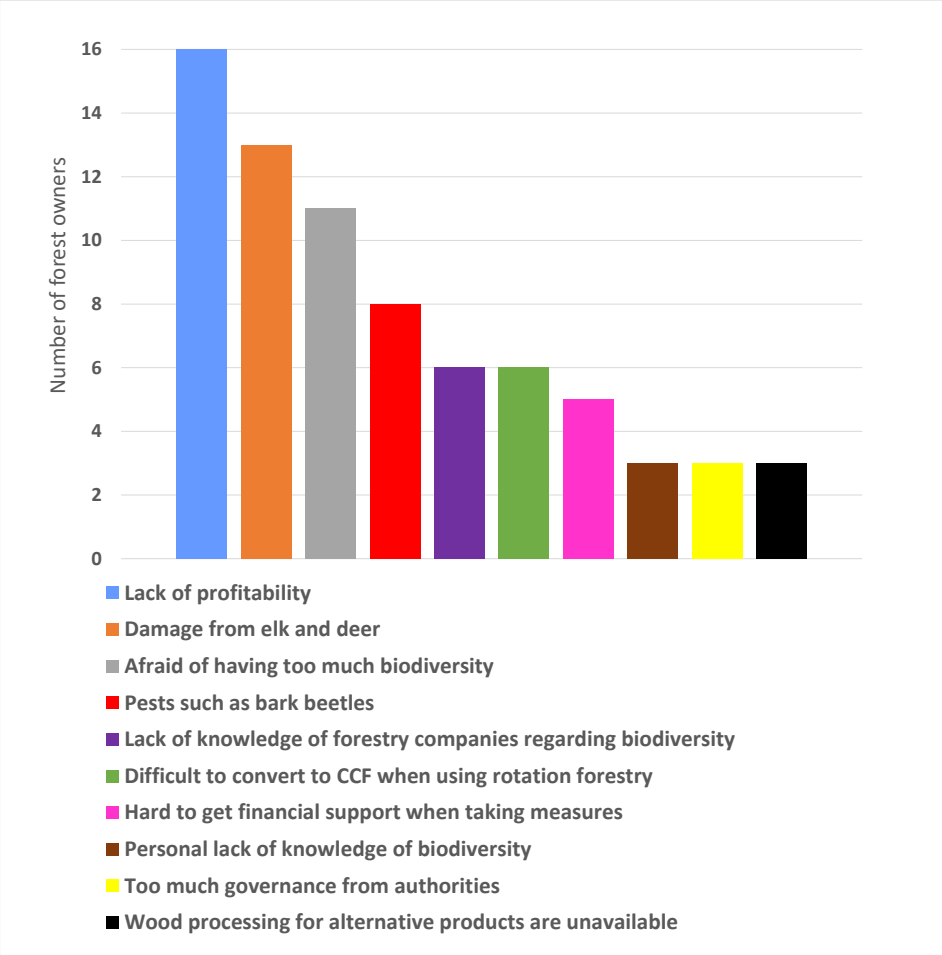

Figure 11 The interviewees perceived challenges to enhance biodiversity in their forest.

Most interviewees, 53% (n=16) believe that the greatest challenge is **lack of profitability** when trying to enhance biodiversity in their forest. Some interviewees mention that a good economy in their forestry is necessary to be able to consider biodiversity conservation. Biodiversity conservation was seen as an expense and was explained to be connected to leaving forest or trees for conservation, to only work at specific times of the year when there is less impact on biodiversity, to plant different species of trees, and to practice CCF methods and natural reforestation.

> *"I think that it is hard to get optimal economy in a forest where you also try to have a lot of biodiversity." (S06)*

Of the interviewees, 43% (n=13) believe the **damage from elk and deer** is a big problem when trying to enhance biodiversity in their forest. Many explain they want to create better biodiversity through planting different species of trees, such as deciduous trees or pine trees in pure spruce forests. These planted trees were said to often get eaten or damaged by elk or deer and avoiding this were said to be both costly and time consuming.

Of the interviewees, 37% (n=11) say they are **afraid of having too much biodiversity** in their forest, as it could threaten their ownership rights. The interviewees fear having high levels of biodiversity, as authorities can make their forest into a protected area. However, there were only a few that had experienced this personally and more gave examples of this happening to neighbours or they had heard about it from friends. Some interviewees say they have no complaints about the financial compensation that is given when creating a protected area, but they do not want to sell their forest, often for emotional reasons. For example, the forest is inherited through many generations or a special bond is created when taking care of the forest for many years, which the financial compensation cannot compensate for. Others think that the financial compensation is basically not good enough and even less so when considering the lost income, from forestry, for the coming generations.

> *"I want a beautiful forest. I want diversity, I want beautiful trees and I want diversity of everything, but it is not simple because I have several people I know who have cared for their forest and it has been cared for several generations and when you are to harvest then it shows no, then you do not get a permit because then it becomes worthy of protection and then there is always a flower or a bird there that is unique and of course you can get some compensation, but it is a tragedy, I think, when the forest is taken from one in this way and I do not dare to take care of my forest too well." (S05)*

Of the interviewees, 27% (n=8) think **pests such as bark beetles** are a challenge when trying to enhance biodiversity. Earlier experiences and worries of having bark beetles in their forest make the interviewees afraid of saving older trees or forest stands. The risk of losing financial income through bark beetle attacks makes it difficult to save the harvesting for later. Forest stands that already have been exposed to bark beetles need to be harvested, because otherwise it is likely that the bark beetle will spread to the rest of the forest.

> *"It is the last old forest we have left with big old spruces, and you want to even out the age distribution so not everything is in the same age. But then it [the trees] cannot stand too long because then the bark beetle eats them." (S02)*

Of the interviewees, 20% (n=6) explains that the **lack of knowledge of forestry companies regarding biodiversity** hired to manage their forest makes it difficult to get their wants understood when aiming for enhanced biodiversity. Some examples were companies that worked for them harvested more trees, especially broadleaf trees than instructed, had bad knowledge of how to harvest in pure broadleaf stands or did not know how to work with CCF methods.

Of the interviewees, 20% (n=6) believe it is **difficult to convert to CCF methods when using rotation forestry** and therefore challenging to enhance biodiversity. Some interviewees mentioned that when the structure of the forest already is adapted to rotation forestry, it is challenging or nearly impossible to start working with CCF methods. It was considered difficult to transition from an even-aged structure to an uneven-aged structure in the forest. The difficulty was said to be primarily the many years until the transition to an uneven-aged forest would be completed and the perceived lack of knowledge on how to do it.

Of the interviewees, 17% (n=5) believe that it is **hard to get financial support when taking measures** for biodiversity. The interviewees experience bad communication with authorities

responsible for delivering the support for biodiversity conservation. In addition to the difficulties to get in contact with the authorities, knowing if support can be given, when it would be given, and how to apply for the support is said to be too complicated.

> *"But to get any kind of financial support, then you get into this troublesome bureaucracy. For example, to call the Swedish Forest Agency is as difficult as calling the health care centre. It's not possible." (S25)*

Of the interviewees, 10% (n=3) say the **personal lack of knowledge of biodiversity** and measures to do for conserving biodiversity, is an obstacle by itself.

Of the interviewees, 10% (n=3) think **too much governance from authorities** makes them work less for biodiversity. Because it is said the motivation gets worse, when somebody else decides what one should do in its own forest.

Of the interviewees, 10% (n=3) believe it is challenging to enhance biodiversity as **wood processing for alternative products is unavailable**. When there are almost no possibilities to refine alternative tree species to other than pulp, the incentives to have a forest with high diversity gets lower for these interviewees.

> *"We felled beech trees in a quite large area, a large cutting area at least for this place. And then 90% of that went to pulp and it was just boiled. It is 100-year-old trees, or even older, that was just boiled to toilet paper." (S01)*

5.3 Perceived possibilities to enhance biodiversity

The interviewees see possibilities to enhance biodiversity in their forest and the findings are categorized as either perceived enablers facilitating or motivating to biodiversity conservation, see Figure 12. Or, as options they can take to enhance biodiversity directly in their forest, see Figure 13. Each possibility is further described in the two following sub-chapter.

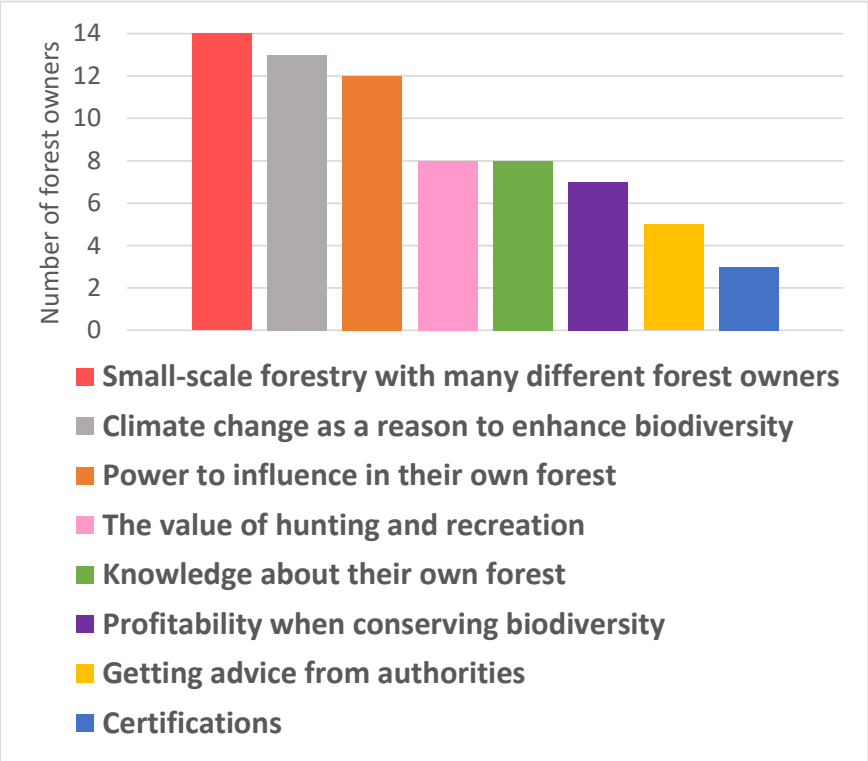

Figure 12 The interviewees perceived possibilities categorized as enablers facilitating or motivating to biodiversity conservation in their forest. The bars show how many interviewees that shared a specific enabler.

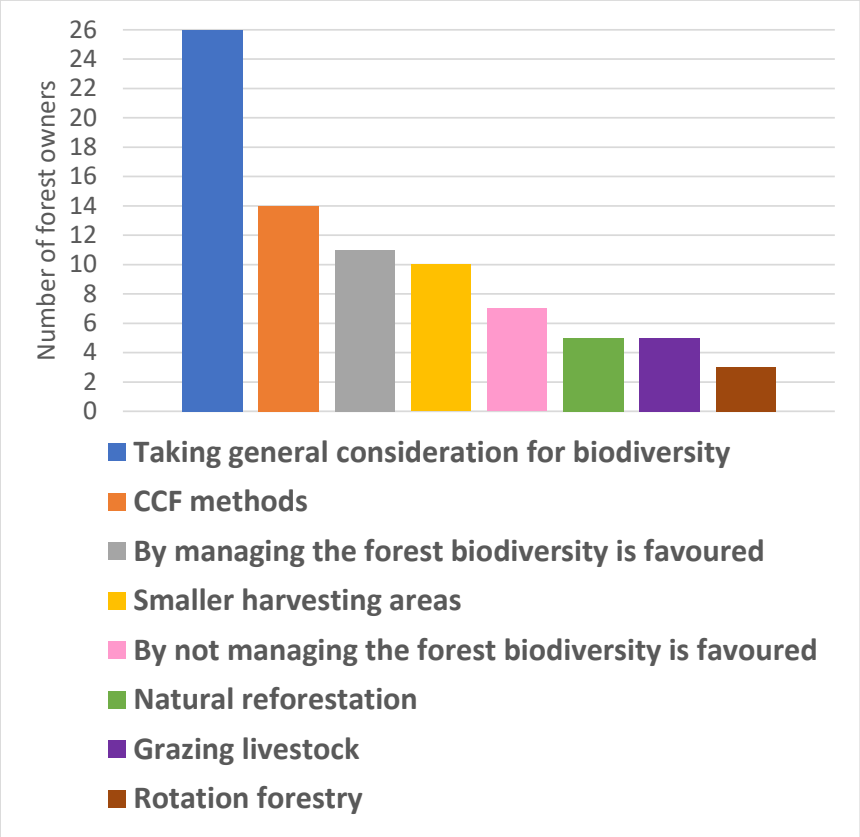

Figure 13 The interviewees perceived possibilities categorized as options to enhance biodiversity directly in their forest. The bars show how many interviewees that shared a specific option.

5.3.1 Perceived possibilities – Enablers

Of the interviewees, 47% (n=14) believe **small-scale forestry with many different forest owners** is an opportunity. They perceive that as a small-scale forest owner they all manage the forest slightly differently from one another leaving room for different types of species. Some believe that some small-scale forest owners do not do anything in their forest, which benefit biodiversity according to them. Making the small-scale ownership a perceived possibility for them to enhance biodiversity.

> *"Family forest owners do have rather small felling areas and the birds move around the areas. If you take down a forest stand of 2 hectares, which is a normal sized stand to cut in the south of Sweden, then the birds will move to the neighbouring forest stand. […] Well, you need to have knowledge and you can choose to some extent what you want to do. Because, if there are ten forest owners then all will do things slightly differently. And it is difficult to say what is right in ten years time. If all do slightly differently, then some will do something right." (S31)*

Almost half, 43% (n=13) of the interviewees sees **climate change as a reason to enhance biodiversity**. The possibility in this case is more of an incentive for the interviewees. They see increased risks in the forest such as drought, pests, and changing living preconditions with climate change that encourage them to enhance biodiversity and creating more resilient forests. They believe they are spreading the risks of climate change by having for example a large variation of trees and using different forestry methods. Some forest owners say that this incentive is more evident in the last few years.

> *I have now realized the need to have a more varied forest. Spruce has been the only tree planted for many years, but now I struggle to get more pine, and a mixture of pine and spruce. And even deciduous trees where it is appropriate. […] Mainly due*

to climate change and the risk of pests. It is not so funny to have the bark beetle everywhere in the forest. That's why you'd want pine as well. I have a mixed forest on many of the land areas where it is suitable. But it takes a lot of work to treat every plant to minimize the damage from moose and deer. So, the question is if it is possible to make ends meet, but I think it will in the long run. (S31)

Of the interviewees, 40% (n=12) believe that the **power to influence in their own forest** is a possibility for them to enhance biodiversity. Since they own the forest, they have all the possibilities to enhance biodiversity.

"Well, in fact I am the one with all the possibilities. We have now talked a lot about barriers and limitations but I, as a real forest owner, can in fact do something [for biodiversity]." (S28)

Of the interviewees, 27% (n=8) believe as they **value hunting and recreation**, they have more incentives to enhance biodiversity in their forest and therefore see this as a possibility. Some of the interviewees say they want a beautiful forest and that it will lead to both more biodiversity and beauty at the same time. And to be able to have better hunting opportunities there need to be a variation and biodiversity in the forest.

As a hunter I want everything [plants and animals]. There is no more boring type of hunting than moose hunting. [Laughter] It's a disaster really. For a whole week you sit in the forest eating your packed food and everything is so slow and boring. It may happen that you shoot a moose, but what's so fun about that, messing around and clearing out the dead moose. And after that you need to drag it home, no fun in that! But while you sit there in the forest and suddenly a flock of chickadees fly by, and I look at little birds and something is happening. That is fun! (S25)

Of the interviewees, 27% (n=8) believe that **knowledge about their own forest** is a possibility for them to enhance biodiversity, as the knowledge comes from years of experience in that specific forest. The knowledge includes the history of the measures done in the past, and the measures believed to work or not in the different forest stands.

"I have found feces from a grouse on a little hill where the vegetation is very dense. I was going to thin in that area when I found these tracks and I thought, no, I cannot do anything there because I see that this is the place where the grouse sits, I can clearly see his feces. Because of that, I have decided to let it be util some authority comes and tells me I must clean or thin or something in that area. He can live with me in the meantime." (S12)

Of the interviewees, 23% (n=7) believe that **profitability when conserving biodiversity** is a possibility for them to enhance biodiversity, as they believe they can earn money and conserve biodiversity as the same time. They see possibilities of collecting revenues from other parts of the forest, than harvesting many trees. Examples of activities mentioned that enables profitability are tourism such as renting out cabins or offering activities like forest bathing or hunting experiences. Others mentioned the option to focus on higher monetary valued timber, which is believed to give higher revenues and profit, resulting in not needing to harvest as many trees to collect the same revenue.

"It is possible to earn money on alternative values [in the forest]. Everything from tourism to wood for handcrafted items." (S03)

Of the interviewees, 17% (n=5) believe that **getting advice from authorities** is a possibility for them to enhance biodiversity, as they get support on what measures they can do. Some believed it is

beneficial that the authorities monitor the plants and animals in the forest so they can get assistance to decide what to conserve or where to take consideration to certain species.

> *"Well, knowledge, I think, is very important. I would say that it is very good that Skogsstyrelsen keeps track on harvests and those things that needs to be reported so that they check what type of forest it is, before they approve it [the harvesting]." (S10)*

Of the interviewees, 10% (n=3) believe **certifications** such as FSC and PEFC are a possibility for them to enhance biodiversity. They say the certifications help them set a minimum level for biodiversity and at the same time get more compensation for the timber and pulp wood when selling. It is said that the certifications guide them on what to conserve, and they experience they conserve more with the certifications than what they would done otherwise.

5.3.2 Perceived possibilities – Options

Almost all interviewees 87% (n=26) describe **taking general consideration for biodiversity** and sees this as a possibility to enhance biodiversity. They describe technological fixes they do to benefit biodiversity in their forest such as having more broadleaf trees, more deadwood, trees more adapted to natural conditions, saving older trees, and creating more mixed species stands.

Almost half, 47% (n=14) of the interviewees believe using **CCF methods** in their own forest is an opportunity for them to enhance biodiversity. These methods are technological fixes that the interviewees believe enhance biodiversity more than rotation forestry. Examples of mentioned methods are seed-tree stand, patch cutting, and selection cutting.

Of the interviewees, 37% (n=11) believe that **by managing the forest biodiversity is favoured**. This often connects to the perception that if a forest is not managed by e.g., cutting down new growth of spruce, the specific biodiversity in that forest is lost, if the goal was to have a forest with oak and not spruce. Forest owners that expressed this attitude also often said that protected areas need to be managed to maintain the biodiversity.

> *"The most important thing is that it [the forest] is being managed so biodiversity gets to be maintained. If one does not have the money to manage it, all will be destroyed in the long run. And then I think it is better for me to own it, as I have the economic strength to manage the forest." (S01)*

Of the interviewees, 33% (n=10) believe **smaller harvesting areas** in rotation forestry is a possibility to enhance biodiversity when comparing with larger harvesting areas. Seven interviewees shared that they think they are using smaller harvesting area than the norm. Five say their typical harvesting area is 0.5-3 hectares and two say a typical harvesting area is 4-8 hectares. Some of the interviewees think that practicing rotation forestry with smaller harvesting areas in the range of around 0.5-3 hectares should be counted as continuous cover forest.

Of the interviewees, 23% (n=7) believe that **by not managing the forest biodiversity is favoured**. These believe that just by letting the forest be, biodiversity gets the opportunity to maintain and enhance itself. The main argument used by these interviewees is that the forest developed and prospered by itself from the beginning, and therefore shows that the forest can take care of itself, humans just need to give it space to do so.

Of the interviewees, 17% (n=5) believe **natural reforestation** within rotation forestry or CCF methods is a possibility for them to enhance biodiversity. As both the genetic variation is thought to be greater than with planted trees and the soil is not left bare to the same extent, keeping a more continuous cover of trees in the forest.

Of the interviewees, 17% (n=5) believe **grazing livestock**, such as cattle, is a possibility for them to enhance biodiversity in the forest landscape, keeping it more open and varied.

Of the interviewees, 10% (n=3) believe **rotation forestry** is a possibility for them to enhance biodiversity, as they take a lot of measures to conserve biodiversity. They think that biodiversity is maintained or increased in their forest with the measures taken to conserve biodiversity within the rotation forestry management system they conduct.

5.4 Attitudes to continuous cover forestry methods

Attitudes concerning CCF methods are described in Figure 14 and the results show that attitudes are varied.

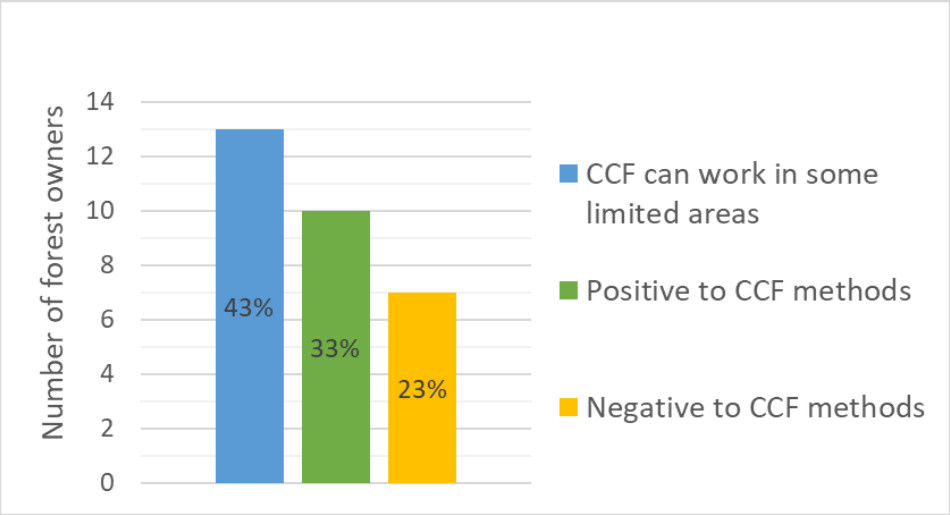

Figure 14 The interviewees attitudes to CCF methods. The bars show how many of the interviewees that were categorized to a specific attitude.

Most of the interviewees, 43% (n=13) believe **CCF methods can work in some limited areas**. These interviewees think rotation forestry in general works better from a practical and economic point of view, but in certain forests CCF methods could be a better option. For example, CCF methods could be a better option if the structure of the forest is already adapted to these methods and if the characteristic of the land especially suits these methods or if the main goal of the forest already is nature conservation.

> *" I don't think that it is either this or that, of course you can do it [continuous cover forestry methods] in certain areas and on certain types of land and where you have certain types of trees that you want to grow, it works well. In other places with other conditions, it does not work so well but I do not see that it is either or, you should adapt your work depending on the situation, this is what I believe." (S04)*

Of the interviewees, 33% (n=10) **are positive to CCF methods** and believe they can work well as a forestry method in their forest. The interviewees in this category generally think these methods create different benefits that improves the value in their forest. Some examples mentioned is that CCF methods make their forest more resilient, create better quality timber, maintains recreational values better and that the annual monetary outtake of the forest gets better distributed as larger forest stands are not harvested at once.

> *"I believe that I work with it [continuous cover forestry methods] already quite a lot, but not in pure spruce stands, that will be considered in the next step. […] My goal is to create as much non-rotation forestry forest as possible, I want to distance myself from that [rotation forestry]." (S01)*

Of the interviewees, 23% (n=7) **are negative to CCF methods**. Interviewees in this category in general do not see any prospects for these types of methods and do not understand how it could work from an economic or practical point of view. Some interviewees in this category considered rotation forestry as a better method to conserve biodiversity. It is thought to be a more effective forestry method producing more timber per land area and therefore it is possible to spare more forest for nature conservation, as you would need less land for the same amount of timber output.

> *"I have a hard time to believe in it, economically, picking out [trees]. Well for us it would not work if I put it that way. It is not economically possible to work in that way." (S13)*

Regardless of attitude, the interviewees experienced difficulties starting or working with CCF methods. Profitability when working with these methods were one perceived overall challenge both in the long- and short-term perspective. Another common challenge was that CCF methods was believed not to suit different types of Swedish forests. Additionally, increased costs for transportation and machines if harvesting is done more frequently, difficulties getting enough sunlight for regeneration, current even-aged monocultures suited for rotation forestry, and the lack of knowledge in CCF methods both for themselves and for forestry companies are challenges expressed by the interviewees. Additional believed risks with CCF methods were the potential for increased storm damages and damages on the ground from driving with forestry machines.

5.5 Attitudes to structural measures

The interviewees have different attitudes towards structural measures for biodiversity conservation in Sweden as seen in Figure 15.

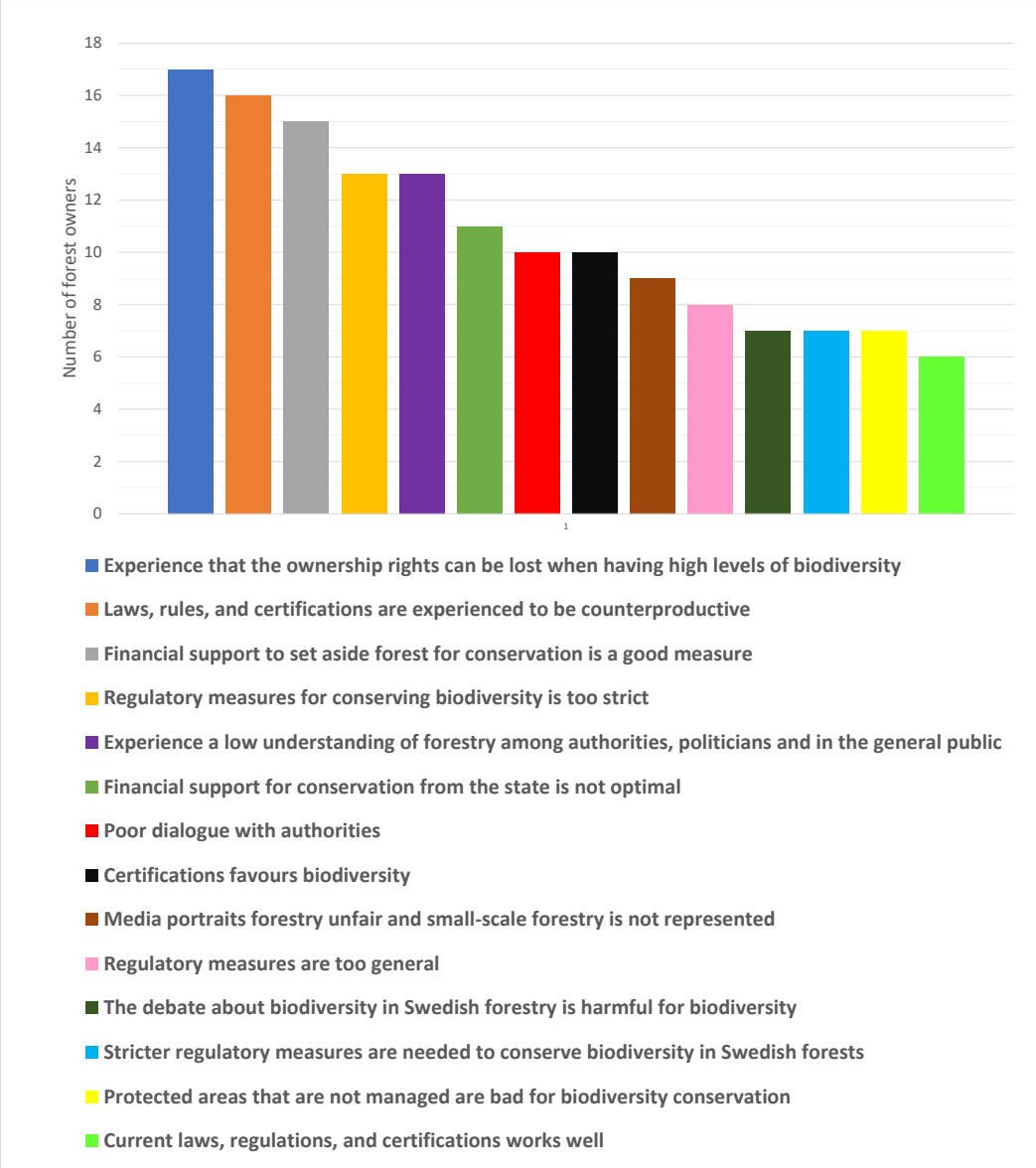

Figure 15 How the interviewees perceive biodiversity conservation in Sweden today specifically concerning laws, regulations, and certifications. The bars show how many of the interviewees that have expressed the specific attitude.

Of the interviewees, 57% (n=17) believe **the ownership rights can be lost when having high levels of biodiversity**, as authorities can make their forest into a protected area. Interviewees express that if authorities suggest that a protected area should be created on their land, there is little or no possibilities to go against such a proposal. The ownership and the feeling of freedom of choice is valued by these interviewees and knowing the risk of not owning or manage the forest in the same way as before is worrying for many. Further description on why the interviewees do not want to make a protected area in their forest is given in chapter *5.3 Perceived possibilities to enhance biodiversity*. This issue is mentioned by the interviewees to be harmful for biodiversity as it both makes people demotivated to conserve biodiversity and to consciously decrease biodiversity. Some say they feel insulted when they are asked to set-aside forest for protected areas, like they are not capable to continue care for the forest as they already done for so long.

Of the interviewees, 53% (n=16) think **laws, rules, and certifications are experienced to be counterproductive.** Some of the interviewees said they feel demotivated with regulatory measures perceived to be too strict. And they said to feel overwhelmed keeping track of and follow all regulations at times, more so when someone else decided what they should do in their forest. Mostly, interviewees described that it could be unfavourable to have biodiversity in their forest as it believed to create negative consequences for their forestry such as potentially hinder the outtake and production of timber, and impair ownership rights. Basically, the interviewees felt that a forest owner with poor biodiversity have more advantages in relation to laws, regulations, and certifications, compared with a forest owner with lots of biodiversity.

> *"There have been many now that have requested harvesting before it is put on hold. […] It has gone so far that people are thinning 160-year-old forests just to clear any potential nature values to be able to harvest later on. And by this, the purpose of handling values in nature and biodiversity is truly lost." (S21)*

Of the interviewees, 50% (n=15) believe **that financial support to set-aside forest for conservation is a good measure**, as well as financial support for other actions enhancing biodiversity. If the right to manage the forest is limited, compensation is crucial. Many of the interviewees mentioned it is important that the compensation is fair and what is deemed to be fair varies among the interviewees.

Of the interviewees, 43% (n=13) think that **regulatory measures for conserving biodiversity is too strict**. More than half of the interviewees of this opinion focuses mostly on the Species Protection Ordinance (2007:845) as the main reason why they believe regulatory measures are too strict. In general, the interviewees have a hard time understanding how forest owners could possibly have the knowledge, time, or money to comply with the Species Protection Ordinance (2007:845) and think that it is too overwhelming for small-scale owners. Some think the rules are unnecessary as they do not see the need to protect that many species or habitats. Some think that the regulations are unreasonable because it is too complicated and puts a too high demand on knowledge and costs on the individual owner.

Of the interviewees, 43% (n=13) **experience a low understanding of forestry among authorities, politicians and in the general public**. Due to previous shifts in the focus of Swedish forestry policy interviewees feel it is difficult to maintain trust in the authorities and politicians on what is best practice. In addition, the interviewees do not deem regulations by the European Union trustworthy with the main argument being that Swedish forestry is believed to be different than other countries and Sweden therefore needs more specific regulations. Some of the interviewees of this opinion believe the public in general have bad knowledge of forestry and think that public opinions about forestry is therefore inaccurate.

Of the interviewees, 37% (n=11) believe **financial support for conservation from the state is not optimal**. The interviewees think the design of the financial support today is not optimal, and they would rather see that the compensation is annually distributed for a given number of years, instead of just getting a large sum at once. Contracts written with the state in a leasing format was also considered a better option than selling the forest. If compensation would be distributed during a longer period of time, some interviewees deem it favourable as it would lead to a continuing income for the coming generations. Some believe the financial compensation they get from the state is not enough and the issue of valuing social aspects of the forest in monetary terms was mentioned. Some said that the procedure to get financial support is simply too difficult to be appealing.

> *"I think it should be redone so that yes, you get a small amount from the beginning, then you get a sum every year during the contracted years. So that it feels like, even in 20 years when the children will take over, the feeling is that they still have an income even though they can't manage the forest." (S03)*

Of the interviewees, 33% (n=10) experience **poor dialogue with the authorities** the Swedish Forest Agency and the County Administrative Boards as they are believed to be rigid and impersonal, and therefore more dialogue is requested. Some interviewees mentioned that in areas with high levels of biodiversity, the request time for harvesting is too long. The experience it takes too long time before the consultation with the authorities happen and the interviewees must wait for a decision on how to proceed, whether it is more consideration areas or creation of protected areas. One said it took 2 years and one shared that it took 7 years before they got information on how to proceed. Some express that it is always the forest owner that must adapt to the authorities and that there is barely a dialog, much more a monologue.

> *"We need better communication, better dialog, much much more dialog and perhaps less bureaucracy. And that it should be more of a conversation and not just that you get a paper in the mailbox that says a lot of things." (S26)*

Of the interviewees, 33% (n=10) believe **certifications favours biodiversity** in forestry. In general, the interviewees think that certifications give further incentives for taking measures, specifically when the timber and pulp wood is more valued monetary with certifications. Some suggest new certifications that could take even more considerations for biodiversity than what exists today. For example, wood material that comes from CCF managed forests could be a new type of certification, which could encourage forest owners to conserve more biodiversity.

Of the interviewees, 30% (n=9) think that **media portraits forestry unfair and small-scale forestry is not represented.** The interviewees believe that media mostly cover corporate large-scale forestry, but still the critique often is applied to them as well, on for example very large harvesting areas, which is believed not to be done by small-scale forestry. The interviewees experience that biodiversity and consideration in small-scale forestry is not as bad as media presents it, and they think biodiversity conservation is much better handled by small-scale owners than what many tend to believe. The interviewees think that the information gets twisted in media and that media do not consider the full spectrum of the diverse group of forest owners.

> *"If we are looking at the picture presented by the mass media, that is being spread, and done so successfully, that it is some criminals [forest owners] that don't manage their forest and that don't improve the biodiversity. Which is not true to a large extent and then this picture of it all becomes very strange." (S09)*

Of the interviewees, 27% (n=8) believe that **regulatory measures are too general.** The precondition for forestry varies and mentioned aspects are geographical location and owner structure. The geographical location of a forest determines type of climate region and therefore the structure of the forest and growth vary. Interviewees also mentioned the variations in owner structure such as large-scale or small-scale forestry, and private or state owned. The interviewees think regulations should consider owner structure and geographical location more, for example forest owners with only a small number of hectares do not have the same financial capacity as large-scale owners or a forest in the north cannot be managed the same way as a forest in the south, therefore they believe regulations should be more adapted.

> *"Of course, there are many aspects, and it is complicated and there is no simple solution. However, forestry in Sweden is extremely varied, what is done in northern and in upper northern Sweden differs considerably from what is done in southern and in central Sweden. And people speak about location adaption, and I think you have to do so." (S29)*

Of the interviewees, 23% (n=7) believes that **the debate about biodiversity in Swedish forestry is harmful for biodiversity**. The interviewees mentioned that they feel offended by the debate, which

leads to less motivation to conserve biodiversity in their forest. The debate is also described to create a negative polarization, which leads to bad communication between different interest groups that further leads to less effective work for improving biodiversity conservation within forestry.

> *"And it is a deep polarization or the polarization that has taken place, I would like to say that it actually disadvantages biodiversity." (S09)*

Of the interviewees, 23% (n=7) think that **stricter regulatory measures are needed to conserve biodiversity in Swedish forests**. They do not think that current regulatory measures are enough to halt the biodiversity loss in Swedish forests and to conserve it better. Some of the interviewees want to ban ground preparation[11] and larger harvesting areas. Some said that more sensitive biotopes such as forests in alpine regions need to be protected. Others suggested that only certain forest owners need stricter regulations and proposed for example the groups of large-scale forest owners and forest owners with a stronger focus on production to be the ones having stricter regulations.

> *"I think we need to protect more forest land and try to move away from clear cuts." (S14)*

Of the interviewees, 23% (n=7) believe that **protected areas that are not managed are bad for biodiversity conservation,** compared to managed forests. Some think it is wrong to set-aside forest in protection areas and not manage it. These interviewees said that if the forest is not managed, the values meant to be conserved are lost as the forest gets bewildered and dense. Some also said that it is better for biodiversity to have managed forests. One example given was if a forest stand is managed with CCF methods, that both take biodiversity and production into consideration, it was deemed to be ineffective to transform such a stand to a protected area.

> *Highly productive land must also be conserved and when it is conserved, you should also take care of it. This thing with protected areas, you shouldn't just conserve things and then leave it untouched. Biodiversity has been created there and then you need to manage it, so it's maintained as it once was intended to be or once became, so that it continues to be so. (S07)*

Of the interviewees, 20% (n=6) think **current laws, regulations, and certifications works well**. Most interviewees in this case feel that current regulatory measures are well-functioning as biodiversity is believed to increase or to already be on a suitable level. The interviewees said it is hard to get perfect regulations that always serves its purpose, but believed the system existing today for biodiversity conservation overall works well.

5.6 Conservation versus regulatory measures and fears

The attitudes on biodiversity conservation were compared with the attitudes towards current laws, regulations, and certifications and being afraid of having too much biodiversity. The findings in chapter *5.1 Attitudes to conservation of biodiversity* indicates that 43% think that biodiversity must be better conserved or increased. However, more than half of these (54%) are either afraid of having too much biodiversity, due to loosing ownership rights or think that some or all regulatory measures are too strict. Of the 57% of the interviewees expressing that biodiversity is fine as it is or that it is important with biodiversity, but production is more important, 94% are either afraid of losing ownership rights due to too much biodiversity or think that some or all regulatory measures are too strict. The findings also shows that those being afraid of having too much biodiversity can restrict the level of biodiversity in their own forest.

[11] Preparation of the land before planting new trees.

6 Discussion

Voluntary actions taken by forest owners to protect biodiversity is part of the *Swedish Forestry Model* and of importance to achieve the SEO *Sustainable Forests*. It is clear from the findings that the interviewees are motivated to take measures to improve biodiversity, and many uses technological fixes. Still, the interviewees express challenges that demotivates them from taking further voluntary actions for biodiversity conservation. There are however limitations to the findings, which are further discussed in this chapter together with the discussion of the findings.

6.1 Method

The selection of interviewees could potentially influence the results. As 22 of the 30 interviewees registered interest themselves for the study, there might be a bias towards those who have strong attitudes regarding biodiversity, either in favour of or against it. Another risk is that those that registered interest on their own on some level have more knowledge than the average forest owner. When reaching out to contacts asking them to participate, several expressed they do not know what they can contribute with knowledge wise, and some declined giving the reason that they do not feel knowledgeable enough on the subject. This can indicate that the selection of forest owners in this study might have more knowledge than the average forest owner or are more confident about their knowledge.

A potential limitation to the findings is the approach during the interviews. The approach was to not suggest any solutions or alternatives to the questions, which could affect the interviewees answers. Examples to the questions were only given if the interviewees asked for it or did not understand the question. Potentially themes might reoccur more frequently if alternatives were given to a larger extent during the interviews. This approach during the interviews was chosen to limit the potential for transferred bias as much as possible and minimize the possibility of the interviewees agreeing just because it might be the norm to have a certain attitude. Concerning transferred bias, the approach during the interviews was also to remain as neutral as possible with regards to values and attitudes. The goal was to create a welcoming and safe atmosphere where all attitudes and opinions were valued, as all have the right to freedom of expression.

In comparison, the selection of interviewees regarding the gender distribution, the spread of owned hectares over the regions, and the number of interviewees in each region, is consistent to a great extent with the Swedish statistics. Still, it should be avoided to generalize the findings for all forest owners in Sweden. The main source of uncertainty is the number of interviewees, which is 30 of the more than 313 000 Swedish forest owners. Another discrepancy in the selection compared to the Swedish statistics is the case study's average and median in the different size classes, which are higher that the Swedish statistics. Meaning there are fewer interviewees owning <=5 to >20 hectares in this selection than in relation to the overall in Sweden.

6.2 Attitude to biodiversity conservation and cognitive fixes

When comparing the findings from chapter *5.1 Attitudes to conservation of biodiversity* with the results from Danley et al. (2021) it appears to be some differences in attitude regarding biodiversity protection. In this study the question was whether biodiversity should increase, decrease, or be maintained at the current level, whereas Danley et al. asked if Sweden needs to protect more forest for biodiversity reasons. This study shows that 43% think biodiversity needs to increase, whereas the study by Danley et al. (2021) shows that 9% think that we need to protect more forest for biodiversity reasons. The framing is somewhat different in the two studies and just because someone thinks biodiversity needs to increase, does not necessarily mean that they think there is a need to protect more forests. One reason to this discrepancy could be that forest owners in this study are more willing to conserve biodiversity compared to the study by Danley et al. (2021). Another reason might be that forest owners in Danley et al. want to conserve biodiversity with other methods than using protected

areas. The previous study collected the data during the years 2014-2015, and another reason for the discrepancy in results might be that the attitudes to biodiversity could have changed during the last seven to eight years. The findings show that almost half have climate change as a motivation to increase biodiversity and they state that the motivation has increased in the last few years. The driver for this group is to create diverse resilient and resistant forests that can cope with the expected extreme weathers, pests, and uncertainties in a future with the global warming. These expressed concerns of climate change's impacts on forests could also be another possible explanation contributing to why this study indicate a greater willingness to protect biodiversity.

As for cognitive fixes, the findings suggest that even though someone values or has knowledge of biodiversity, it is not entirely sure actions to conserve biodiversity corresponds with those attitudes and knowledge. The same conclusion is also evident in previous research (Deutscher, 1966; Heberlein, 2012; Kühl et al., 2009). One example from this study illustrating this is that many interviewees appear to have knowledge on how to conserve biodiversity, and more than half think it is important to do so, to a varied degree. Furthermore, those being afraid of having too much biodiversity can consciously make sure to keep biodiversity at a lower level. As seen in chapter *5.6 Conservation versus regulatory measures and fears*, about half of the interviewees believing biodiversity needs to increase also expresses either to be afraid of having too much biodiversity due to ownership rights or think that some or all laws, regulations and certifications are too strict. This indicates that even though the interviewees want to have high levels of biodiversity in their forest, it does not mean that all interviewees are willing to have a high level or increase the level of biodiversity in their forests themselves.

6.3 Technological fixes

To conserve and increase biodiversity, and thus achieve the SEO *Sustainable Forests,* a suggested solution is to increase the use of CCF methods (Savilaakso et al., 2021). Forest owners' attitudes towards technological fixes such as CCF were therefore explored in this study. The study shows that 76% of the interviewees are positive to use CCF methods to a varied degree, ranging from being the main method to a complement to rotation forestry. Additionally, chapter *5.3 Perceived possibilities to enhance biodiversity* also shows that CCF methods are one of the most frequently mentioned possibilities for the interviewees to enhance biodiversity. The findings indicate a willingness to increase the use of CCF methods in forestry, which in turn increases the likelihood of increasing biodiversity (Savilaakso et al., 2021). Yet, the interviewees express challenges to increase the use of CCF methods, which might need to be addressed to reach a more widespread use of these methods. The interviewees interest in CCF (76%) is larger in percentage, than the actual use today (approximately 1-5%). If more Swedish forest owners share the same attitudes on CCF methods as the interviewees, this can indicate an opportunity for CCF methods to increase in use.

6.4 Structural fixes

Knowing forest owners' attitudes towards structural fixes for biodiversity are important, as consequently structural fixes preferred by forest owners can be applied by e.g., the state or industry. Creating effective structural fixes that are supported by forest owners might increase the likeliness to conserve and increase biodiversity. Even though the findings show that many wants to enhance biodiversity, almost half of the interviewees think that regulatory measures are too strict. Stricter structural measures do not have strong acceptance, which is also concluded by Danley et al. (2021) and Koskela & Karppinen (2021). In contrast, Lindahl et al. (2017) suggests that forest owners have more of a neutral attitude towards additional structural fixes than what was currently in force at the time of that study. Failing motivations are also a pattern seen in the findings in chapter *5.5 Attitudes to structural measures*. Most attitudes are connected to failing motivation to act for biodiversity and are affected by several factors such as poor dialog with authorities, financial support not being optimal, or perceived lack of knowledge in politics and among the public. The study suggests a stronger acceptance to conserve biodiversity if financial support is given, which is also found in prior research.

Previous studies suggest there is a limit to what can be achieved with voluntary measures. Therefore, it can be questioned if Sweden can achieve the SEO *Sustainable Forests* and improve biodiversity without the structural measures that already are in place. Some interviewees have suggested that it is of importance to adapt the regulations to a further extent. It can be discussed if small-scale forest owners should have similar regulations as large-scale forest owners. There might be an opportunity to strengthen the acceptance to structural fixes by better adapted laws, regulations, and certifications. Adapting to current forest owners' attitudes could be a way of navigating around the limit to volunteerism, which might make forest owners experience a better relationship with authorities and become more motivated to conserve biodiversity.

6.5 Small-scale forestry

According to the interviewees, small-scale forestry is considered to be one of the biggest possibilities to enhance biodiversity. The ownership structure is said, by the interviewees, to create a variation among the around 313 000 forest owners in Sweden. However, it can be discussed if the variation of management methods among small-scale forest owners is enough. There is a difference between those that do nothing in their forest, and those that manage their forest more intensely, but it is important to better understand if the variations are large enough to conserve biodiversity in line with the SEO *Sustainable Forests*.

Both Ostrom (1990) and Sterner & Coria (2012) suggests that small-scale forestry could be a more successful ownership structure compared to the state or private companies in terms of biodiversity conservation. Sterner & Coria (2012) implies that local forest owners have better knowledge in relationship to their forest, which is also almost a third of the interviewees' opinion as seen in chapter *5.3 Perceived possibilities to enhance biodiversity.* Furthermore, Sterner & Coria (2012) suggest that local forest owners can adapt the forest management more successfully to the local conditions of the land, compared to the state. Perhaps this entail that small-scale forest owners could have better prospects to effectively manage the forest for biodiversity conservation compared to other ownership structures, but no clear conclusions can be drawn from this study.

6.6 Fear of having too much biodiversity

Land with high levels of biodiversity can become of interest for authorities to protect and some interviewees are afraid of this. Similar results were also found by Hertog et al., (2022). This notion is repeatedly reflected in the findings, and slightly more interviewees tend to see it as a structural challenge making them afraid of losing ownership rights rather than describing it as personal challenge being afraid of having too much biodiversity. The reason could be that it was difficult for the interviewees to articulate the fear or that it was seen more as a general problem for some. Even though only few of the interviewees have personal experience of creating protected areas with the authorities against their will, they have heard stories of it or know others that have experienced this like friends or neighbours. It is perhaps enough to have a few examples in Sweden of this phenomenon to demotivate forest owners overall to enhance biodiversity. The effectiveness of protected areas can be discussed, if they are created against forest owners will, as this could lead to a general negative attitude towards having high levels of biodiversity in the forest. In conclusion, the challenge lies in creating structural fixes that does not make forest owners afraid of having high levels of biodiversity. Therefore, knowing forest owners' attitudes to biodiversity conservation might be important to be able to create such fixes.

Most of the interviewees' forests are certified with FSC or PEFC. Those certified through FSC are obligated to conserve areas with high values of biodiversity without getting further compensation for it than the higher selling price of timber. This implies that a FSC certified forest owner with high levels of biodiversity needs to take a greater economic responsibility compared to someone who has low levels of biodiversity. This flaw in the certification scheme, observed by some of the interviewees and the expert in biodiversity, makes it financially more difficult to be certified with FSC when

having a forest with high levels of biodiversity. This flaw is also observed to incentivize forest owners to have low levels of biodiversity, as if the FSC-certified forest does not have any high values of biodiversity, the forest owner can harvest and sell more of its timber at the higher selling price. To be noted, in this study it was not explicitly expressed by the interviewees if the fear of having too much biodiversity was connected to a specific certification, law or regulation.

6.7 Forestry – a business

As for any other profit driven organization, it is apparent from the findings that profitability is important for many of the interviewees. Some of them see biodiversity as an investment, and others see it as an expense. In addition, many challenges to enhance biodiversity are connected to financial consequences, such as damage from grazing elk and deer or pests such as bark beetle. Some interviewees do however see possibilities with other business models than earning money from only selling timber and pulpwood trough rotation forestry. Some of the interviewees see opportunities to gain profitability by selling more high value products and forest experiences, than trough maximizing sales of forest biomass. For some of the interviewees, high profits are not the goal, yet earnings need to cover the expenses. Enhancing biodiversity can in many cases relate to costs as well as be connected to the fear of losing ownership rights, and this combination can be considered problematic. However, conserving biodiversity is also connected with possibilities mentioned in chapter *5.3 Perceived possibilities to enhance biodiversity*. If the state and the industry take forest owners' attitudes into account in a better way when developing and implementing fixes for biodiversity, more forest owners might be willing to take further actions to conserve biodiversity.

7 Conclusions and recommendations

The purpose of the study was to investigate forest owners' attitudes to conserve biodiversity in forestry. The aim was to explore forest owners' perceived possibilities and challenges to enhance biodiversity in their forest and to investigate forest owners' attitudes regarding CCF methods and structural measures for biodiversity. The findings show that all the interviewees value biodiversity although in different ways. It might be feasible to increase the use of CCF methods, as a majority of the interviewees are willing to use them in their forestry, to a varied degree. The interviewees also expressed several possibilities both in terms of perceived options to enhance biodiversity directly, or possibilities in terms of enablers, as well as perceived challenges to enhance biodiversity.

Conclusions:

- Attitudes to biodiversity conservation varies, where most state that it needs to be better conserved or increased, to different degrees, and nearly a third state the level is sufficient today.
- Of the interviewees, most are positive to use CCF methods, to a varied degree, ranging from being seen as potentially the main method to a complement to rotation forestry.
- The interviewees see several possibilities to enhance biodiversity in their own forest.
    - The most frequent enablers to enhance biodiversity are small-scale forestry, climate change as a motivation, and the power to influence in their forest.
    - The most frequent options to enhance biodiversity are taking general considerations, using CCF methods, and to favour biodiversity by managing the forest.
- The interviewees see several challenges to enhance biodiversity in their forest. The most frequent challenges are lack of profitability when enhancing biodiversity, damage from elk and deer, and being afraid of having too much biodiversity as it could threaten their ownership rights.
- The most frequent attitudes to structural measures are believing that ownership rights can be lost when having high levels of biodiversity, that laws, rules, and certifications are experienced to be counterproductive, and that getting financial support to set-aside forest for biodiversity conservation is a good structural measure.

This study indicate there is willingness to conserve biodiversity, but that there are barriers making it difficult for the interviewees to take further action. The findings suggest that the interviewees are more positive to protect biodiversity than shown by previous research. The observed fear of having too much biodiversity and a weak support for current structural fixes, indicates a potential to strengthen the acceptance to structural fixes if they were designed more with individual forest owners' attitudes in mind. Adapting to forest owners' attitudes could be a way of navigating around the barriers, which might make forest owners more motivated to conserve biodiversity.

There are limitations to the study such as how the selection of the interviewees was done and the limited number of interviews held, therefore it is not possible to generalize the findings for all individual forest owners in Sweden. The findings from this study do, however, add to the research on forest owners' attitudes towards biodiversity conservation. The recommendation for future research is to test the findings quantitatively through further research, to be able to generalize the findings, as well as to investigate fixes for increased forest biodiversity with forest owners' attitudes in mind.

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Appendix

Appendix A – The interview guide

The numbered questions are the main questions that were asked in most interviews. The sequential questions are marked with letters and were asked in many cases but not all. The purpose of the questions was to be enable answers the research questions. The TCS framework is connected to several sections.

INTRODUCTION - THE FOREST

1. Can you tell us about you and your forest?
    a) What do you usually do in your forest?
    b) How often are you in your forest, do you live nearby?
2. Do you have any goal with your forest?

FORESTRY METHODS - TECHNOLOGICAL FIXES
Connected to the research question: What are the individual forest owners' attitudes to continuous cover forestry methods?

1. How do you manage your forest today?
    a) Have you taken any special considerations or used any environmental protection measures that contribute to conserving biodiversity in your forest?
    b) Do you have any certification in your forestry, for example PEFC or FSC?
2. How did you gain knowledge about forestry?
3. Have you considered managing your forest in any other way than you do today?
    a) If yes, what methods have you considered and what do you think of them?
4. Based on your knowledge of CCF methods, how do you think CCF methods can work in your forest and/or in Sweden in general (from a practical and economic perspective)?

BIODIVERSITY - COGNITIVE FIXES AND ATTITUDES
Connected to the research question: What are the individual forest owners' attitudes to conservation of biodiversity?

1. How would you describe the biodiversity you have in your forest?
    a) Could you describe the variety of tree species and the age of your forest?
    b) Could you describe the types of species, in addition to tree species, that live in your forest?
2. Do you feel there is a need to reduce, maintain or increase biodiversity in your forest?
    a) Why or why not?
3. Is your forestry affected by biodiversity or by other values in nature?
    a) In which way?
    b) For example, have you experienced that biodiversity counteracted pests such as bark beetles or prevented harvesting or something similar?

REGULATORY MEASURES - STRUCTURAL FIXES
Connected to the research question: How do individual forest owners perceive biodiversity conservation in Sweden today, specifically concerning laws, regulations, and certifications?

1. How do you think the conservation of biodiversity in Sweden works today? Connected to laws, regulations, and certifications.
    a) Would you like to see a change in the strategies that exist today to conserve biodiversity in Sweden and if so, what would that change be?
    Or

    b) What structural measures do you think could have a good effect on biodiversity conservation?
2. Who do you think is responsible for conserving biodiversity in Sweden?
    a) and why do you think that?
3. In general, do you feel that there is a need to reduce, maintain, or increase biodiversity in Sweden?

CHALLENGES AND POSSIBILITIES TO ENHANCE BIODIVERSITY – ALL THREE FIXES

Connected to the research questions: What are the individual forest owners' perceived challenges to enhance biodiversity in their forest? What are the individual forest owners' perceived possibilities to enhance biodiversity in their forest?

1. Do you experience any challenges when it comes to enhancing biodiversity in your forest?
    a) In which way (or) why not?
2. Do you experience any possibilities when it comes to enhancing biodiversity in your forest?
    a) In which way (or) why not?

THE FUTURE

1. What do you think will be important for forestry in the future?

FINISH

1. Is there anything you want to comment on or add?

Appendix B – A detailed description of the interviews

A more detailed description of how the interviews were done is presented in this appendix. The questions varied depending on the answers and attitude from the forest owners. The descriptions are sorted after each research question.

What are the individual forest owners' attitudes to conserve biodiversity?

The interviewees were asked questions on how they would describe and perceive biodiversity, both in relation to their own forest but also to Sweden. All had to describe the biodiversity they have in their forest. One question was if they believe biodiversity needs to be increased, decreased, or maintained in Sweden or in their forest. Some got a follow-up question on how they value biodiversity, and some were asked what biodiversity mean to them.

What are the individual forest owners' attitudes to continuous cover forestry methods?

The interviewees were asked questions to find out about their attitudes regarding CCF methods. The questions could be related to forestry in their own forest or to forestry in Sweden in general. First, they were asked what current forestry method they used. If the answer was rotation forestry, a follow-up question could then have been what they think about CCF methods, from a practical and economic point of view. If the forest owner did not see it as an appropriate forestry method in their own forest, a further follow-up question could then have been, what prospects they think CCF methods can have in Swedish forestry. If the forest owner mainly used CCF methods, similar follow-up questions as in the previous case were still asked.

How do individual forest owners perceive biodiversity conservation in Sweden today specifically concerning laws, regulations, and certifications?

The interviewees were asked questions connected to how they perceive biodiversity conservation in Sweden today related to laws, regulations, and certifications. After the initial question on how they perceive the conservation today a multitude of follow-up questions were asked, depending on their initial answer. Some examples of follow-up questions that were asked were what measures they think could be more beneficial for conserving biodiversity, how they would design the system with regulations if they could decide or if they would like to change any regulations and in what way in that case.

What are the individual forest owners' perceived challenges and possibilities to enhance biodiversity in their forestry?

When the interviewees were asked about possibilities or challenges to enhance biodiversity in their forest, often follow-up questions were asked. Such as why they think it is a possibility or challenge and how and when they have experienced this themselves.

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