Uncovering Hidden Efforts:
Statistical Estimation of Owner-Performed Silvicultural Work in Finland

Tiina Mäkipää

Natural Resources Institute Finland (LUKE), Helsinki, Finland

Abstract

In Finland, a significant share of silvicultural work is carried out by private forest owners, yet these self-directed activities have not been included in official statistics. Official statistics data are collected from professionals and organizations that offer and perform forest management services, so forest owners' activities in their own or family-owned forests remain largely undocumented. Since current data sources do not capture the silvicultural work carried out by private individuals, this affects the reliability of forest management data and undermines the evaluation of policy instruments such as silvicultural subsidies.

This study introduces a method for estimating self-directed silvicultural activities using data from Finland's National Forest Inventory (NFI13) and national Silvicultural and Forest Improvement Work Statistics. The method involves calculating correction coefficients by comparing NFI-derived activity levels with the reported figures from the statistics. These coefficients are adjusted regionally based on forest ownership categories, allowing for a more accurate estimation of unrecorded work.

Pre-commercial thinning is used as a case study, since it is assumed to include more self-directed work than most other silvicultural activities. The case study reveals significant regional variation in coefficients.

Preliminary findings indicate that incorporating forest owner's self-performed silvicultural work into national statistics could substantially enhance the reliability of forest data. This would provide a more comprehensive foundation for evaluating policy outcomes and resource allocation. The study raises questions about the sufficiency of current data, proposing that these estimates of self-directed silvicultural work could be useful and should be introduced as a statistical component.

Keywords: estimation; silviculture; pre-commercial thinning; owner-performed; forestry.

1. Introduction

Forestry is a significant component of Finland's national economy; for instance, in recent years the forest industry products have accounted for 16–17% of the country's exports. A substantial share of Finland's forests — nearly 44% of the forests — is owned by private individuals [1]. These forest owners play an important role in securing timber supply for the forest sector and in managing the overall development of Finland's forests.

Finnish forestry and the management of forests available for wood production are based on even-aged silviculture, in which trees are even-aged, and each rotation begins after a regeneration harvest. The new rotation then progresses through stand management schedule: the regeneration phase, the young-stand management phase, the thinning phase, and the final felling. The objective is to use forests efficiently while maintaining their long-term vitality. During the regeneration and young-stand phases, forest owners either commission or carry out by themselves multiple operations aimed at ensuring optimal wood production and revenues from their forests. These operations constitute silvicultural work.

Silvicultural work is a key element of sustainable forest management. In the regeneration phase, the establishment of a new forest generation is secured through actions such as site preparation followed by seeding or planting. In the young-stand phase, competing vegetation or excess

seedlings are removed, ensuring adequate light and nutrient availability for the remaining trees. Pre-commercial thinning improves growing conditions and accelerates stand development, which is especially reflected in the larger stem sizes observed at later thinning stages [2]. In Finland, forest owners have been encouraged to undertake silvicultural work through advisory services, training, and financial incentives [3–4]. Given the economic importance of silvicultural operations, as well as the need to monitor the effectiveness of silvicultural incentives, regional statistics on silvicultural work are essential.

The Silvicultural and Forest Improvement Work statistics compiled by the Natural Resources Institute Finland (Luke) provide annual and regional estimates of the volumes and costs of silvicultural operations [5]. These statistics are used, for example, to assess the effectiveness of political steering instruments. The data are compiled from work-volume and cost information reported by the state, forest industry companies, forest management associations, and other companies providing forest services. Information is collected annually from the state, the largest forestry companies and the forest management associations. Smaller companies are surveyed when they are included in the sample. The sample is drawn from the list of companies that have applied for state support for silvicultural work. The published work volumes are underestimates, as owner-performed silvicultural work is not included [6].

Research has shown that a large proportion of forest owners carry out silvicultural work themselves without using any service provider [7]. Historically, these independent contributions were included in the statistics, as forest owners were legally required to belong to forest management associations, which reported such work for statistical purposes. The number of forest management associations has declined, their operational areas have expanded, and their forest managers no longer have a reliable view of the work carried out by individual forest owners. Since 2014, statistics have no longer provided a comprehensive account of owner-performed forest management activities. This shortcoming is considered to be unfortunate by statistical users, as it complicates both the monitoring of incentive effectiveness and the assessment of compliance with silvicultural standards.

In this article, I describe a new method for calculating forest owners' independent silvicultural work into statistical work volumes so that the statistics more accurately reflect actual figures. Estimates derived from the field data of the National Forest Inventory (hereafter NFI) are used to represent the volumes of silvicultural work that has taken place in forests. These estimates are then compared with the work volumes reported in the Silvicultural and Forest Improvement Work statistics. The aim is to derive regional coefficients for different types of silvicultural operations, enabling annual estimation of total work volumes.

The focus of this study is on estimating the volume of pre-commercial thinning. The intention is that the method can serve as a basis for estimating other types of silvicultural work. Pre-commercial thinning in this study includes early pre-commercial thinning (early clearing) and later pre-commercial thinning (seedling thinning), like it does in the statistics [5]. Pre-commercial thinning was selected because forest owners are known to perform this type of work frequently and with high quality in their own forests [7]. Koho et al. (2004) reported that pre-commercial thinning was one of the most common silvicultural activities conducted independently by forest owners [8]. Studies from the 1990s found that approximately 70% of pre-commercial thinning was performed independently [7]. However, the intensity of early clearing varies a lot between regions, highlighting the need for targeted incentives and advisory measures [9].

The Finnish government provides financial support for pre-commercial thinning. Pre-commercial thinning is one of the most expensive silvicultural operations, and the timing has a significant impact on costs. Delays increase the difficulty and duration of the work, as competing understory trees grow thicker and more numerous, which reduces the efficiency of the worker [2]. The

METKA support scheme, introduced in year 2024, subsidizes pre-commercial thinning and the management of young forests by reimbursing part of the costs based on clear eligibility criteria and support levels [3–4]. Statistical information enables support funds to be directed to areas with the greatest need and helps estimate future funding requirements for upcoming budgets.

2. Methods

This study combines two sources of information. The Silvicultural and Forest Improvement Work statistics describe the annual outputs (in hectares or kilometres), unit costs (€/unit), and total costs (€) of silvicultural and forest improvement operations carried out by service providers and state [4]. These statistics do not include work performed independently by private forest owners.

The National Forest Inventory (NFI) is a sample-based field inventory, which uses systematic cluster sampling as its method. A wide range of variables are measured and recorded from the sampling plots. During each field visit, in addition to tree measurements, information is recorded on silvicultural and harvesting operations carried out within the surrounding stand. These operations are documented using defined retrospective time windows [10]. For example, fellings are recorded for the previous 10 years and soil preparation for the previous 30 years, while for some operation types only the most recent event is registered. Based on these observations, estimates can be produced for the total volume of silvicultural work carried out during a given period. These estimates can be calculated either for Finland as a whole or for specific regions, such as individual provinces.

The information collected in the NFI is not sufficient to replace the data provided by the official statistics, as it does not include information on the costs of silvicultural work. In addition, the regional sampling precision of the NFI is lower at the annual level, and the differing retrospective recording periods applied to different work types affect their visibility in the data. However, NFI data can be used to complement the statistics, since it excludes the owner-performed component, which can be substantial in some silvicultural work types. In this article, the share of owner-performed work in pre-commercial thinning is estimated by combining the annual work volumes and cost data from the Silvicultural and Forest Improvement Work Statistics with estimates derived from the NFI. Because owner-performed work represents a significant share of pre-commercial thinning, accounting for it separately would improve the reliability of overall work volume estimates.

The objective is to estimate the amount of independent work and complement the statistical work volumes accordingly. The method is straightforward. First, the total volume of each work type over the five-year period is derived from NFI data. This is used as the best available representation of the true overall volume for that period. Five-year averages are then calculated separately for the NFI-based values and for the volumes reported in the Silvicultural and Forest Improvement Work statistics. The ratio between these averages provides a correction coefficient, which is used to estimate the portion of work missing from the statistics. In this article, this estimated portion is considered to be owner-performed work, although it may also include work volumes missing from the statistics for other reasons. The correction coefficients are calculated for each stumpage price region, and the same coefficient is applied to all years within the five-year calculation period. The uncertainty of the estimates is assessed using the standard error of the NFI estimates. The result is an experimental time series that complements the official statistics.

The published, open NFI data did not allow regional monitoring restricted solely to non-industrial, private owned forest [11]. Minna Räty, Senior Research Scientist at the Natural Resources Institute

Finland, provided additional NFI-derived estimates indicating the amounts of pre-commercial thinning for private lands only, for the periods 2019–2023 and 2020–2024, and for the land-use category “forest land–poorly productive forest land,” which practically means “forest” in Finland [12]. Ownership classes in the NFI do not fully correspond to those in the statistics, but by aggregating several NFI ownership classes, a sufficient correspondence level was achieved. NFI data package included the standard errors for each of the NFI estimates, which enabled the calculation of standard errors for each stumpage price region. The standard errors are relatively small, with the exception of Åland. They are shown in Table 1.

Table 1: Standard errors of the NFI13 estimates used, by price region.

Price region	Standard error (ha)	Standard error (% of total)
Southern Finland	7474	5,5 %
Central Finland	11611	1,6 %
Kymi-Savo	6841	5,5 %
Savo-Karelia	8295	6,4 %
Southern Ostrobothn	10736	1,9 %
Kainuu-Ostrobothnia	7879	7,1 %
Lapland	10931	2,0 %
Åland	2506	40,8 %

The ratio between the amounts of pre-commercial thinning based on forest statistics and based on NFI were compared (r = NFI/statistics), and the difference between the two data sources (d = NFI – statistics) were analysed by price region for two consecutive time periods (2019–2023, 2020–2024). The variability of the ratio r was smaller than that of the difference d. The median of ratio r did not change substantially during the periods examined. This encouraged the use of a coefficient r rather than fixed addition to the figures. Moreover, owner-performed pre-commercial thinning is likely to scale annually in line with the service-based work (weather conditions affect both), which favors the use of a coefficient in estimating annual volumes.

The five-year NFI time window (2019–2023) was selected, because each NFI is measured to certain predetermined time periods. Selected time window corresponds to the time period of the measurements of 13th National Forest Inventory (NFI13). A similar assessment could be produced for 2024–2028 once NFI14 calculations will be completed in 2029. Annual regional estimates would be much more unstable due to sampling variation caused by the much smaller amount of field data that is measured in one year; thus, the method was kept consistent with NFI system. The annual adjusted time series were obtained by multiplying the statistical pre-commercial thinning volumes by the constant coefficient for the selected time period.

Calculations were initially performed at the regional (province) level. However, because the silvicultural statistics are published by forest ownership class only by the stumpage price regions, the coefficients were calculated for these regions. Each price region (Southern Finland, Central Finland, Kymi–Savo, Savo–Karelia, South Ostrobothnia, Kainuu–Ostrobothnia, Lapland, Åland) consists of one to five provinces. The Åland Islands have self-government in Finland, and their statistical data is collected and provided by the Government of Åland.

Using the coefficients r for the published work volumes for pre-commercial thinning of the statistical owner class “private, non-industrial” by the price regions, private forest owner’s self-made work can be calculated. This is done for the years 2019–2023. By adding these new amounts

to total work volumes year by year, an estimate of the total work performed each year can be obtained.

3. Results

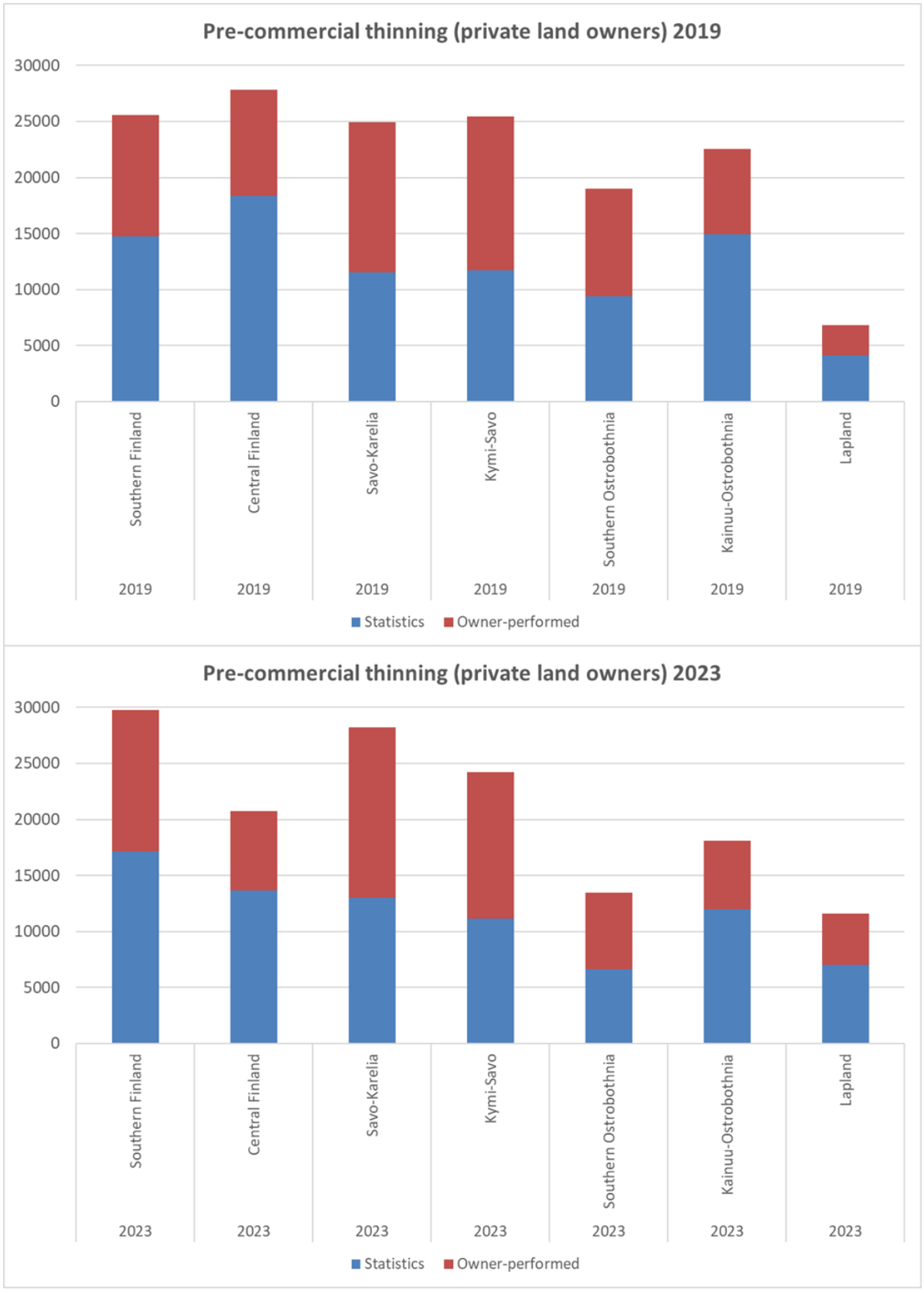
The coefficients r calculated for the stumpage price regions ranged from 2.17 (Savo–Karelia and Kymi–Savo) to 0.84 (Åland). Reduction of the published silvicultural figures would distort the statistics. So, the coefficient for Åland was set to 1, which is minimum for the coefficient in this case. The statistics on the work volume in Åland were known to be reliable, as the data is obtained directly from the Åland administration. The regional coefficients for each price area are presented in Table 2.

Table 2. Coefficients for independent pre-commercial thinning by price region, used to scale the statistically recorded pre-commercial thinning (early clearing + pre-commercial thinning) on private land.

Price region	Coefficient
Southern Finland	1,74
Central Finland	1,52
Kymi-Savo	2,17
Savo-Karelia	2,17
Southern Ostrobothnia	2,03
Kainuu-Ostrobothnia	1,51
Lapland	1,65
Åland	1,00

The amounts of independent pre-commercial thinning were calculated for non-industrial, private owned land for the years 2019–2023 by multiplying the statistical figures of work volumes by the corresponding coefficients for each price region. The results for 2019 and 2023 are shown in Figure 1. The values for Åland are redacted for statistical reasons in some years and are therefore excluded from the comparative figures.

Figure 1. Pre-commercial thinning volumes on private land by price region in 2019 and 2023, with statistically recorded work shown in blue and the estimated independent component shown in red. Åland is excluded because no additions are applied and its values are often redacted due to the low number of data providers.



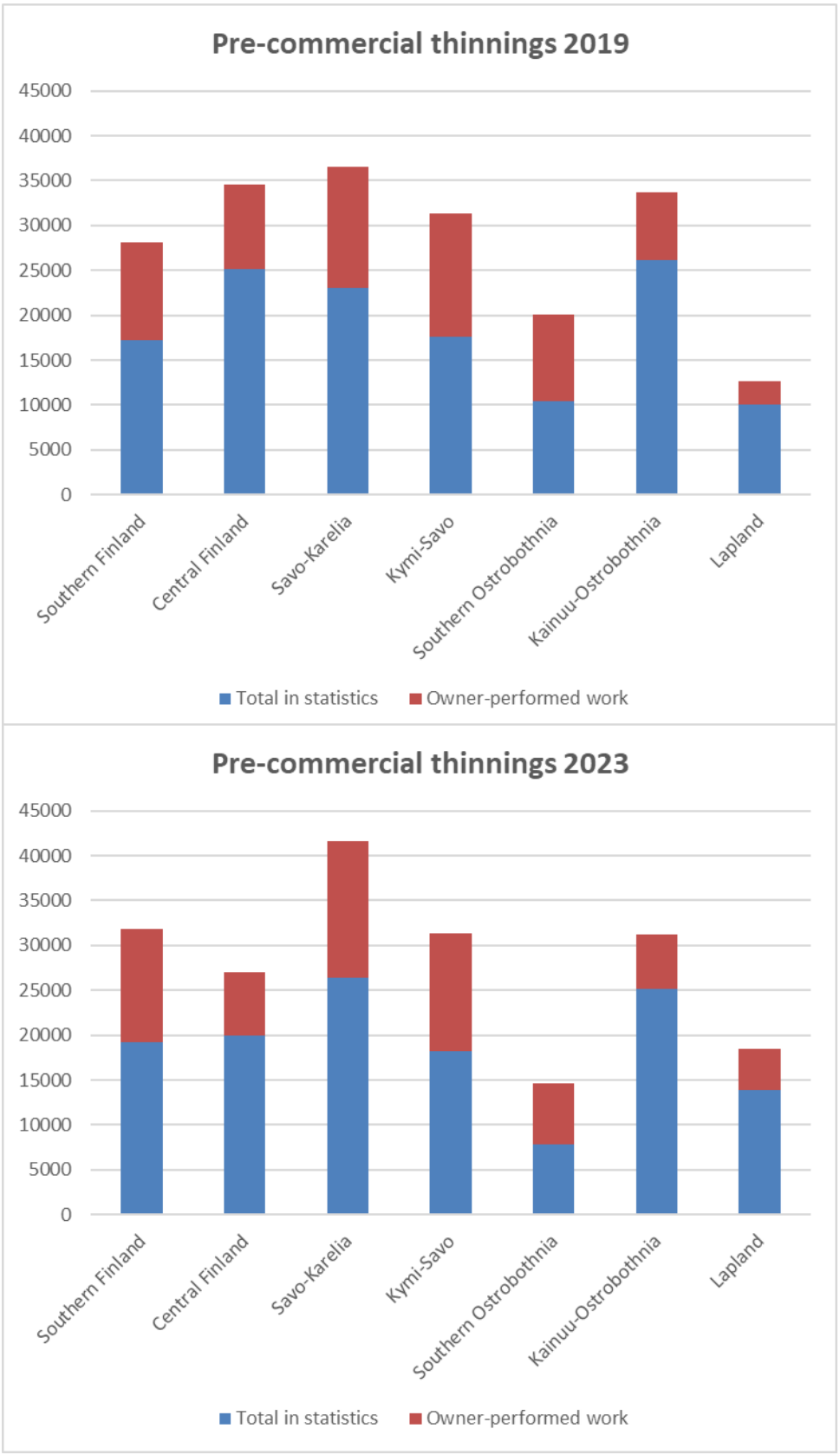
After estimating the volumes of independent pre-commercial thinning, these were added to the total volumes reported in the Silvicultural and Forest Improvement Work statistics to produce estimates of total pre-commercial thinning for the years 2019–2023. These enlarged pre-commercial thinning volumes, along with the relative increase (%) from the original statistics, are presented in Table 3.

The total pre-commercial thinning area for the whole country has varied annually from 171,000 to 223,000 hectares. The peak year was 2020 (222,609 hectares) and the lowest volume during 2019–2023 occurred in 2022 (171,265 hectares). On average, the calculated additions corresponded to a 51% increase from the published statistics. Although annual work volumes varied, the annual percentage increase remained consistent between 50% and 53%.

Table 3. Calculated pre-commercial thinning volumes for all of Finland (excluding Åland) based on the coefficients, and their percentage increase relative to the statistically recorded work volumes in 2019–2023.

	Calculated work volumes	Increase compared to statistics
2019	196924	52 %
2020	222609	53 %
2021	194509	50 %
2022	171265	52 %
2023	196093	50 %

Figure 2. Statistically recorded pre-commercial thinning volumes for all ownership classes (blue), the calculated independent component (red), and their combined totals (full columns) by price region.



4. Discussion

The results show that the proportion of forest owner-performed work within the total volume of pre-commercial thinning is substantial and regionally consistent. The observed increase fits in with earlier evidence on the extent of owner-performed work in pre-commercial thinning [13]. Overall, the findings indicate that self-performed pre-commercial thinning is a considerable and regionally stable additional component on top of the statistically recorded outputs performed by forest service providers. Owner-performed work forms an essential part of the total effort.

Holding the coefficients derived from NFI13 constant over the five-year time period means that annual variation reflects primarily changes in the statistically recorded volumes. Nevertheless, the relative magnitude of the independent component across price regions remains similar from year to year, reinforcing the regional consistency of the results.

Total work volumes increase substantially once owner-performed work is added. This finding is consistent with previous studies [7, 8]. The size of the addition appears logical and follows the overall levels of pre-commercial thinning across ownership classes (private land, forest industry land, and state-owned land). Thus, owner-performed work can be said to follow the general trends in total work volumes of pre-commercial thinning. Variations in workloads follow regional stages of forest development and conditions that regulate the need for and productivity of both professional contractors and private landowners [7]. Poor conditions for pre-commercial thinning are poor regardless of who performs the work, as most of the tasks rely on manual labour.

It should be noted that some of the work observed on private, non-industrial forest land in the NFI consists of operations performed by commercial silvicultural service providers. Consequently, the additions derived from the NFI-based coefficients may partially include such work, because small silvicultural companies are surveyed by sample in the statistical data collection. This may lead to regional underestimation in the statistics. Some of the work assessed as owner-performed in this article may therefore be carried out by small service providers. This increase caused by companies omitted from statistical sample is unlikely to be significant compared to the amount of owner-performed work, but it should be investigated in more detail.

The purpose of this study was to identify a method for estimating the volume of silvicultural work performed independently by forest owners. Based on the five-year NFI window, the use of coefficients derived from NFI data appears to function well for pre-commercial thinning. This approach is not applicable to all types of silvicultural work, as some operations are not recorded in NFI field assessments, or are difficult to quantify in the field. For example, seeding, planting, and pre-harvest clearing are recorded incompletely, resulting in underestimation in the NFI data. However, this type of method for estimating the owner-performed work could be considered for other activities, such as soil preparation or ditch network maintenance.

In this report, the extent of owner-performed work in pre-commercial thinning has once again proven to be a significant part of forest management in Finland, consistent with earlier findings. The Silvicultural and Forest Improvement Work statistics would benefit from incorporating the computational approach described here—or another suitable method—to ensure that owner-performed silvicultural work is also represented in the official statistics.

References

[1] Finnish Forest Centre. Metsätalousmaan omistus omistajaryhmittäin. Available from: https://www.metsakeskus.fi/fi/avoin-metsa-ja-luontotieto/tietoa-metsien-omistuksesta/metsatalousmaan-omistus-omistajaryhmittain. Accessed 26 Feb 2026.

[2] Huuskonen S, Haikarainen S, Sauvula-Seppälä T, Salminen H, Lehtonen M, Siipilehto J, et al. Benefits of juvenile stand management in Finland—impacts on wood production based on scenario analysis. Forestry. 2020;93(3):458-70.

[3] Finnish Government. Metkan tukitasot ja -ehdot on vahvistettu. [Internet] Press release. 16.11.2023. [cited 2026 Feb 19] Available from: https://valtioneuvosto.fi/-/1410837/metkan-tukitasot-ja-ehdot-on-vahvistettu

[4] Finnish Forest Centre. Taimikon ja nuoren metsän hoidon tuki. [Internet] Finnish Forest Centre; 2026 [cited on 2026 Feb 20]. Available from: https://www.metsakeskus.fi/fi/taimikon-ja-nuoren-metsan-hoidon-tuki#:~:text=Taimikon%20ja%20nuoren%20mets%C3%A4n%20hoidon%20tuki%20%7C%20Mets%C3%A4keskus

[5] Natural Resources Institute Finland (Luke). Silvicultural and forest improvement work 2023. [Internet] Helsinki: Luke; 2024 Aug 29. Available from: https://www.luke.fi/en/statistics/silvicultural-and-forest-improvement-work/silvicultural-and-forest-improvement-work-2023

[6] Natural Resources Institute Finland (Luke). Documentation of statistics: Silvicultural and forest improvement work. [Internet] Helsinki: Luke; 2025 Jun 18. Available from: https://www.luke.fi/en/statistics/silvicultural-and-forest-improvement-work/documentation-of-statistics-silvicultural-and-forest-improvement-work-1

[7] Valkonen J, Tanttu V, Peltola M. Omatoimisen taimikonhoitotyön tuottavuus ja laatu. TTS tutkimuksen julkaisuja 401. Nurmijärvi: Työtehoseura; 2007.

[8] Koho R, Hänninen H, Karppinen H, Ovaskainen V. Omatoimisuus metsätaloudessa. Metsäntutkimuslaitoksen tiedonanto 912. Vantaa: Metsäntutkimuslaitos; 2004.

[9] Tanskanen J. Taimikon varhaishoitoaktiivisuuden kunnittaiset erot. Opinnäytetyö. Karelia-ammattikorkeakoulu; 2024.

[10] Korhonen KT. Valtakunnan metsien 14. inventointi (VMI14): maastotyön ohjeet 2024. Helsinki: Natural Resources Institute Finland (Luke); 2024.

[11] Korhonen KT, Räty M, et al. Forests of Finland 2019–2023 and their development 1921–2023. Helsinki: Natural Resources Institute Finland (Luke); 2024.

[12] Räty M. Estimates of pre-commercial thinning based on NFI data 2019–2023 and 2020–2024 for privately owned, non-industrial forests. Unpublished data; 2025.

[13] Antikainen J. Self-motivated Forest Owners in Young Stand Management. Thesis. Karelia University of Applied Science; 2019.