



Ideal vs real forest management: Challenges in promoting production-oriented silvicultural ideals among small-scale forest owners in southern Sweden

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ABSTRACT

Land uses such as forestry are concerned with applying standardized management schemes to meet management goals and serve the interests of various actors. As a consequence of differences in actors' power to influence forest management, certain goals and silvicultural ideals will be promoted at the expense of others and thereby homogenize forest management. At the same time, "ideal" outcomes are often hard to achieve in practice and forest owners might not be willing to fully implement programs promoted by the state or industrial actors due to conflicting ideas. In southern Sweden a profit and production-oriented paradigm bolstered by powerful industrial forestry actors promotes clearcutting with Norway spruce (*Picea abies*) or Scots pine (*Pinus sylvestris*) on the areas managed for timber production. Through qualitative interviews with forestry advisors and desk research this study investigates challenges associated with promoting these production-oriented silvicultural ideals among small-scale private forest owners. The study highlights deviations of actual practices from the silvicultural ideals, and explores forest advisors' perceptions of causes of these deviations, thereby providing insights into challenges associated with production-oriented steering through advisory services. In the studied case, owners and advisors have had to cope with extreme storms and severe browsing damages. Interviewed advisors also perceived a number of other factors to be associated with deviations, such as lack of time or knowledge among owners, high costs associated with pre-commercial thinning and owner preferences.

1. Introduction

Silvicultural practices and systems have historically been developed as a response to human needs and various external factors outside forestry, e.g. population pressure, technical and scientific progress and economical philosophy (see Puettmann, 2009, p. 1–39). Shaped by differences in goals, problems and various contextual factors, unique "silvicultural toolboxes" were developed, which today can be discerned in different forest management traditions on sub-national or national level in Europe (for examples, see Pommerening and Murphy, 2004; Brukas and Weber, 2009; Puettmann et al., 2009; Duncker et al., 2012; Brang et al., 2014). In forestry and forest science there is a long tradition of investigating, defining and promoting "ideal types" of management schemes. Such ideals, sometimes referred to as "best practices" (Arts et al., 2013, p. 28) or "best treatments" (Puettmann et al., 2009, p. 55), are standardized courses of action oriented towards fulfilling goals promoted by powerful actors. Historically such programs were often solely oriented towards timber production, but have broadened during

the last decades as a result of the emergence of more holistic conceptualisations of sustainable forest management (Farrell et al., 2000).

Consequently, the forest management tradition of a particular country or region is normally characterized by silvicultural ideals which are promoted by the state and/or non-state actors with powerful positions in forestry. Such ideals, together with the applied mechanisms of steering (e.g. different policy instruments, see (Krott, 2005)), often act as strong homogenizing forces in forest management. As highlighted by Weiss et al. (2019), European forest owners are not situated in a vacuum but embedded in contexts that constrain available forest management alternatives. For example, in most of the former communist countries, the type of management implemented in forests is largely under state control, regardless of ownership group (Nichiforel et al., 2018). In other regions, such as Scandinavia, owners have formally a high level of decision-making freedom. However, advisory services and assistance with harvesting commercial round wood are provided by companies and forest owner associations (FOAs) promoting production-oriented ideals (Mattila et al., 2013; Mattila and Roos, 2014). As

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highlighted by Hokajärvi et al. (2011, p. 475): “The forest owner is certainly the acknowledged final decision-maker in his/her forests, but taken the strong advisory system in Finland: does the owner have the real power to make decisions?”

Nevertheless, research indicate that silvicultural ideals seldom are fully implemented in practice. A recent study (Schelhaas et al., 2018) found that traditional yield tables, developed to provide management guidance for maximise production, have limited value in explaining the harvesting pattern among European forest owners. There are several possible reasons for the apparent rarity of management ‘by the hand-book’. First, like people engaged in any human activity, forest owners and managers might struggle to meet their own and others’ expectations, and more generally various obstacles may complicate ideal implementation of any management program. Second, a growing number of typology studies, as recently reviewed by Ficko et al. (2019), show that owners nowadays have diverse objectives, needs and desires that might not be consistent with traditional timber-oriented programs. This shift in values is often coupled with the emergence of ‘new’ types of forest owners, who are (*inter alia*) increasingly urban and less financially dependent on forest incomes than previous generations (Westin et al., 2017). Accompanying tendencies of owners to favour non-timber objectives and declines in their knowledge of forest management might have negative effects on the wood supply (Kuuluvainen et al., 2014; Follo, 2011). As highlighted by Follo (2011, p. 391), forest owners might “live happily with their forest without any forestry activity: It is not the forest they move way from, but forestry”. The importance of owner heterogeneity as a diversifying factor in forest management has also been recognised in scenario studies projecting ecosystem services. Researchers have tried to capture its effects by constraining the area available for harvesting in the projections (Rose et al., 1993), and more recently by defining different forest owner types with different management logics (Eggers et al., 2015; Hengeveld et al., 2017; Mozgeris et al., 2017; Sotirov et al., 2019; Trubins et al., 2019; Lodin et al., 2020).

This study investigates challenges associated with promoting production-oriented silvicultural ideals among small-scale private forest owners in southern Sweden, a “hot-spot” region of intensive forestry in Europe (Levers et al., 2014; Schelhaas et al., 2018). In Sweden, where the silvicultural ideals are backed up with only limited legal stipulations (Appelstrand, 2012; Lidskog and Löfmarck, 2016), advisors from public and private organization share the responsibility for advising owners about production related matters. Such advisors holds epistemic authority in forest management, “a social position for authoritatively delivering recommendations within a specific domain” (Lidskog and Löfmarck, 2015, p.146) and thereby play a large role in influencing private forest owners’ management practices (Blennow, 2008). Through qualitative interviews with advisors involved in steering small-scale private forest owners on a daily basis, complemented with desk research, this study aims to answer the following two research questions:

- i) What are the main deviations from the silvicultural ideals?
- ii) What do the advisors’ perceive to be the main causes of the witnessed deviations?

Previous studies have investigated the consequences of the existing management variation on the provision of ecosystem services (Eggers et al., 2015), and possibilities to meet different levels of future wood demand (Lodin et al., 2020). Using a qualitative approach this study provides new perspectives on the decision-making contexts shaping the witnessed practices. Instead of focusing on individual practices, such as regeneration (Karppinen, 2005; Lodin, 2017), thinnings (Fällman, 2005; Karppinen and Berghäll, 2015) or final felling (Lönstedt, 1997) this study examines all major silvicultural treatments during a forest rotation. This study also contributes to the existing literature addressing “street-level” challenges with soft steering through forest advisory services. Previous Swedish studies have *inter alia* investigated

challenges associated with providing guidance in the aftermath of recent major storms, where forestry advisors played a key role in governing immediate (infestations by bark beetles) and long term (re-planting “risky” forests) threats with different levels of success (see Lidskog and Sjödin, 2016). Other studies have focused on strategies adopted by public advisors from the Swedish Forest Agency (SFA) to cope with challenges faced in their advisory practice, such as funding cut-backs and uncertainties related to the future effects of climate change (Lidskog and Löfmarck, 2015, 2016). The increased heterogeneity of small-scale owners is another challenge for both public (Lidskog and Löfmarck, 2016) and private forest organisations (Andersson and Keskitalo, 2019). They perceive to be increasingly exposed to owners with limited forest management knowledge and a more critical “consumer identity”, the later potentially undermining their epistemic authority. By investigating deviations from the silvicultural ideals promoted by powerful actors this study provides additional insights into what effects the owner heterogeneity has on practical forestry.

2. Conceptual underpinnings

In his famous book “*The structure of scientific revolutions*”, Kuhn (1962) introduced the ‘paradigm’ concept to describe the shared frame of reference, well-established knowledge and dominant methods of inquiry, of the scientific community associated with a particular discipline and time-period. The concept can also be used to describe the collective lenses characterising professions, and it has been applied in several earlier studies to describe forest management ideologies in the forest sector (e.g. Behan, 1990; Brown and Harris, 1992; Brukas and Weber, 2009; Winkel, 2014; Borrass et al., 2017). Forest management paradigms are historically conditioned and contextual, thereby reflecting the socio-economic drivers, actor constellations, dominant values and scientific knowledge of a given time and place. Silviculture, a key constituent of forest management, refers to sequentially applying treatments to forest stands in efforts to meet targeted objectives (Smith et al., 1997). The application of the ideas, knowledge and priorities etc. of a particular forest management paradigm at stand level is manifested in **silvicultural ideals**. We define these as *prevailing stand level management schemes orientated towards fulfilling dominant objectives in a studied case*, see Brukas (2015) for a similar interpretation.

Silvicultural ideals can be promoted by various means, including forest policy instruments sanctioned by the state, internal organisational guidelines, market incentives, and information exchange by various actors (Krott, 2005, p.151 – 245; Krott et al., 2014). The pathways of influence are case-specific and depend, among other things, on the governance model (e.g. hard law versus soft law), forest ownership structure and power resources of different stakeholder groups. In the studied case, characterised by soft-steering, forestry advisors play a central role. They are the “social intermediaries” (Brukas and Sallnäs, 2012) between different forest organisations (both public and private) characterised by organisational interests in promoting certain management practices, and the targeted small-scale forestry owners. Through education, training and professional work the forestry advisors have develop a prominent “professional habitus” (Lidskog and Sjödin, 2016), where the prevailing forest management paradigm and the associated ideals are the key constituents. This creates a degree of uniformity in the advisory work, where the advisors, with additional support of standardized thinning guidelines and management plans (Brukas and Sallnäs, 2012), assess stand conditions and provide guidance through similar production-oriented lenses. The promoted silvicultural ideals are not always necessarily ‘ideal’ in terms of the objectives of an individual private forest owner or even national forest policy goals, instead they describe solutions to problems defined by the interests of powerful actors in forest management. Nevertheless, in Sweden forestry advisors and their organisations holds epistemic authority in forest management (Blennow, 2008). Combined with other

power resources, such as market incentives for the produced wood assortments, advisory services thereby push the actual management practices towards the silvicultural ideals, implying that certain silvicultural systems and management intensities tend to dominate over others.

At the same time, various factors complicate implementation of the ideals in practice. First, there are wide ranges of ideas, representing the diverse set of stakeholders that are involved in, influenced by, and/or otherwise concerned with forests' management. For example, some owners might have a limited interest in active forestry (e.g. Eggers et al., 2014), others might not share the ideas of the prevailing paradigm, and utilize alternative sources for advice and information regarding their forests' management (e.g. see Eggers et al. (2020), for ideal practices defined by different actors). Second, "the proper" implementation of the silvicultural ideals might be limited by a lack of various financial, technical and human resources (e.g. knowledge see Follo, 2011), or an overall unfavourable context for active forestry (e.g. very small properties see Kumer and Malovrh, 2019). Third, nature is not always easy to 'tame' and both abiotic disturbances (e.g. storms) and biotic stressors (e.g. pests and pathogens) may impede implementation of an intended course of action and/or alter expected outcomes (e.g. see Valinger et al., 2014). All of these factors increase the heterogeneity of silvicultural practices of a particular country or region, thereby causing divergence between the ideals and the real forest management.

3. Material and methods

The case study Kronoberg County, one of ten case study areas in a larger EU project ALTERFOR,¹ is representative of the forest management context of southern Sweden. 13,700 private forest owners control 77.3 % (514,000 ha) of the productive forestland ($> 1 \text{ m}^3 \text{ ha}^{-1} \text{ yr}^{-1}$) (SFA, 2014, p. 32; SLU, 2017, pp. 81–82). The forests are dominated by Norway spruce (*Picea abies*), Scots pine (*Pinus sylvestris*) and birch (*Betula* spp.), which account for ca. 50, 31 and 12 % of the standing volume, respectively (SFA, 2014, p. 61). In a European perspective, the studied case is an example of Scandinavian small-scale forestry, where private owners constitute a strong ownership group that overall is well integrated into industrial forestry, due to their comparatively large properties, the presence of large FOAs, a long forestry tradition and well-developed markets (Keskitalo et al., 2017, p. 32–36). The studied case is characterized by well-established production-oriented ideals, substantial decision-making freedom (Nichiforel et al., 2018), but also an observed variation among the small-scale owners with regards to the applied management intensities (Eggers et al., 2014) and prioritized objectives (Ingemarson et al., 2006). Thus, a fitting instrumental case (Pickard, 2007, p. 86) for studying ideal versus real forest management, and challenges associated with soft production-oriented steering.

FOAs are influential actors in Swedish small-scale forestry (Lönnstedt, 2014) as well as in the studied case (Lodin, 2017), where the FOA Södra plays a very prominent role in promoting active forestry. They organize half of the privately owned forest in southern Sweden (SFA, 2014), own large industrial capacities, offer far-reaching advisory services (Guillén et al., 2015), educate owners in profit-oriented forestry (Kronholm, 2016), and provide the members dividends from the industrial revenue (Lönnstedt, 2014). Södra's silvicultural manual "Forest management by Södra" ("Så sköter Södra skog") (Södra, 2017) therefore serves as a very fitting source for retrieving silvicultural ideals for this study. The manual provides a summary of Södra's silvicultural guidelines to assist their staff engaged in provision of advisory services to private forest owners.

The two selected silvicultural ideals, the clearcutting system with either Scots pine or Norway spruce, are the dominant silvicultural

programs promoted towards private forest owners on the area managed for wood production. This is a goal normally assigned to approx. 90 % of the productive forestland on private owners' properties. Due to differences in suitable site conditions and in the management programs (see section 4) we categorize the two species into separate silvicultural ideals. These two ideals only constitute a small share of all possible production-oriented programs (e.g. see different management programs for broadleaves in Södra, 2017, p. 65–67). Other production-oriented management schemes are undoubtedly applied in the studied case. However, the variation in the practical execution of other practices were not studied due to their marginal importance in the studied case, where the clearcutting system with the native conifers is very dominant. Retention for conservation purposes at final felling, which applies to all production stands, and implies detailed requirements for certified owners (> 10 trees and 3 high stumps ha^{-1}) (Gustafsson and Perhans, 2010; Brukas et al., 2013) were also excluded from the study due to the following reasons. Such measures form a small part of the management programs, are on average above certification requirements (13 trees and 4 high stumps ha^{-1}) (Claesson et al., 2015, p. 36) and are standardized measures over which individual private owners often exercise quite limited control (Keskitalo and Liljenfeldt, 2014).

Deviations between ideal and real forest management were identified through interviews with forestry advisors in Kronoberg, who also provided their perceptions of the causes of the witnessed deviations. We could have chosen two possible kinds of informants as direct sources of information in our investigation of the deviations. Forest owners are the ultimate decision-makers, but a large scale statistical survey would be needed to properly map the diversity of their practices and underlying motivations, with limited possibilities for contextualised insight. Instead, we chose wood buyers (from industrial actors) and state employed forest consultants from the SFA as informants for the following reasons. First, in a governance model characterized by soft policy tools, such as information and advice, rather than prescriptive legislation (Appelstrand, 2012), forest consultants and wood-buyers play a crucial role as advisors to private forest owners (Brukas and Sallnäs, 2012; Guillén et al., 2015). Thus, they normally directly interact with hundreds of forest owners and have very good overviews of the actual forest management practices in their area as well as forest owners' concerns. Second, because they each serve a large number of forest owners they can provide information on an aggregated level, which made it sufficient to interview a fairly small-sample of informants. At the same time, the advisors can also provide detailed qualitative accounts about their experiences from specific encounters with owners. Third, the interviews were part of a larger investigation aimed at detailed mapping of forest management practices (see Lodin et al., 2020), providing better insights into the 'big picture' as well as saving time in interviewing. The drawbacks associated with this sample of informants are brought up in the discussion.

The selection procedure was designed to find a group of informants with long working experience, representing different organizations and working in different areas of the county. Assisted by senior managers from three participating organizations (the SFA, the FOA Södra and wood procurement organisation Sydved), 13 potential informants (designated I 1–13) were identified, all of whom agreed to participate (Table 1). All informants had long experience of working in the forest sector in Kronoberg, including provision of advisory services for private forest owners. Each of the wood-buyers had contact with approximately 300–400 owners in defined areas of procurement, where they provide management advice to owners as an integral part of their daily work (Table 1). The SFA is the governmental agency in charge of implementing the national forest policy, where face-to-face advisory services to private forest owners traditionally has been an important implementation tool (Guillén et al., 2015; Lidskog and Löfmarck, 2016). However, the reported reduction of advisory services at the SFA, caused by centralisation and budget cuts (Appelstrand, 2007, pp. 198, 218; Lidskog and Löfmarck, 2016; Andersson et al., 2017), was manifested in

¹ <https://alterfor-project.eu/>

Table 1
Characteristics of the interviewed informants.

Informant code	Organization	Current main work duties	Working experience*
I1	Södra	Buying wood, advisory services	30
I2	Södra	Buying wood, advisory services	20
I3	Södra	Buying wood, advisory services	35
I4	Södra	Buying wood, advisory services	28
I5	Södra	Buying wood, advisory services	28
I6	SFA	Nature conservation grants	37
I7	SFA	Forest management plans	38
I8	SFA	Regulatory supervision	22
I9	SFA	Forest management plans	41
I10	SFA	Nature conservation	18
I11	Sydved	Buying wood, advisory services	10
I12	Sydved	Buying wood, advisory services	27
I13	Sydved	Buying wood, advisory services	23

* In the forest sector in Kronoberg county (years).

the work duties of the interviewed SFA consultants (Table 1). At the time of interviews, two of five interviewed forest consultants were still engaged in provision of face-to-face advisory services for private forest owners, primarily in connection with the preparation of forest management plans. Although the SFA as an organisation is less production-focused than the industrial actors, promoting the typical even-aged management programs of the native conifers remains central in the production forests (see Normark and Fries, 2019, p. 142–144), making their consultants suitable informants for the purpose of our study.

Twelve recorded semi-structured qualitative interviews (Kvale and Brinkmann, 2009) were conducted during the period 6–22 February 2017 at the workplace of each interviewee (I9 and I10 participated in the same interview). Each interview lasted 90–190 min and was fully transcribed. The interviews were also conducted to collect information about forest management practices among small-scale owners for another study (see Lodin et al., 2020). The interviews therefore addressed a wide range of topics related to forest management by private forest owners, such as characteristics and practices of different owner types, variation within the dominating silvicultural practices, less common practices, nature conservation and the informants' views regarding the future. This study focuses on parts of the interviews that addressed variation within the dominating silvicultural practices, i.e. variation within even-aged management of Scots pine and Norway spruce stands (Table 2). In line with the semi-structured nature of the interviews, the two questions in Table 2 elicited preliminary comments related to this topic. The interviewer subsequently “dug deeper” by asking spontaneous additional questions to obtain more detail about how and why mentioned practices deviate from the silvicultural ideals.

The empirical data were analysed thematically, following the step-by-step guide by Braun and Clarke (2006). The coding process was data-driven (i.e. inductive) and directed towards describing the informants' views regarding causes of the deviations from the silvicultural ideals. All the coded data extracts were ordered in a codebook, which formed the basis for constructing themes that structured the perceived causes according to their relation to different silvicultural treatments (e.g. perceived factors causing deviations in precommercial thinning). The informants' accounts were triangulated (Miles and Huberman,

1994, p. 266–267) against other sources to validate and further describe current management and the identified deviations between the ideals versus real practices. These included statistics, books, peer-reviewed research papers, as well as SFA reports. These sources were selected based on their relevance and the availability of specific information for the studied case. Thus, they include sources providing specific information about Kronoberg County, complemented with information valid for small-scale forestry in southern Sweden and/or Sweden generally (for examples, see Table 4). The informants described deviations, as well as many (but not all) of the perceived causes, are therefore backed up by information from other sources.

4. Background to the studied silvicultural ideals

In Sweden the forest sector constitutes an important part of the economy, accounting for approximately 3 % of GDP (Forest Europe, 2015, p. 182), and the country is the third largest exporter of forest products globally (SFIF, 2018). Forest management practices are heavily oriented towards producing pulpwood and timber of Norway spruce and Scots pine, two species that combined constitute 89 % of the annual consumption of industrial round wood (SFA, 2014, p. 193). From being heavily debated and used in parallel during the first part of the 20th century, clearcutting replaced selective cutting in the 1950s, and has been totally dominant ever since (Lundmark et al., 2013).

The Swedish forest management paradigm has been characterized as strongly profit-oriented (Brukas and Weber, 2009). The prevailing economic rationale can be related to two economic schools, the Bodenreinertragslehre (soil rent) and Waldreinertragslehre (forest rent), which date back to the emergence of forest management in central Europe (Puettmann et al., 2009, pp. 6–9). The soil rent school treats forest management as any other type of financial investment, the purpose being to maximize the internal rate of return or Net Present Value (NPV) at competitive discount rates. In contrast, the forest rent school disregards the value of time and associated delay between investment cost and revenue, and thus aims to maximise the cash-flow. In a European perspective, the Swedish forest management paradigm is closer to Bodenreinertragslehre ideas (Brukas and Weber, 2009), favouring shorter rotations and more cost-effective silvicultural practices (e.g. planting leas seedlings, fewer and more intensive thinning) than regimes in many other European countries. However, rather than maximizing the internal rate of return, which in boreal conditions would often imply exploitative clearcutting with no regeneration efforts, the widely used discount rate of 2–3 % reflects an adaptation to the feasible sustainable limits of profitability within forestry (Brukas et al., 2001; Brukas and Weber, 2009). Finally, although the prevailing economic thinking promotes harvesting before the culmination point of the mean annual increment (MAI), the production losses associated with such programs are modest due to the flatness of the MAI-curve around the

Table 2
Questions in the interview guide used to elicit data this study is based upon.

Based on the dominant silvicultural practices in Kronoberg County (clearcutting system with pine/spruce) and the recommendations you give in association with your work with advisory services/wood procurement, which treatments (regeneration, pre-commercial thinning, thinning, final-felling) are the private forest owners generally best/worst at performing in a proper way?
What are the reasons why private forest owners are more/less prone to conduct this treatment (regeneration, pre-commercial thinning, thinning and final felling) in a proper way?

Table 3

Silvicultural ideals for Scots pine and Norway spruce stands at typical sites (H_{100} Pine = 24, H_{100} Spruce = 28, where H_{100} Pine and H_{100} Spruce are dominant heights of the respective species at 100 years, in metres) in southern Sweden (Södra, 2017, pp. 34, 63-64). Minimum allowable rotation ages are 65 and 60 years at H_{100} = 24 and H_{100} = 28 sites, respectively (SFA, 2019b).

Scots pine			Norway spruce	
	Height	Description	Height	Description
Regeneration		Scarification, planting 2800 seedlings ha ⁻¹		Scarification, planting 2500 seedlings ha ⁻¹
1 st PCT*	1–2 m	Mainly birch removal	1–2 m	Mainly birch removal
2 nd PCT	2–4 m	Mainly birch removal to 2500 trees ha ⁻¹	2–4 m	Mainly birch removal to 2200 trees ha ⁻¹
Thinning	13 m	To 1650 trees ha ⁻¹	14 m	To 1300 trees ha ⁻¹
Thinning	17 m	To 950 trees ha ⁻¹	19 m	To 700 trees ha ⁻¹
Thinning	20 m	To 650 trees ha ⁻¹		
Final felling	24 m	At ca. 100 years age	25 m	At ca. 75 years age

* Note: PCT = pre-commercial thinning.

Table 4

The most prominent deviations between the silvicultural ideals and the real practices, together with the witnessed (storm felling) and perceived (owners' motives) causes according to the informants.

Silvicultural treatment(s)	Type of deviation	Description	Main cause(4)
Regeneration	Tree species choice	> 50 % of the pine sites planted with Norway spruce (SFA, ÅBIN 2015–19).*	Fear of browsing damage
PCT	Level of activity	37 % of the young forest area (dbh < 10 cm) in immediate need of PCT (SLU, 2017, p. 82, 89). ** 25% of the young forest area never treated with any PCT (Claesson et al., 2015, p. 34). **	Short-term costs, lack of time.
Thinning	Poor economic result	High harvesting costs in the first thinning due to high stand density.	No or low intensity PCTs.
Final felling	Intensity and timing	Less final felling (0.88 % of the area annually) than forest companies (0.95 %) despite more productive land (Lidestav et al., 2017, p.122). *** Longer rotations than silvicultural ideals (Fries et al., 2015). **	Owners' preferences.
PCT, thinning, final felling	Level of activity, timing	Reduced activity in PCT and commercial thinning after storm Gudrun (Valinger et al., 2014). * 18 % of the standing stock in Kronoberg felled by storm Gudrun (Holmberg, 2005). *	Storm fellings

In: *Kronoberg county, **southern Sweden, ***Sweden.

culmination (Fries et al., 2015, p. 24).

Table 3 exemplifies the two silvicultural ideals, the clearcutting system with Scots pine or Norway spruce, for stands managed for production on typical sites in southern Sweden. The difference in fertility of typical sites for the two species shown in Table 3 is aligned with standard guidelines in southern Sweden, which recommend reforestation with Scots pine on poor sites, Norway spruce on richer sites, and on average sites both species are suitable. In certified forest (71 % of the productive forestland in Kronoberg by 2018, SFA, 2019a) stands should not be pure monocultures since the certification standards require a small admixture of broadleaves throughout the rotation (e.g. min. 10 % of stand volume in FSC) (Brukas et al., 2013).

5. Ideal vs real forest management

The actors supporting the current paradigm and the associated ideals have high overall success in promoting active forestry among private forest owners, nationally, as well in the studied case. Despite the increasing heterogeneity of private forest owners (Ingemarson et al., 2006; Haugen et al., 2016; Westin et al., 2017) their silvicultural activity on national level has increased in recent decades (Lidestav et al., 2017; p. 129). The utilization intensity (harvest/gross increment ratio) on productive forestland excluding the formally protected areas is 67 % nationally (2014–2018) and 83 % in southern Sweden (calculations based on SLU, 2019, p.117, 131). This is one of the highest national harvesting intensities in Europe (Forest Europe, 2015, p. 114; Levers et al., 2014). The practices applied in the small-scale forestry are also similar to those applied in large-scale forestry (i.e. by the state forest company Sveaskog and private companies), both characterised by even-aged management with the native conifers (Claesson et al., 2015; Bergquist et al., 2016). On average, Swedish private forest owners also have a strong orientation towards production. Compared with the general public they show higher preferences for landscapes characterised by even-aged stands and clear-felling (Nordén et al., 2017). Despite the identified overlaps between the ideals and actual practices,

there is still some variation in the management intensities applied in small-scale forestry (Eggers et al., 2014), which to varying degrees contrasts with the silvicultural ideals. In this section we describe discrepancies highlighted by the forestry advisors and provide their perspective regarding the factors responsible for the witnessed deviations.

5.1. Low level of reforestation with Scots pine

The clearcutting system is initiated by scarification and planting after final felling. As in the rest of the country, private forest owners in Kronoberg actively engage in reforestation. 92 % of the regeneration area in the county exceed the minimum seedling density (seedlings of accepted production species) stipulated in the Forestry Act (SFA, 2017a). The quality of regenerations has also improved during the last decade, as the current rate of approval nationally exceeds the previously missed forest sector target for 2005–2010 (Duvemo et al., 2012, p. 7; SFA, 2018a). However, the high rate of approval is partly explained by a more permissive attitude towards including naturally regenerated birch in the stem count, which became an accepted production species on most sites in the Forestry act after 1993 (Bergquist et al., 2016; p. 26–27). In southern Sweden naturally regenerated broadleaves constitute 20–25 % of the production stems in regenerations on average, and without them only approx. 50 % of the regenerations would pass the minimum legal threshold (Bergquist et al., 2016; p. 26–27). Several informants' state that the use of naturally regenerated birches was more common in the regenerations after the major storm Gudrun in 2005 (see 5.4 about Gudrun), which also been shown in earlier research (Lodin et al., 2017).

Despite the high rate of approval, reforestation within in the studied case is far from unproblematic, because the current browsing pressure impedes proper site-adaption. In line with previous findings (e.g. Lodin et al., 2017), the advisors perceive that owners reforest with the more browsing-tolerant Norway spruce more widely than recommended, at the expense of Scots pine, due to the fear of browsing damage.

“There are quite a lot of poor areas where Scots pine would have been the preferred species, but we plant (when owners buy this service) these areas with spruce anyhow, because moose destroy the pine plantations.” I12

Accordingly, statistics published by the SFA (2019c) indicate that 63 % of the pine trees in young forests (1–4 m average height) in Kronoberg are damaged by moose. Moreover, inventories of regenerations during the last five years show that the less palatable Norway spruce (10 % damaged in 2017) has been planted on more than half of the low fertility reforestation areas (SFA, 2015, 2016, 2017b, 2018b, 2019c), for which SFA and industrial actors such as Södra consider Scots pine to be the most suitable species (Södra, 2017, p. 8; SFA, 2019c). Hence, the most recent Swedish forest outlook study highlighted an expected increase of Norway spruce at the expense of Scots pine in southern Sweden as a major concern (Claesson et al., 2015, p. 88).

5.2. Pre-commercial thinning

In PCT, trees of the desired species and quality are released from competition, thereby substantially improving the financial revenue obtained from subsequent commercial thinnings. High PCT activity is also in line with the production goal of the Forestry Act, and the national forest inventory keeps track of the area ‘in immediate need’ of PCT. Although PCT activity has doubled during the last two decades (SFA, 2017c), the forest sector target for PCT (set for 2005–2010) was not reached (Duvemo et al., 2012), and the activity is still below the desired level imposed by the current paradigm. 300,000 ha, or 37 % of the total area covered by young forests (dbh < 10 cm) area, are ‘in immediate need’ of PCT in the small-scale forestry of southern Sweden (SLU, 2017, p. 82; 89). According to the most recent outlook study 25 % of the young forest area is never treated with any PCT (Claesson et al., 2015, p. 34). Not surprisingly, most informants regard the level of PCT activity to be lower than desired and consequently strive to activate the owners. They state that the deficiencies may be related to the fact that this silvicultural treatment requires substantial investment of time or money.

Similarly to planting, many private forest owners carry out PCTs by themselves (63 % nationally in 2013) (Lidestav et al., 2017, p. 129). However, time constraints have been found to be a major cause of neglected PCTs (Fällman, 2005). Competing with career and family life, informants perceive that owners sometimes have problems finding the time required:

“It’s exactly what I said in the beginning, many believe that they’ll manage to do it (PCTs) themselves. But then it’s not done, or we do it in the end, but then the cleaning is much more expensive.” I2

The alternative to self-employment is to buy the service from entrepreneurs affiliated with the forestry organizations. Some informants perceive that the incurred short-term costs constitute a major barrier for some forest owners:

“If I said that I’d do the cleaning for free, it would be done everywhere. They (the forest owners) see it as a cost: ‘What do I really get out of this, it’s probably not necessary, it’s not so dense’. They don’t see it as an investment, and maybe they don’t have the money either, if you want to clean 10 ha you need 50 000 SEK: ‘No this isn’t possible, I’ll do it myself’. That’s the answer to me or somebody else.” I11

With extensive knowledge of forest management economics, the informants regard PCT as an important investment, which pays off in subsequent thinnings and final felling. They state that some private forest owners lack this understanding, and emphasize short-term costs more strongly, sometimes disregarding or being unaware of the long-time benefits. In addition, and as exemplified in the above quotation, informants perceive that owners with large areas of young forest (often caused by the Gudrun storm, see 5.4) sometimes lack the financial resources to bear the costs. The informants state that lack of or light PCTs

is the major cause of suboptimal outcomes in commercial thinning. In these cases, the required manual removal of small trees prior to harvest, in combination with the smaller diameter of the harvested trees, drastically reduce the net revenue from the first commercial thinning. Finally, in a recent report the SFA concludes that PCTs, in addition to not keeping up with the need, and often being conducted too late, often are lighter than financially optimal (Bergquist et al., 2016, pp. 40–42). Accordingly, the most recent forest outlook study estimated that average densities following PCTs by private forest owners in southern Sweden are ca. 3500 trees ha⁻¹ (Claesson et al., 2015, p. 35), ca. 1000 trees ha⁻¹ higher than the recommendations in standard guidelines (Table 3). Some informants reported that the high density after PCT partially is due to the high self-activity, as private forest owners (unlike the professional entrepreneurs) are too cautious and consequently remove too few trees:

“And sometimes when they do it by themselves they’re much too careful. When it comes PCT it should be a little bit hurtful (because you need to remove a lot of trees), it is hard for many to do it correctly” I12

5.3. Timing and intensity of final felling

Acquiring wood from final felling is the most important task for the interviewed wood buyers. Consequently they try to steer private forest owners towards silvicultural ideals where the ‘mature forest’ is harvested without excessive delays. Keeping rotations short is also considered as a good strategy to reduce certain risks (e.g. storm-felling and bark-beetle infestation) (Roberge et al., 2016). At the same time, studies have shown that harvesting intensity within the small-scale forestry is below the standard guidelines (Lönnstedt, 1998; Eggers et al., 2015), and private forest owners, despite owning more productive land, conduct final felling less frequently than forest companies (Lidestav et al., 2017, p. 122). The average harvest intensity is also significantly lower on private forest owners’ land in Småland (the Swedish province that includes Kronoberg) than on land in public ownership (where the state forest company Sveaskog is the biggest owner) (Schelhaas et al., 2018). Moreover, a recent investigation by the SFA shows that the rotation periods among private forest owners in southern parts of Sweden are varying substantially (Fries et al., 2015, p. 31). The majority (> 50 %) of stands are felled later than 20 years past the minimum allowable age. Compared with the spruce program depicted in Table 3 (recommended harvest at 75 years), this implies the actual rotations in most cases are longer, and in many cases substantially longer, than 80 years. Consequently, the actual rotations often tend to be longer than the relatively short rotations that are financially optimal according to the Swedish application of Faustmannian soil rent theory (i.e. maximising NPV at a 2–3 % discount rate). Hence, while the use of discounting and an ideology centred around “management for profit” (Brukas and Weber, 2009) are key features of the overarching Swedish forest management paradigm, they are much less clear features of actual practices. This is supported by a recent SFA report stating that many stands have had very low value growth in late phases of their rotations (Bergquist et al., 2016 p. 60). Reflecting this, one of the informants described perceived challenges faced in his efforts to promote “adequate financial thinking”, including reinvestment of income from final fellings of older stands to increase returns on capital:

“Because then it is not growing if it is the type of forest that I mean, 80 years and low growth, maybe half a percent a year (annual growth in value), and then they have 10 ha that need PCT. To reinvest and get a return on the capital, that’s what it’s all about, in my world that’s how I want to see the forest ownership and management. But we are not there, sure the owners harvest, but too few see it as a company where you can move the capital within different parts of the estate and keep the capital, it’s not about taking out the profits, but to reinvest, in maintenance of ditches, roads, PCT. That’s the view that I all the time struggle with and

try to promote, I get equally happy every time they understand.” 17

Final felling is often preceded by information exchange and negotiations between the informants and individual forest owners, because (for diverse reasons) recommended cutting ages in decontextualized guidelines may not tally with the desires or needs of owners at a specific time and place. Some informants also saw such variations to be justified by varying income needs of individual forest owners, in contrast to recommendations regarding other measures that are based solely on the forest state. Beyond the obvious influence of the prices of timber and pulpwood, some informants perceive that low needs for income and/or the presence of emotional ties to “mature” forests inhibit final-felling.

Private forest owners nowadays mainly earn their incomes outside their property and do not depend heavily on incomes from harvesting to support their livelihood (Andersson et al., 2010; Lidestav et al., 2017 pp. 118–119). The harvesting intensity on private forest owners' land also often changes during the ownership period. For example, Lönnstedt (1997) found that it was higher during the set-up phase (when a new owner takes over) than later, as income needs generally declined gradually towards the end of the ownership. Low income needs of older owners was highlighted as a perceived barrier to felling by informant I3, as exemplified by the following quotation:

“The older forest owners are free of debt and don't have any great need of incomes, and cutting down the forest leads to needs for scarification and planting, and other following treatments, it is much simpler to just leave the forest standing.” I 3

The presence of intangible motivations among private forest owners, such as aesthetical objectives and emotional ties to certain places on a property, is well-documented (Hugosson and Ingemarson, 2020). Some informants perceived that such factors were related to deviations from the promoted ideals towards the end of the management program. This included late thinnings motivated by aesthetical reasons rather than production, and emotional ties to mature forest acting as a barrier to final felling. The latter is exemplified in the following quote:

“But the large majority of owners have emotional thoughts that blur their judgment. I normally compare it with agriculture: Nobody cries when the farmer harvests the grain in the autumn, it is quite natural when it is a one-year rotation. But when the rotations are 60–70 years, then it is suddenly very hard to accept that it is time for final harvest.” I12

5.4. Natural hazards and related difficulties with later thinnings

In 2005, southern Sweden was hit by the most devastating storm (“Gudrun”) in modern Swedish history (Holmberg, 2005), felling 75 million m³ of wood, or approximately three times the annual cut in southern Sweden (Andersson and Keskitalo, 2016). In 2007, there was another storm that felled 12 million m³. Kronoberg County was situated in the core area of both these catastrophic events. Hence, rather than being an outcome of deliberate decisions by owners, a substantial share of recently harvested timber has resulted directly or indirectly from storm fellings.

The forest sector has the capacity to handle minor events with small disruptions, but large-scale devastating storms disrupt established routines, with all efforts focusing on gathering the damaged timber. Swift action is crucial for diminishing the economic losses, as well as avoiding secondary attacks of bark-beetle that mass reproduces on newly dead trees. This, obviously, reduces other silvicultural activities (Valinger et al., 2014):

“...and then came this (storm Gudrun), for 5 years after Gudrun nobody was performing PCTs, nothing was cleaned (treated with PCT), all efforts were oriented towards reprocessing (the storm-felled trees), straightening out clear-cut borders, cutting bark beetle-infested trees, because we had bark beetles. Hardly any commercial thinnings were

performed either.” 17

The recommended silvicultural ideals have been modified by the experience drawn from these storms. Informants state that ‘risky’ thinnings in higher stands (avoiding thinnings in stands > 20 m is the current ‘rule of thumb’) nowadays are less common. However, thinnings tend to be performed with some delay and it can be tricky to get the standard number of thinnings (two or three) performed on owners properties before a risky height as illustrated by the following quotations:

“It goes quite fast, between the first and the second thinning. I visit many properties each or every other year, on these properties it is easier to keep track of it (the thinnings). But then there are some properties that you don't visit for several years for some reason (where the second thinning can be late). It (the situation in small-scale forestry) differs from company owned forest, they (the companies) keep track of when to conduct the second thinning. It is crucial that the owners are a bit active: ‘is it not time now? (to do a thinning)’” I2

“It is difficult to get the second thinning done among some owners: ‘It has already been thinned once and it will probably blow down’. The first thinning is seldom a problem (to get the owners to do it), the stand is dense like a wall, no strip-roads, and pitch dark: ‘of course it needs to be thinned out’. They (some owners) don't really see the need (for the second thinning), also as a wood buyer it can be difficult to see the need for a second thinning. It does not feel so dense, no panic, even though you have 1100–1200 stems and you want to have 600–700 stems at the final felling. Do you have some recommendation, e.g. “don't thin above this height”? Yes, the general recommendation that came after Gudrun, at 20–22 m the risk of storm damage increase considerably. You want to be done at that time. But it is hard if you do the first thinning at 18.5–19 m” I11

The increased risk awareness among owners and/or advisors implies that some risky second thinnings are called off. However, others are still performed, which been confirmed in the SFAs investigations of thinning practices, showing that thinnings in stands > 20 m in southern Sweden are common (Bergquist et al., 2016, p. 53, 56).

Finally, there is a consensus among the informants that rotations should, and will, be shortened in the future to reduce risk of storm damage. At the same time several informants perceive that attachment to the remaining older undamaged forest increased among owners that suffered severe storm damages. In a shorter-term perspective, these owners are more reluctant to harvest forest that is ready for final felling:

“There is some resistance among owners to harvest the last mature production stand on a property. There are these types of connections. They want to have some timber trees left.” I2

5.5. Summary

Table 4 summarises the main findings from the analyses presented in sections 5.1–5.4, including the most prominent deviations discerned from the silvicultural ideals and the informants' perceptions of the main causes.

6. Discussion

This study reports on causes to deviations from silvicultural ideals as perceived by forest advisors in the small-scale forestry. Our qualitative study therefore complements earlier investigations by the SFA (e.g. Bergquist et al., 2016) that quantify the extent of silvicultural problems without investigating the causes behind in detail. In addition, although the findings of this study reflect the specifics of the studied case, its narrative on factors shaping forest management practices is relevant to similar settings elsewhere, especially in Scandinavia

(Lawrence et al., 2020). These are settings where production-oriented advisors, often representing industrial actors, for obvious reasons face various challenges in their efforts to promote traditional timber-oriented programs among owners with increasingly diverse life-styles, priorities and levels of forest management knowledge. Andersson and Keskitalo (2019) found that forestry actors in Sweden increasingly perceive certain groups of owners, often non-residential, to lack the “right” forest management knowledge and/or to be less motivated by economic goals. By spotlighting the deviations from the silvicultural ideals our study provides more profound insights into how such factors are perceived to complicate production-oriented steering, e.g. due to the lack of “adequate economic thinking”.

The studied Swedish case represent an interesting case of “soft forcing” through information and advice, largely without resorting to mandatory or economic policy instruments. Performance of such soft steering is of a high theoretical and practical interest, when considering effective mixes of forest policy instruments in any jurisdiction. In this respect, the scrutiny of the different silvicultural treatments in this study provides some instructive clues. The mandatory forest regeneration forms an exception from the otherwise deregulated Swedish approach. Regeneration is characterised by small deviations (> 90 % of the area pass the required legal thresholds), setting aside the specific issue of spruce reforestation on pine sites. There are largely no legal demands for thinnings and final fellings, owners’ behaviour is mostly steered by their own preferences, information and market incentives. Coincidentally, these treatments were overall found to be characterised by moderate deviations in the context of the overall high utilization intensity. The largest deviations are found for PCTs that are not required by legislation and impose short-term expenses or requires substantial investments of time. This is a treatment that has for a long time been an area of concern in the Swedish forest sector (Duvemo, 2012). Norm pressure through advisory services is important for Scandinavian small-scale owners’ intention to carry out PCT (Karppinen and Berghäll, 2015), at the same as the short-term costs and owners’ time constraints have been found to be major barriers (Fällman, 2005; Karppinen and Berghäll, 2015), in line with perceptions of our informants.

Consequently, our case indicates that production-oriented steering could be facilitated if the involved actors have different types of power resources (i.e. coercion, incentives, information) at their disposal. Informational steering in a deregulated system is more challenging when immediate economic incentives for the concerned treatment are lacking. This is also supported by research showing that European forest landscapes are controlled by owners with different degrees of responsiveness to structural factors, such as markets and policy tools (Deuffic et al., 2018; Sotirov et al., 2019). Thus, by having steering tools triggering several behavioural logics among the targeted owners a paradigm and its associated silvicultural ideals can be promoted more effectively. Illustratively, in neighbouring Finland cost-sharing of PCT through public subsidies combined with informational steering has been found to increase small-scale owners PCT activity and also stimulate additional private investments, i.e. not only substitute the owners own PCT investments (Ovaskainen et al., 2017). Finally, as already noted the reported Scandinavian case is characterised by an overall very favourable context for production-oriented forestry, in other settings the main barriers to active forestry among small-scale owners may be of a more fundamental nature, such as lack of forestry tradition and other supportive structures (e.g. FOAs) (Keskitalo et al., 2017, p. 36–39) or inefficient property structure (Kumer and Malovrh, 2019).

In our comparison of ideal vs real forest management, interviews with forestry advisors provided empirical data that enabled acquisition of a good overview of the silvicultural practices combined with rich contextualised information. We also utilized additional sources to validate and further describe current management and the identified deviations (e.g. official statistics, SFA reports). However, our method yielded no empirical data about owner motives directly from the

owners. Instead the interviews provided advisors’ perceptions of owners’ motives, interpretations which may be coloured by the advisors’ strong preference for production (Nordén et al., 2017), and their contacts are also skewed towards the more active owners. Although the informants’ perceptions of owner motives often where in line with existing literature, the reported causes to the deviations should still be interpreted with care. They reflect the production-oriented advisors perspective on forest management among small-scale private forest owners.

Looking at a larger picture, the interpretation of the identified deviations between ideal and real management depends on the adopted perspective. From the perspective of the production-oriented advisors and the forest industry they are, as this study has showed, perceived as problematic. For example, the low activity in PCT among some owner implies that the forestry actors, and their harvesting entrepreneurs, are faced with stands that are more difficult and costly to manage. Moreover, the tendency for prolonged rotations can of course be an obstacle to wood buyers’ possibilities, and related short and medium term goals, to source round wood. Looking into the future, the existing owner diversity might also complicate the practical implementation of the forest sector’s goal to increase forest growth by 20 % until 2050 (Normark and Fries, 2019), as not all owners are likely to unite around such ambitions.

From a conservation perspective Swedish forest management practices are already intensive and homogenous, which in turn stress the need for more diverse practices (Felton et al., 2020a). In this regard, Southern Sweden is a hot-spot region of intensive forestry at the European level (Levers et al., 2014; Schelhaas et al., 2018), and in the studied case only 8 % of the productive forestland is protected (formal and voluntary set-asides combined) for conservation purposes (SEPA-SFA, 2017; Statistics Sweden, 2019). This implies that the ecological quality (e.g. amount of large trees and deadwood) of the production forest matrix, i.e. the area targeted by the production-oriented silvicultural ideals, is highly important for the conservation status of many forest dependent species (Felton et al., 2020a). Hence, some of the identified “deviations” (e.g. longer rotations, neglected PCT resulting in more broadleaves and increased mortality due to self-thinning) provide increased matrix heterogeneity for the benefit of conservation. This has previously been confirmed by Eggers et al. (2015) who showed that the existing owner diversity, and the resulting deviations from the production-oriented ideals were beneficial for several ecological and social sustainability indicators. Pushing the real practices towards the silvicultural ideals, such as shortening the rotations periods, therefore risks causing negative effects on biodiversity conservation and cultural ecosystem services (Roberge et al., 2016; Felton et al., 2020a), and thereby complicate the fulfilment of Swedish conservation targets. Finally, addressing the current high browsing pressure would yield positive outcomes for both production and conservation. It would result in more diverse regenerations for the benefit of conservation and other ecosystem services (Angelstam et al., 2017; Petersson et al., 2019), while at the same time alleviating production risks (e.g. storm felling and climate change related risks such as drought and bark-beetles) associated with forest management practices so heavily dependent upon Norway spruce (Felton et al., 2020b).

7. Conclusion

This study mapped deviations from the production-oriented silvicultural ideals in the small-scale forestry of southern Sweden and investigated challenges faced by forestry advisors in their daily efforts to promote these ideals in practice. In Sweden, private forest owners have strong property rights in forest management and after a forest been established (reforestation is mandatory) they have great freedom to decide if, and when, a particular treatment should be conducted. One group of perceived causes were therefore related to the agency of the owners, where advisors experienced that owners for various reasons

(e.g. high costs related with PCT, lack of time or knowledge, preferences), tend to execute the recommended treatments to insufficient extent, and/or too late. The other group of causes were biotic (e.g. browsing) and abiotic disturbances (i.e. storms), over which the owners and the advisors exercised limited control in a short-term perspective. In this regard it is evident that the direct (i.e. storm damage) and indirect (e.g. prioritization among treatments, increased attachment to older forest) effects of storm damages on forest management have been more pronounced in the studied case than in other parts of Sweden during the last decades (Valinger et al., 2014).

Zooming out to the European level, this study reports on moderate variations within a stronghold of intensive and profit-oriented forestry (Brukas and Weber, 2009; Levers et al., 2014). We identified cases of advisors perceiving that the ideals were not matching the needs and preferences of the owners. Such tensions could potentially be relaxed through incentivising more diversified silvicultural ideals, which also would contribute with increased variation in the production forest matrix for the benefit of conservation (Felton et al., 2020a). Silvicultural ideals are promoted in national contexts characterized by major differences in owner types, regulatory frameworks, advice providers and tools (see Lawrence et al., 2020). As a complement to the typical Scandinavian case presented here, it would therefore be interesting to see future studies in other countries, e.g. investigating ideals vs real practices in forestry under stringent legislative regulation.

CRedit authorship contribution statement

Isak Lodin: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Visualization. **Vilis Brukas:** Conceptualization, Methodology, Writing - review & editing, Supervision, Funding acquisition.

Declaration of Competing Interest

None.

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