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ORIGINAL PAPER

Availability and mobilization of forest resources in Sweden

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Abstract

The available amount of wood supply is essential for national strategic planning and evaluation of forestry in Sweden. Since Sweden holds a large part of the forests in the European Union and plays a significant role in the global trade of wood-based products, a precise estimate of the potential of the Swedish forest resource is also important in regional and global outlook studies. In this study, we analyse factors influencing the availability and mobilization of wood supply. By comparing data from the Swedish National Forest Inventory with the stand registers of the five largest forest owners in Sweden, we estimate the productive forest area not included in the forest owners' stand databases. Our results show that 0.4 million hectares, or 5% of these large-scale forest owners productive forest area, is outside their stand registers and therefore neither included in their long-term harvesting plans nor in their nature conservation plans. For small-scale forest owners, we analyse the final felling rate during 2004–2020 using satellite imagery to estimate the proportion of properties that abstain from final fellings and thereby could affect the potential mobilization of wood supply. During this period, 32% of the forest properties owned by small-scale forest owners have not done any final felling. These forest estates hold in total 1.1 million hectares of productive forest land or 9% of the area owned by small-scale forest owners. This implies a gap between the potential and realistic estimates for Forest Available for Wood Supply.

Keywords Availability · Mobilization · Forest planning · Forest resources · Wood supply

Introduction

Historically, now and in the future, forests play a significant role for society around the globe, e.g. as provision of food and other non-wood forest products (Lovrić et al. 2020), as carbon storage and carbon sequestration in mitigating climate change (Nabuurs et al. 2007), as contribution to national economies (FAO 2014) and not least as a resource for renewable fossil-free products (Verkerk et al. 2022). For decision-making on how to manage and utilize the forest resource now and in the future, there is a need for information about the availability and mobilization of this resource for wood supply. However, although forests cover almost one-third of the land area globally, most of it is not available or designated for wood production (FAO 2020). This means that there are uncertainties regarding how much of the forest resource could be utilized for wood production, depending on how much of the undesignated forest will be available for wood supply in the future. Hence, long-term scenario analysis of future harvest levels and estimates of the potential of wood-based products in a fossil-free future are highly uncertain.

Since wood and especially wood-based products are traded on a global market, it is of high interest to make projections and assessments of the potential future supply of wood on global, regional, national, and sometimes sub-national scale. The different scales used in modelling also mean that the quality and the level of details in input data differ, e.g. regarding the availability of forest area for wood supply (Verkerk et al. 2015). Regionally for Europe, action has been taken to harmonize the definition and reporting according to the terms Forest Available for Wood Supply (FAWS) and the inverse Forest Not Available for Wood Supply (FNAWS) (Alberdi et al. 2016; Fischer et al. 2016).

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A regional-based assessment of the future supply of woody biomass in Europe has considered availability constraints, showing that the realisable potential represented 50–71% of the theoretical potential (Verkerk et al. 2011). However, there is a wide range of differing national projection systems, making comparisons and collaborations between countries on a regional basis complicated (Barreiro et al. 2016).

Long-term scenario analyses based on reliable data are especially relevant for countries with a strong forest sector, such as Sweden. Sweden has a high utilization rate of its available forest resources (FOREST EUROPE 2020*)* and is a major supplier of wood-based products to the global market (FAO 2021; United Nations Economic Commission for Europe 2022). At the same time, Sweden is a country with a high share of private ownership (FOREST EUROPE. 2020) and the Swedish Forestry Act (SFS 1979) gives a high decision-making power to forest owners (Nichiforel et al. 2020). Therefore, repeated scenario analysis and impact assessments are important for both public and private decision-makers and an interesting case for this study where we focus on availability and mobilization.

Besides the technical availability, the mobilization of wood is determined by the forest owners' objectives and behaviour and the market demand for wood.

A common approach to studying forest owners' preferences is to categorize different typologies based on structural variables as age and gender and their attitude towards economic, ecological or social values (Ficko et al. 2019). For Swedish small-scale forest owners, Ingemarson et al. (2006) identified five different types: the economist, the conservationist, the traditionalist, the multi-objective owner and the passive owner. Eggers et al. (2014) came up with five management strategies that could be identified; Passive, Conservation, Intensive, Productivity and Save. Thus, in both studies, a group of passive owners was identified, i.e. owners with low forest management activities such as harvesting.

The potential effects of these different preferences and strategies among small-scale private forest owners on the state of the forest and harvesting have also been studied in long-term scenario analysis, showing that management strategies of forest owners constrain wood supply (Eggers et al. 2015; Lodin et al. 2020). In Finland, scenario analyses accounting for forest owner behaviour showed that the high harvesting targets set by the government to supply the growing bioeconomy could be hard to reach since small-scale forest owners have other preferences (Heinonen et al. 2020).

There is, however, a lack of studies that validate these typologies with actual behaviour regarding forest management activities such as harvesting and by that enabling better projections of future wood supply (Ficko et al 2019).

On national level, the Swedish Forest Agency (SFA) and the Swedish University of Agricultural Science regularly carry out long-term scenario analysis and impact assessments to assess a sustainable potential harvest level (Swedish Forest Agency 2022a). These scenario analyses have a typical policy impact approach, trying to answer what could happen if a certain policy or management strategy would be applied (Börjeson et al. 2006; Hurmekoski and Hetemäki 2013). In some cases, the scenarios express a more general orientation than a specific policy or could have elements of external impact on forest management (e.g. forest damage, changes in market demands) that make the analysis more explorative.

The analyses are based on estimates using sample plot data from the Swedish National Forest Inventory (NFI) (Fridman et al. 2014), combined with information on which forests are not available for wood supply, where the total forest area is reduced by formally protected areas, voluntary set-asides, retention patches and non-productive forest land. For Sweden, this means that approximately 70% of the total forest area is considered to be available for wood supply (FOREST EUROPE 2020).

However, such projections do not fully consider the global market demand, nor the limitations regarding availability or the forest owners' willingness to harvest (Nordström et al. 2016; Heinonen et al. 2020). This in turn could lead to problems for decision and policy making regarding, e.g. investments in forest industry or nature conservation policies.

Therefore, the potential harvest level articulated by the SFA may not be realistic. The harvest level in Sweden is close to the potential indicating small margins to increase harvests (FOREST EUROPE 2020). An overestimation of the potential harvest may lead to unsustainable harvesting in parts of the country or by some large forest owners.

The objective of this study is to estimate how much the area of forest available for wood supply in Sweden should be adjusted if aspects of technical availability and mobilization driven by socio-economic factors would be accounted for. The question of availability is assumed to be a problem mostly for large-scale forest owners who have a rational planning system that does not handle smaller uncertainties in their data. The availability question is therefore limited to large-scale forest owners. The question of mobilization, on the other hand, is probably mostly linked to forest owners with a low degree of final felling, i.e. passive forest owners (Eggers et al. 2014). The mobility question is therefore limited to passive small-scale forest owners. Thus, more specifically, we answer the following questions:

- How much of the forest resource is not accounted for within the planning systems of large-scale forest owners?
- How much of the forest resource and harvest potential is allocated to passive small-scale forest owners?

Table 1 Large-scale forest owners included in this study. The productive forest area excludes formally protected areas

Large-scale forest owner	Area of productive forest land (million ha). The proportion of Sweden total productive forest land in brackets (%)
Sveaskog	3.0 (13.6)
National Property Board Sweden	0.3 (1.4)
SCA	2.0 (9.0)
Holmen	1.0 (4.4)
StoraEnso	1.1 (4.9)
Total	7.4 (33.4)

Table 2 Possible outcomes of mapping forest owners stand register and NFI sample plot data

	NFI productive forest land	NFI other land
Forest owner planned area	Match	Mismatch Type II
Forest owner unplanned area	Mismatch Type I	Match

Material and methods

The two different research questions in this study were analysed with two different methods.

Availability

To estimate the availability of the forest resource, we collected geographical data from the five largest forest owners in Sweden regarding their forest management planning (Table 1). These datasets contained information on which areas that were included in management plans and had some designation regarding land use, and which areas were not included or designated. In this context, areas in the management plans correspond to the area included in the forest stand database (tabular data with forest information combined with map data with stand boundaries).

The large-scale forest owner dataset covers 7.4 million ha of productive forest land (excluding formally protected areas), which is one-third of the total area of productive forest land (excluding formally protected areas) in Sweden (Nilsson et al. 2021). Productive forest land refers to the Swedish Forestry Act (SFS 1979), which stipulates that forest land with a production capacity < 1 m^3 ha^{-1} $year^{-1}$ is seen as non-productive forest land and should not be available for forest management and harvest.

By combining the large-scale forest owner dataset with NFI sample plot data for the period 2016–2020, we identified which sample plots were within the same land-use class (match) and which differ (mismatch) (Table 2). Two types of mismatches can occur. Type I occurs if productive forest land is observed in the NFI but the area is not planned or designated in the forest owner dataset. Type II refers to the opposite situation, where the NFI data say other land (including non-productive forest land), while the forest owner data classify the same area as planned/designated for wood production. This mismatch is usually handled in a more detailed operational planning before harvesting (Ulvdal et al. 2023). However, surveys of environmental consideration conducted by the SFA show that non-productive forests almost always remain unharvested (Swedish Forest Agency 2021). NFI data also support that almost no harvesting occurs in non-productive forest areas. Therefore, we concentrate the study on the type I mismatch of unplanned productive forest land.

By using the NFI sample plots that were classified as Type I, we describe the current forest properties in areas that are accounted for in the national forest impact assessment, but not accounted for in forest owners' internal planning tools.

Even if the NFI data suggest that there is productive forest land outside the forest stand database, these could be scattered since the NFI plots are small and do not consider spatial distribution. To analyse this aspect, we use the National Land Cover Database provided by the Swedish Environmental Protection Agency (EPA) (2020), a raster dataset on vegetation type and forest productivity with a grid cell size of 10×10 m. From this dataset, we calculated the total area of productive forest land situated within the unplanned area by summarizing raster cells and clustering them to analyse the size distribution of patches with productive forest land (Fig. 1).

Mobilization

To identify forest properties owned by small-scale forest owners (i.e. individual or family forest owners) that could be classified as passive owners, we identified properties where no final felling operations have taken place during 2004–2020 by spatially combining two datasets:

- Dataset one is the Real Property Register hosted by the Swedish mapping, cadastral and land registration author-

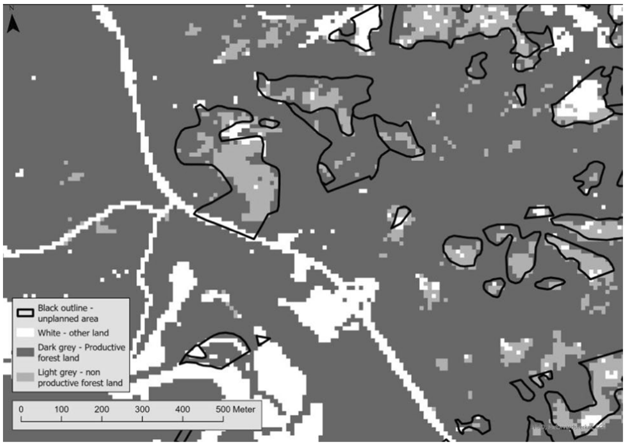

Fig. 1 Example of analysis of unplanned areas (Black outline) compared to land cover data. Dark grey is productive forest land, light grey is non-productive forest land, and white is other land. Dark grey area within the black outlines is summarized to unplanned productive forest land. (Color figure online)

Table 3 Calculation of theoretical property size needed to on average have done a final felling during 2004–2020, by region. Based on (1) NFI data on average final felling ages, transformed into (2) yearly final felling rate (100/average age of final felling), summarized for the period of 17 years (3). The average size of final felling (4) divided by (3) gives the theoretical property size needed to on average have done one final felling during 2004–2020 (5)

	Northern Sweden	Southern Sweden	Sweden total
1. Average age of final felling	126	93	108
2. Theoretical yearly final felling rate (%)	0.8	1.1	0.9
3. Total theoretical final felling 2004–2020 rate (%)	13	18	16
4. Average size of final felling (ha)	4.0	2.3	2.8
5. Property size (ha) for one final felling 2004–2020	31	13	18

ity, containing information on addresses, buildings, and property tax assessment, e.g. area of productive forest land. It also includes the digital cadastral index map (The Swedish mapping, cadastral and land registration authority 2022).

- Dataset two contains maps with polygon data for final felled areas. The maps are produced by the SFA and are based on change detection in satellite imagery to map final felled areas on a yearly basis (Swedish Forest Agency 2022b).

Then, we analysed the size of the property since this could explain why there is no final felling during this period (2004–2020). Using average numbers on final felling age (as a proxy for rotation length) and final felling areas, we calculated how large a property needs to be on average to have been subject to at least one final felling during the period 2004–2020 (Table 3). Since rotation length varies considerably throughout the country due to differences in productivity, which is lower in northern Sweden compared to southern Sweden, this analysis is made for two regions of Sweden. On average, a property of 18 ha productive forest land would have done one average size final felling during 2004–2020. The area varies from 13 ha in southern Sweden to 31 ha in northern Sweden.

Results

Availability

For the five large-scale forest owners studied, NFI data show a total area of 767 000 ha productive forest land that is not included in their forest stand database. This means that 10% of their total productive forest area is undesignated or unplanned. However, 51% or 389 000 ha of that area is within formally protected areas and thus not available for wood supply. This leaves 379 000 ha of productive forest land that is not included in the forest stand databases of these five large-scale forest owners. Hereafter, the results refer to this unplanned and not formally protected area. These areas could be considered as "unknown" FAWS or unknown set-asides for nature conservation and carbon storage.

Table 4 Area (ha) of productive forest land (excluding formally protected areas) and other land in unplanned and planned area. Proportion in brackets

	Productive forest land	Other land
Planned	6 952 000 (93%)	537 000 (7%)
Unplanned	379 000 (7%)	4 956 000 (93%)

Corresponding to Table 2, the results in Table 4 show the same proportion of productive forest land in the unplanned area (Type I mismatch) as other land in the planned area (Type II mismatch). The latter is larger in absolute terms since the planned area is much larger. As described earlier, there is an awareness of Type II mismatch, and it is handled in the stand register but Type I is unknown.

Table 5 Forest data, comparing unplanned area with planned area and Sweden total. Productive forest land excluding formally protected areas. (Coefficient of variation (%) in brackets)

	Unplanned area	Planned area	Sweden total
Productive forest area (hectare)	379 000 (6.3)	6 952 000 (2.4)	22 148 000 (0.9)
Growing stock (mill. m^3 over bark)	40.8 (7.2)	810.6 (2.6)	3 115 (1.0)
Growing stock per hectare (m^3 over bark)	108 (3.9)	117 (1.2)	141 (0.6)
Annual growth (mill. m^3 over bark)	1.0 (7.9)	28.6 (4.1)	115.4 (5.2)
Annual growth per hectare (m^3 over bark)	2.6 (3.9)	4.1 (1.2)	5.2 (0.6)

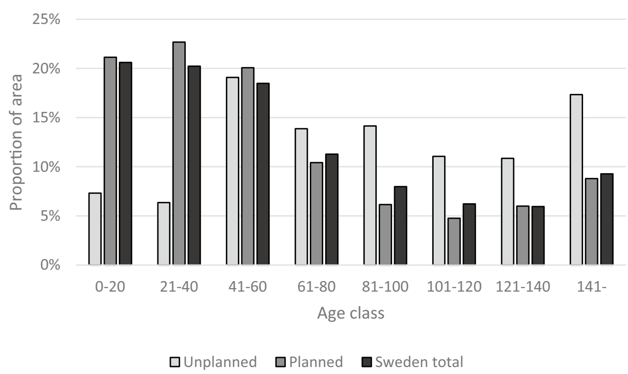

Fig. 2 Age class distribution in unplanned area, planned area and Sweden total. Percentage refers to all productive forest land excluding formally protected areas in the three categories

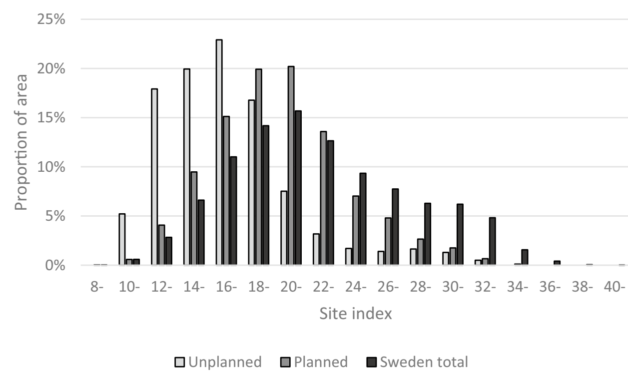

Fig. 3 Site index distribution in unplanned area, planned area and Sweden total. Percentage refers to all productive forest land excluding formally protected areas in the three categories

Since the studied organizations mainly own forests located in northern Sweden, most of the unplanned productive forest land is concentrated to the north (318 000 ha), while a smaller part (61 000 ha) is in southern Sweden.

As wood supply

The unplanned area accounts for 5.1% of the productive forest land, 4.7% of the growing stock, and 3.5% of the annual tree growth for the organizations included in the analysis (Table 5).

Most of the unplanned area is covered with older forest; 39% is over 100 years, which is a considerably higher proportion than for the planned area where 19% is over 100 years (Fig. 2).

The unplanned productive forest area is disproportionally distributed towards lower productivity (site index) than the planned productive forest area (Fig. 3). This, in combination with more old forest, explains the lower annual growth).

By using the land cover dataset, we identified 302 000 ha of productive forest land within unplanned or undesignated areas, which is 77 000 ha less than according to the NFI data. Out of these 302 000 ha, around 52% are situated in patches larger than 0.5 ha (Table 6).

Table 6 Size distribution of areas with productive forest land within unplanned areas

	< 0.5 ha	0.5–1 ha	1–5 ha	> 5 ha
Area (ha)	142 000	37 000	58 000	64 000
Proportion	47%	12%	19%	21%

As nature conservation

Every NFI plot is described by the stand character, e.g. natural forest character which is similar to primary forest (FAO 2018, 2020). Of the unplanned area, 4.4% is assessed as primary forest which is more than double the proportion in the planned area (1.7%) and higher than for the total of Sweden (3.1%).

The unplanned areas have a total amount of 3.5 million m^3 dead wood or 9.4 m^3 ha^{-1}, which is a little less than for the planned area (10.4 m^3 ha^{-1}).

The tree species distribution is quite similar for the unplanned and the planned area (Fig. 4). The unplanned area has a somewhat higher proportion of broadleaf and lower (but not zero) proportion of lodgepole pine (*Pinus contorta),* which was introduced in Swedish forestry to a larger extent in the 1970s.

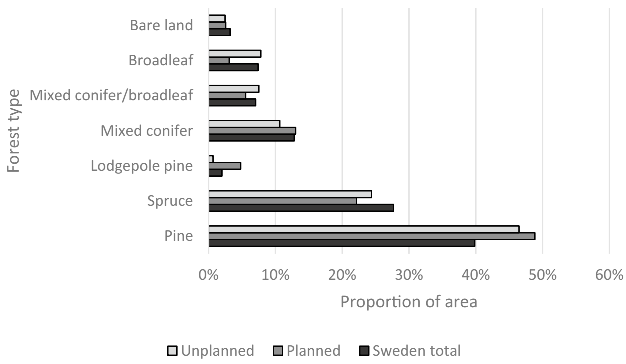

Fig. 4 Area proportion by forest type (tree species composition) in unplanned area, planned area and Sweden total. Percentage refers to all productive forest land excluding formally protected areas in the three categories

Table 7 Properties owned by small-scale forest owners. Total number, total productive forest area within passive properties and as proportion of all properties, by region

		All properties	Properties with no final felling (Proportion of total in brackets)	Properties with no final felling, exceeding the size needed (Proportion of total in brackets)
Number of properties	Northern Sweden	72,405	23,923 (33%)	5,009 (7%)
	Southern Sweden	150,718	47,285 (31%)	8,929 (6%)
	Sweden total	223,123	71,208 (32%)	13,938 (6%)
Productive forest area (ha)	Northern Sweden	5,019,000	604,000 (12%)	447,000 (10%)
	Southern Sweden	6,206,000	446,000 (7%)	271,000 (5%)
	Sweden total	11,225,000	1,050,000 (9%)	718,000 (8%)

Mobilization

In total, there are 223 123 properties in Sweden with productive forest area owned by small-scale forest owners (Table 7). Out of these, 32% have not done any final felling during 2004–2020 and are thus classified as passive. This corresponds to 9% of the productive forest area within this group of owners. Referring to the calculations of the property size needed for, on average, at least one final felling to have occurred during the period (see Table 3), these numbers are reduced to 6% of the properties and 8% of the productive forest area.

For the distribution by size, the number of small-size properties is disproportionally larger in the passive group compared to all properties (Fig. 5). This pattern is weaker when looking at the productive forest area.

Discussion

In this study, we show that the five largest forest owners in Sweden, in their stand registers, neglect nearly 0.4 million ha of productive forest land. Another 1.1 million ha of productive forest land are within properties owned by small-scale forest owners that could be considered passive.

This confirms previous research (Alberdi et al. 2016, 2020; Fischer et al. 2016) that not all parameters are accounted for when determining FAWS in Sweden, which results in an overestimate of the potential wood supply. It also supports previous research on small-scale forest owners suggesting a sub-group with passive management behaviour (Ingemarson et al. 2006; Eggers et al. 2015) and adds estimates on the size of this sub-group regarding FAWS. If there is an overestimation of FAWS, it also means that there is an underestimation of Forest Not Available for Wood Supply (FNAWS). This could affect nature conservation policies and assessments of the need to protect forest.

Since these aspects of availability and mobilization previously have not been considered in Swedish national long-term scenario analysis and impact assessment or in international reporting of forest statistics, the potential wood supply is probably being overestimated. Projections showing too high future potential harvest levels could, for instance, lead to over-investments in forest industry capacity. It could also lead to a situation where the overestimated supply will be harvested from a smaller area, leading to a non-sustainable balance between increment and felling. There are, however, also other mechanisms, market-based such as prices and certification schemes, or legal-based such as restrictions on final felling age in the Swedish Forestry Act, that have a balancing impact on harvest levels. For now, the felling/increment ratio for FAWS in Sweden is 87% (FOREST EUROPE 2020), implying that this problem is handled by other instruments even if it is not included in the national scenario analysis.

The unplanned productive forest land could also be seen as a neglected part for nature conservation. The nearly 0.4 million ha could be compared to the 2.6 million ha of the productive forest land in Sweden that is formally protected or voluntarily set-aside (Statistics Sweden 2021). For the large-scale forest owners studied, it represents 5.1% of their

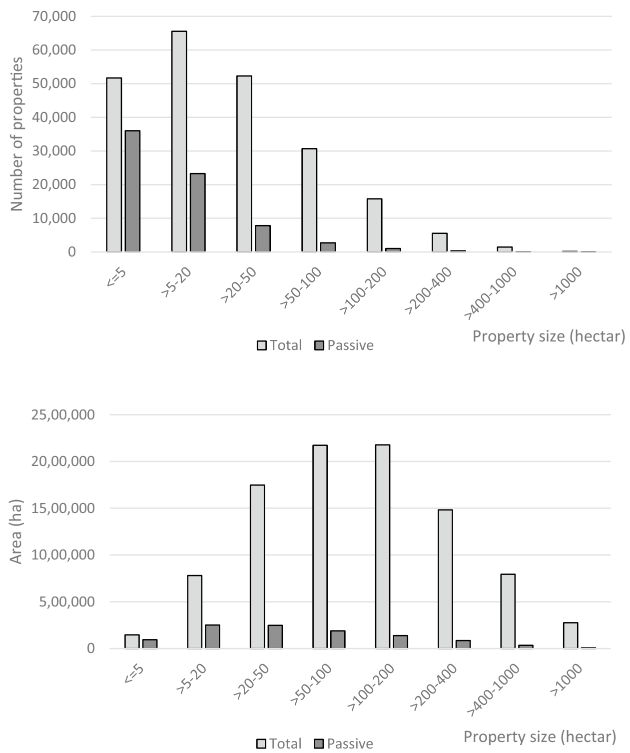

Fig. 5 Distribution of all properties and passive properties over properties. Top chart shows number of properties. Bottom chart shows productive forest area. Referring to small-scale forest owners

total productive forest land, which could be compared to the standards for certification of 5% voluntary set-asides (FSC Sweden 2020). Compared to the entire country, the unplanned area constitutes less than 2% of the forest area, growing stock, and annual growth. The unplanned areas are older, are more like primary forest, situated on lower site index and have a little less dead wood per hectare than the planned areas. This can be explained by the lower productivity in the unplanned area, which results in lower mortality even though these forests are, on average, older than the planned forests. Overall, the unplanned areas seem more likely to hold higher conservation values than the planned area.

There is of course a statistical uncertainty in the estimations from the NFI. As shown in Table 5, the estimated unplanned productive forest area is not significantly separated from the planned forest area or from the estimation of the national total. This uncertainty also applies to growing stock and annual growth. This means that the general uncertainty in national long-term scenario modelling based on NFI data also covers for this uncertainty. However, in this study, we only include the five largest forest owners, which implies an overall underestimation of the unplanned productive forest area.

The effect on the potential wood supply also depends on geographical scale and timeframe. The properties owned by passive small-scale forest owners are spread over Sweden with a small dominance in northern Sweden, and a large majority of the unplanned productive forest area within the studied large-scale forest owners are in northern Sweden. This means that the total effect on availability and mobilization of wood supply is larger regionally in northern Sweden than for the whole country, suggesting that this factor is even more important to consider in regional or local analyses of future harvest potential. Since a large part of the unplanned productive forest land contains older forests, they provide a short-term wood supply potential while the relative low site index indicates a lower potential in a long-term perspective.

For the availability aspect, the distinction between productive and non-productive forest land stipulated in the Swedish Forestry Act probably plays a role. It is hard by any method to define the productivity of 1 m^3 ha^{-1} $year^{-1}$, which could result in a precautionary action of avoiding borderline areas.

Also, the spatial distribution could create lock-in effects where the productive forest area is not technically available if it is surrounded by non-productive forest land or other land that is a barrier for harvest operations. This is only a problem for the wood supply aspect, not if the areas are set aside for conservation.

One could ask if the gap between potential and realistic FAWS that we have detected is temporal or permanent since we study a specific period. Regarding the technical availability, we use the state of 2020. However, the age distribution with older forest in the unplanned area compared to the planned area suggests that these unplanned areas have been so for a long time. On the other hand, the occurrence of the introduced tree species lodgepole pine shows that the forest stand database is not static.

Even though most of the unplanned areas have been unplanned until now, this could change in the future. By using modern remote sensing data acquisition systems, such as different types of laser scanning or high-resolution aerial or satellite imagery, the forest areas could be detected and delineated with higher resolution (White et al. 2016). This will give the forest owner a possibility to include previously overlooked areas in the forest management plan. Also, a shift to precision forestry could make these areas more interesting for management (Wilhelmsson 2023).

Regarding the mobilization part, we studied a period of 17 years, which is quite short considering average rotation length and property size distribution in Swedish boreal forest. Another uncertainty regarding the analysis of mobilization is that we only studied final felling operations. The absence of final felling is not the same as a passive property; other harvesting could have taken place, e.g. thinning, or selective harvest in a continuous-cover forestry system.

Matilainen and Lähdesmäki (2023) showed that only one-third of forest owners in Finland classified as passive according to statistics were fully passive in their forest management and timber sales.

Behaviour and goals can also be explained by structural factors. The size of the estate has been linked to the importance of income from the forest which implies a higher harvest rate on larger forest properties in Sweden (Eggers et al. 2014). In Finland, however, this correlation only seems to apply for very small forest properties, while wood supply from forest properties larger than 5 ha is rather constant (Verkerk et al. 2011). In addition, timber prices and their expected change play a role in harvesting behaviour even though it is less important for passive owners (Aguilar et al. 2014; Sjølie et al. 2019). Since the degree of activeness is related to structural factors with the forest owner which shift regularly, these areas should not be seen as permanent passive management. The absence of final fellings could also be affected by the age distribution of the forest, and we suggest further research on comparing passive and active forest owners.

By numbers, the gap in potential and realistic harvest level is far greater from socio-economic driven mobilization than from the technical availability. Also, the technical availability in the future might be handled by improved techniques for data acquisition and delineation, whereas the forest owners' willingness to harvest depends on many factors that could change over time.

Conclusion

There is a significant area of productive forest land that is not accounted for in large-scale forest owners forest data bases. There is also a sub-group of small-scale forest owners which could be described as passive regarding wood supply mobilization. The combination of this availability and mobilization problem should be included in projections of potential biomass extraction, nature conservation and carbon storage. There is a need for further research on the long-term effects of availability and mobilization constraints. Such studies should include simulations of the development of these forests under the assumption of continuously being unmanaged, as well as more studies of the group of passive forest owners regarding their drivers and management choices.

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Author contributions AE contributed to conceptualization and writing, E-MN, JE, SC and KÖ contributed to supervision and writing, and JF, MN and PO contributed to data analysis.

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Availability of data and material Data for the analysis are available upon request.

Code availability Not applicable.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethics approval Not applicable.

Consent to participate Sveaskog, National Property Board Sweden, SCA, Holmen, and StoraEnso provided data for the analysis and thereby consent to participate.

Consent for publication Authors approved the version to be published and agree to be accountable for all aspects of the work.

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