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Overstory stability, growth and regeneration across ten years after shelterwood cuts in *Nothofagus pumilio* stands from Tierra del Fuego (Argentina)

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Abstract *Nothofagus pumilio* is a native tree from the Andean Patagonia, including Tierra del Fuego archipelago, with exceptional timber quality. In *N. pumilio* natural forests, harvesting generates changes in structure, which in combination with natural disturbances, particularly windthrown, modify the recovery pathways to face management proposals. Overstory stability and diameter growth of remnant trees (>5 cm diameter), and density and height of natural regeneration (<5 cm) were analysed in stands managed with shelterwood after preparatory cuts (PC), final cuts (FC), and thinning (T) in Tierra del Fuego (Argentina). Overstory stability measured as fallen basal area of remnant trees was evaluated across 10 years-after-harvesting (YAH), diameter growth was evaluated during 2012-2018 and 2019-2022, and regeneration was evaluated before harvesting and 10 YAH. PC (fallen basal area 6.0%) and FC (8.4%) promoted greater stability than T (21.0%), in which higher instability was recorded during the first 4 YAH. Diameter growth did not show significant differences between shelterwood cuts (3.6-4.2 mm·yr^{-1}) and thinning (3.7-4.6 mm·yr^{-1}). PC and FC showed abundant regeneration (21.8 and 17.0 x 10^{3} ind·ha^{-1}, respectively). Our study showed that shelterwood cuts (PC and FC) in *N. pumilio* forests promoted greater tree stability and natural regeneration while thinning generated greater growth values at stand level.

Keywords: silviculture, stand stability, stand recovery, forest structure, Patagonia.

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Introduction

Silviculture has been defined as the art and science of controlling the establishment, growth, composition, health, and quality of forests to meet diverse needs and values (Nyland 1996, Puettmann et al. 2025). However, the purely empirical approach to silviculture has become increasingly difficult to justify in the context of unprecedented socio-environmental changes affecting forests worldwide (Achim et al. 2022, Velasco-Muñoz et al. 2022, Psistaki et al. 2024), and new perspectives were incorporated such as ecology, modelling, disturbance dynamics, and adaptive management (Szmyt & Dering 2024, Palik & D'Amato 2025). Traditional silviculture in some areas relied strongly on local empirical experience, especially in non-developed countries and less populated areas as Patagonia (Argentina), e.g. some silvicultural proposals were imposed without checking their effectiveness on the ground (Bava & Caselli 2025).

Nothofagus pumilio (Poepp. et Endl.) Krasser (lenga) represents the most important native timber resource (quality and quantity) in southern Argentina and Chile (Gea-Izquierdo et al. 2004, Rosenfeld et al. 2006). In Tierra del Fuego (Argentina) these forests cover 214,300 ha, where 18% of this area are under timber production (Collado 2001, Chaves et al. 2024).

Several silviculture treatments have been applied in these forests, e.g. selective cuts (Alonso et al. 1968, Gea-Izquierdo et al. 2004), clear-cuts (Mutarelli & Orfila 1973), shelterwoods cuts (Schmidt & Urzúa 1982) and variable retention harvesting (Bottan et al. 2025). To date, shelterwood represent the most widely implemented silvicultural system on *N. pumilio* forests (Chaves et al. 2024), including two cut stages: (i) preparatory, that reduce the overstory cover to promote natural regeneration, leaving around 30 $m^2 \cdot ha^{-1}$ basal area (BA) and a maximum distance between trees of 12 m; and (ii) final, which removes the remnant overstory, retaining or not some dispersed trees for conservation purposes (< 5 $m^2 \cdot ha^{-1}$ BA).

In the secondary forests resulting from harvesting, thinning and pruning are implemented to enhance growth and quality of future timber trees (Hawley & Smith 1982, Schmidt & Urzúa 1982, Swanson 2009, Ramos & Paredes 2012, Cruz et al. 2018, del Campo et al. 2022). Thinning also regulates the stand values, including tree age balance, spacing, and conservation values (Daniel et al. 1982, Moreau et al. 2022). Thinning can significantly vary in timing, and intensity. In Tierra del Fuego, several thinning intensity trials were conducted to evaluate stand stability as the survival of trees across the time without damage of windthrow, and competition (e.g. Cruz et al. 2018, Chaves et al. 2024). In this context, harvesting operations, including thinning, result in forest structures that differ from those found in stands without silvicultural intervention, which in turn leads to different post-harvest successional trajectories (Zenner et al. 2013, Searle et al. 2022, Guignabert et al. 2024).

There are managed areas where final cuttings have been applied although little is known about the post-harvest stand dynamics (e.g. Chaves et al. 2024). In addition, frequent windthrow can affect the stability of the remaining overstory, resulting in less than half of the trees retained after preparatory cuts surviving the first 10 years-after-harvesting (YAH) (Gea-Izquierdo et al. 2004). The stability of trees depends on several factors as wind exposure, slope, soil moisture, tree height–diameter ratio, and canopy openness after harvesting (e.g. Rebertus et al. 1997, Peltola 2006, Ekeoma et al. 2024).

The objective of this study was to analyse stability and diameter growth of remnant overstory, and density and height of natural regeneration of *N. pumilio* across 10 YAH in stands managed with thinning and shelterwood cuts in Tierra del Fuego, Argentina.

Material and methods

Study area

The study area comprised 39.9 ha of *N. pumilio* forests with middle-low site quality classes with 15-22 m dominant tree height (Martínez Pastur et al. 1997), located near Río Milnak-Bombilla Forest Reserves (54.622 SL, 67.739 WL) (Figure 1A). This area was harvested between 1980 and 1990 by high-grading cuts, resulting in uneven-aged forests with low timber quality remnant trees (Gea-Izquierdo et al. 2004) intermixed with unmanaged areas maintained for conservation purposes.

The study area is in the central area of Tierra del Fuego (Argentina) (Figure 1B), and it is representative for commercial forests, based on site quality, natural dynamics and current land use (Gutiérrez 1994, Gea-Izquierdo et al. 2004). Mean annual temperature is 5.5 °C (1.6 °C in the coldest and 9.6 °C in the warmest month) and frost may occur at any time of the year. Precipitation is evenly spread over the year, with an average of 500 mm·yr^{-1}, declining towards the north. Landscape occupied by forests is mostly that of glacial origin with loess and alluvial materials in the foothills, where acid brown soils are the most common (Romanyà et al. 2005).

Treatments and monitoring

Three treatments were surveyed: thinning (T), preparatory cuts (PC), and final cuts (FC). Harvested stands were chosen according to the existing logging trail (Figure 1C). The objective of harvesting was to obtain timber logs (>25 cm diameter with healthy wood) and to improve quality and growth of remnant trees. For sampling, we established two types of permanent plots to evaluate treatment effects over 10 YAH.

(i) Adults plot: overstory remnant stability and tree diameter growth was measured in plots of 500 m² (50 x 10 m) for PC (n = 5) and FC (n = 5), and of 314 m² (10 m radius) for T (n = 5) (15 plots in total) (Figure 1), where annual winter monitoring of remnant trees was conducted for 10 YAH (2012-2022). Windthrown trees were identified in the field as individuals that were either uprooted from the soil or snapped by the wind. Plot size in T was reduced given the substantially higher tree densities. Using smaller plots allowed us to maintain a comparable number of sampled individuals per plot and measurement effort among forest types, while avoiding excessive clustering and spatial autocorrelation within plots. Diameter at breast height (DBH, cm) was measured with a tree calliper and height (H, m) was measured with a hypsometer (Impulse, Laser Technology, New Jersey, USA) for all adult trees (DBH >5 cm) to determine tree density (TD, ind·ha^{-1}) and basal area (BA, m^2·ha^{-1}). Total volume over bark (TOBV, m^3·ha^{-1}) of each stand was determined using DBH and H (Martínez Pastur et al. 2002). Tree diameter growth corresponded to the periodic annual increment between years (PAI, mm·yr^{-1}). Each tree was identified by numbered tags or painting.

(ii) Regeneration subplot: At each adult plot we established 10 m² subplots (5 x 2 m) for measuring regeneration density (DBH <5 cm), distinguishing between initial ($H < 1.3$) and advanced ($H \geq 1.3$ m) at YAH = 0 and YAH = 10. For advanced regeneration, mean height (MH) as the average of all individuals in the plot, and dominant height (DH) as the highest value of the plot was recorded at 10 YAH.

Figure 1 (A) Location of Tierra del Fuego in Argentina. (B) Distribution of *Nothofagus pumilio* forest. (C) Location of treatments and permanent plots. T: thinning, PC: preparatory cuts, FC: final cuts, C: conservation areas, LT: logging trails.

Statistical analyses

Overstory remnant stability was evaluated by comparing silvicultural treatments for each year using analyses of variance (ANOVA), with TD, DBH, BA, TOBV, and WBA as response variables. Post-harvest tree growth was assessed by comparing PAI among treatments for the periods 2012–2018 and 2019–2022. Regeneration before harvesting and at 10 YAH was compared between PC and FC using ANOVA, with TD, MH, and DH as response variables. Means were compared using Tukey's test ($p < 0.05$). To assess post-harvest tree growth, we also conducted ANOVAs comparing PAI among treatments for two time periods (2012-2018 and 2019-2022). Finally, to determine the natural regeneration values, we conducted ANOVAs to compare PC and FC, analysing TD, MH, and DH before harvesting and 10 YAH. Means were compared using Tukey's test ($p < 0.05$).

Results

Changes in forest structure among silvicultural treatments showed significant differences in tree density, basal area, and total over bark volume along the years-after-harvesting (Figure 2). As was expected, thinning presented higher TD, BA and TOBV than PC > FC. The greatest change was observed during the harvesting (first dot represent the original structure and the second one the post-harvesting structure), however, changes occurring across the years. No significant differences were found in DBH for all treatments, although it was higher in PC compared to FC and T (Appendix A). The percentage of basal area removed during harvesting varied among treatments: 60.5% for thinning, 55.0% for preparatory cuts, and 42.2% for final cuts.

No significant differences were found in fallen basal area (FBA) across the first 10 YAH among the studied treatments (Appendix B), due to greater variability exists among plots. In the sampled stands, the total FBA for the first 10 YAH was $1.84\ m^2 \cdot ha^{-1}$ (6.0% total BA) in CP, $1.2\ m^2 \cdot ha^{-1}$ (8.4% total BA) in FC, and $9.1\ m^2 \cdot ha^{-1}$ (21.0% total BA) in T (Figure 3). Additionally, the highest proportion of fallen trees, reaching 73% of the total BA lost, occurred within the first 4 YAH after the harvesting (Figure 3).

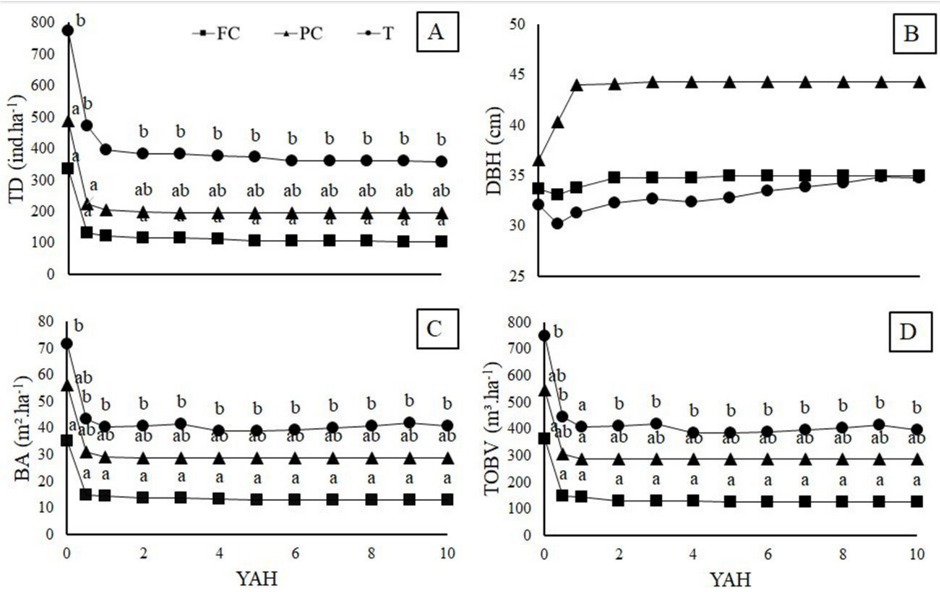

Figure 2 Variation of (A) tree density (TD), (B) diameter at breast height (DBH), (C) basal area (BA), and (D) total over bark volume (TOBV) during 10 years-after-harvesting (YAH) at preparatory cut (PC), final cut (FC), and thinning (T). Different lower-case letters indicate significant differences of means for each year (Tukey's test, $p < 0.05$). One-way ANOVA outputs were presented in Appendix A.

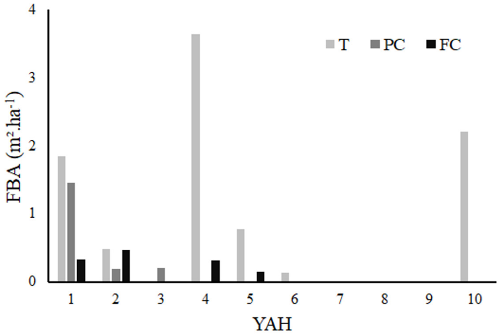

Figure 3 Fallen basal area (FBA) across the years-after-harvesting (YAH) under thinning (T), preparatory cuts (PC) and final cuts (FC). ANOVAs outputs were presented in Appendix B.

No significant differences in DBH growth between treatments were found. The mean periodic annual increment (PAI) for PC, FC and T was 3.59 mm·yr^{1} for the 2012-2018 period and 4.24 mm·yr^{1} for the 2019-2022 period (Table 1). Thinning showed an increase of 23.8% in the second period compared with the first one, while PC showed an increase of 32.5%. FC not present differences between both periods. Initial and advanced regeneration were recorded after harvesting (YAH = 0) and at the end of the study (YAH = 10) in the regeneration treatments (PC and FC). Initial regeneration was scarce at the beginning of the study at both treatments, and greatly increased at the end of the study, but without differences at YAH = 10 (Table 2). Density of advanced regeneration was significantly higher in FC than in PC at the beginning of the measurements (YAH = 0), but these differences disappear at YAH = 10; however, the height the advanced regeneration was significantly higher at FC than PC (Table 2).

Table 1 Simple ANOVA for mean periodic annual increment (PAI, mm·yr^{-1}) for thinning (T), preparatory cuts (PC) and final cuts (FC) during 2012-2018 and 2019-2022. F = Fisher test, p = probability between brackets.

Treatment	Period 2012-2018	Period 2019-2022
T	3.70	4.58
PC	3.44	4.56
FC	3.63	3.59
F (p)	0.16 (0.851)	0.97 (0.382)

Discussion

Many silvicultural proposals must be adapted to the ecological particularities of the managed forest species, e.g. tree tolerance to windblow after harvesting (Gea-Izquierdo et al. 2004, Chaves et al. 2024). In this context, silviculture needs to consider the ecosystem complexity and environmental variability in their implementation, both in terms of changing environmental conditions (Hagerman & Pelai 2018), and must consider the new societal demands (e.g. ecosystem services) (Biber et al. 2015). During harvesting, the manipulation of natural forest structure through cutting plays a crucial role in promoting natural regeneration, which leads to tree establishment under the shelter of the remnant overstory (Chaves et al. 2024). These manipulations of forest structure emulate the type and intensity of natural disturbances (e.g. gap dynamics) that achieve similar results but usually unfold more randomly (Pommerening et al. 2024).

Table 2 Simple ANOVAs of initial regeneration (IR, <1.3 m height) and advanced regeneration (>1.3 m height and <5 cm diameter) comparing preparatory cuts (PC) and final cuts (FC) during the beginning (YAH = 0) and end of the survey and (YAH = 10) for regeneration density (RD, thousand ind·ha^{-1}), mean height (MH, m), and dominant height (DH, m). Different letters showed significant differences by Tukey test (p <0.05), while the absence of letters indicates no significant differences. F = Fisher test, p = probability between brackets.

Levels		RD YAH = 0	RD YAH = 10	MH YAH = 10	DH YAH = 10
IR	PC	0.1	16.0	-	-
	FC	0.0	8.0	-	-
	F (p)	0.00 (0.999)	1.31 (0.286)	-	-
AR	PC	1.4 a	5.8	1.5 a	1.8 a
	FC	6.5 b	9.0	3.2 b	4.8 b
	F (p)	5.80 (0.042)	0.38 (0.552)	11.54 (0.009)	10.10 (0.013)

Silviculture based on natural regeneration always wants to accelerate the forest term (e.g. reduce the timeline between regeneration periods), optimizing tree density and tree quality of secondary forests by providing favourable structural, microclimatic and edaphic conditions (Smith et al. 1997), ensuring a continuous transition from one forest generation to the next (Rosenfeld et al. 2006). Sustaining the structure provided by natural forests to face disturbance regimes represents a great challenge for forest managers and policy makers, allowing to maintain the function and services that they provided (Gea-Izquierdo et al. 2004, Biber et al. 2015). For this, a wide range of adaptation approaches must be proposed centred on enhancing ecosystem resilience and adaptive capacity; however, considerable uncertainty exists regarding how to translate these broad and often theoretical adaptation frameworks to on-the-ground practice (D'Amato & Palik 2021, Arteaga et al. 2023, 2024). This approach needs to combine ecological properties of the forest ecosystems and the consideration of the human-centred benefits derived from those properties. In *Nothofagus pumilio* forests, the regeneration treatments are based on two critical factors that operate after harvesting, as well as for silviculture in general: (i) the stability of remnant trees, and (ii) the establishment, survival and growth of natural regeneration (Chaves et al. 2024). In our study, we focus on tree stability and natural regeneration during 10 YAH monitoring based on the theoretical proposals of the literature. However, harvesting operations damage the bases and crowns of residual trees, affecting their stability (Gea-Izquierdo et al. 2004).

Windthrows are frequent events in *Nothofagus pumilio* forests, especially in stands that have been recently harvested (Rebertus et al. 1997, Chaves et al. 2024). In our study the shelterwood cuts (preparatory cuts followed by final cuts) followed the expected theoretical paths in the first 10 YAH according to models proposed by Schmidt & Urzúa (1982). However, thinning presented overstory trees with lower stability, evidenced by the BA reduction across the years. The higher overstory tree stability of PC can be attributed by the presence of mature trees with DBH >40 cm, compared to FC and T (33 cm and 30 cm, respectively). FC presented a mixture of large trees (remnant trees of the original forests) and small trees of the secondary structure established after the harvesting. Trees with larger DBH are typically in more advanced growth stages, implying a longer exposure to climate events, which are generate greater resistance due to the development of their root systems (Gardiner 2021). However, for DBH >60 cm, stability may be reduced due to increased occurrence of heartwood and white rot, which are common in *N. pumilio* trees (Richter & Frangi 1992). Treefall in 61 natural *Nothofagus* stands <100 years in Tierra del Fuego corresponded to trees <32 cm DBH (Rebertus et al. 1997). These authors also defined a vulnerability threshold of 20 cm DBH for natural windthrow events. In our study, DBH of fallen trees was 34 cm, higher than those reported by Rebertus et al. (1997), which could be explained by the inclusion of all individuals regardless of age, thereby raising the overall average. Moreover, a large proportion of windthrows occurred during the first year after harvesting, which is consistent with observations in variable, aggregated, and dispersed retention methods (Martínez Pastur et al. 2019, Chaves et al. 2024, Bottan et al. 2025), where treefall tends to stabilize over time.

In general, for the three treatments analysed, the highest proportion of fallen trees occurred within the first four years following intervention, declining thereafter, as the most wind-sensitive individuals are likely to have already fallen (Wardle 1984). Martínez Pastur et al. (2019) reported a 17% reduction in residual BA at stand level under aggregated and dispersed retention after 15 YAH in Tierra del Fuego. In our study, this BA reduction was lower for PC and FC (6.0% and 8.4%) and higher for T (21.0%), which may be explained by differences in post-harvest damage, harvesting intensity, residual stand structure, specific windstorm events, and the number of years analysed. Although thinning initially increases the risk of windthrow, there is good evidence that thinning young stands reduces risks by promoting the development of structural roots and favouring the acclimation of trees to high wind loads (Moreau et al. 2022). For this, our study findings allowed to define if the losses and gains are enough to achieve economically levels for timber forest companies. Besides, thinning can be an effective tool to reduce forest vulnerability to several stressors, creating a window of opportunity to implement longer term adaptive management strategies such as assisted migration (Ameztegui et al. 2017, Moreau et al. 2022, Palik et al. 2022).

Growth of the remnant trees are also crucial to evaluate the feasibility of the proposed silvicultural methods (Pommerening et al. 2024). In our study, tree growth no presented differential effects among treatments when periodic annual increment was compared. However, the growth recorded 6 and 9 YAH (3.6 mm·yr^{1} and 4.2 mm·yr^{1}, respectively) are consistent with those reported for PC and thinning in young *N. pumilio* stands in Santa Cruz and Tierra del Fuego (e.g. Silva et al. 2008, Cruz et al. 2018). Martínez Pastur et al. (2019) reported growth rates ranging from 3.5 to 6.8 mm·yr^{1} under heavy thinning in middle site quality stands. Similarly, Cruz et al. (2018) reported increments >10.2 mm·yr^{1}, with no significant differences between thinning of secondary stands and timber trees in remnant trees regeneration treatments. Additionally, Silva et al. (2008) evaluated a preparatory cutting over eight years in forests with a similar structure (TD = 538 ind·ha^{-1}, AB = 67 m^{2}·ha^{-1}, and TOBV = 674 m^{3}·ha^{-1}) of middle site quality, recording a growth rate of 3.3 mm·yr^{1} and canopy volume losses of 18%, which was higher than those observed in this study. Cruz Johnson et al. (2007) reported that *N. pumilio* exhibits a strong growth response to intermediate cuttings in mature stands, maintaining high growth rates even after 100 years of age. Besides, in our study we recorded higher growth than those studies under several thinning treatments (1.7 to 2.9 mm·yr^{1}), probably due to the influence of stand age and climate variability. Although all the thinning treatments in the literature involved young stand structures, the observed differences can be explained by the intensity of the applied treatment. In this sense, the remnant forest structures showed a consistent growth across the landscape, which, despite the lack of significant differences between them, aligns with prior research on their response capacity (e.g. Gea-Izquierdo et al. 2004, Martínez Pastur et al. 2019). This indicates that the applied treatments successfully enhance growth and sustain favourable post-harvest health.

As in most tree species, natural regeneration in *N. pumilio* forests represents the most vulnerable stage during forest management, due to it is influenced by multiple factors such as environmental conditions, competition with understory vegetation, browsing of seedlings and saplings by large mammals, and foraging of seeds by insects and birds (e.g. Martínez Pastur et al. 2019, Bottan et al. 2025). Harvesting causes significant changes in forest structure, stimulating growth release of seedlings already present in the seedling bank (Rosenfeld et al. 2006). In our study, the analysed silvicultural treatments (PC and FC) showed higher seedling densities 10 YAH compared to the pre-harvest stage, which can be related to canopy opening (Chaves et al. 2024). The pre-harvest regeneration density in FC (6,500 ind·ha^{-1}) was enough to ensure forest continuity, considering a reference threshold of 5,000 ind·ha^{-1} (Rosenfeld et al. 2006). However, regeneration density alone does not guarantee forest continuity, being influenced by environmental variability, post-harvest mortality, herbivory, etc. (Martínez Pastur et al. 2019). FC had the greatest canopy opening with the lower BA (132 ind·ha^{-1} and 14.82 m^{2}·ha^{-1}). On the other hand, harvesting leads to regeneration loss, impacting over survival and growth rates due to damage caused by machinery, soil remotion and soil compaction (Valenzuela et al. 2018, Picchio et al. 2020). In our study, regeneration density after 10 YAH in the stands managed with PC surpassed that those values observed in FC. This can be related to self-thinning of the secondary trees (Zeide 1991, Liu et al. 2025). The regeneration (initial and advanced) densities recorded 10 YAH in PC and FC (21,800 and 17,000 ind·ha^{-1}, respectively) are consistent with those reported under variable and dispersed retention harvesting after 11 and 15 YAH (21,110 and 8,600-20,900 ind·ha^{-1}, respectively) (Martínez Pastur et al. 2019). In our study, PC and FC exceeded the pre-harvest levels and remained above the reference regeneration threshold, ensuring the recovery and continuity of the forest (Gea-Izquierdo et al. 2004, Chaves et al. 2024).

The current challenge in implementing intermediate (e.g. thinning) and regeneration treatments (e.g. shelterwood) worldwide, is to adapt theoretical approaches into reliable and economically feasible practices in the field (Martínez Pastur et al. 2019). Many studies analysed the correspondence between theory and practice (e.g. Gea-Izquierdo et al. 2004, Chaves et al. 2024, Bottan et al. 2025); however, the problem may not simply be a mismatch between theory and practice, but rather the transfer of theoretical frameworks or management practices developed in one region to another without proper adaptation.

Managers follow the principle of adaptive management based on long-term monitoring outputs and must consider the probability of increasing extreme natural climate events (e.g. large windthrow impacts) (Rosenfeld et al. 2006, Martínez Pastur et al. 2019). Here we presented the monitoring outputs of 10 YAH in forests that were harvested before, showing that the proposed homogenization of theoretical models is not accomplished in the practice. It is needed more specific planning at each stand, following the management objectives. Also, we put in evidence that intermediate treatments are more vulnerable than those regeneration methods based on shelterwood cuts.

These findings are consistent than those previously informed in permanent plots. In this context, considerable uncertainties remain about magnitude and character, if not general direction of anthropogenic disturbances in managed natural forests, and specially under climate change scenarios (Park et al. 2014). Even though the understanding of natural forests has increased during the last years, this understanding has resulted in a higher demand for further knowledge, both more precise in nature and broader in scope (Hüttl et al. 2000). During the last decades, sustainability concept includes more variables (e.g. ecosystem services) with broader interpretation, that usually were not included in the classical silvicultural proposals. As a result, current forest practices and policies tend to change with management practices adapted to changes in the environment and climate events (Falk et al. 2022, Triviño et al. 2023).

Conclusions

Our study showed that shelterwood preparatory and final cuts promoted greater tree stability than thinning in our study case of *N. pumilio* forests growing in Tierra del Fuego. No differences in diameter growth were found among treatments, however thinning presenting the highest values influencing over tree performance more than shelterwood cuts. Abundant natural regeneration after preparatory and final cuts indicates a high potential for forest recovery after harvesting operations. Windthrow reduce yield and represents a limitation for long-term planning, affecting the harvesting operations at larger forested areas. For this, post-harvest stand monitoring is key to generate new knowledge and establishing effective strategies for forest management. It is essential to deeply research stand stability, considering additional associated factors (e.g. landscape variation or site quality) and temporal scale (e.g. extreme climate events). Some of the limitations of the present study should be addressed by increasing replication across the landscape and implementing larger post-harvest monitoring to provide the data needed to support adaptive management of these forests.

Conflict of interest

The authors declare no conflicts of interest.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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