Choice of tree species in the aftermath of two major storms

– a qualitative study of private forest owners in southern Sweden

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Abstract

The forests in Götaland, the most southern part of Sweden, are dominated by Norway spruce (*Picea abies* (L.) H. Karst). This species is very important for the Swedish forest sector, but also associated with certain risks, such as wind-throw. Götaland was hit by the storm Gudrun in 2005, causing damages of a magnitude never experienced in the modern Swedish history. Two years later the same region suffered severe damages in another storm, Per. Due to the ownership structure in southern Sweden the reforestation efforts after the storms were largely made by small-scale private forest owners. Disproportionally high losses of Norway spruce exposed the risks associated with previous practices. In addition, reforestation grants were available through the Swedish Forest Agency that compensated for the higher regeneration costs associated with broadleaves. Despite this, the vast majority of the storm felled areas were regenerated with Norway spruce. Through qualitative interviews and subsequent analysis, this study examined how small-scale private forest owners' reasoned in their choice of species and which factors that were of decisive importance for the final outcome. Regeneration with Norway spruce was mainly an expression of forest owners evaluating the different alternatives based on economic rationality. Past and current economic conditions have been and still are favorable for this species, and forest owners therefore relayed on experience-based knowledge in their reforestation decision. Meanwhile, there are other contextual factors that steered forest owners towards planting spruce, such as a high browsing pressure and influence from dominant forest management norms. Regeneration with other species reflects situations where forest owners incorporated other aspects in their decision-making processes. Regeneration with broadleaves was favored by consideration of aesthetical values and an awareness of potential future risks with Norway spruce. In addition, since large areas had to be regenerated, forest owners ceased the opportunity to vent their curiosity with new species (especially exotic conifers/broadleaves) on smaller areas. The soft policy instruments that characterize Swedish forest policy also had a facilitating effect. Forest owners received information about alternatives through various pathways and the reforestation grants were of crucial importance for the owners that planted broadleaves. This study also suggests that the higher share of naturally regenerated birch found in regenerations surveys after Gudrun cannot simply be regarded as an effect of lower level of ambition, but also expresses a shift towards a more positive attitude concerning this species.

Key words: reforestation, small-scale private forest owners, Gudrun, Götaland, Norway spruce, reforestation grants

Sammanfattning

Skogen i Götaland, den sydligaste delen av Sverige, domineras av Gran (*Picea abies* (L.) H. Karst). Denna art är mycket viktig för svensk skogsindustrin, men kopplas också samman med vissa risker, såsom en högre risk för stormfällning. 2005 så drabbades Götaland av stormen Gudrun, som orsakade skador av en omfattning som aldrig tidigare upplevts i modern svensk historia. Två år senare så drabbades samma region av stormen Per. Ägandestrukturen i södra Sverige innebar att föryngringsbesluten efter stormarna i hög grad utfördes av småskaliga skogsägare. Disproportionellt stora skador på granskog visade på riskerna med tidigare skogsbruksmetoder, samtidigt som skogsstyrelsens återväxtstöd kompenserade för lövträdens högre föryngringskostnad. Trots detta föryngrades de stormfällda områdena i mycket stor utsträckning med gran. Med kvalitativa intervjuer och efterföljande analys undersöktes i denna studie hur privata skogsägare resonerade i sina föryngringsbeslut och vilka faktorer som var av avgörande betydelse för det slutgiltiga utfallet. Föryngring med gran var främst ett uttryck för skogsägare som värderade de olika alternativen utifrån ett ekonomiskt perspektiv. Förhållandena för ett graninriktat skogsbruk har varit stabilt gynnsamma under lång tid, vilket gjorde att skogsägare planterade arten grundat i en erfarenhetsbaserad kunskap. Samtidigt så är det andra kontextuella faktorer som styrt skogsägares trädslagsval mot gran, såsom ett högt betestryck och påverkan från normer i omgivningen. Föryngring med andra arter återspeglar situationer där skogsägare vägt in andra aspekter i beslutsprocessen. Föryngring med lövträd gynnades av beaktandet av estetiska värden och en medvetenhet om framtida risker förenande med gran. Eftersom stora områden skulle föryngras så tog skogsägare tillfället i akt att prova nya arter som de var nyfikna på (framförallt exotiska barrträd/lövträd). De mjuka styrinstrument som karaktäriserar svensk skogspolitik har också haft en positiv påverkan. Skogsägare fick på olika sätt information om alternativ och återväxtstödet var av avgörande betydelse för de som planterade lövträd. Enligt den här studien så kan den högre andelen av naturligt föryngrad björk i föryngringarna efter Gudrun inte endast förklaras av en lägre ambitionsnivå i föryngringsarbetet, utan ska också ses som ett uttryck för en utveckling mot en mer positiv inställning till björk.

Nyckelord: återbeskogning, småskaliga privata skogsägare, stormar, Götaland, Gran, återväxtstöd

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1. Introduction

The forests in Götaland, the most southern part of Sweden, are dominated by Norway spruce (*Picea abies* (L.) H. Karst). On the productive forestland (> 1 m^3 ha^{-1} yr^{-1}) of approximately 5 million hectares the volume of Norway spruce corresponds to 47.3 % of the standing stock (excluding protected areas) (SFA 2014b, p. 51, 60). This raises some concern for the future because Norway spruce is a species that is associated with certain types of risks. One of these risks is connected to the likely event of a future with a warmer climate, where the suitability of Norway spruce in Götaland remains uncertain (Bradshaw et al. 2000). Hence this justifies the adoption of risk-spreading strategies with the aim to reduce the dominance of Norway spruce (Felton et al. 2010). Another major risk is connected to wind-throw, where Norway spruce has a lower mechanical stability compared to Scots pine (*Pinus sylvestris* L.) and birch (*Betula* spp.) (Peltola et al. 2000), the other two most common species in the region (SFA 2014b, p. 60). Huge economic losses can be associated with wind damage, as was demonstrated by the consequences of the Gudrun storm in 2005.

The night between the 8 and 9 of January 2005 southern Sweden was hit by a storm, which resulted in losses of forest of a magnitude never before experienced in modern Swedish history (Holmberg 2005). Approximately 75 million m^3 (stem volume over bark) of timber was felled, the vast majority in Götaland, where 72-73 million m^3 was felled (Svensson et al. 2011, p. 8). To get a better understanding of the magnitude, one can relate this figure to the harvested volume in Sweden in 2013 of 86.3 million m^3 (SFA 2014b, p. 151) or the fact that the felled volume corresponded to approximately three years of harvest in Götaland at that time (SFA 2006, p. 149). 80 % of the volume consisted of Norway spruce, which is disproportionally high considering the fact that the proportion of Norway spruce in Götaland prior to the storm was 49 % of the standing stock (Fridh 2006, p. 17). Not surprisingly, a subsequent analysis found that the large damages partly could be explained by the high proportion of Norway spruce (Valinger & Fridman 2011). In total the storm damaged approximately 270,000 hectares (Valinger et al. 2006, p. 20), out of these between 110,000-130,000 hectares required reestablishment of new forest in accordance with the forest act (Wallstedt 2013, p. 4). The same region also suffered damages in 2007, when the storm Per felled 15-20 million m^3. In many cases Per expanded the regeneration areas that were created two years earlier in the Gudrun storm.

The ownership structure in Götaland is strongly dominated by small-scale forest holdings, controlling 77.7 % of the productive forestland (SFA 2014b, p. 36). Forest owners in Sweden have a great deal of freedom in the management of their forests due to the liberal approaches to forest governance, which characterize Swedish forest policy since 1993 (Appelstrand 2012). Taken together, this means that the species distribution in the reforestation efforts after the storms largely can be explained by individual decisions of small-scale forest owners. The regeneration decision were made in a moment of crisis, where many forest owners suffered huge economic losses due to reduced prices, higher harvesting costs and other costs associated with the storm (Svensson et al. 2011). To facilitate an acceptable regeneration result the Swedish government therefore supported the establishment of new forest through reforestation grants available from the Swedish Forest Agency (Wallstedt 2013). Another aim with the grants was to promote the establishment of broadleaves and thereby reduce the risk for future catastrophic storm events while at the same time favouring biodiversity. To achieve this, the reforestation grants were designed in such a way that the choice between Norway spruce and broadleaves was cost neutral for the forest owners.

Hence the regeneration decisions were made by forest owners that experienced the risks with Norway spruce, in an environment where the alternatives were made more economically attractive. Despite this no changes in tree species choice compared to the period prior to the storm could be detected and 90 % of the planted area consisted of Norway spruce (Valinger et al. 2014). In total the state subsidies supported 88,000 hectares of conifer plantations, the overwhelming majority with Norway spruce (Wallstedt 2013, p. 21-22). In contrast only 3000 hectares were supported for the establishment with broadleaves. However inventories by the Swedish Forest Agency showed a higher proportion of broadleaves (29 %) in the regeneration of the storm felled areas after the Gudrun storm (Wallstedt 2013, p. 26), which indicates a higher use of passive approaches to regeneration e.g. relaying on spontaneous natural regeneration of birch.

Only a few studies have examined how forest owners reasoned in their tree species choice in the aftermath to the storms and which factors that were decisive for the final outcome. Lidskog & Sjödin (2014) performed a secondary analysis of four studies (Ingemarson et al. 2006; Guldåker 2009; Sellerberg 2011; Linné 2011), which dealt with various issues connected to the Gudrun storm, two of them (Sellerberg 2011; Linné 2011), partly with the regeneration of the storm-felled areas. They concluded that the high proportion of Norway spruce in the reforestation activities could be explained by the fact that forest owners in their decision were guided by an experience-based knowledge of growing spruce. Alternatives, such as broadleaves, were considered uncertain and thereby more risky. Forestry in Sweden is conducted in a liberal regulatory environment where transfer of information and advice are crucial policy tools to influence how forest owners manage their forest and facilitate well-informed decisions (Appelstrand 2012; Brukas & Sallnäs 2012). This task is largely conducted by regionally stationed forest consultants representing private as well as public interests (Blennow 2008). In the storm damaged areas the Swedish Forest Agency, the forest owner association SÖDRA and the timber-buying organisation Sydved constitutes major stakeholders. According to Lidskog & Sjödin (2015) forest consultants representing these organisations were also uncertain about the alternatives to Norway spruce and hence hesitated in promoting them in their contact with forest owners. This lowered the efficiency of the measures taken by the Swedish Forest Agency to promote species diversity in the reforestation efforts.

This thesis will investigate the choices of tree species by small-scale forest owners in the region most severely damaged by the Gudrun storm. The time period spans the decade that lapsed since the Gudrun storm until now. In addition to a longer period of analysis, this study differs from earlier work (Lidskog & Sjödin 2014) by not limiting the investigation to factors making owners to choose Norway spruce. The current study also considers factors favouring the use of other tree species. The aim with this study is thus to investigate forest owners reasoning and influential factors connected to different tree species choices since the Gudrun storm. The following research questions will be addressed:

- Which factors can explain the high dominance of Norway spruce in regeneration activities?
- Which factors favoured regeneration with other species?

2. Study context

2.1 Forest composition and ownership structure in Kronoberg

The study was conducted in Kronoberg County, situated in southern Småland. This is a largely forested part of southern Sweden and the coverage of productive forestland corresponds to 78 % (81.6 % if unproductive forestland (<1 m^3 ha^{-1} yr^{-1}) are included) (SFA 2014b, p. 51). Norway spruce dominates the forests, together with a substantial proportion of Scots Pine and birch (Table 1). However since the region is situated in close proximity to the northern edge of the nemoral zone (Aldetun 1997) there is also a small proportion of noble broadleaves[1] such as oak (*Quercus* spp.) and Beech (*Fagus sylvatica* L.) (Table 1). Kronoberg County was the region that suffered the most severe damages in the Gudrun storm, which felled 18.3 % of the standing stock (Svensson et al. 2011, p. 8). The region also suffered damages in the storm Per in 2007 (Wallstedt 2013). The total standing volume today amounts to 94.4 million m^3 (Table 1) (SFA 2014b, p. 61), compared to 114 million m^3 prior to the storms (SFA 2006, p. 57). The disproportionally high losses of Norway spruce (Fridh 2006) have also modified the species distribution in terms of the proportion of total volume. Prior to the Gudrun storm Norway spruce was even more dominant and corresponded to 57.1 % of the standing stock (SFA 2006, p. 57).

Table 1. Total volume (million m^3) of different species and species composition (% of total volume) on all forestland (productive and unproductive) in Kronoberg (SFA 2014b, p. 61).

Species	Volume (million m^3)	% of total volume
Picea abies	46.4	49.2
Pinus sylvestris	29.2	31.0
Other conifers	0.2	0.2
Betula spp.	11.4	12.1
Other broadleaves	3.2	3.4
Quercus spp.	2.5	2.6
Fagus sylvatica	1.2	1.3
Other noble broadleaves	0.2	0.2
Total	**94.4**	**100**

In Kronoberg private forest owners control 78.6 % of the productive forestland (SFA 2014b, p. 36), the ownership structure being representative for Götaland in general. Hence these are the owners that through their decisions largely determine the composition of the forest landscape. Moreover, with such a high forest cover these decisions have a great importance in shaping the landscape in general. Private forest owners manage their forest based on objectives that are characterised by diversity on two levels. Firstly, to own and manage forest is connected to the fulfilment of a multitude of different objectives, which apart from timber production and economic efficiency also includes objectives connected to recreation, nature conservation and aesthetical values (Hugosson & Ingermarson 2004). Secondly, there is a great diversity among private forest owners in the valuation of these different aspects, which means that the overall objectives of private forest owners are characterised by heterogeneity (Ingemarson et al. 2004) i.e. some puts greater emphasis on economic revenue while others think nature conservation is more important.

[1] The term noble broadleaves includes the following species or native species groups: Elm (*Ulmus* spp.), Lime (*Tilia Cordata* L.), Ash (*Fraxinus excelsior* L.), Hornbeam (*Carpinus Betulus* L.), Beech (*Fagus sylvatica* L.), Oak (*Quercus* spp.), Cherry (*Prunus avium* L.) and Norway maple (*Acer platanoides* L.).

2.2 Forest policy related to tree-species choice

Although Swedish forest policy since 1993 mainly is implemented through “soft “policy instruments such as transfer of information and advice (Appelstrand et al. 2012) there is still some legislation in the Forest act linked to the regeneration of new forest. In a normal situation the minimum allowable rotation age is of great importance, because it determines when final harvest is allowed (SFA 2014c). This age depends on the dominant species of the stand and the fertility of the site. However, regardless if the stand has been normally harvested or felled in a storm the forest owner is obliged to re-establish forest above the minimum acceptable seedling density with natural regeneration, seeding or planting. The required seedling density depends on site productivity and the dominant species. Concerning the choice of species the owner has a great deal of freedom and can chose among both native and exotic species. Although there is a stipulation in the forest act stating that the species need to be suitable to the site conditions this seems to be quite liberally applied in practice. For example in the area affected by the Gudrun storm the use of naturally regenerated birch was generally accepted by the Swedish Forest Agency, as a consequence of the liberal governance approach since 1993 (Wallstedt 2013). If naturally regenerated birch would be excluded the approval rate of the regenerations of the areas felled in the Gudrun storm would drop from 85 % to 50 % (Wallstedt 2013, p. 28). Hence this practice of implementation makes it much easier for forest owners to pass the minimum seedling density required.

There is one field where the regulations concerning tree species choice are more detailed and consequently restricts the authority of the forest owners. This concerns areas dominated by noble broadleaves where regeneration with noble broadleaves is mandatory (SFA 2014c). This legislation was adopted in 1984 with the purpose to guarantee the maintenance of these forests for the future (similar legislation for Beech dominated forest had existed since 1974) (Enander 2007, p. 261-262). Due to the high establishment costs of these species the regulation is combined with subsidies available through the Swedish Forest Agency (SFA 2015a). The grants covers 80 % of the total establishment cost (fencing, scarification, and seedlings) as well as 60 % of the cost for pre-commercial thinning. However since noble broadleaves constitutes 3.9 % (SFA 2014b, p. 61) of the standing stock in Kronoberg County this prescriptive legislation only concerns a small proportion of the forest area.

The grants that supported the regeneration of the storm-felled areas after the Gudrun storm were available during 2006-2010 (Wallstedt 2013). In total 330 million SEK were granted for the regeneration of approximately 91,000 hectares. To achieve cost neutrality between Norway spruce and broadleaves the amounts granted were highly variable. An owner who applied for support of a plantation of conifers received 3000 SEK/ha while the support for a plantation with broadleaves or noble broadleaves varied between 19,800 - 36,000 SEK/ha. This large variation within the broadleaved/noble broadleaved group is explained by the fact that the cost per hectare of fencing, which was a requirement to receive financial support for these species, is extremely size dependent. Forest owners could also receive subsidies for natural regeneration with native species susceptible to browsing i.e. Scots Pine and broadleaves/noble broadleaves (except birch and Beech). Since this alternative didn’t include the cost for any seedlings the amounts granted was consequently lower (6400 - 19,500 SEK/ha). The areas regenerated in the aftermath to the storm Per didn’t receive any financial support from the government.

In addition to the formal governance approaches adopted by the state to address issues connected to forest management there is also a parallel process of non-state governance through forest certification. In 1997 the first Swedish FSC (Forest Stewardship Council) standard emerged, after a process of negotiations between the forest industry, environmental NGOs and other stakeholders (Johansson et al. 2012). In 2000 a competing standard named PEFC (Programme for the Endorsement of Forest Certification Schemes) was adopted, initiated by the forest owner associations. Today both these voluntary standards are widespread within the forest sector in Sweden, with approximately 11.3 million hectares certified according to PEFC (PEFC 2013) and the corresponding figure for FSC of approximately 12 million hectares (FSC 2013). The certification standards require a certain proportion of broadleaves at both estate and stand level (Table 2). There are also restrictions concerning the usage of exotic species (Table 2). Hence apart from the detailed regulations connected to noble broadleaves, regulations relevant for the choice of species are mainly found within the voluntary non-state governance model of forest certification.

Table 2. Requirements in the certification standards (FSC and PEFC) concerning the maximum proportion of exotic species (% of productive forestland), minimum proportion of broadleaved dominated stands at estate level (% of productive forestland) and minimum proportion of broadleaves at stand level (% of total volume at the end of rotation) (PEFC 2012, FSC 2014).

Certification standard	Max proportion (%) of exotic species at estate level	Min proportion (%) of broadleaved dominated stands at estate level	Min proportion (%) of broadleaves at stand level
FSC	5*	5	10
PEFC	25	3	5

* Only includes exotic species planted since 2009

3. Theoretical underpinnings

Rational choice and institutionalism are among the most common theories used in forest policy analysis (Arts 2012). Both theories provide valuable perspectives when examining forest owners' choice of species. According to rational choice humans act to fulfil their self-interest (Arts 2012). With this approach outcomes can be understood by examining how different alternatives conforms to the objectives of the decision maker. However rationality is considered to be bounded, meaning that the struggle to maximise individual utility is restrained by the lack of sufficient knowledge. Institutionalism rejects the notion that humans act to maximise their own utility, because according to this theory social structures such as rules, norms and beliefs steer individuals towards what is considered as an appropriate behaviour. Perspectives provided by rational choice are highly relevant considering that the forest in Kronoberg County is mainly controlled by small-scale forest owners (SFA 2014b, p. 36), characterised by heterogeneity in terms of their overall objectives (Ingemarson et al. 2004). Moreover, the concept of bounded rationality indicate that the level of knowledge and/or experiences of these owners is of key importance for their final decision making. Meanwhile institutionalism addresses the logic adopted by Swedish Forest Agency when imposing rules or initiating information campaigns to steer human behaviour. Hence both these perspectives need to be considered when examining forest owners' tree species choice.

However according to Arts et al. (2014) scientists show a tendency towards favour either the actor perspective (rational choice) or the structure perspective (institutionalism) in their research. Therefore they have developed the practice based approach, which focuses on examining how actor-structure interactions maintain or alter practices within forestry and/or natural resource management. This is a relevant and open-minded approach towards conceptualising forest owners' tree species choices that emphasises the importance of a detailed description of the actors and their interaction with their contextual setting.

Figure 1 shows a conceptual model of forest owners' tree species choice inspired by Arts et al. (2014). According to this model a tree species choice (practice) constitutes a site-specific entwinement of the forest owner (actor) and his/her contextual setting (structure). The structural component has been expanded beyond the focus on social structures provided by institutionalism (Arts 2012), thus also including biotic/abiotic characteristics of the ecosystem as well as the market. A forest owner's decision making will be influenced by the contextual setting where the decision takes place. However this is not a one-way process since this influence is mediated through subjective interpretation, where the characteristics of the forest owner are of key importance. Due to the liberal legislation connected to the choice of species this will be the major process explaining individual decisions, with the exception of areas classified as noble broadleaved forest where behaviour is externally imposed. After the storm certain policy fields were clearly defined e.g. Swedish Forest Agencies ambition to increase regeneration with broadleaves coupled with different levels of financial support for different species (Wallstedt 2013). However, Swedish forest policy is largely implemented by regionally stationed forest consultants (Blennow 2008), and the low number of binding rules means that policy implementation is hard to predict. Similarly to the forest owners' consultants will most likely act based on interpretation, variability in their consulting is therefore a logical consequence of differences in personal characteristics as well as the organisations they represent. Moreover, not all tree species choices are preceded by transfer of information and/or advice from forest consultants or other sources.

To summarize, differences in the characteristics of the actor and/or the contextual setting from case to case means that every tree species choice is a result of a unique actor-structure interaction.

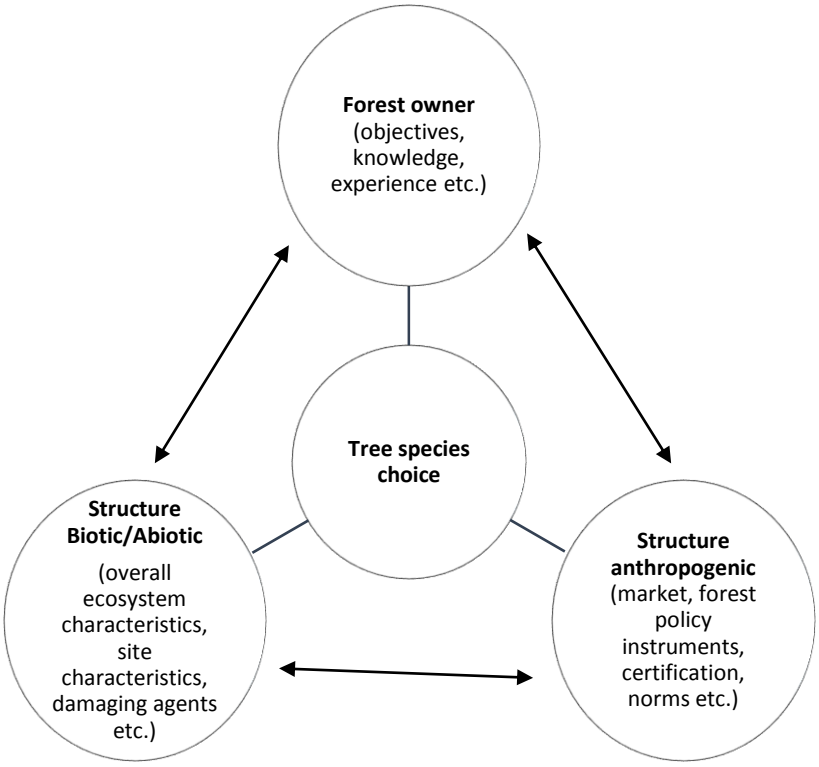

Figure 1. A tree species choice at a specific site.

4. Methods

4.1 Study approach

A qualitative approach was considered most suitable to fulfil the aim with this study. This approach puts the forest owner subjective perceptions and reasoning at the centre of the analysis. In this study the findings are therefore produced in an inductive manner, based on what the forest owners actually considered decisive in the choice of species rather than testing the importance of factors pre-determined by the researcher (deduction) (Ahrne & Svensson 2011, p. 15). This is a more just description of the drivers behind individual decisions because it takes into consideration that decisions are performed by subjective actors in a context that varies according to time and place.

4.2 Study design and analysis

The data consists of a qualitative interview with owners of seven small-scale forest holdings in Kronoberg County. Information about potential participants was gathered with the help of the Swedish Forest Agency in Kronoberg. In total three local offices in the region were contacted. The following desired characteristics of the forest owners and their estates were presented to the forest consultants: i) forest owners that owned their estates during a long period of time (at least since the 1980s) ; ii) estates with differences in terms of tree species choices and/or forest composition; iii) an existing forest management plan. The idea was to gather a wide variety of tree species choices within a small sample of forest owners. The fact that a long ownership period was considered crucial has to do with the fact that the initial aims of the study was more extensive in terms of the time period considered. The initial thought was to investigate influential factors and reasoning behind private forest owner's tree species choices as far back in time as their ownership would allow. Hence to be able to maximise the historical dimension forest owners with a long continuity in their ownership were required. The desire to interview owners with a forest management plan was seen as a way to facilitate the communication during the interview as well as making the gathered material more credible. In a forest management plan past decisions are manifested in the description of the forest composition, especially at stand level. Hence to use the forest management plan in the interview situation can thus help the forest owners to better remember past decisions, something that will increase the credibility of retrospective interview data.

A final selection of the forest owners suggested by the forest agency was conducted based on compliance with the desired characteristics. Some forest owners were also excluded based on other aspects that were considered important. This adhered to some estates with many owners, where it would be hard to reassure that all owners that were active in the management of the estate could participate. In some cases forest owners were also excluded because their silvicultural knowledge was expected to be unrepresentatively high. The initial goal was to interview 5-10 forest owners. Nine forest owners were considered suitable and were consequently contacted, out of these two decided to not participate.

The interviews were conducted during the period 7 - 23 of April 2015. They were semi-structured (Kvale 2009) which means that the interviews followed an interview guide but at the same time allowed for the interviewer to ask follow-up question. If it was possible to handle logistically and the forest owners were willing to participate the interviews were preceded with a round tour on the estate. Out of the seven interviews four involved field visits lasting 0.5 – 2 hours, however on one

occasion this took place after the interview. The pre-interview field tours were a valuable asset because it facilitated the emergence of relevant follow-up questions and the questions could be more precisely formulated when the interviewer had a better knowledge about the estate in general. It is likely that this also improved the quality of the retrospective interview data by facilitating the memory of past decisions. The main focus in the interviews was tree species choice in regeneration activities and to some extent tree species choices in pre-commercial thinning (Text box 1). However to get a good understanding of the overall context surrounding these decisions general questions concerning the forest owner, the estate and forest management as well as questions related to external influence on the tree species choice were also covered (Text box 1). The entire ownership period of the forest owners was covered in the interview, often complemented with information even further back in time. The interviews were tape recorded and lasted for 1.5 – 2.5 hours.

Text box 1. Summary of the issues covered in the interviews.

General information
- General information about the forest owner, the estate and the management during the ownership period.
- Overall objectives with the management of the estate, the importance of the economic revenue.
- Changes in the forest composition and land-use during the ownership period and the reason behind these changes.

Planting
- Tree species choices during the ownership period specified in time, the reasoning behind the different decisions.
- The most decisive factors that influenced forest the choice of species.
- Degree of perceived freedom of choice among different species.

Natural regeneration and precommercial-thinning
- The usage of naturally regenerated trees in general and which species in particular.
- Changes in tree species choice in pre-commercial thinning and the reason behind any changes.

Influence from the surroundings
- Sources of information connected to tree species choices.
- Forest management plan, influence on the suggestions in the FMP, influence of FMP on the tree species choice.
- Forest certification and its influence on tree species choice.
- Degree of self-employment in planting and pre-commercial thinning and the usage of entrepreneurs. Influence on how entrepreneur conducts the planting and pre-commercial thinning.

All interviews were transcribed completely. During the transcription and subsequent analysis a need emerged to straighten out some unclear parts of the interviews and/or to ask some relevant follow-up questions. Hence all forest owners took part in 1-3 complementary interviews, between 4 to 23 minutes long. The follow-up interviews were conducted over phone and tape-recorded. The interviews were then transcribed and added to the main transcript. The decision to limit the time frame of the analysis was mainly based in the fact that the diversity in terms of tree species choices among the forest owners mainly expressed diversity since the Gudrun storm. The interview data that dealt with the period before the storm was also hard to analyse, with fewer tree species choices and an unevenness in how long it was possible to go back in time between different forest owners. Hence the analysis focused on the tree species choice in the regeneration activities since the Gudrun storm. Both tree species choices performed through planting and natural regeneration were included. However the analysis was not solely restricted to these parts of the interview data. Information from other parts constituted a valuable asset in contextualising the individual decisions.

4.3 Ethical considerations

Prior to the interview all forest owners received a letter of information. This letter informed about: the (initial) aim of the study, student and supervisor involvement, how the interviews would be conducted and which topics that would be covered. In addition, all forest owners were guaranteed anonymity and were informed that they could leave the study whenever they wanted.

5. Results

5.1. The profile of the interviewed owners and their estates

There is a strong male dominance among the interviewed owners, only one of the participants was female (Table 3). As a consequence of the selection criteria (see Method) the forest owners participating in this study represents owners with a long period of ownership, ranging from 24 to 51 years. However, in all except one case (FO 101) this doesn't adhere to the entire forest they control today, since the forest area have expanded through purchase during their ownership period. In the case of FOs 107 the generation shift has largely taken place, since 2010 the son (X) owns 343 hectares and the father (Y) 37 hectares. They are however still managing the forest together.

Due to a long ownership period and/or being part of a family tradition of managing forest the interviewed owners overall had a lot of experience of forest management when they were faced by the consequences of the Gudrun storm. In this regard FOs 107 differ from the others. They formally controlled their estate since 1980 but up until the Gudrun storm the forest was to a high degree managed by the women's father. The consequences of the Gudrun storm as well as a more relaxed working situation have initiated a higher activity of FOs 107 during the last decade, concerning both the acquisition of knowledge and silvicultural decision-making.

Table 3. Some characteristics of the interviewed forest owners and their estates.

Forest owner	Individual code	Owner(s) characteristic	Age	Total area (ha)*	Productive forestland (ha)*	FMP	PEFC	FSC
FO 101	-	Male	49	144	96.6	x	x	x
F0 102	-	Male	72	77	70	x	x	
F0 103	-	Male	72	142	121	x	x	
F0 104	-	Male	48	374	339	x	x	x
F0s 105	Y - X	Father - Son	79 - 47	382	318	x	x	x
F0 106		Male	57	216	170	x	x	x
F0s 107 **	A - B	Husband - Wife	65 - 68	111.1	102.8	x	x	x

* Area of all properties combined within Kronoberg.

** They also owns a property (78 ha) outside of Kronoberg County.

The forest owner's control 77 to 382 hectares of land in Kronoberg County, with the corresponding figures for productive forestland of 70-339 hectares (Table 3). During the last decade all the forest owners in this study can without exception be classified as being active owners. In regard to silvicultural measures and especially reforestation, a high activity is of course not surprising due to the storm events. There are however also other factors that supports the notion that the forest owners can be regarded as active. For example all forest owners have an updated forest management plan and their estates are certified (Table 3), and even though highly variable, all forest owners in this study have performed practical silvicultural measures on their estates during the last decade. An overall impression from the interviews is that these forest owners' puts great value into owing and managing their forest and have a general interest of forestry. This is supported by the observed expansion of forest ownership, as well as a great interest in keeping up to date through participation in excursions/courses organized by various organizations and by reading forestry related papers.

The forest owners are overall characterized by a low dependency on the incomes from harvesting activities to support their livelihood. Instead it has functioned as an extra income and/or supported the maintenance of buildings and the purchase of new forest land. FO 104 differs slightly from the other owners in this regard because he has always been self-employed on his estate. However since he is involved in hunting tourism and other hunting related activities (breeding of partridges, pheasants and dogs) the incomes from harvesting activities only constitutes a small share of the total incomes.

To summarize, the interviewed forest owners are characterized by: a long continuity of ownership, a high activity within the last decade, a general interest in owning and managing their forest and a low dependency on the incomes from harvesting activities to support their livelihood. As a contrast to the other forest owners FOs 107 have mainly been involved in forestry during the last decade and consequently acquired their understanding of forestry more recently.

Table 4 shows the species-specific total area regenerated for each owner during the last decade. Overall a vast majority of the area regenerated was due to damages inflicted by the storm events. Norway spruce has been the most dominant species in reforestation for all forest owners, corresponding to 51-84 % of the regenerated area.

Table 4. Area (ha) of regeneration with different species, total regenerated area (ha) and proportion of Norway spruce (% of total regenerated area and % of total planted area) since the Gudrun storm.

Species	**F0 101**	**F0 102**	**F0 103**	**F0 104**	**FOs 105**	**FO 106**	**FOs 107**
Picea abies	11.7	3.35	19	13	41*	25-27	21
Pinus sylvestris (planted)	0.4	0.35					
Pinus sylvestris (n-regeneration)				3			
Betula spp.	1.7						2.5
Natural regeneration (mainly birch)	1.5	2.5	10			7-9	
Fagus sylvatica							3
Fraxinus excelsior			2				
Quercus spp.	0.5						3
Hybrid aspen	2.3				3.5		
Populus	0.7						
Curly Birch							3
Hybrid larch	0.6		1.5	3	2.5		
Picea sitchensis	0.4				1.1		
Pseudotsuga menziesii	0.2				0.5		
Abies grandis	1.5						
Picea omorika	0.2						
Abies procera	0.2						
Picea pungens	0.2						
Acer platanoides	0.1						
Prunus avium	0.1						
Tilia cordota	0.1						
Alnus glutinosa	0.5						
Total regenerated area	**22.9**	**6.2**	**32.5**	**19**	**48.6**	**34**	**32.5**
Norway spruce (% total regenerated area)	**51**	**54**	**58**	**68**	**84**	**74-79**	**65**
Norway spruce (% total planted area)	**55**	**95**	**84**	**68**	**84**	**100**	**65**

* On 5.7 hectares they utilised naturally regenerated birch as the main species when the planted Norway spruce suffered high mortality.

5.2 Regeneration with spruce

5.2.1 Problems with pine

It is very evident from almost all the interviews that the browsing pressure on Scots Pine has played a decisive role in the tree species choices since the Gudrun storm. In the interviews some forest owners expressed a will to have more Scots pine on their estates and that this species has a great value on drier sites and/or sites with lower fertility. Hence for two forest owners (FO 101 and FO 102) the will to perform site-adapted tree species choices has resulted in the establishment of plantations with Scots pine, however the fear of browsing damages limited the planted area. For other forest owners the massive damages that they assumed a Scots Pine plantation would suffer meant that this species was not considered a realistic alternative:

> "*I have an idea, where it is G26* (site-index), *one could plant pine instead. But you can't do it, the moose takes it. But we will try now* " FO 105/Y

In the interview FOs 105 expressed a wish to have more Scots pine on their estates, a species which they believe would produce as good as Norway spruce on sites with moderate fertility (G26). However the high browsing pressure meant that they anyhow have regenerated these types of sites

with Norway spruce. Hence to some extent the browsing pressure has limited their ability to perform site-adapted tree species choices. F0s 105 also experienced that the browsing pressure has gone worse during the last decades. Their will to regenerate with Scots pine still exists and they will try in the near future, they are however clear on the fact that the success largely depends on the use of browsing repellents.

FOs 102 is one of the forest owners that despite the high browsing pressure regenerated with Scots pine after the Gudrun storm. He wanted to establish Scots pine on an area he considered as too dry for Norway spruce, and where the previous generation of that species suffered from root rot. There were however problems to get hold of enough seedlings, and to increase the area planted with Scots pine he therefore mixed it with Norway spruce. The total area corresponded to 0.7 hectares. To achieve an acceptable result he annually applied sheep wool on the pines, which he had read should have a protective function. Today the treetops are out of reach of the moose and he has succeeded in establishing Scots pine on a site where he considers it to be the best alternative. This is an indication of the workload that might be required to regenerate Scots pine with good result in Kronoberg without the use of fences, which is something that FO 102 has a negative attitude towards. However the fear of browsing has favoured the use of Norway spruce, because FO 102 use of Scots pine was restrained since he considered it a risky alternative:

> *"Of course, now I know how you could have done* (with the sheep wool). *I planted 1.000 seedlings, and it went well, but if I had planted 10.000, then I don't know how that would have turned out. Had the moose or deer eaten it all, 10,000 seedlings for example, it had been difficult to manage. Both financially and operationally."*
> F0 102

The browsing pressure is however not a factor that restrains the use of Scots pine everywhere in Kronoberg. FO 104 has a pine dominated property with a lower fertility compared to the estates of the other forest owners in this study. He had no problem to regenerate Scots pine both prior to and after Gudrun, except during a period with a lot of roe deer's during the 1980s. His tree species choices have always been based on site-adaption, Scots pine on the poorer sites and Norway spruce on the richer ones. Broadleaves have not been considered as a viable alternative due to the low fertility. There is one factor that has made him favour Norway spruce on sites with moderate fertility, where he is convinced that it grows as good as Scots Pine:

> *"Actually all the time since then* (1986) *it's been some problems with the pine timber, what's mostly been harvested is spruce. The richer areas have been harvested. Tougher and tougher with the pine timber."* F0 104

The difficult market for pine timber has influenced the tree-species choice of F0 104 during his entire ownership period. Apart from choosing Norway spruce whenever it is "growth neutral" the disproportionally high use of Norway spruce in regeneration activities can also be explained by a market situation that steered his harvest activities towards areas suitable for Norway spruce. During the last decade he regenerated 13 out of 19 hectares with Norway spruce. Apart from the factors already mentioned the high proportion of this species is also partly explained by the Gudrun storm, because it steered his regeneration activities in a similar manner as the market i.e. mainly damaging

areas suitable for Norway spruce. Even though F0 104 knows that he, compared to many other forest owners, can regenerate with Scots pine and get a good result, he has not made full use of this advantage. The high proportion of regeneration with Norway spruce is in line with his long-term goals:

> *"That's also my goal* (to get more Norway spruce)*, to get a better balance in the tree-species distribution. It becomes easier to manage marketwise if you have both pine and spruce"* F0 104

F0 104 also mentions that he experienced that planted Scots pine suffers from poor quality. This has not restricted his use of Scots pine, but resulted in a situation where he, until now, only regenerated naturally with seed-trees. According to FO 106 Scots pine is not suitable on his estate because the soils are too productive to get any decent quality. Apart from that he also mentions problems with the market situation and browsing. Hence in his valuation of the feasibility of Scots pine, all the problems found in this study are incorporated simultaneously. The lack of regeneration with Scots pine during his entire ownership period can therefore be explained by a very negative attitude towards its potential:

> *"Now I sold logs to Sydved in an felling assignment, the spruce cost 700 SEK and the pine 600 SEK (…) Then it's not particularly stimulating, you work against better judgement from all directions* (if you plant pine)" F0 106

To summarize, forest owners in Kronoberg see problems with Scots pine that have restrained its use for a long time, both prior to and after Gudrun. The most severe problem has been the high browsing pressure. In a conifer dominated region such as Kronoberg a restrained use of the second most common conifer species tends to favour the use of Norway spruce in reforestation activities.

5.2.2 Benefits with spruce

For some forest owners the decision to regenerate with Norway spruce has been quite uncomplicated because they see it as a species with many advantages (Table 5). These forest owners mentioned slightly different reasons to why they planted spruce, covering aspects mainly connected to forest management, growth and market demand. The overall picture is that these forest owners planted Norway spruce because it is considered to be the most profitable species. They have also owned spruce dominated properties for decades and are familiar with what they see as a quite undemanding management regime. Even though they have felt restricted in their ability to regenerate with Scots pine (See 5.2.1) their choice of Norway spruce is still largely based on site-adaptation, because they consider their estates to be dominated by land suitable for growing Norway spruce.

Table 5. Some examples of quotes describing motivations for planting Norway spruce.

Quote	Relevant aspects
"In some way, a lot of our lands are good for spruce, so much comes naturally, that it becomes spruce again." FO 105/X	-Site-adaptation
Y: "*It is the profitability.* X: *Rewarding tree species, easy to regenerate.* Y: *Tough species* X: *That's what we have today, you never know how it looks like in 50 years. That's where you have the economy, the economic backbone on a property like this."* FOs 105/Y-X *"Because I felt that it is what gives the best economy. It's quite easy to manage, I am used to it and I know how to do."* FO 103	- Economic rationality - Easy to manage - Experience
"It grows relatively quickly and get started and grows out of the low stage quickly. That is what is fundamental for the choice of spruce." FO 103	- Fast growing
"It is that you get better quality, you get good quality on the spruce. If I say, if you look back the spruce have had a higher demand here, regardless if you sell it as standing timber, timber or sawn goods the spruce has been… it has had a wider range of uses" FO 106	- Wood quality - Market demand

5.2.3 Stakeholder involvement and normative pressure

A recurring topic is that forest owners prior to their tree species choices often have discussed or consulted different stakeholders in their environment, which have been critical for the final outcome. There are some examples in the interview data that suggest that the reforestation decision after Gudrun was performed in an environment that was focused on Norway spruce and/or where alternatives were considered problematic. This influenced some forest owner's through different paths and ultimately led to a higher proportion of Norway spruce compared to the initial plan.

One reason why FOs 102 kept his Scots pine plantation with sheep wool at a small scale was the influence from his neighbours. He was well aware of the problem with browsing, but the comments from neighbours, who considered it to be an unwise alternative, amplified his uncertainty regarding the potential success of planting pine:

> *"About 1000 seedlings* (pine). *Planted every other spruce and pine. It was a bit the pressure from the neighbours that made me not plant more pine. They said that the moose will eat them all"* FO 102

FOs 107 had large areas on two different properties to regenerate after Gudrun, both formerly consisting of Norway spruce forest. On the smaller estate the women's father had planted Norway spruce on agricultural land during 1956-1962, stands that almost entirely blew down in the storm. Faced by the consequences of past decisions their initial thought was to regenerate with broadleaves, since they feared that reforestation with Norway spruce would once again result in economic losses. This was however not in line with the opinions of their surroundings, where relatives, the forest agency and especially the forest companies argued for a continued use of

Norway spruce. This quote describes the type of advice they received from the forest companies on their smaller property:

> "*…To plant anything else than spruce was considered odd, especially when you talked to the forest companies, they didn't think it was much to consider. They said that it is what is most economic* (spruce). *Then I said that it doesn't seem so good because it blew down. But then they said: that it's still the best economy* (spruce)*, it was just* a coincidence (the storm damages), w*e had not learnt enough about storms, now we know more (…). But the entire industry and everybody that knows about forest thought that we should plant spruce. "* FO 107/A

It is evident from this quote and from the entire interview with F0s 107 that they feel that the forest companies active in their region are very spruce orientated. The experience by F0s 107 indicates a consulting with a low degree of flexibility, focused on convincing, rather than adapting, to the scepticism of F0s 107. At the end F0s 107 planted three hectares with Norway spruce on their smaller estate and 18 hectares with Norway spruce on the larger one. They say that it was an independent decision, that they gathered and valued information from various sources and based on this made their final decision. However, their uncertainty about which way to go meant that an environment that largely spoke with the same voice, had a decisive impact on their final decision. The result was a higher proportion of Norway spruce compared to the initial plan. F0s 107 also mention that they felt that the grants that were available after the storm to some extent favoured the use of Norway spruce. This had to do with the fact that to obtain support for planting birch the area had to be fenced. Something FOs 107 didn't want on their smaller estate from an aesthetical point of view. An overall impression from the interview is that FOs 107 regret that they planted such a high proportion of the regeneration area with Norway spruce. This is clear from this quote, which relates to the Norway spruce plantation on their smaller estate:

> "It is not so strange really (what will happen), thousands of seedlings were planted during the 50-60's, and they blew down, then it's clear that it will blow down again." FO 107/B

The fact that FOs 107 today regret their high usage of Norway spruce is connected to positive experiences of the performance of birch (naturally regenerated and planted) during the last decade, which was the main alternative on the sites where they regenerated with Norway spruce. In their large Norway spruce plantation (18 ha) they have consequently saved a lot of naturally regenerated birch in the precommercial-thinning, thus allowing a high degree of flexibility concerning the future species distribution. However, FOs 107 were not willing to follow the recommendations to plant Norway spruce on the entire storm-felled area. On some areas they had other priorities and consequently chose differently (See 5.3.2 and 5.3.3).

It took a couple of years to clear the regeneration areas after Gudrun, which put FO 106 in a new situation. There was one area, 5-10 ha, with massive birch regeneration and F0 106 who never had planted anything else than Norway spruce before, considered to utilise the naturally regenerated birches instead of planting. He thought it would be interesting to add some diversity to his otherwise highly spruce dominated property and at the same time avoid the costs associated with site preparation and planting. However his respect for the opinions of forest consultants in the area,

combined with an uncertainty about the performance of naturally regenerated birch on these types of sites, meant that this idea was abandoned:

> *"You can say that they* (forest consultants) *are somewhat traditional. It is quite hard to motivate things like this (….). Because it is also the forester, it is that it should be planted, you can say that you would have stepped on their toes a little bit by doing it"* FO 106
> *"Yes, if you talk with everybody that is here* (say that it is best to plant), *SÖDRA and Sydved and such. Then it's so that in such a case you have to more or less go your own way a little bit. It takes hell of a long time, if you say that you have accidentally made the right decision, it will take hell of a long time to get it proven, it takes 20 years, it is not like if you put oat or wheat on a field, then you will see in the autumn"* F0 106

Formally F0 106 had a high degree of freedom in his tree species choice, and in the interview he mentions that the use of naturally regenerated birch would not result in any legal sanctions from the Swedish Forest Agency. However, this would not be in line with the silvicultural norms of the forest consultants, which is clearly indicated by his use of the expression "stepped on their toes ". Generally FO 106 seems to be a forest owner that wants to conduct a forest management that receives recognition. A recognition that is easier to receive if your methods are in line with the dominant silvicultural norms of your surroundings. Apart from the Swedish Forest Agency he is mainly in contact with forest consultants from Sydved. FO 106 was also uncertain about the suitability of naturally regenerated birch due to the site conditions, which he describe as average and bit hilly. At the end he planted the entire area with Norway spruce, which is a decision that he seems to regret today. That his lack of experience in this specific case straightened the influence of dominant norms is clear considering other regeneration decisions performed within the last decade. Out of the 34 hectares regenerated since Gudrun 7-9 hectares were left unplanted. The discrepancy is due to differences in site conditions. The unplanted areas had wet and peaty soil, scarification was therefore problematic. By experience he also knew that on these sites plenty of birch generally establish after clearance, followed by Norway spruce. Consequently he was more certain to succeed and therefore felt that he could act more independently.

5.3 Regeneration with other species

There are many different factors that have favoured regeneration with other species than Norway spruce. This is a consequence of the diversity of trees species choices found in the interviews but also reflects differences among the forest owners in terms of the factors they incorporated in their decision making process. In addition, rather than a single major driver decisions can often be explained by an aggregated combination of many different factors. Here follows the most important factors, which alone or in combination have steered the reforestation decisions towards a lower dominance of Norway spruce.

5.3.1 Experiences drawn from the storm

All forest owners lost considerable volumes of Norway spruce in the storm Gudrun in 2005. Many owners also experienced damages in the storm Per in 2007, and in the aftermath to the storms when Norway spruce was harvested in salvage cuttings due to bark-beetle attacks. For some of the owners this experience changed how they value different tree species in terms of risk and/or economic

potential. However, the pathway between experiences drawn and substantial change is not always straightforward. This has already been demonstrated by the tree species choices of F0s 107 (See 5.2.3). In the following two examples from the interviews, certain changes in the tree species choice can be traced back to changed attitudes inflicted by the storms. However, it is also evident that these changes at the same time are hold back by past experiences of the profitability of Norway spruce.

F0s 105 have been influenced by the Gudrun storm and the debate that followed. They now have a more positive view towards broadleaves; one of the reasons is that they consider them to be more wind-firm. However, there is one factor that has restrained their use of broadleaves since the Gudrun storm:

> "*It is the only thing that gives any money* (spruce). *It has to do with the profitability. There must be more research concerning broadleaves and they need to come with results* (concerning the economy)*, then I think one can increase it even more*"
> F0 105/Y

F0s 105 want to achieve a high production and economic revenue in their forestry and see Norway spruce as the main species to achieve this goal (See 5.2.2). Their uncertainty with the potential of broadleaves combined with some failures with plantations in the past restrained their use of broadleaves after the Gudrun storm to 3.5 hectares plantation of Hybrid aspen (*Populus tremula x Populus tremuloides*). The more positive view towards broadleaves has mainly manifested itself in pre-commercial thinning, where they saved a higher proportion of naturally regenerated birch. They also relayed heavily on naturally regenerated birch in a failed Norway spruce plantation of 5.7 hectares, thus avoiding the need for supplementary planting. Hence due to uncertainty with broadleaves it was a rational decision for F0s 105 to utilise some of the birches that came naturally, free of charge, rather than to make investments.

Since Gudrun F0 103 is aware of the risks connected to a spruce oriented forestry. In the area that was most heavily struck by the storm he draw the conclusion that Norway spruce is not suitable and established two hectares of Ash in 2007, supported by the reforestation grants from the Swedish Forest Agency. Unfortunately he was not aware about the potential risk of Ash dieback and the stand has consequently suffered a high mortality rate. He didn't receive any information about this risk from the forest consultants from ATA timber and the Swedish Forest Agency, who he had contact with during the decision making process. This can probably be explained by the fact that Ash dieback was a quite new phenomenon in Sweden at that time (Barklund 2015). However F0 103 sees Norway spruce as a species with many advantages (See 5.2.2) and therefore regenerated more than half the storm-felled area with this particular species. His positive attitude towards Norway spruce means that the risk of storm damages is a risk worth taking:

> *"I think that you have to take a little risk with the spruce anyhow* (with storms)*. Of course it takes a while but when they gets 30* (years old) *it gives a good revenue."*
> F0 103

There is one owner were the linkage between the experience of Gudrun and subsequent tree species choices is very clear. FO 102 is an owner who made very few clear felling prior to Gudrun because he

used the estate as an alternative form of retirement savings. This meant that he had a lot of old Norway spruce forest that was lost in Gudrun, an experience that changed his way of thinking:

> *"…You should try to get them* (the stands) *as wind-firm possible. All the spruce that went down was actually devastating. Therefore I strive for mixed forest if it's possible. Pine and spruce and broadleaves in some form, that's my goal and I steer it to the extent I can influence in that direction."* F0 102

In the regeneration activities that followed he embraced a risk-adverse strategy, with a clear intention to favour regeneration with broadleaves and Scots pine. The experience from the storm made him believe that these species are more robust and that using them consequently lowers the risk of catastrophic storm events in the future. Since Gudrun his goal to strive for mixed forest is evident both at estate level i.e. favouring establishment of stands with different dominant species, as well as stand level i.e. favouring species mixtures. After the storm he left 2.5 hectares without any measure, thus utilizing naturally regenerated birch as the main species. He has also utilized the naturally regenerated birch to form a spruce-birch mixture on one out of three hectares planted with Norway spruce. Apart from expressing a will to match sites with the suitable species, his small-scale trail with Scots pine can also be seen as a manifestation of this strategy. However as already described, the use of this species was restricted by the fear of browsing and problems to get hold of seedlings (See 5.2.1 and 5.2.3).

5.3.2 Different economical reasoning as a legitimation of broadleaves

Prior to their tree species choices forest owners evaluated the potential of different alternatives and here the supposed economical potential often played a decisive role for the final decision. When the valuation was based on knowledge gained from experience, combined with an aim to achieve high economical yield from wood production, forest owners often decided to plant Norway spruce (see 5.2.2). However, when the past is seen as a poor representation of the future, or when a different view on forest economics is applied, forest owners might arrive at a different conclusion. Here I will present two different cases where forest owners saw regeneration with broadleaves as a rational economical investment after the storms.

F0 101 decision to partly regenerate with broadleaves after the storms can be explained by his view of the future. This quote is a good example where he describes another main goal with the management of his estate, in addition to getting an economical return:

> *"The other part is to spread the risks. I believe that it will become warmer, we will have a warmer climate, I believe that the broadleaves will cope better so to speak (…). I have worked within the wood industry at SÖDRA, there is a great potential there too. We have lost a lot of knowledge on what you can use the trees for. I believe that's a value that will come back."* F0 101

F0 101 thinks that the conditions for forestry will change and he has some ideas about a likely direction. He thinks that the warmer climate will favour the performance of broadleaves while at the same time potentially put Norway spruce at risk. With his background he is also aware about a potential to increase domestic supply of broadleaved wood and he has witnessed a positive

development with increased demand on the market. The decision to decrease the proportion of Norway spruce was therefore a rational economic decision, with an emphasis on adapting his species distribution to supposed future conditions. F0 101 therefore established two fenced broadleaved plantations with a total area of 5.7 hectares. One area was planted with Hybrid aspen and birch, the other with Hybrid aspen, birch, populus (*Populus maximowiczii x Populus trichocarpa*) and four different species of noble broadleaves. Both supported by the grants that were available through the Swedish Forest Agency to increase the regeneration with broadleaves after the storm. Apart from these two broadleaved plantations he has also planted 0.5 hectares of Black alder (*Alnus Glutinosa* L.) and left approximately 1.5 hectares without any measure, where naturally regenerated birch now dominates. However the shift towards broadleaves has not been radical, and about half of the area regenerated has been planted with Norway spruce. This was due to the fact that he considered it to be a safe-card with a better market situation. The overall picture is therefore quite complex, because spruce was considered to be both a security and a risk. His regeneration decisions since Gudrun have therefore been a trade-off between the merits and risks of Norway spruce, and here the time frame is crucial to understand his thinking. In a short perspective the market situation is favourable for Norway spruce, while with a longer perspective a warmer climate constitutes a potential risk. The final decision has been a compromise between these two different views.

In 2009 FOs 107 bought a larger estate by the same lake as their other estate is situated. In the area there is an ongoing process to create a national park and a lot of recreational tourism, were people come with canoes and camp on their estate. This influence on how FOs 107 think about the economic return from their estates:

> *"It's important* (economic return). *That's the thing, then you can have different views on what the economy is. We can say that we might have put a greater emphasis on that the economic value on X* (the larger estate*) and also on XX* (the smaller estate) *is the natural values. It's not the forest. But we don't do this without considering economic aspects if you understand what I mean, it's only a different plan."* FO 107/A

From the interview it is evident that F0s 107 also incorporate aesthetical values in the term "natural values". Nevertheless, this different view regarding the main source of the economic return is evident in the management of their newly bought estate. Here they have future plans to build cabins and rent them to people that come to the area to experience the nature. By doing so they also hope to exploit the larger flow of people that may come when the national park has been established. This plan had a large influence on their tree species choices. On the areas close to the future cabins and on a cape in the lake they planted nine hectares of broadleaves, with an equal proportion of Oak, Beech and Curly birch. Out of this, six hectares were fenced, supported by the grants from the Swedish Forest Agency. With a larger share of broadleaves they wanted to increase the nature- and aesthetic values and thereby create a more attractive environment for paying visitors in the future. Hence the choice of broadleaves was regarded as an economical rational decision because a future investment in cabins benefits from being placed in a recreationally friendly environment. The future plans with the recreational village and the associated broadleaved plantations are also an expression of a solid economy, which gives FOs 107 access to the possibility of utilizing the natural/aesthetical values as a source of economic income.

On the areas further away from the future cabins (18 hectare) they listened to the recommendations from Vida and planted Norway spruce, even though they initially had other plans (see 5.2.3). The rationality for the choice of Curly Birch can be understood with issues included in section 5.3.4. Reflecting a curiosity to try a species that potentially can yield a very high economic return. However their long-time goal is that also this area should be transformed to noble broadleaves by utilizing naturally regenerated trees when the Curly Birches are harvested.

5.3.3 Aesthetical values

Almost all forest owners have some areas on their properties where they take aesthetical values more into consideration and since broadleaves are considered to have higher aesthetical values these forests are often broadleaved dominated. There is often a zonation within the estates, where these stands are situated in proximity to areas where there is a bigger flow of people and/or higher perceived beauty e.g. houses, roads, meadows and lakes. If these stands are of high age they are generally classified as NS/NO (nature conservation with/without management) in the forest management plan and therefore not managed for wood production. Some have been established or modified with active measures such as planting or selective removal of Norway spruce, while others have just been kept untouched. Since the storms felled a lot of spruce forest it opened up the possibility to improve the aesthetical values through the establishment of broadleaves. There are a few cases where aesthetical values played a role in the final tree species choice e.g. FOs 107 in the case just described (see 5.3.2). I will present two additional cases, where aesthetical values favoured the establishment of birch.

F0 102 is an owner who takes aesthetical and recreational values much into consideration in the management of his forest. Apart from the desire to favour a species distribution that is more tolerant to storms (See 5.3.1) these values also played a decisive role in his choice of birch. In this quote he describes were the birch stands are situated and one aspect that motivated him to regenerate with this particular species:

> *"They were situated in the proximity to the house* (where he regenerated with birch)*. I mean it was a little bit park like that I wanted it to be that way, close to the houses you want to have broadleaves instead of dark spruce forest"* F0 102

After the Gudrun storm FO 102 ceased the opportunity to increase the perceived beauty of his estate. In areas where aesthetical values had a higher priority, such as close to his house, he chose to leave the clear-cuts without any measure and utilize the naturally regenerated birch. The goal was to create an environment with more light as a contrast to the former generation of dark spruce forest.

As already mentioned the two estates owned by FOs 107 are located by a lake in an area where there is ongoing work to create a national park. On both estates there are substantial proportions of old noble broadleaved forest. On their smaller estate (36 hectares) this forest is considered so valuable that a nature reserve of 12 hectares has been created. FOs 107 highly appreciates the beauty of their estates and its surroundings, this had an impact on their management where aesthetical values are seen as very important. This influenced the reforestation after Gudrun, this quote relates to their smaller property:

''In that process we thought that because it's such a small property, if you plant spruce, the wood you can get in that time is rather small because it's such small areas, then it feels unnecessary to walk in it all these years. That's why we planted broadleaves along the road, around the house we only have broadleaves, then we planted here (points on a map) because it was so close to the water" F0 107/A

Some years prior to the storm F0s 107 harvested a Norway spruce stand and regenerated naturally with birch. The motive was to increase the level of light close to the house. Then Gudrun came and felled 5.5 hectares of Norway spruce. On a small property the value of the wood production from spruce, expressed by the forest companies (See 5.2.3), couldn't outweigh the negative aesthetical aspects on the entire storm felled area. They followed the recommendations given from the forest companies and planted Norway spruce on three hectares. However on 2.5 hectares, located by the road and by the lake they made a different valuation and planted birch. Here the opportunity to continue with the aesthetical improvements of their estate was considered more important. Since aesthetics was a key priority they didn't use any fences on these plantations. Thus accepting a higher establishment cost, since fencing was required to obtain financial support.

These two examples (and also FOs 107 in section 5.3.2) indicates that one factor that seems important for the tree species choice after Gudrun is the location of the storm felled stands. Areas that were blown down in core parts of the estates, where aesthetical values are considered more important, were more likely to be regenerated with broadleaves than areas further away. This suggestion is also strengthened by the fact that this type of reasoning has been decisive in regeneration decision also prior to the storm. For example FO 101 harvested a Norway spruce stand in 1999 in proximity to his house and established a stand of mixed noble broadleaves to increase the perceived beauty. The same motivation made FOs 105 establish birch in proximity to a meadow on one of their estates prior to the Gudrun storm. Hence consideration of aesthetical values is a factor that favoured broadleaves in general, not only in the period since the Gudrun storm.

5.3.4 The opportunity to experiment

The interviews cover all the tree species choices forest owners have conducted during their entire period of ownership. It is therefore possible to conclude that for the majority of the interviewed forest owners the diversity of species has increased since the storms. Apart from the aspects already covered, this express a general interest in trying something new. The fact that large areas of clear-cuts were created within a short period of time stimulated many of the interviewed forest owners to try species they never tried before on smaller parts of the regeneration areas. For the forest owners that planted broadleaves the reforestation grant available through the Swedish Forest Agency was often a prerequisite for their final decision. Since prior experience with these species was largely lacking the decision can sometimes be traced back to information received during forest excursions organized by different forest related organisations and/or inspiration from forest consultants.

The forest owners that planted Hybrid larch, Sitka spruce (Picea sitchensis (Bong.) Carr), Douglas fir (Pseudotsuga menziesii (Mirb.) Franco) and Grand fir (Abies grandis (Dougl. ex D. Don) were all attracted by the potentially high growth rates of these species. The most frequently used exotic tree species among the forest owners in this study was Hybrid Larch. FO 101 and FO 103 planted Hybrid larch on drier areas, where Norway spruce was considered unsuitable and susceptible to root rot. In

an environment where regeneration with Scots pine is very problematic (See 5.2.1), Hybrid larch was the best option for FO 101 on these types of sites because he knew from experience that they were more tolerant to browsing.

Two of the forest owners planted Hybrid aspen after the Gudrun storm. The same type of motivation guided their decision:

> *"After Per and Gudrun one wanted something that grows quickly"* FO 105/Y
> *"After Gudrun another factor was to experience forest again on that area. Alright, hybrid aspen, 40 years maybe, then you have a forest. That's something I am a little bit attracted to"* FO 101

The storms had a large effect on the appearance of the forest, transforming large areas to bare ground. Forestry in general and in Sweden in particular is an activity with long-time perspectives. This means that the period between reforestation and the feeling of having a "real" forest can be quite long, something you might never experience again in your lifetime. This made Hybrid aspen an attractive species for FOs 105 and F0 101. Because its rapid initial growth and short rotation period means that it hopefully will grow in height quickly, hence it constituted a short-track to the feeling of having a real forest again. FO 101 also planted Populus based in the same type of motivation.

The will to try new species is something that varied between different forest owners. For some the lack of prior experience was a restraining factor while for others it seems to be the other way around. For F0 101 the will to try new species has played a major role in the tree species choices since Gudrun. Combined with a positive view regarding the future potential of broadleaves (See 5.3.2) this has resulted in a large diversity in his tree species choices. His will to experiment is not only indicated by the diversity of species but also by the layout of his plantations. This is clear from this quote, in which he describes a regeneration decision some years after the storm:

> *"I made a clear-cut in an area that was severely infested* (bark-beetles) *that became an extension of another clear-cut. There I planted half the area with the standard spruce from Södra. On the other half I tried douglas* (*Pseudotsuga menziesii*), *serbian* (*Picea omorika* (Panč.) Purk.)*, cascade* (*Abies procera* Rehd.) *and blue spruce* (*Picea pungens,* Engelm.)*. Planted approximately 200-250 of the different varieties. Only to see and compare."* F0 101

The layout of some of the plantations established by FO 101 seems to be somewhat inspired by scientific field trials. On this area he used Norway spruce as a reference, next to small quantities of different exotic species to compare their growth. In another plantation he directly mentions the use of a Norway spruce "reference" to compare the growth with Hybrid aspen and birch. The will to aggregate many different species is also evident from one of his fenced broadleaved plantations, where more than seven different species were planted on approximately two hectares. Taken together it is clear that the tree species choices of FO 101 have been influenced by his large interest in trying new species and compare their performance. However, since he kept his plantations with new species quite small and also aggregated many species together, Norway spruce has still been planted on about half the regeneration areas since Gudrun.

FO 101 is the only forest owner in this study that mentions a potential conflict with the certification standards, in his case as a result of his high use of exotic species. Overall the certification has had a negligible effect on the tree species choices of the forest owners and the knowledge about the stipulations concerning species distribution is highly variable. However FO 101 is double certified (FSC/PEFC) and aware about the requirements, which he tries to follow. He thinks he is close to the maximum proportion of exotic trees allowed but not really certain, because he don't know whether or not Hybrid aspen and Hybrid larch are defined as exotic.

5.3.5 Opportunistic use of birch

It is evident from some of the interviews that certain circumstances connected to the regeneration decision in the aftermath to Gudrun differed compared to a normal situation. Rather than removed at once, the former stand were sometimes gradually removed due to multiple damaging events. For F0 101 and F0 103 this favoured the use of passive regeneration approaches on parts of the regeneration areas, where they highly relayed on naturally regenerated birch. For both owners the gradual removal meant that a lot of naturally regenerated birches were already established when they made their final decision. Thus they took the opportunity to use this source of seedlings rather than to invest in active measures. While the use of this approach was limited to approximately 1.5 hectare for FO 101, it accounts for a large proportion of the area regenerated by FO 103 during the last decade (10 hectares).

For FO 103 groups of trees were still remaining after the storm on these areas, groups that were attacked by bark beetles and consequently harvested a few years later. This meant that the naturally regenerated birch got a head start and the decision to utilise this source of seedlings gradually emerged:

> "*It is quite hard to say* (when he decided to utilise the naturally regenerated Birch), *because it emerged gradually when I saw that that it was such a god natural regeneration of Birch on that area. It was not something that I decided in advance so to speak."* FO 103

F0 103 did not consider regenerating with birch at first but when he witnessed the natural course of succession he decided to utilise the stems provided rather than to invest in active regeneration measures. However a high initial domination of naturally regenerated birch doesn't mean that the stand needs to maintain this high dominance in the future:

> "*The nice stems are remaining* (of birch after precommercial thinning*), I will thin if spruce comes from beneath, and let the spruce emerge when it's possible. If a lot of spruce emerge that will be the main thing in the future*" FO 103

Similar to many of the other forest owners in this study, F0 103 knows by experience that the shade-tolerant Norway spruce often emerges when the birch are already established. Due to his positive attitude towards this species (See 5.2.2 and 5.3.1), the future species distribution in the stand therefore remains uncertain.

As a final remark concerning birch, it is evident that a multitude of factors have steered forest owners to regenerate with this species e.g. site-characteristics (F0 106), opportunistic use (F0 101 and F0 103), aesthetical values (FO 107 and FO 102), spreading risk connected to wind damage (FO 107) and climate change (F0 101). Factors that generally are owner and/or site specific. However since the interviews cover the entire ownership period of the forest owners, it is evident that the high use of birch also should be seen as an expression of a larger trend during the last decades:

> "*According to the old forest act* (prior to 1993) *you should grow spruce, brushes and birch were banned. I know that my dad struggled to get his spruce plantations to survive. They froze* (when there was no birch shelter)" FO 101
> "*Birch has become more valuable than it was 25 years ago. Now you even produce yarn out of it*" F0 103

The high use of birch should be understood against this background. Several forest owners refers to changed attitudes towards birch within the forest sector, less prescriptive legislation concerning its use, as well as an emerging market demand. Hence compared to a few decades earlier the tree species choices after Gudrun were performed in an environment where birch could be considered as a realistic alternative. Apart from being used by many of the forest owners as the main species on some areas, birch is used as an admixture in plantations, especially in wet areas, to fill-up gaps and some also mentions that it is required according to the certification standard.

5.4 Summary results

Figure 2 summarises the major factors that influenced the choice of species in this study. The factors are separated into tree different sub-groups. Personal drivers and constraints (left) describe some characteristics of the forest owners that influenced their decision making process i.e. the actor in the conceptual model (see Figure 1). Contextual drivers and constraints (right) refer to factors in forest owners' environment that influenced their decision i.e. the structure in the conceptual model (see Figure 1). These factors act on different scales e.g. some were influential for most owners while others had a more limited overall importance. Finally the key motivations (middle) summarises the characteristics and/or functions that made forest owners regenerate with a certain species. The final tree species choice with its underlying key motivation constitutes an entwinement of actor and structure i.e. practice in the conceptual model (see Figure 1). Thus a result of decision performed by subjective actors, who were influenced by and/or adopted to his/her contextual setting.

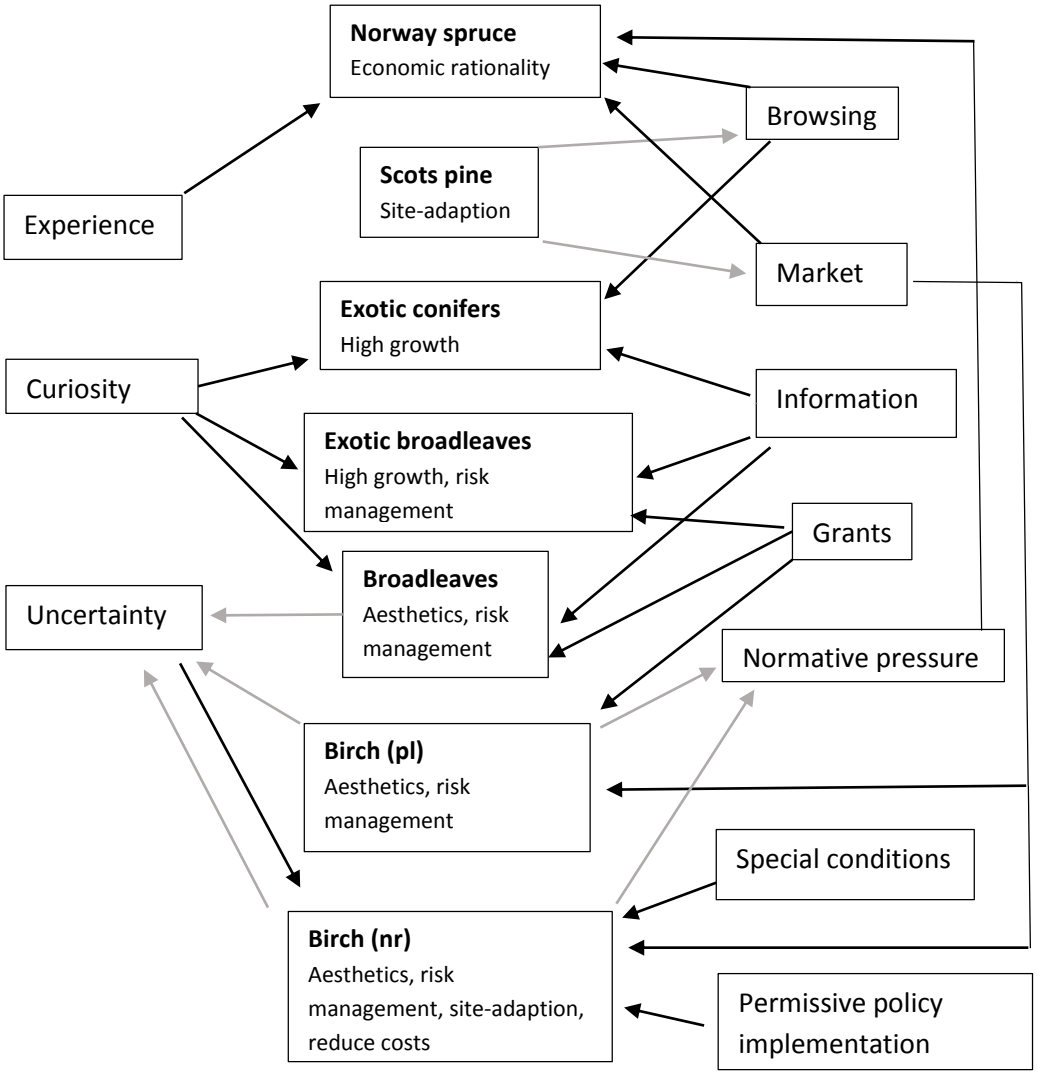

Figure 2. Summary of factors influencing forest owners' tree species choice during the last decide. Personal drivers and constraints (left), key motivations (middle), contextual drivers and constraints (right). Drivers (black arrows), Constraints (grey arrows).

5.4.1 Regeneration with spruce

The decision to regenerate with Norway spruce is related to two different mechanisms. Firstly, forest owners regenerated with Norway spruce based on the species own merits. High growth rates, simple management regime and good market situation means that this species is considered as economically attractive. The decision to regenerate with Norway spruce was also strengthened by the fact that this belief is not based in theoretical assumptions, but rather knowledge acquired through own experience. The second mechanism relates to contextual setting that steered the regeneration decision towards this species. The prevailing high browsing pressure in Kronoberg makes regeneration with Scots Pine very problematic and thus favours the use of Norway spruce. The interview with F0 103 indicates that even when browsing is not limiting its use, a spruce dominated market can be a restraining factor. In some cases when forest owners considered alternatives (Scots pine and birch through natural regeneration/planting), their uncertainty amplified the influence of dominant norms, thereby steering their regeneration decision towards Norway spruce.

5.4.2 Regeneration with other species

For several forest owners in this study the large regeneration areas created by the storm stimulated a curiosity to try something new. This curiosity can sometimes be traced back to information received during forest excursions and/or contact with forest consultants. The reforestation efforts were also performed in a favourable contextual setting, where the grants available for fencing stimulated establishment of broadleaved plantations.

Affected by the consequences of the Gudrun storm, the use of broadleaves was stimulated by an awareness of future risks of storms. In addition, one forest owner regenerated with broadleaves to safeguard against climate change. Regeneration with broadleaves was also associated with the ambition to enhance the aesthetical qualities of the forest.

Birch was the second most common species in this study. In addition to the key motivations and contextual drivers already covered this is largely a result of the fact that this species has been favoured by the high use of passive regeneration approaches. The liberal governance style that characterise Swedish forest policy means that forest owners can rely on naturally regenerated birch without facing any legal sanctions. Since birch often establish without difficulty it has been used as a species to relay on during special conditions. This relates to areas felled in the Gudrun storm that were considered too wet for planting or when the plantation of Norway suffered heavy mortality. Another special circumstance that favoured regeneration with birch in two cases was a gradual stand removal in the aftermath to the Gudrun storm. This gradual removal meant that the forest owners utilised naturally regenerated birches that were already established instead of planting. The high use of birch in this study is an expression of more positive attitude towards its potential that has developed during the last decades, where forest owners witnessed an emerging market demand. However, lack of prior experience still means that regeneration with birch often was associated with uncertainty. In this regard the permissive policy concerning the use of naturally regenerated birch has been of great value, because it enabled forest owners to utilize this species without making investments.

The curiosity with new species especially manifested itself in the establishment of exotic species. Some forest owners have been attracted by the potentially high growth rate of exotic conifers and broadleaves and planted them on minor parts of the regeneration areas. Of these species Hybrid larch has been most frequently used, apart from being motivated by higher growth rates two forest owners have also used it as a substitute for Scots Pine on poorer sites. For FO 101 the will to try new species has been a driver towards diversity in its own, not always complemented with a perception that certain species has a great potential (the small scale trials with *Picea omorika*, *Pseudotsuga menziesii*, *Picea pungens* and *Abies procera*).

6. Discussion

6.1 Research method

This study is based on extensive qualitative interviews with few informants. With this approach it was possible to acquire a level of understanding concerning specific tree-species choices that would not be possible to obtain with quantitative surveys. However a key concern connected to qualitative approaches relates to what degree the findings can be generalized as representative of a larger population (Svensson & Ahrne 2011, p. 28).

The findings of this study are based on decisions performed by forest owners that can be characterized as more active and interested than the average forest owner. This is not surprising considering the selection criteria as well as the selection procedure. The intention was to interview forest owners with a forest management plan, and the selection procedure was partly outsourced to the Swedish Forest Agency. The owners participating are therefore most likely forest owners whom the local forest consultants know better due to more frequent contact, which is an indication of a more active forest management. In addition, apart from the described selection criteria, other characteristics of the forest owners and their estates (property size, importance of income from forestry etc.), which are known to influence forest owners' management strategy (Eggers et al. 2014) were not considered. However there are no Swedish studies that have examined the influence of such characteristics on forest owners' tree species choice.

This qualitative study provides indications of factors that might have been influential on the larger scale, where the general validity can be tested in future quantitative surveys. Due to the inductive approach the findings holds great value as input for such surveys, since it provides suggestions of influential factors that otherwise might be overlooked by researchers.

Even though it is not possible to draw a statistical inference, the results concerning Norway spruce can with a higher certainty be said to provide indications to the general situation in Kronoberg County. This species was planted by all forest owners, owners with different priorities in their management as well as different attitudes towards Norway spruce. Some of the findings related to this species also conform to results in earlier studies (Lidskog & Sjödin 2014; Lidskog & Sjödin 2015) as well as other important sources of information (SFA 2015b; SFA 2015c). The findings concerning other species are more fragmented, which is not surprising considering that this involves a high number of species. At the species level these results are often based on few of the participating owners, hence it is less likely that all influential factors have been presented.

6.2 Factors favouring regeneration with Norway spruce

Regeneration with Norway spruce was to a high degree based in an economic rationality. Most forest owners in this study experienced that this species is a reliable volume producer on their forestland, at the same time as the assortments produced are requested on the market. This is in line with the findings of Lidskog & Sjödin (2014) who found that forest owners relayed on experienced-based knowledge of growing Norway spruce in their regeneration decision. This species constituted 90 % of the area planted after the storm (Valinger et al. 2014), which suggests that this type of reasoning have had a decisive impact in shaping the forest landscape of Kronoberg.

Steering through dominant norms was found to favour regeneration with Norway spruce in a few cases. This mechanism is actually a manifestation of how the liberal governance approach adopted by the Swedish state is supposed to work (Appelstrand 2012). Forest owners are given a lot of freedom concerning the management of their forests, at the same time as transfer of information and advice are supposed to establish a self-regulating "code of conduct", in line with the overall policy goals. Forest consultants have a pivotal role in the implementation of Swedish forest policy. According to Lidskog and Sjödin (2015) they hold epistemic authority i.e. they are seen as reliable sources of knowledge and advice connected to forest owner's management decision. Hence it is natural that forest owners that are faced by uncertainty will rely more heavily on their authority. In this study forest consultants were found to have a twofold role, sometimes steering towards Norway spruce while in other cases acting as a valuable support for forest owners who tried other options. This is in line with the findings of Lidskog & Sjödin (2015), who found that forest consultants, representing both public and private interest, were uncertain about the performance and market demand of alternatives to Norway spruce. Thus in their contact with the forest owners some promoted alternative species, while others recommended reforestation with Norway spruce.

Considering the relaxed regulatory environment the individual characteristics of forest consultants are most likely of key importance for their provision of services. In this regard promotion of Norway spruce might have been amplified by inaccurate assumptions about private forest owners' objectives. A survey conducted in 2002 found that forest consultants overestimates the importance forest owners puts on timber production (Kindstrand et al. 2008). Since forestry in Kronoberg is focused on Norway spruce and the forest consultants were uncertain about the economic potential of other options (Lidskog & Sjödin 2015), such a discrepancy would promote a spruce-oriented consulting. Moreover, consultants that represent organisations that are dependent on a continuous supply of Norway spruce will most likely promote these interests in their contact with forest owners. This suggestion is supported by a local-case study from Kronoberg County (Guillén et al. 2015).

However forest consultants steering towards Norway spruce found in this study can't be seen as contrary to the ambition of the Swedish Forest Agency. Their influence favoured active reforestation measures when forest owners considered to entirely or partly rely on naturally regenerated birch. The first paragraph in the Forest Act states the overall orientation of Swedish forest policy: "*The forest is a national and renewable resource. It shall be managed in such a way as to provide a valuable yield at the same time preserve biodiversity…..*"(SFA 2014c). The subsidy system created after the can be seen as manifestation of this orientation. Trade-offs between the production goal and conservation goal meant that a certain type of species diversity was promoted, namely diversity obtained through active measures.

The moose (*Alces alces* L.) are known to prefer Scots pine to Norway spruce (Shipley et al. 1998). In this study a high browsing pressure was the most important factor that restrained the usage of Scots Pine, consequently favouring Norway spruce and in one case Hybrid larch. That browsing is a large-scale problem in southern Sweden, not restricted to the forest owners in this study, is evident by the results from the latest inventory of browsing damages on Scots Pine (ÄBIN) (SFA 2015c). Showing that young forest of Scots Pine in entire Götaland suffer from severe or very severe browsing damages. Moreover, this study indicates that this situation limits forest owner's possibilities to perform site-adapted tree species choices. This finding is supported by the latest ÄBIN-inventory

from Kronoberg, showing that Norway spruce was planted on more than half of the sites classified as unfertile (SFA 2015b), sites where Scots pine is the most suitable species.

6.3 Factors favouring regeneration with other species

This study shows that a forest owner that manages his/her forest based on multiple-objectives (Hugosson & Ingermarson 2004) will not be satisfied with only relaying on Norway spruce. Norway spruce is seen as a producer of timber, not a species that is preferred from an aesthetical point of view. To uphold aesthetical qualities on their properties forest owners therefore strived to maintain or add some species diversity, and regarding aesthetical values broadleaves are considered as superior. This is in line with a Danish study showing that broadleaved forest is preferred over Norway spruce for recreational purposes (Jensen & Koch 2004). After the storm some forest owners ceased the opportunity to improve the aesthetical values on areas of special concern. The fact that forest owners' overall objectives are characterised by heterogeneity (Ingemarson et al. 2004) suggests that this type of motivation might have been an important driver for the decision to regenerate with broadleaves.

Regeneration with broadleaves was favoured by the awareness of the risks connected to future storms and climate change. This is in line with findings from survey studies, which shows that forest owners' use of active measures to manage the risk of wind-damages (Blennow 2008) and climate change (Blennow 2012) are increasing. To manage these risks by increasing the share of broadleaves is not only in line with the policy adopted by the Swedish Forest Agency after the Gudrun storm, but also supported by scientific studies (Bradshaw et al. 2000; Valinger & Fridman 2011). However a tree species choice involves managing a number of different risks with different time frames. Moreover, risk trade-offs mean that decreasing one risk often increases another. While regeneration with Norway spruce involves future risks of wind-damages and climate change, this species has been shown to be a profitable alternative in the current contextual setting of Kronoberg. Thus even though most forest owners in this study have changed their views concerning Norway spruce due to the storm events, changes in tree species choice have partly been restrained by their experience of the merits of this species and/or uncertainty concerning alternatives. That this sort of reasoning restrained the use of other alternatives is in line with the findings of Lidskog & Sjödin (2014).

The high use of naturally regenerated birch among several of the forest owners in this study is in line with the findings of inventories performed by the Swedish Forest Agency (Wallstedt 2013). The use of naturally regenerated birch as the main species was an active tree species choice, where forest owners applied their knowledge about the successional dynamics of the boreal ecosystem on suitable sites or used birch opportunistically where it was already established. The Swedish Forest Agency tried to favour species diversity in the regeneration of the storm-felled areas by supporting active regeneration with broadleaves and Scots pine (Wallstedt 2013). However the forest owners in this study are situated in a region where birch generally establishes well naturally after clearance, at the same time as the liberal forest policy implemented since 1993 means that forest owners can rely upon this source of seedlings. Thus in this contextual setting it is valuable to include natural regeneration when evaluating forest owners regeneration decision in the aftermath to the storm. According to Lidskog & Sjödin (2014) forest owners didn't regenerate actively with broadleaves because they were associated with a lot of uncertainties. This study suggests the barrier towards change is not as high when forest owners can rely on naturally regenerating seedlings rather than

making investments. In addition, this study shows examples of “active use of passive approaches”, conducted by forest owners that have a more positive view towards the potential of birch. This suggests that forest owners’ will to change towards other species than Norway spruce might be underestimated if one only considers the area actively regenerated, which was the case in Lidskog & Sjödin (2014).

It is evident that for several forest owners in this study the large areas that were created in the Gudrun storm triggered a will to try new species. However previous experience with the species chosen were often lacking, which were found to be a major restraining factor in an earlier study (Lidskog & Sjödin 2014). Thus why were not these forest owners restrained by uncertainty to the same degree? Apart from the motivations and factors that have already been covered it is likely that the characteristics of the forest owners are of key importance. The forest owners in this study can be classified as active and interested owners. Several refers to contact with forest consultants as well as forest excursions as valuable sources of information in their tree species choice. Thus their interest in forestry means that they are exposed to the soft policy tools that characterise Swedish forest policy (Appelstrand 2012). By keeping up to date these forest owners most likely made more well-informed decisions, due to a better knowledge about potential alternatives and the possibility to obtain financial support. The high interest in forestry also meant that the uncertainty, for example concerning the performance of species with potentially high growth, sometimes could stimulate species diversity by its own. The suggestion that these types of forest owners are ideal from the perspective of the Swedish Forest Agency is also supported by a study from Belgium, which found a positive relationship between forest owners’ knowledge about forestry and their acceptance of forest policy instruments (Serbryns & Luyssaert 2006).

6.4 Policy recommendations

If there is a public interest to increase species diversity in reforestation efforts also in the future, this study provides some suggestions of possible measures. The following recommendations assume maintenance of the current liberal governance style, thus relying on soft policy tools rather than prescriptive regulation.

The first issue relates to what type of diversity that should be promoted. In this study many forest owners tried exotic species after the storm, and the use of exotic broadleaved was favoured by the grants available for fencing. However frequently used exotic tree species are associated with ecological risks such as invasiveness, hybridisation with native species (Hybrid aspen) and pest/pathogens (Felton et al. 2013). Moreover, favouring exotic species with financial support and/or information efforts is problematic considering the environmental goals in the current Forest Act (SFA 2014c) and is contra productive since the usage of these species is restricted in the certification standards (PEFC 2012; FSC 2014).

The current level of browsing needs to be addressed to enable forest owners to regenerate with Scots pine. The fragmented ownership structure in southern Sweden (SFA 2014b p. 36) most likely makes it more difficult to deal with this situation, since coordinated efforts such as planting massive amounts of Scots pine is more problematic when there are a high number of stakeholders that control the forest resource. In this regard the pilot project “Mera Tall” situated in Uppvidinge municipality in Kronoberg County holds great promise (SFA 2014a). The project is a coordinated

effort at the landscape level where the goal is to establish a better balance between forage availability and the number of browsers, thereby facilitating regeneration with Scots pine. Another possible approach is to establish a system where forest owners can apply for financial support for fencing when they regenerate with Scots pine through planting or natural regeneration. However in addition to higher costs this approach doesn't address the underlying problem, since it would only redistribute the browsing damages to other areas. The fact that forest owners sometimes have a negative attitude towards fencing also indicates that it will be less efficient in promoting regeneration with Scots Pine.

With a goal to increase regeneration with broadleaves also in the future, the permissive policy concerning the usage of naturally regenerated birch should remain intact. From this study it is also evident that the reforestation grants that were available after the Gudrun storm was a key factor behind forest owners' decision to establish broadleaved plantations. At the current situation the subsidy system that is available for regeneration with noble broadleaves seems to be underfinanced. The Swedish Forest Agency therefore prioritize reforestation with noble broadleaves in already existing noble broadleaved forest (SFA 2015a). Subsidies to regeneration with noble broadleaves on "normal forestland" are included, but have the lowest priority. Adequate and long-term funding of this measure is probably decisive if the goal is to increase the share of noble broadleaves at the landscape level. Moreover, subsidies for planting birch could be another measure to consider.

However the high proportion of Norway spruce in the regeneration efforts after the Gudrun storm indicates that forest owners tend to relay on familiar practices even when alternatives are made more attractive. Therefore transfer of information, workshops, advice etc. must be crucial ingredients in an effort to stimulate regeneration with other species, policy tools that efficiently influenced several of the forest owners in this study. When experienced based knowledge is lacking and the long-time perspectives in forestry means that such knowledge establish gradually, the concept of bounded rationality (Arts 2012) indicates that a more rapid change of practices will largely depend on the provision of information.

7. Conclusion

This study examined seven forest owners' choice of species in Kronoberg County during the last decade. The vast majority of regeneration decisions during this period were due to damages inflicted by the storms Gudrun and Per. In theory every tree species choice can be regarded as unique, since there always exists some differences from case to case regarding characteristics of the forest owners and/or the contextual setting where the decision takes place. However in practice there are certain factors that are more decisive i.e. widespread perceptions and contextual factors that favour certain types of behaviour. In the past/current context Norway spruce has been and still is a reliable producer of timber requested on the market (Figure 3). Forest owners have therefore relayed on experienced based knowledge concerning the economic attractiveness of this species in their regeneration decision. Meanwhile regeneration with Scots Pine has been restrained, especially by the high browsing pressure. In an environment focused on spruce management and where active regeneration measures are favoured by forest consultants steering through dominant norms has also favoured regeneration with this species. Especially since alternatives were connected to a higher degree of uncertainty.

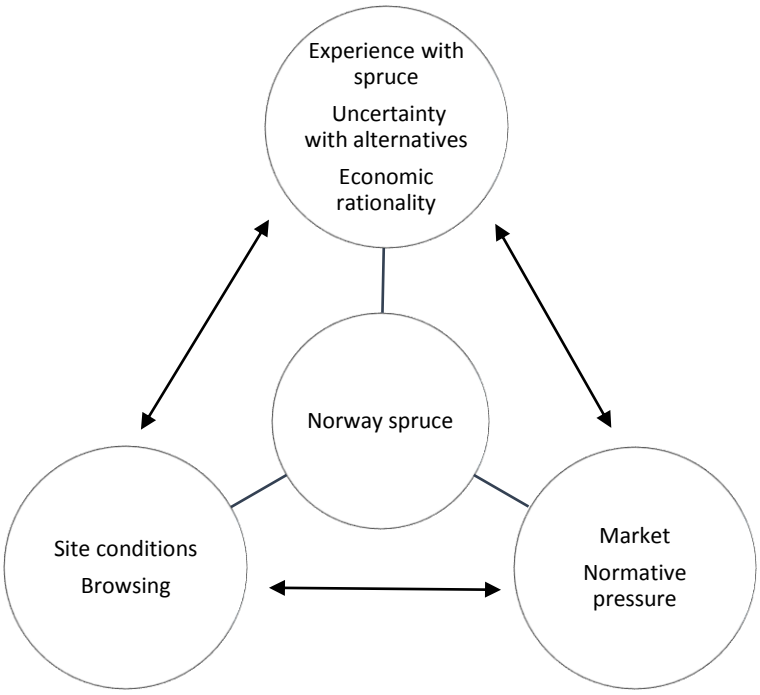

Figure 3. Factors favouring regeneration with Norway spruce during the last decade in Kronoberg County. Characteristic of the forest owner (top), abiotic/biotic structure (bottom left), anthropogenic structure (bottom right).

However, not all forest owners planted Norway spruce after the storm events. This study suggests that regeneration with broadleaves partly is an expression of multiple-objective owners, who regenerated with broadleaves to fulfil objectives related to forest aesthetics. Regeneration with broadleaves was also favoured by an awareness of the risks that are associated with Norway spruce. Large areas have been regenerated during the last decade, and forest owners ceased the opportunity to vent their curiosity with new species. In this regard different forest policy instruments have had a facilitating effect. Transfer of information and advice through various pathways stimulated forest owners will to try something new, at the same time as the reforestation grants meant that

alternatives were made more economically attractive. Consequently the grants favoured establishment of broadleaved plantations that would not been established in a normal situation. This study also suggests that the higher proportion of birch found in regenerations surveys cannot simply be regarded as an effect of lower level of ambition, but in contrast might express a shift towards a more positive attitude concerning this species.

This study is another example of qualitative studies (see Lidskog & Sjödin 2014; Lidskog & Sjödin 2015) that analysed the reforestation activities in the aftermath to the Gudrun storm. Quantitative surveys are required to gain a general understanding, examining which factors and motivations that have been most decisive for the larger population of forest owners. If such studies will rely on retrospective surveys their credibility will most likely depend on whether or not they are initiated in the near future.

8. References

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