



Report on managers' and
owners' willingness to adopt
management scenarios and
feasibility of a mechanism of
payment for forest ecosystem
services



CLIMB-FOREST

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Contents

Contents	3
List of Tables	3
List of Figures	4
Executive Summary	5
Introduction	6
Materials and Methods	8
Case study regions	8
Data collection	9
Analytical framework	11
Barriers to adoption	11
PES feasibility	15
Results and Discussion	18
Barriers to adopt alternative forest management strategies	18
Close-to-Nature	20
Multifunctional	22
Timber production	26
Assessment of the feasibility of a payment for ecosystem services mechanism	30
Economic feasibility of implementing a PES scheme	30
Adoption constraints and perception of subsidies and PES schemes	35
Limitations	37
Conclusion	39
References	41
Appendix	48
Appendix A: Theoretical Framework PES	48
Appendix B: Tables	48

List of Tables

Table 1: Stakeholders for Semi-Structured Interviews	9
Table 2: Practices in each forest management strategy	12
Table 3: Identified barriers to transition towards less and more intensive management strategies	14
Table 4: Forest management intensity scenarios and associated ecosystem services provisioning	17
Table 5: Mean agreement value of barriers to transition from close-to-nature forestry towards less (unmanaged) and more (multifunctional) intensive management strategy	20
Table 6: Mean agreement value of barriers to transition from multifunctional forestry towards less and more intensive management strategy	23
Table 7: Mean agreement value of barriers to transition from timber production forestry towards less and more intensive management strategy	26
Table 8: Estimated private profitability	33
Table 9: Economic feasibility of PES scheme to transition towards less intensive management strategies ..	34

Table 10: Semi-structured interview questionnaire format	48
Table 11: Overview of forest management activities by interviewee and resulting management strategy classification.....	50
Table 12. Population (pop) count and forested area (ha) used to calculate CS per management regime per study region	51
Table 13: Classification of additional barriers to transition towards less and more intensive management strategies	52
Table 14: Compensating Surplus (EUR/ha/year) calculated for a shift between forest management strategies	55

List of Figures

Figure 1: Overview of the study regions	9
Figure 2: Forest management intensity spectrum	11
Figure 3: PES boundaries.....	15
Figure 4: Average cost and revenue structure across management strategies	32

Executive Summary

European Union (EU) forest policy framework simultaneously calls for increased wood mobilisation to support the bioeconomy and for greater protection of forest ecosystems to enhance biodiversity and climate resilience. As forest management decisions are ultimately made by forest owners and managers, this deliverable addresses the critical need to understand the factors hindering transitions to less and more intensive forest management practices and thus achieve EU policy objectives. Our findings reveal that transitions towards alternative forest management strategies are hindered by a wide range of economic, institutional, knowledge-related, social, and environmental barriers. Among economic barriers, intensification is primarily constrained by high transition and operational costs, while the lack of financial incentives for conservation consistently emerges as the most important barrier to less intensive management, underscoring the need to develop market mechanisms that effectively remunerate non-productive Forest Ecosystem Services (FES). Institutional and policy-related factors further constrain the scope for change: owner and managers preferences and policy momentum converge more strongly around close-to-nature and multifunctional forestry than towards fully unmanaged regimes. Combined with evidence from a Discrete Choice Experiment indicating welfare losses associated with transitions to unmanaged forest, these findings suggest an implicit agreement among policymakers, society, and forest managers that a minimum level of management is required. At the social level, transitions towards more intensive strategies are similarly constrained by societal expectations, norms, and foresters' preferences, suggesting that forest management decisions are embedded within broader social and cultural systems. Beyond economic, institutional, and social barriers, our results show that environmental, and particularly climate change-related barriers, hinder management changes in either direction through two main pathways: climate hazards and ecological uncertainty discourage departure from established practices, while limited technical guidance constrains the capacity of forest owners and managers to adapt.

Turning to policy instruments to transition towards less intensive management strategies, the feasibility analysis of Payment for Ecosystem Services (PES) schemes illustrates how demand- and supply-side dynamics shape the viability of such instruments. In Flanders, where demand for FES is high relative to forest supply and the timber sector is comparatively small, a PES scheme could be both economically viable and socially supported. In southern Spain, a PES scheme appears feasible only for transitions from multifunctional to close-to-nature forestry, and even there, feasibility remains sensitive to variations in foresters' opportunity costs and citizens' compensating surplus. In contrast, our findings indicate that a citizen-financed PES scheme is unlikely to be feasible in Norway for transitions from timber-oriented to multifunctional forestry, given that the supply of FES exceeds demand and legislation already allows free access to many FES. Our findings highlight that PES schemes to transition towards less intensive management strategies must be considered at a local scale, considering economic, institutional, social and ecological factors. Importantly, our results show that economic feasibility alone does not determine the success of PES schemes. The experiential dimension, encompassing forest owners' and managers' experiences, perceptions, and capacities, plays a decisive role in uptake. Administrative burden, long-term contractual commitments and limited awareness of subsidy and PES schemes, all emerge as critical non-economic barriers to participation, particularly for small holders.

Taken together, these findings underscore that no single instrument will suffice to align forest management transitions with EU policy objectives. Overcoming the interconnected barriers identified in this deliverable will require a coordinated combination of mechanisms, designed to account for changing climatic conditions: strengthened communication across governance levels, expanded training and advisory capacity, and well-calibrated financial compensation schemes that reduce not only economic but also experiential barriers to participation.

Introduction

Covering approximately 35% of the land area in Europe (FOREST EUROPE, 2020), European forests provide a wide range of ecosystem services (ES). Forest Ecosystem Services (FES), defined as the direct and indirect benefits that [forest] ecosystems provide to humans (Daily et al., 1997), can be grouped into three distinct categories: regulating and maintenance services (e.g., carbon sequestration, hazard mitigation), provisioning services (e.g., timber and non-timber products), and cultural services (e.g., outdoor recreation, access) (Haines-Young, 2023). The type and quantity of FES supplied by a forest are strongly shaped by forest management strategies, which create inherent trade-offs between management intensity and ES provision (Duncker et al., 2012; Sing et al., 2018). For instance, intensively managed forests deliver high timber yields but can reduce biodiversity and hazard protection (Sing et al., 2018). In addition to these management-related trade-offs, climate change is intensifying the frequency and severity of disturbances such as storms, droughts, wildfires, and pest outbreaks, thereby threatening forests' capacity to deliver these services (Appiagyei et al., 2022; Bolte et al., 2009; Sousa-Silva et al., 2016; Winkel et al., 2022). Together, these pressures highlight the central role of forest management decisions in maintaining the long-term provision of FES (Bolte et al., 2009; IPCC, 2019).

Current forest management in the European Union (EU) increasingly acknowledges the multifunctionality of forest ecosystems. This shift is reflected in the EU Green Deal, which promotes the substitution of fossil-based materials and fuels with forest-based biomass, while simultaneously positioning forests as a key nature-based solution for climate mitigation. Complementing these goals, the EU Forest Strategy for 2030 emphasizes sustainable forest management and calls for the protection of primary and old-growth forests to enhance biodiversity and strengthen climate resilience (European Commission, 2021, 2019; Scherpenhuijzen et al., 2025; Truffer et al., 2025; Westin et al., 2023). Together, these ambitions create a governance trilemma in which policymakers must balance increasing wood supply for the bioeconomy, enhancing forest carbon storage for climate mitigation, and safeguarding biodiversity alongside other FES (Högbom et al., 2021).

Within this evolving policy landscape, several EU countries promote management strategies that aim to strengthen ecological integrity while maintaining financial viability (Dawson et al., 2025). However, despite these political ambitions, forest management decisions are ultimately made by forest owners and managers. These stakeholders therefore play a critical role, acting as the link between policy objectives and the ecological reality of forest ecosystems, while determining which ES are prioritised (Juutinen et al., 2021; Sousa-Silva et al., 2016; Truffer et al., 2025). Numerous studies report increasing awareness among these actors regarding the impacts of climate change as well as a growing willingness to adopt adaptive practices (Blennow et al., 2012; Brunette et al., 2020; Hoeben et al., 2025; Roitsch et al., 2023; Sousa-Silva et al., 2018; Willig et al., 2025). However, evidence also points to a persistent implementation gap: although forest owners and managers recognise the need for adaptation, this recognition does not consistently translate into concrete actions (Hoeben et al., 2025; Sousa-Silva et al., 2018; Willig et al., 2025). Understanding then the factors that hinder the adoption of more and less intensive forest management strategies is therefore crucial for the design of effective and targeted support mechanisms that encourage transitions towards alternative management approaches. Particularly, given that EU policy simultaneously promotes both more intensive and less intensive forest management pathways, this study examines the perceived barriers that prevent forest owners and managers from adopting either direction of change.

One approach to addressing this implementation gap is through Payment for Ecosystem Services (PES) schemes. Within the EU Forestry Strategy for 2030, PES schemes are considered a financial mechanism to support forest owners and managers in implementing concrete measures that enhance forest adaptation, resilience, and the provision of FES (European Commission, 2021; Wunder et al., 2018). Wunder (2005)



defines PES as “a voluntary transaction where a well-defined ES (or a land-use likely to secure that service) is being ‘bought’ by a (minimum one) ES buyer from a (minimum one) ES provider if and only if the ES provider secures ES provision”. This definition implies that a crucial precondition for the implementation of PES scheme is that ES beneficiaries’ willingness to pay exceeds the ES providers’ willingness to accept (Wunder et al., 2018). Consequently, assessing the feasibility of PES schemes requires estimating both societal demand for ES (i.e., valuation by beneficiaries) and potential supply (i.e., the expected costs of ES delivery borne by forest owners and managers). Next to evaluating whether a PES scheme is economically feasible, we must also consider that a forester, or land manager in general, may be more or less likely to enroll in a PES scheme given their past and expected future experiences with said scheme. Administrative burden, Monitoring, Reporting, and Verification (MRV), and ease of compliance are all non-economic elements that further determine whether enrolling in a PES scheme is feasible for a forest manager/owner.

This deliverable aims to (i) identify the factors that forest owners and managers across different forestry paradigms perceive as barriers to transitioning towards less/more intensive forest management strategies, and (ii) assess the feasibility of implementing a PES scheme to support such a transition through an economic valuation approach. To complement the valuation analysis, we also explore forest owners’ and managers’ perceptions of PES schemes, enabling the identification of potential gaps between economic feasibility and practical implementation of such schemes. To address these objectives, we conducted nineteen semi-structured interviews with forest owners and managers across six European countries: Belgium, the Czech Republic, France, Norway, Poland, and Spain. In parallel, results from a Discrete Choice Experiment (DCE) was carried out to estimate citizens’ demand for a bundle of FES under alternative management strategies were used. This DCE and its results are described and reported in Deliverable D3.3 (Van Ruymbeke et al., 2025). Due to data availability constraints, the PES feasibility analysis was carried in three of the six study regions: Belgium (Flanders), Norway, and Spain.

The report is structured as follows. We first present the materials and methods, describing the case study regions, data collection procedures, and analytical framework. The results and discussion then follow, organised into two main parts. The first part examines the economic, regulatory, knowledge-related, social and environmental barriers faced by forest owners and managers when transitioning towards less intensive and more intensive forest management strategies. The second part assesses the economic and experiential feasibility of adopting a PES scheme to support less intensive management strategies. Finally, the deliverable concludes with a discussion of the study’s limitations and a synthesis of the main findings.

Materials and Methods

This study applies a mixed-methods analytical approach to address its two core objectives: identifying perceived barriers to transitions in forest management intensity and assessing the feasibility of PES schemes to support such transitions. First, qualitative data from semi-structured interviews with forest owners and managers were collected to elicit perceived barriers to shifting towards both less and more intensive forest management strategies. While current EU forest policy and scientific discourse often prioritise transitions towards less intensive, biodiversity-oriented management, policy objectives simultaneously promote increased wood mobilisation and biomass production to support the bioeconomy and climate mitigation. Consequently, forest owners and managers face incentives to adjust management intensity in both directions. To reflect this policy-driven tension, the analysis explicitly considers barriers to transitions towards both less and more intensive management strategies. Interview responses were subsequently quantified by assigning weighted scores to forest owners' and managers' barrier ratings, enabling comparative analysis across management strategies. On the feasibility side, supply-side opportunity costs were approximated using interview-based estimates of changes in forest profitability under alternative management scenarios, while demand-side benefits were derived from DCE-based compensating surplus estimates for bundles of FES.

Case study regions

To identify the factors that forest owners and managers perceive as barriers to transitioning towards less/more intensive forest management strategies, this study focuses on six European regions: Belgium, Czech Republic, France, Norway, Poland, and Spain. Figure 1 presents the location of these study regions within Europe (Part A in legend). These study regions capture Europe's east–west and north–south gradients in forest types and composition, as well as diverse economic, social and cultural ties to the forestry sector.

The PES feasibility analysis was conducted in three study regions: Belgium (Flanders), Norway and Spain. Although the DCE was conducted in four regions (Flanders, the Czech Republic, Norway and Spain), Czech Republic was excluded from the feasibility analysis due to a lack of cost and revenue data. Furthermore, as the DCE was only conducted in Flanders, Wallonia was excluded from the analysis as well. Figure 1 presents the location of these study regions within Europe (Part B in legend).



Figure 1: Overview of the study regions

Data collection

Data was collected via a series of online semi-structured interviews with forest owners and managers operating in six European countries: Belgium, the Czech Republic, France, Norway, Poland, and Spain. Forest owners and managers affiliated with the CLIMBFOREST project were contacted and interviewed when possible. To identify additional stakeholders, a thorough online research was conducted to identify national, regional and local level institutions managing forests in each country such as public forest management bodies, government ministries, regional and local authorities, municipal forest bodies and forest owners associations. After identifying relevant institutions, several stakeholders in each institution were contacted. Though the response rate was limited, we were able to collect data from 19 stakeholders. A breakdown of the stakeholders is presented in Table 1.

Table 1: Stakeholders for Semi-Structured Interviews

Occupation	Location	Ownership status	Code
Support forest managers	Wallonia, Belgium	Public (municipal)	BW1
Manager	Wallonia, Belgium	Public (state, municipal, province, CPAS)	BW2
Manager	Wallonia, Belgium	Public (municipal, regional)	BW3
Manager	Flanders, Belgium	Private and Public (municipal)	BF1

Forest Officer	Flanders, Belgium	Private and Public (except state forest and community ownership)	BF2
Owner and Manager	Flanders, Belgium	Private (individual/family)	BF3
Manager	Flanders, Belgium	Public (state, municipal)	BF4
Manager	Flanders, Belgium	Private (individual/family)	BF5
Manager	Flanders, Belgium	Mostly private	BF6
Forest Officer	Czech Republic	All except National Parks	C1
Owner and Manager	Hauts de France, France	Private (individual/family)	F1
Consulting forester	Nouvelle Aquitaine, France	Public (municipal)	F2
Manager	South of Oslo, Norway	Private (individual/family)	N1
Forest Officer	South Eastern Norway	Private (individual/family)	N2
Owner and Manager	South Eastern Poland	Private (individual/family)	P1
Officer	Poland	Public (state)	P2
Manager	South of Valencia, Spain	Private (religious institution or NGO)	S1
Officer	Valencia, Spain	Public (municipal)	S2
Officer	North of Valencia, Spain	Public (regional, municipal)	S3

From Table 1 we see that the number of interviews conducted per country is unbalanced: Belgium (9), the Czech Republic (1), France (2), Norway (2), Poland (2), and Spain (3). All interviews were conducted online between September and December 2025, and the interviews lasted between 50 min and 2 hours. All interviews except for one were recorded and they were undertaken by two different interviewers. The interviews were structured along a pre-established set of questions, which were grouped into five main blocks: (i) the interviewee's occupation within the forestry sector, (ii) contextualisation of the forest(s) being managed, (iii) barriers to transition towards alternative forest management strategies, (iv) basic costs and revenues structures of the forest, and (v) the interviewee's experience with payment schemes (e.g., PES and subsidies). The full set of questions are presented in Table 10 in Appendix. The questions were approved by the Social and Societal Ethics Committee (SMEC; G-2023-6247) of KU Leuven, and all interviewees provided their informed consent prior to participation.

Blocks 1 and 2 consisted of introductory and contextual questions. Block 1 focused on the interviewee's role within the forestry sector and their level of involvement in forest ownership or management. Block 2 aimed to contextualize the forest(s) concerned, covering aspects such as location, size, ownership structure, management history, decision-making processes, current activities taking place in the forest, management approach, and potential future changes. When an interviewee was involved with (overseeing) the management of multiple forest sites, they were asked to provide this information for the site most representative of the area. In Block 3, the interviewees were asked to classify a series of economic (4 barriers), regulatory and legislative (4 barriers), knowledge and capacity (2 barriers), social (5 barriers), and environmental (1 barriers) barriers into four categories (strong, medium, weak, not a barrier) based on how strongly they (may) act as a barrier in shifting to a less and/or more intensive forest management approach. Interviewees were also given the opportunity to mention additional barriers. Initially, interviewees were asked to reflect on barriers to transitioning towards alternative management strategies for the specific forest they own or manage. However, when this was not feasible because interviewees managed multiple forests across the management spectrum

or worked at a regional forestry department, they were asked to consider a typical forest within their region. Responses from Blocks 2 and 3 were used to assess barriers to adoption.

Block 4 addressed the cost and revenue structure of current forest management. Interviewees were asked to estimate total costs and revenues and how these might change under less or more intensive management scenarios. Specifically, interviewees were asked to estimate how their costs and revenues are distributed across different components. They reported the percentage of total costs allocated to the following categories: planning and administration, silviculture, protection and risk management, harvesting and utilization, environmental and biodiversity management, and social and recreational management. For revenues, interviewees indicated the percentage of total income derived from different sources, including timber production, non-timber forest products (NTFPs), subsidies and/or payments for forest ecosystem services (FES), recreation and tourism, land leasing or concessions, and forestry services (e.g. forest planning, mapping, logging, and consulting). For both costs and revenues, interviewees could specify additional categories if necessary. In the final part of the interview (Block 5), the interviewees were asked to answer a series of questions about their experience with, and willingness to participate in, PES or subsidy schemes. Responses from Blocks 4 and 5 were used to evaluate the feasibility of a PES scheme.

In addition to the semi-structured interviews, results from a Discrete Choice Experiment (DCE) were used to estimate citizens' demand for a bundle of FES under alternative management strategies. This DCE was designed and implemented as part of the work reported in Deliverable D3.3 (Van Ruymbeke et al., 2025).

Analytical framework

Barriers to adoption

Five forest management strategies were identified based on academic literature (Duncker et al., 2012; Jactel et al., 2012; Sing et al., 2018). Figure 2 presents these strategies along a gradient of management intensity, ranging from least to most intensive: unmanaged forestry, close-to-nature forestry, multifunctional forestry, timber production forestry, and bioenergy production forestry. These strategies differ in terms of management decisions that determine the intensity of resource use, including tree species composition, harvesting systems, regeneration methods, use of machinery and chemical inputs, and the integration of biodiversity conservation and other FES (Duncker et al., 2012). Table 2 provides an overview of the specific activities associated with each strategy.



Figure 2: Forest management intensity spectrum

Unmanaged forestry refers to forests where natural processes and disturbance regimes unfold with no or minimal human intervention. Active management is largely absent, and interventions that could significantly alter forest structure, such as clearcutting or artificial regeneration, are not permitted. However, limited actions

may occur to support ecosystem functioning or societal use, such as habitat restoration, deadwood retention, protection of regeneration from browsing, or the development of recreational infrastructure. **Close-to-nature forestry** aims to mimic natural forest dynamics. Management interventions focus on enhancing and conserving ecological functions, through measures such as deadwood retention and habitat protection. Timber harvesting is permitted but is designed to emulate natural disturbance processes, relying on selective or group cutting and prioritizing natural regeneration. **Multifunctional forestry** is characterized by the simultaneous provision of multiple objectives, including timber production, biodiversity conservation, recreation, and FES. A wide range of silvicultural practices can be applied, including selective cutting, thinning, and, in some cases, clearcutting. Both natural and artificial regeneration methods may be used, and management is more flexible, allowing for trade-offs between different forest functions. **Timber production forestry** represents a more intensive management approach focused on maximizing the production of timber, particularly for high-value wood products. Harvesting is typically based on even-aged systems, often involving clearcutting, and is supported by thinning and various regeneration methods (natural, assisted, or artificial). Biodiversity and recreational functions may be considered but are generally secondary to production objectives. **Bioenergy production forestry** is the most intensive strategy and is primarily oriented towards the production of biomass for energy. It is characterized by short rotation periods, frequent clearcutting, and the use of fast-growing species or coppicing systems. Management practices prioritize high yields of fuelwood, often with limited emphasis on biodiversity conservation or other FES.

During the interviews information was collected regarding the management practices implemented in each forest. This information was used to assign each interview to a management strategy. The classification was based on three main criteria: (i) harvesting methods; (ii) the presence of multiple forest uses, such as timber production, recreation, biodiversity conservation (e.g., deadwood retention), and other forest products; and (iii) the type of regeneration. The resulting classification is presented in Table 11 in Appendix B.

Table 2: Practices in each forest management strategy

	Unmanaged forestry	Close-to-nature forestry	Multifunctional forestry	Timber production forestry	Bioenergy production forestry
Selective cutting	No	Yes	Yes	Yes	Yes
Group selection or group cutting	No	Yes	Yes	Yes	Yes
Clearcutting for timber production	No	No	Possible	Yes	Possible
Clearcutting for biomass production	No	No	Possible	Possible	Yes
Coppicing	No	Possible	Possible	Yes	Yes
Thinning (pre-commercial or commercial)	No	Possible	Yes	Yes	
Natural regeneration	Yes	Yes	Yes	Yes	No
Assisted natural regeneration	No	No	Yes	Yes	Yes
Artificial regeneration	No	No (only to restore the "naturalness" of the forest)	Yes	Yes	Yes
Deadwood retention	Yes	Yes	Yes	Possible	No

Chemical pest control	No	No (natural methods are preferred)	Possible (natural methods are preferred)	Yes	Yes
Invasive species control	Yes	Yes	Yes	Yes	Yes
Controlled burning or fire prevention	/	Yes	Yes	/	/
Biodiversity conservation or habitat restoration	Yes	Yes	Yes	Possible	No
Recreation or tourism development	Yes	/	Yes	/	/
Non-timber forest product collection ¹	/	Yes	Yes	Yes	/
No active management	Yes	Yes	/	/	/
Hunting	/	Yes	Yes	Possible	/

¹ Non-timber forest product harvesting largely depends on country-specific property rights (Sheppard et al., 2020)

Sources: (Duncker et al., 2012; European Commission, 2023; Jactel et al., 2012; Larsen et al., 2022; Liebhold et al., 2017; Sheppard et al., 2020; Sing et al., 2018; Stritih et al., 2026; Weidlich et al., 2020)

Interviewees were asked to classify 16 barriers to transition from their current management strategy towards less and more intensive forest management strategies. Each barrier was later rated using a four-point scale according to its perceived importance: strong (4), medium (3), weak (2), not a barrier (1). To identify a complete list of relevant barriers to adoption, an extensive literature search was conducted using a mixed approach of a search string, combined with snowballing and targeted searches in WebOfScience and Google Scholar repositories. The following search string implemented in WebOfScience (in March and April, 2025) produced 198 hits: ((ALL=(barrier\$)) AND ALL=("continuous cover forest" OR "integrated forest" OR "sustainable forest")) NOT ALL=(agroforestry). This corpus was supplemented with articles sourced through a snowballing approach as well as targeted searches to include relevant grey literature. A core set of 10 peer-reviewed articles (Table 3) were used to identify a set of 19 barriers which could be categorised into the themes indicated above. This list was presented to, and evaluated by, a forestry research expert, after which the list was reduced to a final set of 16 barriers, categorized into five distinct categories: Economic, Regulatory and Legislative, Knowledge and Capacity, Social and Environmental barriers (Table 3). Although we did not provide strict definition of the barriers during the interviews to avoid overstimulation, the barriers were explained and when asked we provided additional clarification.

In addition, interviewees were given the opportunity to supplement the list of barriers with any additional barriers they perceived when transitioning towards less and/or more intensive management strategies. These additional barriers were subsequently classified through a systematic procedure. When an additional barrier corresponded conceptually to one of the predefined barriers, it was assigned to that barrier. If no suitable match existed, a new barrier was defined and assigned to the most relevant of the five existing categories (economic; regulatory and legislative; knowledge and capacity; social; or environmental). Finally, due to the frequent mention of climate-related issues during the interviews, an additional thematic category was defined to group all climate change-related barriers, including climate change uncertainty, climate-related hazards, and limited knowledge on climate adaptation. The classification of all additional barriers and their assignment to existing or newly defined barriers and categories is reported in Table 13 in Appendix B.

Table 3: Identified barriers to transition towards less and more intensive management strategies

Category	Barrier	Definition	Source
Economic	EC1 Pressure to meet timber demand	Pressure to meet timber demand due to the rise of novel timber markets such as petrochemical and carbon credits, discourages biodiversity-oriented practices like habitat tree retention	(Aggestam et al., 2020; Deuffic et al., 2018; Hertog et al., 2022; Kneeshaw et al., 2021; Konczal et al., 2023; Larsen et al., 2022; Sousa-Silva et al., 2016)
	EC2 Lack of financial incentives for conservation	Foresters lack sufficient economic support to integrate nature conservation into forest management	
	EC3 High ongoing operational costs	Alternative forest management approach may involve higher recurring expenses, such as monitoring, maintenance and/or labour	
	EC4 High transition/implementation costs	Significant, upfront one-off investments (e.g., new equipment, training, infrastructure)	
Regulatory and legislative	RL1 Weak legislative support for alternatives	Alternative forest practices are not supported by enforceable laws or incentive structures	(Aggestam et al., 2020; Buttoud et al., 2011; Deuffic et al., 2018; Konczal et al., 2023; Larsen et al., 2022)
	RL2 Conflicting or incoherent policies	Misaligned or overlapping current policies across forestry, environmental, agriculture, or economic sectors create contradictions that hinder adoption	
	RL3 Uncertainty about future political/institutional conditions	Unpredictability about future policy directions or institutional priorities, such as shifting political agendas, evolving regulations, or changing value chains	
	RL4 Fragmented forest ownership	Small, dispersed properties make coordinated landscape-level forest management difficult	
Knowledge and capacity	KC1 Limited access to specialized machinery and/or labour	A lack of access to trained personnel and specialized machinery limits adoption of alternative management approaches	(Aggestam et al., 2020; Deuffic et al., 2018; Hertog et al., 2022; Konczal et al., 2023; Larsen et al., 2022; Sousa-Silva et al., 2016; Zafra-Calvo et al., 2024)
	KC2 Insufficient technical knowledge	Forest managers lack the information and guidance needed to apply adaptive forest practices	
Social	SO1 Weak demand for non-productive services	Low societal prioritization of recreation, biodiversity, or public goods	(Aggestam et al., 2020; Hertog et al., 2022; Konczal et al., 2023; Zafra-Calvo et al., 2024)
	SO2 Public opposition to visible management	Aesthetic preferences and poor public understanding of forestry lead to resistance against (lack of) visible interventions	
	SO3 (Your own) established preferences and practices	Strong habits, risk aversion, or preference for familiar approaches inhibits change	
	SO4 Strong social norms and pressure to conform	Prevailing social norms within peer groups can discourage deviation from the common management approach	
	SO5 Low trust and weak collaboration among peers	A lack of trust among peers can prevent the coordination, information sharing, or cooperation needed to adopt management approach	
Environmental	EN1 Ecological suitability and constraints	Local ecological conditions (e.g., climate, native species composition) may limit the suitability or	(Aggestam et al., 2020; Hertog et al., 2022)

		effectiveness of alternative forest management approaches.	
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To analyse barriers to transitioning towards less and more intensive management strategies, weighted averages were calculated for each management strategy (close-to-nature, multifunctional and intensive management). For each barrier and management strategy, the number of interviewees who rated it as *strong*, *medium*, *weak*, or *not a barrier* was counted. A weighted average was then computed by assigning scores of 4, 3, 2, and 1 to these categories, respectively:

$$\bar{x}_i = \frac{4 * N_{i,strong} + 3 * N_{i,medium} + 2 * N_{i,weak} + 1 * N_{i,not\ a\ barrier}}{N_{i,total}}$$

where $\bar{x}_i$ represents the weighted average score for the barrier i , $N_{i,strong}$, $N_{i,medium}$, $N_{i,weak}$ and $N_{i,not\ a\ barrier}$ denote the number of interviewees assigning each respective rating to barrier i , and $N_{i,total}$ is the total number of interviewees evaluating that barrier. The weighted average scores were estimated separately per management strategy and were interpreted as follows: values below 1.50 indicate that barrier i is not considered a barrier; values between 1.50 and 2.49 indicate a weak barrier; values between 2.50 and 3.49 indicate a medium barrier; and values of 3.50 or higher indicate a strong barrier to transition.

PES feasibility

The rationale behind PES mechanisms lies in the Kaldor-Hicks compensation principle which defines a Pareto improvement as a situation where the maximum amount the winners would be willing to pay is greater than the minimum amount the losers would require as compensation (Hueth and Just, 1991). This principle implies that FES beneficiaries (citizens) would be willing to give up part of the FES value in order to compensate forest owners and managers for the costs of adopting forest management practices that enhance FES (Górriz-Mifsud et al., 2016). The feasibility of a PES scheme is then defined, on the supply side, by the opportunity cost of changing management strategies, and on the demand side by the willingness of beneficiaries to pay for FES improvement (Compensating Surplus), as shown in Figure 3.

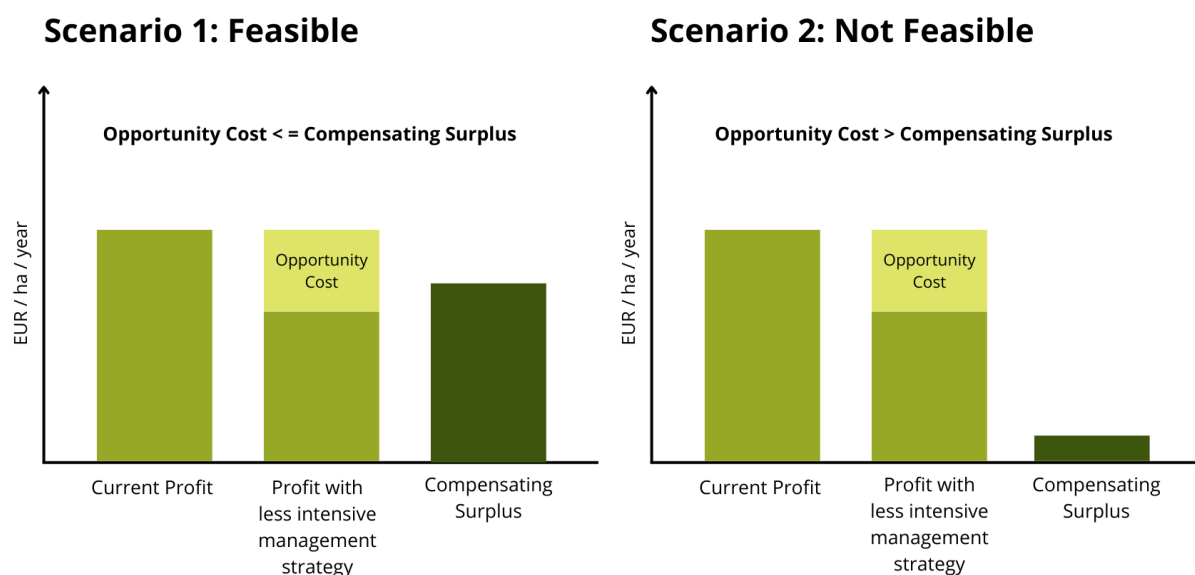


Figure 3: PES boundaries

Sources: Adapted from Górriz-Mifsud et al. (2016)

On the supply side, opportunity costs reflect the minimum compensation required for forest owners and managers to adopt alternative management strategies (Möhring and Rüping, 2008). Although forest management decisions are influenced by factors such as site conditions, country-specific characteristics (Westin et al., 2023), foresters' socio-economic characteristics and values (Häyrynen et al., 2025; Juutinen et al., 2020; Winkel et al., 2022), we assume that forest owners and managers respond to monetary incentives that maximize their profit (Górriz-Mifsud et al., 2016; Gregory et al., 2003). Under this assumption, profit changes associated with alternative management strategies are used as a proxy for opportunity costs. Private profitability was therefore estimated separately for each interviewed forest owner and manager. Information on costs and revenues (collected during the interviews using the questions in Block 4) was used to estimate current profit levels for each forest, expressed in euros per hectare per year. Due to data restrictions on costs and revenues, private profitability could only be estimated for one observation under close-to-nature forestry in Spain (S3), four observations under multifunctional forestry across Flanders (BF3, BF4 and BF5) and Spain (S1) and three observations under timber production forestry across Flanders (BF6) and Norway (N1 and N2). Interviewees were also asked how their costs and revenues would change under less or more intensive management strategies. The results indicate that, when transitioning towards alternative management strategies, profit can either decrease, stay largely the same, or increase. The direction in which profits shift is determined by the underlying costs and revenue structures¹. We use insights from the interviews to determine whether profits are likely to increase, stay the same, or decrease in each specific study region. Once the direction of change has been determined, we estimate profit change for two scenarios, an upper and a lower bound. The upper bound represents a maximum increase/decrease of profit at $\pm 60\%$ of the current profit level. The lower bound represents a minimum increase/decrease of profit change at $\pm 20\%$. When profits were indicated to stay largely the same, the upper and lower bound represent a $+10\%$ and -10% change in profit respectively.

On the demand side, the feasibility of a PES scheme is bounded to the willingness of beneficiaries to pay for FES improvement, measured as the Compensating Surplus (CS). Under the assumption of neoclassical microeconomic rationality, individual preferences can be measured and aggregated, implying that FES beneficiaries are willing to pay for increases in FES provision according to the value they attribute to them (Hanemann, 1984). To quantify the benefits that citizens derive from changes in FES provision, we use results from the DCE designed and reported on as part of Deliverable D3.3 on citizen preferences for FES (Van Ruymbeke et al., 2025). The DCE was implemented in four study regions: Belgium (Flanders), the Czech Republic, Norway, and Spain. In the DCE, respondents were presented with hypothetical forests scenarios and asked to indicate their preferred option. These scenarios were described using a set of FES attributes, where each attribute represents a specific FES and its levels correspond to different degrees of service provision. The selected attributes and levels were designed so that their combination reflect the range of FES outcomes associated with the five forest management strategies considered in this study (Table 4). The FES used to characterise the forests included timber provision, carbon sequestration potential, local temperature regulation capacity, accessibility for recreation, landscape diversity, and protection against natural hazards. Based on the DCE results, marginal willingness-to-pay (MWTP) estimates were derived for each FES in each study region. These estimates capture the average value citizens place on incremental changes in individual FES.

We use the MWTP estimates to calculate CS for scenarios representing shifts between forest management strategies. CS represents the average willingness of citizens to pay (or accept compensation) for moving from the current management strategy to an alternative one, whether less or more intensive. It therefore captures

¹ Generally, since the transitions being considered reflect a shift towards less intensive management strategies, profits are most often seen to either stay the same or decrease due to loss of revenues from timber. In the exceptional case (BF5), profits may increase when shifting towards less intensive if revenue streams are more diversified to start with, for example through hunting.

the welfare change associated with differences in FES provision resulting from alternative forest management strategies (Górriz-Mifsud et al., 2016; Varela et al., 2017). Following Hanemann (1984) and Varela et al. (2017), CS is calculated as:

$$CS = - \frac{(V_A - V_C)}{\beta_{price}}$$

Where V_C and V_A represent the estimated WTP for a bundle of FES under the current management scenario C and an alternative management scenario A , respectively. The FES bundles associated with each management scenario were identified based on academic literature and are presented in Table 4. β_{price} represents the estimated price coefficient and captures the average price sensitivity of respondents. Because the payment vehicle in the DCE was specified as an increase in annual household taxes, the resulting CS is initially expressed in PPP-corrected euros per household per year.

Table 4: Forest management intensity scenarios and associated ecosystem services provisioning

FES	Unmanaged	Close-to-nature	Multifunctional	Timber production	Bioenergy production
Timber volume	Low	Low	Moderate	High	High
Carbon sequestration potential	High	High	Moderate	Moderate	Low
Cooling capacity	High	High	Moderate	Low	Low
Accessibility for recreation	Low	High	High	Moderate	Low
Landscape diversity	Multiple + 5m	Multiple + 5m	Multiple + 50m	Single + 50m	Single + 50m
Hazard protection	Moderate	High	moderate	Moderate	Low

Source : D3.3 Report on the demand side: Citizens' preferences/demand for forest ES and biodiversity and consumer preferences/ demand for long-lived wood products

To ensure comparability with cost and revenue data reported by forest managers (expressed in euros per hectare per year), several conversion steps were applied to the CS. First, CS values were converted to a per-person basis by dividing household-level CS by the average household size (considering only individuals with taxable income). Next, the per-person CS was multiplied by the population living within a 50km radius of forest areas currently managed under scenario A in each study region. In calculating CS, it is assumed that individuals are entitled to the current forest management scenario. Therefore, CS reflects the value of transitioning from the current management regime to an alternative once. Finally, to express CS on a per-hectare basis, the aggregated population-level CS was divided by the total forested area (in hectares) currently managed under scenario A and eligible for conversion. Population data were obtained from the 2021 EU population census data (Eurostat, 2025), while the total ha under each management strategy in each study region was obtained from Scherpenhuijzen et al. (2023) (Table 12 in Appendix).

To acknowledge that forest management decisions do not rely solely on monetary incentives, we qualitatively assess the adoption potential of a PES scheme among forest owners and managers through a series of interview questions. As shown in Table 10 in Appendix, interviewees were asked about their experiences with PES or subsidy schemes, their reasons for non-participation, and the challenges associated with participation. These questions complement the quantitative analysis and provide further insight into the barriers to adoption.

Results and Discussion

This section is divided into two parts. The first section presents the perceived barriers that forest owners and managers face when considering a transition toward less intensive and more intensive forest management, relative to their current management approach. Barriers were evaluated across five categories: (i) economic; (ii) regulatory and legislative; (iii) knowledge and capacity; (iv) social, and (v) environmental. This section first provides an overarching synthesis of the findings, followed by sub-sections presenting a more detailed analysis of perceived barriers for each management strategy. The second part focuses on the feasibility of adopting a PES mechanism. In this study, PES feasibility is assessed along two complementary dimensions: an economic dimension and an experiential dimension. Accordingly, this part is structured into two sub-sections addressing each dimension in turn.

Barriers to adopt alternative forest management strategies

To account for variation in management objectives and practices, interview responses were grouped into three management strategy types based on adopted practices: close-to-nature forestry (2 observations), multifunctional forestry (13 observations), and timber production forestry (4 observations). For each management strategy, barriers to transition towards less and more intensive management strategies were assessed and compared with existing literature. Overall, our results highlight the existence of a wide range of interconnected factors hindering the adoption of alternative forest management strategies. Few barriers were considered irrelevant in the transition towards alternative management strategies, suggesting that most factors were seen as barriers to some extent, with their intensity largely depending on both the current strategy being abandoned and the alternative strategy being adopted.

Economic barriers are perceived differently depending on the direction of change along the intensity grading. Transitions towards less intensive management strategies are consistently constrained across management strategies by the lack of financial incentives for conservation (EC2). This not only underscores the importance of better demonstrating and communicating how nature conservation and biodiversity measures can generate economic value through alternative FES (Aggestam et al., 2020), but also the need to create markets for such FES. In contrast, transitions towards higher management intensity are primarily constrained by cost-related factors. High operational costs (EC3) and transition or implementation costs (EC4) are most salient for intensification from close-to-nature and multifunctional forestry. These transitions often require substantial upfront investments in silvicultural interventions, forest infrastructure, and specialized machinery, which translate into significant financial burdens. Although timber-oriented forest owners and managers face comparatively lower economic barriers when intensifying further, likely because they already operate within costly production systems and have access to the necessary infrastructure and capital, low and volatile timber prices emerge as an important barrier to intensifying management. Overall, these patterns align with existing literature emphasizing the central role of economic considerations in shaping forest management decisions (Aggestam et al., 2020; Buttoud et al., 2011; Kneeshaw et al., 2021; Konczal et al., 2023; Willig et al., 2025).

When transitioning towards less intensive management, the perceived importance of **regulatory and legislative barriers** varies across forest management strategies. Notably, close-to-nature forestry is more strongly constrained by these barriers, whereas multifunctional and timber-production forestry encounter comparatively weaker regulatory limitations. This pattern suggests that existing policy frameworks primarily support transitions towards close-to-nature and integrative forestry approaches, but provide fewer enabling conditions for further shifts towards unmanaged or strictly protected regimes. As a result, forest owners and managers already practicing close-to-nature forestry perceive a lack of regulatory support for moving further towards non-intervention, while multifunctional and timber-oriented managers face fewer constraints in this

respect. In contrast, transitions towards more intensive management strategies are generally perceived as moderately constrained by regulatory and legislative barriers for close-to-nature and multifunctional forestry, but as weakly constrained among timber-production-oriented managers. Despite these differences, uncertainty about future political and institutional conditions remains a notable concern, particularly for multifunctional and timber-oriented managers. In addition, site-specific regulatory frameworks, such as those governing natural parks or Natura 2000 areas, emerge as an important constraint on intensification, as their strict management guidelines limit the scope for adopting more intensive forestry practices.

Knowledge and capacity barriers are particularly constraining when transitioning from timber production to less intensive management systems. Insufficient technical knowledge (KC2) to manage uneven-aged forestry systems and limited access to low-impact machinery (KC1) hinder this transition. These barriers are generally weaker for transitions toward more intensive management, where established expertise and technology for even-aged forestry reduce perceived constraints. An exception is the transition from close-to-nature forestry towards intensification, where limited access to specialised machinery remains a relevant constraint. Overall, these findings align with Mason et al. (2022), who report widespread knowledge gaps across 33 European countries related to continuous-cover forestry, including limited professional expertise and unclear technical guidance for the use of mechanised harvesting systems in uneven-aged stands.

The **social barriers** illustrate that transitions between forest management strategies are not purely economic or technical decisions, but are deeply embedded in societal expectations, public demand, and the preferences of forest owners and managers themselves. Public opposition to visible management (SO2) and strong social norms (SO4) are, on average, perceived as weak barriers when management intensity decreases, but become more important for transitions toward more intensive practices. This pattern reflects growing societal concern over clear-cuts and monocultures, alongside heightened awareness of climate change and biodiversity loss and increasing demand for alternative FES. In addition, the results highlight that entrenched preferences and established practices of forest owners and managers (SO3) constitute a barrier to adopting alternative management strategies in both directions. These findings are consistent with previous research demonstrating that individual values, beliefs, educational background, traditions, and management cultures strongly shape forest management decisions (Aggestam et al., 2020; Deuffic et al., 2018; Hertog et al., 2022; Konczal et al., 2023; Maier and Winkel, 2017; Tiebel et al., 2022). Furthermore, these findings align with previous studies demonstrating that forest owners' adaptive capacity is strongly linked to whether they believe in climate change and consider adaptation measures effective (Blennow et al., 2012; Sousa-Silva et al., 2018; Yousefpour and Hanewinkel, 2015). Low trust and weak collaboration among peers (SO5) is a weak-to-medium level barrier to transition towards less intensive. Importantly, our findings highlight the need to differentiate the low trust and weak collaboration among peers with the lack of trust between foresters and institutions. These findings align with recommendations from forest conservation research, which consistently highlight the need to further strengthened relationships among stakeholders, particularly among forest owners themselves and between owners and external actors, to enable the adoption of conservation measures (Tiebel et al., 2022).

Environmental barriers emerge as important constraints on transitions towards both less intensive and more intensive forest management strategies. The results indicate that local ecological conditions related to climate, native species composition, ungulate overpopulation, and forest geomorphology (e.g. steep slopes) significantly limit the feasibility of changing management practices.

Based on the interview data, an additional category of barriers can be identified: **climate change-related barriers**. Within this category, two closely related constraints emerged: (i) uncertainty associated with climate change and its related hazards, and (ii) limited knowledge on how to adapt forest management practices to changing climatic conditions. Forest owners and managers frequently highlighted climate change uncertainty, including increased risks from droughts, storms, and pest outbreaks, as a key barrier to transitioning towards alternative management strategies. This suggests that heightened ecological uncertainty significantly



influences forest owners' and managers' willingness to modify existing practices, a pattern also noted by Heltorp et al. (2018). In addition, forest owners and managers emphasised a lack of knowledge on how to adapt to climate change. Similar knowledge gaps have been documented in previous studies (Mason et al., 2022), which attribute them to insufficient communication and shortcomings in knowledge transfer between research, advisory services, and practice (Morin et al., 2015; Sousa-Silva et al., 2016; Willig et al., 2025). Consequently, forest owners and managers face a dual challenge: rising ecological uncertainty associated with climate change, combined with limited knowledge on how to adjust management accordingly.

Overall, few factors were identified as non-barriers to the adoption of alternative management strategies, suggesting that multiple mechanisms are required to incentivize management changes in line with EU forest policy objectives. For instance, strengthening vertical and horizontal communication (Kleinschmit et al., 2018; Mattijssen et al., 2018), expanding educational programs (Aggestam et al., 2020; Willig et al., 2025) or creating financial compensation schemes (Aggestam et al., 2020). While multiple forms of mechanisms may be effective (Aggestam et al., 2020; Mayer and Tikka, 2006), this study focuses on economic instruments designed to offset the foregone revenues associated with adopting alternative management practices.

Close-to-Nature

Table 5 presents the mean barrier scores for transitions away from close-to-nature forestry towards less intensive management (unmanaged forestry) on the one hand, and towards more intensive management (multifunctional forestry) on the other. The results are discussed in the following subsections

Table 5: Mean agreement value of barriers to transition from close-to-nature forestry towards less (unmanaged) and more (multifunctional) intensive management strategy

Category	Barriers	Close-to-Nature	
		Towards less intensive (Unmanaged)	Towards more intensive (Multifunctional)
Economic	EC1 Pressure to meet timber demand	1.00	2.50
	EC2 Lack of financial incentives for conservation	2.50	2.00
	EC3 High ongoing operational costs	2.00	3.00
	EC4 High transition/implementation costs	1.50	3.00
	Average	1.75	2.63
Regulatory and Legislative	RL1 Weak legislative support for alternatives	4.00	3.00
	RL2 Conflicting or incoherent policies	3.00	2.50
	RL3 Uncertainty about future political/institutional conditions	2.50	1.50
	RL4 Fragmented forest ownership	2.50	4.00
	Average	3.00	2.75
Knowledge and Capacity	KC1 Limited access to specialized machinery and/or labour	2.50	3.00
	KC2 Insufficient technical knowledge	2.00	2.00
	Average	2.25	2.50
Social	SO1 Weak demand for non-productive services	2.50	2.50
	SO2 Public opposition to visible management	1.00	2.00
	SO3 (Your own) established preferences and practices	3.50	3.00
	SO4 Strong social norms and pressure to conform	1.00	2.00
	SO5 Low trust and weak collaboration among peers	3.00	2.50
	Average	2.20	2.40
Environmental	EN1 Ecological suitability and constraints	3.50	2.50



Legend	Not a barrier (0 - 1.49)	Weak barrier (1.50 - 2.49)	Medium barrier (2.50 - 3.49)	Strong barrier (3.50 - 4.00)
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Less intensive: From close-to-nature to unmanaged forestry

To transition from close-to-nature forestry to unmanaged systems, economic constraints are perceived as weak barriers on average. The pressure to meet timber demand (EC1) is not perceived as a barrier to this transition, suggesting that forest owners and managers operating under close-to-nature forestry are already weakly embedded in market-driven supply chains and face limited production-oriented constraints when moving towards unmanaged systems. Both high operational costs (EC3) and high transition or implementation costs (EC4) are consistently rated as weak barriers, underscoring the absence of active management in unmanaged systems. In contrast, the lack of financial incentives for conservation (EC2) emerges as a medium-level barrier, indicating that even in forest management systems whose primary objectives lie outside economic optimization (Duncker et al., 2012; Jactel et al., 2012; Sing et al., 2018), economic support remains important for enabling further shifts towards non-intervention.

Regulatory and legislative barriers are, on average, perceived as medium-level constraints to transition from close-to-nature forestry to unmanaged systems. Within this category, uncertainty about future political/institutional conditions (RL3) and conflicting or incoherent policies (RL2) are consistently perceived as medium-level barriers to transition from close-to-nature forestry to unmanaged systems, reflecting concerns about the long-term stability, coordination, and legal security required to commit to permanent or near-permanent non-intervention. Particularly, a forest manager (S3) commented that policies focus on promoting fire prevention practices rather than promoting a transition towards less intensive management. In addition, fragmented forest ownership (RL4) is also considered as a medium-level barrier, implying the difficulty in transitioning to unmanaged systems when forests are highly fragmented. In contrast, weak legislative support for alternative management approaches (RL1) stands out as a strong barrier, indicating that forest owners and managers already practicing close-to-nature forestry perceive an absence of enabling or supportive regulatory frameworks when moving further towards non-intervention.

To transition from close-to-nature to unmanaged forestry, limited access to specialized machinery and/or labour (KC1) is a medium barrier whereas insufficient technical knowledge (KC2) is a weak barrier. This pattern suggests that owners and managers already practicing close-to-nature forestry are generally familiar with low-intensity and nature-oriented management approaches.

Social barriers present a complex pattern to transition from close-to-nature forestry to unmanaged systems. Public opposition (SO2) and social pressure to conform to established practices (SO4) are not considered barriers, suggesting social acceptance to reducing management. Moreover, weak social demand for non-productive services (SO1) and low trust and limited collaboration among peers (SO5) are medium-level barriers to transition towards un-managed systems, suggesting that broader social conditions limit the attractiveness of unmanaged forestry. Forest owners' and managers' established preferences and practices (SO3) emerge as a strong barrier to transition towards unmanaged forestry. These preferences reflect a broader scepticism among forest owners and managers about the effectiveness of leaving forests unmanaged. Studies from Sweden (Hallberg-Sramek et al., 2022) and other European contexts (Willig et al., 2025) similarly show that many practitioners believe some level of management is necessary to ensure biodiversity, recreation, and climate-adaptation outcomes. This perception is reinforced by the strong importance attributed to environmental constraints (EN1), which are rated as a strong barrier to transition from close-to-nature forestry to unmanaged systems. In particular, one forest manager (S3) explicitly highlighted climate change

uncertainty as a key concern, suggesting that unmanaged forestry is perceived as a high-risk option in the face of increasing climate-related disturbance frequency and severity.

More intensive: From close-to-nature to multifunctional forestry

To transition from close-to-nature to multifunctional forestry, the most relevant economic barriers are the high operational costs (EC3) and transition or implementation costs (EC4). Increasing management intensity often requires substantial upfront investment such as specialized site preparation, artificial regeneration, or more frequent interventions which may partly explain the perceived financial burden (Eyvindson et al., 2021). Moreover, the intensified harvesting requires increased infrastructure and accessibility (i.e. additional forest roads and extraction paths) which may be an economic burden and constraint to increase intensification, particularly in remote areas (Mederski et al., 2021). The pressure to meet timber demand (EC1) is also considered as a medium-level barrier, whereas the lack of financial incentives for conservation is perceived as a weak barrier.

Regulatory and legislative barriers to transition from close-to-nature to multifunctional forestry are on average rated as medium-level. Fragmented forest ownership (RL4) stands out as a strong barrier to transition which is largely explained by the fact that forest fragmentation reduces economies of scale, discouraging forest owners undertake more intensive forest management (Hatcher et al., 2013; Zhu et al., 2020). The weak legislative support for alternatives (RL1) and conflicting or incoherent policies consistently emerge as medium-level barriers, highlighting the role of regulatory frameworks in constraining transitions towards more intensive management strategies.

To transition from close-to-nature forestry to multifunctional forestry, limited access to specialized machinery and/or labour (KC1) is a medium-level barrier suggesting that this transition entails additional operational requirements (specialized skills, equipment, or organizational capacity) that go beyond current management practices. In contrast, insufficient technical knowledge (KC2) rated as a weak barrier indicates a continuity in silvicultural principles between the two strategies, meaning that the transition does not require fundamentally new knowledge or a radical departure from existing expertise.

Forest owners and managers preferences (SO3) is a medium-level barrier to transition from close-to-nature to multifunctional forestry. Previous studies suggest that forest owners and managers' preference play a constraining role among less profit-oriented owners who often favour multifunctional and ecosystem-oriented management approaches (Feliciano et al., 2017; Hallikainen et al., 2010; Pynnönen et al., 2018; Tiebel et al., 2022). For these groups, intensifying management contradicts their motivations and values, especially given concerns about the impacts of intensive practices on soil, water, and landscape integrity (Zafra-Calvo et al., 2024). Similarly, the weak demand for non-productive services (SO1) and the low trust and weak collaboration among peers (SO5) also emerge as a medium-level barrier, highlighting that such barriers constraint transition towards both more and less intensive management.

Lastly, environmental constraints (EN1) are perceived as medium-level barriers to transition from close-to-nature to multifunctional forestry.

Multifunctional

Table 6 presents the mean barrier scores for transitions from multifunctional forestry towards less intensive management (close-to-nature) and towards more intensive management (timber production forestry). The results are discussed in the following subsections.

Table 6: Mean agreement value of barriers to transition from multifunctional forestry towards less and more intensive management strategy

Category	Barriers	Multifunctional	
		Towards less intensive (Close-to-nature)	Towards more intensive (Intensive timber production)
Economic	EC1 Pressure to meet timber demand	2.46	1.83
	EC2 Lack of financial incentives for conservation	2.92	2.67
	EC3 High ongoing operational costs	2.38	2.92
	EC4 High transition/implementation costs	2.85	3.17
	Average	2.65	2.65
Regulatory and legislative	RL1 Weak legislative support for alternatives	2.29	2.42
	RL2 Conflicting or incoherent policies	2.69	3.17
	RL3 Uncertainty about future political/institutional conditions	2.31	2.92
	RL4 Fragmented forest ownership	2.54	2.42
	Average	2.46	2.73
Knowledge and capacity	KC1 Limited access to specialized machinery and/or labor	2.38	1.92
	KC2 Insufficient technical knowledge	2.43	2.00
	Average	2.41	1.96
Social	SO1 Weak demand for non-productive services	2.15	1.25
	SO2 Public opposition to visible management	2.08	3.50
	SO3 (Your own) established preferences and practices	2.23	3.08
	SO4 Strong social norms and pressure to conform	2.00	3.25
	SO5 Low trust and weak collaboration among peers	2.00	2.00
	Average	2.09	2.62
Environmental	EN1 Ecological suitability and constraints	2.64	2.75

Legend	Not a barrier (0 - 1.49)	Weak barrier (1.50 - 2.49)	Medium barrier (2.50 - 3.49)	Strong barrier (3.50 - 4.00)
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Less intensive: From multifunctional to close-to-nature

On average, economic barriers are rated as medium-level to transition from multifunctional to close-to-nature forestry. Interestingly, the pressure to meet timber demand (EC1) is as a weak barrier to transition from multifunctional forestry to close-to-nature forestry, which diverges from Konczal et al. (2023) who report that rising timber demands is a major factor hindering the integration of nature conservation measure into forest management. The lack of financial incentives for conservation (EC2) is a medium-level barrier to transition from multifunctional to close-to-nature systems. The salience of this barrier reflects a structural tension in forestry: managers face a trade-off between revenue from timber extraction and the adoption of biodiversity enhancing measures such as deadwood retention or set aside areas, all of which reduce short-term profitability. This trade-off becomes more acute in competitive international timber markets (Aggestam et al., 2020; Larsen et al., 2022). Similarly, Konczal et al. (2023) reports that foresters perceive the lack of financial incentives as particularly constraining for adopting conservation-oriented practices in nine European countries (Austria, Belgium, Denmark, France, Germany, Poland, Spain, Switzerland and Sweden). In addition, high transition and implementation costs (EC4) are also considered as a medium-level barrier to transition from

multifunctional to close-to-nature forestry. These results suggest that economic parameters related to costs and revenues constraint the adoption of less intensive management strategies for multifunctional forestry.

Regulatory and legislative barriers to transitions from multifunctional to close-to-nature forestry are, on average, perceived as weak. While weak legislative support for alternatives (RL1) and the uncertainty about future political and institutional conditions (RL3) are perceived as weak barriers, conflicting or incoherent policies across sectors (RL2) emerge as a medium-level barrier. This pattern likely stems from the inherently multi-objective nature of multifunctional forestry. This management type simultaneously integrates timber production, biodiversity conservation, recreation, and the provision of various FES. As a result, multifunctional forestry is exposed to multiple policy domains which do not always align. For instance, Blattert et al. (2022) reports that in Finland, the national forest strategy, the biodiversity strategy and the bioeconomy strategy present conflicting strategies in terms of management requirement which hinder the promotion of multipurpose forestry. In addition to policy incoherence, fragmented forest ownership (RL4) is also perceived as a medium-level barrier to transitions from multifunctional to close-to-nature forestry. This finding is consistent with previous studies showing that fragmented ownership and small plot sizes constrain the adoption of climate change adaptation measures (Pinto-Correia, 2000; Sousa-Silva et al., 2018), integrated forest management strategies (Krumm et al., 2020), nature conservation practices (Tiebel et al., 2022) and close-to-nature forestry (Zafra-Calvo et al., 2024). These constraints are partly explained by empirical evidence demonstrating that fragmentation affects biodiversity and ecosystem functioning (Wilson et al., 2016), implying that on small or highly fragmented parcels ecological benefits from adopting less intensive practices are uncertain.

Knowledge and capacity barriers to transition from multifunctional to close-to-nature forestry are, on average, perceived as weak. This suggests that forest owners and managers operating within multifunctional systems are generally familiar with, and capable of adopting less intensive management practices. However, this familiarity coexists with more specific knowledge gaps. Two interviewees explicitly mentioned uncertainty regarding the selection of tree species suited to future climatic conditions, highlighting climate-change-related decision-making as a persistent challenge. This concern is widely documented in European-level research (Aggestam et al., 2020; Larsen et al., 2022; Mason et al., 2022; Sousa-Silva et al., 2018) and global surveys (FAO, 2012), suggesting that while general silvicultural knowledge is adequate to transition towards less intensive systems, adaptive knowledge for long-term climate uncertainty remains limited.

All social barriers are perceived as weak to transition from multifunctional to close-to-nature forestry. The fact that public opposition to visible management interventions (SO2) and strong social norms and pressure to conform (SO4) are rated as weak barriers suggest that forest owners and managers expect some public resistance to changes in forest structure, even when management objectives aim to decrease management intensity. Previous studies similarly point to limited public understanding of forest dynamics and ecological processes, resulting in negative reactions to changes in forest appearance, regardless of whether these changes stem from interventions or natural disturbances (Konczal et al., 2023; Willig et al., 2025). As such, social barriers persist at a low level because aesthetic expectations and preferences can still trigger opposition, even when management objectives aim to enhance biodiversity and ecological integrity. Moreover, while low trust and weak collaboration among peers (S5) are on average perceived as weak barriers to transitions from multifunctional to close-to-nature forestry, one forest manager in Wallonia (BW2) emphasised persistent mistrust between forest owners and institutions. This distinction suggests that horizontal trust within the forestry community may be less problematic than vertical trust between forest owners and governance bodies, which may still undermine confidence in policy-driven or institutionally supported transitions. In addition, a forest manager in Wallonia (BW2) emphasised that transitions towards less intensive management strategies can increase human-related safety risks such as accidents due to falling trees. This concern introduces an additional social barrier, particularly in forests with high recreational use, where safety considerations can influence the acceptability of reduced intervention.

Environmental constraints (EN1) to transition from multifunctional to close-to-nature are perceived as medium barriers. In addition to site-specific ecological conditions, a forest manager in Wallonia (BW2) highlighted that ungulate overpopulation is a strong barrier to transition to less intensive management strategies as the high browsing pressure limits natural regeneration and restricts opportunities to diversify species composition (Hallberg-Sramek et al., 2022; Larsen et al., 2022; Mason et al., 2022).

Beyond these local biophysical constraints, climate change uncertainty emerged as a particularly salient concern. Forest owners and managers repeatedly linked this uncertainty to changing climatic conditions, water availability, and an increased frequency of natural hazards, all of which complicate decisions to move towards less intensive management. Similar patterns are reported by Heltorp et al. (2018), who show that climate change uncertainty is a key barrier preventing forest owners from undertaking adaptation actions, as the uncertainty is too large to undertake substantial changes to current practices.

More intensive: From multifunctional to timber production

To transition from multifunctional to timber production systems, the most relevant economic barriers are the high operational costs (EC3) and transition or implementation costs (EC4). Similar to transitions from close-to-nature to multifunctional forestry, moving from multifunctional to timber production typically entails significant silvicultural interventions and investments in infrastructure and machinery (Eyvindson et al., 2021; Mederski et al., 2021). These requirements increase both upfront and recurring costs for forest owners and managers, thereby acting as important economic constraints on intensification. The pressure to meet timber demand (EC1) is considered as a weak barrier, whereas the lack of financial incentives for conservation is perceived as a medium-level barrier.

To transition from multifunctional to timber production, regulatory and legislative barriers are, on average, perceived as medium-level by forest owners and managers. This perception reflects EU policy frameworks such as the EU Biodiversity Strategy and the EU Forestry Strategy which prioritize integrative, close-to-nature, and continuous-cover forestry approaches. By promoting the joint delivery of ecological functions and timber production, and by discouraging clear-cuts and monoculture plantations, these policies constrain further intensification of forest management (Nagel et al., 2025). In addition to these overarching policy constraints, two interviewees (BF4 and S1) identified site-specific regulatory restrictions as a strong barrier to intensification. Both pointed out that the forests they manage are located within Natura 2000 sites or designated natural parks, where legal requirements strictly limit adopting more intensive management practices.

Knowledge and capacity barriers to transition from multifunctional to timber production are, on average, perceived as weak. This indicates the widely disseminated knowledge and technical expertise to manage even-aged and intensive forestry systems in Europe (Hallberg-Sramek et al., 2022).

As expected, weak demand for non-productive services (SO1) does not hinder transitions from multifunctional to timber production forestry. However, forest owners and managers' preferences (SO3) and strong social norms (SO4) are medium-level barriers and more importantly, public opposition to visible management (SO2) is a strong barrier. Strong social norms and public opposition may stem from increasing societal awareness of the environmental impacts associated with intensive forestry and concerns over climate change and biodiversity loss (Dawson et al., 2025). For example, European citizens generally hold negative views toward large clear-cuts, as demonstrated by the literature review of by Ciesielski and Stereńczak (2018). In addition, experiences of catastrophic events such as recent bark beetle outbreaks in the Czech Republic have heightened public sensitivity to forest health, cultural ES, and the need for climate-adaptive management (Hlásny et al., 2021). The growing demand for alternative forest uses such as recreation, green spaces and species habitat further reinforces preferences for multifunctional forestry (Aggestam et al., 2020). Echoing this trend, many forest owners and managers perceive the social pressure from the public as a core element to

adopt nature conservation measures (Konczal et al., 2023). Such pressures make transitions to more intensive management socially less acceptable. In addition to external pressure, previous studies suggest that forest owners' and managers' intrinsic preferences can further constrain intensification, particularly among less profit-oriented actors who prioritize multifunctional and ecosystem-oriented objectives (Feliciano et al., 2017; Hallikainen et al., 2010; Pynnönen et al., 2018; Tiebel et al., 2022). For these groups, intensifying management contradicts their motivations and values, especially given concerns about the impacts of intensive practices on soil, water, and landscape integrity (Zafra-Calvo et al., 2024).

Environmental constraints are perceived as a medium-level barrier to transitions from multifunctional forestry to timber production, indicating that ecological conditions restrict intensification.

Five forest owners and managers explicitly identified climate-change-related uncertainty as a key deterrent to intensification, referring to increased exposure to climatic hazards such as windstorms, changing microclimatic conditions, prolonged droughts, and pest outbreaks. These concerns reflect a growing awareness that even-aged and intensively managed forests tend to be more vulnerable to both biotic and abiotic disturbances, particularly under changing climatic conditions. This perception is well aligned with existing literature, which highlights the heightened sensitivity of intensive forest systems to disturbance and climate-related risks compared to more structurally diverse management approaches (Aggestam et al., 2020).

A particularly illustrative example comes from the Czech Republic, where a forest manager noted that the severe bark beetle outbreak of 2017–2019 is now perceived as a major barrier to intensification. The drought-induced bark-beetle infestation resulted in record-high sanitary logging, peaking in 2020 at approximately 64.8 million m³, more than three times the 2017 level (CZSO, 2024). Though drought had a predominant role in the bark beetle outbreak of 2017-2019, Czech forest composition was particularly prone to large-scale outbreaks due to the dominance of Norway spruce, which represents around 52% of the country's species composition and are mostly planted in monocultures (Hlásny et al., 2021; Podrázský et al., 2014). This structure significantly reduces the survival probability during bark beetle outbreaks when compared to spruces growing in species diverse forests (Griess et al., 2012; Hlásny et al., 2021; Neuner et al., 2015). In response to these events, studies increasingly call for diversification of tree species and the implementation of climate-adaptive measures in Central Europe (Vacek et al., 2019; Weger et al., 2025). However, undesirable outcomes such as the re-establishment of new and even-aged forests with low climate change resilience remain possible, as suggested by Hlásny et al. (2021). Similar dynamics have been observed in Sweden, where large-scale forest fires in 2018 created a window of opportunity to shift toward less intensive management. Yet, no substantial debate on adaptation emerged within the forestry sector (Hertog et al., 2022), demonstrating how crises do not always translate into systemic changes.

Timber production

Table 7 presents the mean barrier scores for transitions from timber production forestry towards less intensive management (multifunctional forestry) and towards more intensive management. The results are discussed in the following subsections.

Table 7: Mean agreement value of barriers to transition from timber production forestry towards less and more intensive management strategy

Category	Barriers	Timber production	
		Towards less intensive (Multifunctional)	Towards more intensive production
Economic	EC1 Pressure to meet timber demand	2.00	1.00

	EC2 Lack of financial incentives for conservation	2.50	1.00
	EC3 High ongoing operational costs	2.25	1.50
	EC4 High transition/implementation costs	2.00	1.75
	Average	2.19	1.31
Regulatory and legislative	RL1 Weak legislative support for alternatives	1.75	2.50
	RL2 Conflicting or incoherent policies	2.25	2.25
	RL3 Uncertainty about future political/institutional conditions	2.75	2.50
	RL4 Fragmented forest ownership	2.25	1.50
	Average	2.25	2.19
Knowledge and capacity	KC1 Limited access to specialized machinery and/or labour	3.25	1.50
	KC2 Insufficient technical knowledge	2.75	1.75
	Average	3.00	1.63
Social	SO1 Weak demand for non-productive services	3.00	1.00
	SO2 Public opposition to visible management	1.75	3.00
	SO3 (Your own) established preferences and practices	3.00	2.75
	SO4 Strong social norms and pressure to conform	2.25	2.50
	SO5 Low trust and weak collaboration among peers	1.75	1.25
	Average	2.35	2.10
Environmental	EN1 Ecological suitability and constraints	3.00	3.75

Legend	Not a barrier (0 - 1.49)	Weak barrier (1.50 - 2.49)	Medium barrier (2.50 - 3.49)	Strong barrier (3.50 - 4.00)
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Less intensive: From timber production to multifunctional

Timber production-oriented owners and managers rated economic constraints as weak on average. This contrasts with the findings of Willig et al. (2025), who, in the context of climate-change adaptation, show that timber-oriented managers tend to perceive economic factors as major constraints, highlighting how the salience of economic barriers may depend on the specific decision context examined. The pressure to meet timber demand (EC1) is as a weak barrier to transition from timber production to multifunctional. This diverges from Krumm et al. (2020), who found market demand to be a critical impediment to integrate biodiversity conservation measures, especially among timber-production oriented forests. Konczal et al. (2023) also report that rising timber demands is a major factor hindering the integration of nature conservation measure into forest management. In addition, both high operational costs (E3) and high transition or implementation costs (E4) are consistently rated as weak barriers, indicating that multifunctional forestry is perceived as less cost-intensive, likely because it relies less on practices such as artificial regeneration, frequent silvicultural interventions, or high-input harvesting systems. Conversely, the lack of financial incentives for conservation (EC2) is a medium-level barrier to transition from timber-production to multifunctional forestry. As previously explained, these findings align with previous studies (FAO, 2012; Konczal et al., 2023) and reflects a structural tension in forestry: managers face a trade-off between revenue from timber extraction and the adoption of biodiversity enhancing measures such as deadwood retention or set aside areas, all of which reduce short-term profitability. This trade-off becomes more acute in competitive international timber markets (Aggestam et al., 2020; Larsen et al., 2022).

Among regulatory and legislative barriers to transition from timber production to multifunctional systems, weak legislative support for alternatives (RL1), incoherent policies (RL2), and fragmented ownership (RL4) are weak barriers to transition towards less intensive systems. This pattern reflects the increasing institutional

acceptance of multifunctional forestry across European policy frameworks. In contrast, uncertainty about future political or institutional conditions (RL3) is a medium-level barrier, highlighting that current policy frameworks do not always provide the long-term consistency and credibility required for forest management decisions.

Both limited access to specialized machinery (KC1) and insufficient technical knowledge (KC2) are perceived as medium-level constraints to transition from timber production systems to multifunctional forestry. Because timber harvesting machinery can significantly disrupt ecosystem functions through soil compaction, reduced water quality, loss of biodiversity, and erosion (Pastén H. et al., 2025), transitioning toward less intensive management inherently requires access to low-impact harvesting technologies capable of minimizing these environmental footprint of forest management (Aggestam et al., 2020). Consistent with previous studies (Aggestam et al., 2020; Larsen et al., 2022), our results therefore suggest that forest owners and managers face practical limitations in accessing such specialized or low-impact equipment, which constrains their ability to diversify management objectives. Furthermore, the importance of knowledge gaps (KC2) suggests that traditional knowledge of uneven-aged forestry is eroding among intensively managed systems. Similarly, Mason et al., (2022) documents substantial knowledge gaps regarding forest-resilience outcomes of continuous-cover forestry and the practical management of uneven-aged stands among professionals. These gaps reflect both the erosion of traditional silvicultural knowledge related to uneven-aged forestry and the dominance of intensive models in education and professional practice, also reported by Hallberg-Sramek et al. (2022).

Social barriers to transition from timber production to multifunctional forestry are, on average, perceived as weak. Public opposition to visible management (SO2), the strong social norms and pressure to conform (SO4) and low trust and weak collaboration among peers (SO5) are considered weak barriers for transitioning from timber production to multifunctional forestry. However, two barriers stand out as medium-level. Weak demand for non-productive services (SO1) is a medium-level barrier to transition from timber production forestry to multifunctional forestry. This aligns with research indicating that the lack of monetary returns from non-timber forest products such as foraging and recreation can constrain the implementation of climate adaptation measures (Hallberg-Sramek et al., 2022). Similarly, Krumm et al. (2020) note that the insufficient economic incentives for the provisioning of FES other than timber hinders the adoption of integrated forest management. This highlight the need for innovative governance structures aimed at promoting multifunctional forestry, particularly in an industry-dominated forestry context (Buttoud et al., 2011). Forest owners' and managers' established preferences and practices (SO3) also emerge as a medium-level barrier, indicating that transitions away from timber-oriented management are not only shaped by external social demand, but also by internally held values and professional identities that favour production-focused forestry.

Environmental constraints (EN1) are perceived as medium-level barriers to transition from timber production to multifunctional forestry. Beyond the ecological constraints of the sites, climate change uncertainty and its implications for management was also mentioned among forest owners and managers as a constraint to transition towards less intensive management strategies. As previously mentioned, this suggests that the uncertainty related to climate change is too large to undertake substantial changes to current practices. Interestingly, existing literature indicates that in Norway climate-related pressures are often framed by forest owners and managers less as constraints and more as opportunities, driven by expectations of increased tree growth and rising demand for bio-based products in a climate-mitigation context (Heltorp et al., 2018). However, this view is not fully reflected in our results. In our study, Norwegian forest managers classified environmental suitability and site constraints as a medium-level barrier, with one forest manager (N2) explicitly referring to climate change uncertainty as a limiting factor (Table 13).

More intensive timber production

Lastly, considering a shift from timber production towards more intensive strategies means for forest owners and managers having even shorter rotation periods and more monoculture stands, whether for more intensive timber production or for bioenergy.

Timber production-oriented managers generally found that economic factors posed no barriers when considering a shift towards more intensive practices. Pressure to meet timber demand (EC1) and the lack of financial incentives for conservation (EC2) are intuitively irrelevant in this direction, as intensification aligns with existing economic motivations. Similarly, high operational and transition costs (EC3 and EC4) are perceived only as weak barriers, likely because intensive managers already operate within a cost-intensive production model and may have greater access to capital or existing infrastructure. Conversely, a Norwegian timber production-oriented manager (N2) noted that low and volatile timber prices are a strong barrier for further intensification.

Regulatory and legislative barriers are perceived as weak to intensify timber production. Incoherent policies (RL2), and fragmented ownership (RL4) are weak barriers to transition towards more intensive systems, while uncertainty about future political or institutional conditions (RL3) and weak legislative support for alternatives (RL1) are perceived as medium-level barriers. These suggests that for managers who already operate under intensive, production-oriented systems, regulatory frameworks and long-term commitment constraint further intensification

To transition towards more intensive timber production, knowledge and capacity barriers are weak, reflecting once again the widely disseminated knowledge and technical expertise to manage even-aged and intensive forestry systems in Europe (Hallberg-Sramek et al., 2022).

Though weak demand for non-productive services (SO1) and low trust and weak collaboration among peers (SO5) does not hinder intensification of timber production, public opposition to visible management (SO2), forest owners and managers preferences (SO3) and strong social norms (SO4) are medium-level barriers to transition towards more intensive systems. As for transitions from multifunctional forestry to timber production, these medium-level barriers reflect increasing societal awareness of the environmental impacts associated with intensive forestry and concerns over climate change and biodiversity loss (Dawson et al., 2025), as well as the growing demand for alternative FES (Aggestam et al., 2020). Interestingly, for timber production, forest owners and managers' preferences also constraints further intensification.

To transition from timber production to more intensive systems, environmental constraints was perceived as a strong barrier. Beyond ecological constraints, a forest manager particularly specified that climate change is a barrier to transition towards more intensive management strategies. As for transitions from multifunctional to timber production, these barriers reflect the growing awareness that even-aged and intensively managed forests tend to be more vulnerable to both biotic and abiotic disturbances, particularly under changing climatic conditions (Aggestam et al., 2020).



Assessment of the feasibility of a payment for ecosystem services mechanism

The feasibility of a PES scheme can be assessed along two dimensions, the economic dimension and the experiential dimension. The economic dimension implies that a forester is compensated sufficiently for implementing a certain scheme and the associated management practices. At worst, this means compensating foresters for their foregone profits. At best, this means providing a top-up equal to the estimated value of the additional FES and biodiversity gains that the forester is delivering. Next to evaluating whether a PES scheme is economically feasible, we must also consider that a forester, or land manager in general, may be more or less likely to enroll in a PES scheme given their past and expected future experiences with said scheme. Administrative burden, Monitoring, Reporting, and Verification (MRV), and ease of compliance are all non-economic elements that further determine whether enrolling in a PES scheme is feasible for a forest manager/owner. In this section of the deliverable, we evaluate the overall feasibility of a PES scheme by considering both dimensions. First, we evaluate the average costs and revenue structure of each forest management strategy under a business-as-usual (BAU) scenario. Following this, we use the cost and revenue structure to evaluate the economic feasibility of implementing a PES scheme by considering societal demand for FES under different management scenarios. The feasibility of a PES to promote transitions from the current management strategy to more intensive management was not analysed as our results suggest that, in all cases, citizens are not willing to finance a transition towards more intensive strategies and thus a citizen-financed PES scheme would not be (theoretically) possible. Second, we complement the assessment of economic feasibility by reflecting on forest owners' and managers' experiences with existing subsidies and PES schemes, with a particular focus of the factors constraining their accessibility and adoption.

Economic feasibility of implementing a PES scheme

A first step to assess the economic feasibility of a PES is to understand the costs and revenues structure of the different management strategies under a BAU scenario. This will allow us to compare costs and revenue structures between management strategies and identify potential opportunities. In this section, interviewees were grouped into the same three management strategy types as before: close-to-nature forestry (2 observations), multifunctional forestry (13 observations), and timber production forestry (4 observations). Figure 4 presents the average costs and revenues as shares across a set of common categories per management strategy.

The average **costs** within each forest management strategies are distributed as shares across six categories: planning and administration, silviculture, protection and risk management, harvesting and utilization, environmental and biodiversity management, and social and recreational management. **Close-to-nature** forestry allocates the largest share of costs to protection and risk management costs (52%), followed by harvesting and utilization costs (25%). The comparatively small shares devoted to silviculture (6%) and to environmental and biodiversity management (8%) reflect the low-intervention character of this system, where natural regeneration and minimal stand manipulation are central. Consistent with this pattern, close-to-nature forestry exhibits substantially lower silviculture expenditures than multifunctional forestry (46%) and intensive timber production forestry (22%). This finding aligns with existing literature indicating that continuous-cover forestry reduces regeneration and silvicultural costs relative to even-aged management systems (Vauhkonen and Packalen, 2019). While intensive forest management is generally associated with higher levels of silvicultural intervention, the observed differences between multifunctional and timber-oriented forestry may partly reflect economies of scale or differences in operational efficiency. **Multifunctional** forestry's cost structure is dominated by silviculture costs (46%), while protection (11%), planning (14%), harvesting (9%),

environmental management (15%), and social or recreational activities (7%) each represent moderate contributions. **Intensive timber** production forestry shows a more balanced structure, though harvesting and utilization represents the largest share (30%), followed by silviculture costs (22%) and environmental and biodiversity management (19%). For timber production, road maintenance was included as an additional cost category, representing 7% of total costs. Finally, social and recreational expenditures remain relatively similar across the three strategies, ranging between 6–7%. Although these figures represent relative shares rather than absolute expenditure levels, they nonetheless provide valuable insight into the different cost structures characterizing each forest management strategy.

Figure 4 also presents the average **revenue** structure within each forest management strategies. **Close-to-nature** forestry's major sources of income are subsidies and/or payment schemes (48%), followed by timber extraction (41%). For **timber production**, the revenue structure is predominantly concentrated on timber production (70%), followed by revenues from subsidies and/or payment schemes (23%). The sources of income for **multifunctional** forestry are more diversified than those for close-to-nature forestry and timber production, although timber extraction still represents over half of total revenues (56%), while subsidies and PES represent 19%. Multifunctional forestry has the highest proportion of income from alternative FES (other than timber): recreation, tourism, hunting and agriculture together represent 22% of total revenues.

These average revenue structures suggest that provisioning FES (timber production, non-timber forest products and others) consistently constitute the largest share of incomes for multifunctional (60%) and timber production forestry systems (70%), and an important share for close-to-nature forestry (51%). These findings align with those of Lovrić et al. (2025) as they show that about 80% of forest income across Europe comes from provisioning FES (wood biomass, game and wild forest products).

In contrast, despite the increasing demand of cultural and regulating FES reported in the literature (Acharya et al., 2019; Bruzzese et al., 2022; De Groot et al., 2012; Lovrić et al., 2025; Torralba et al., 2020), these services continue to play a limited role in forest owners' revenue structures, highlighting a persistent economic mismatch between demand and remuneration (Lovrić et al., 2025). Evidence from our analysis of barriers to management transitions further reinforces this mismatch: forest owners and managers consistently identified insufficient financial incentives for conservation and weak market demand for non-productive services as key obstacles to shifting towards less intensive management strategies. These findings point to a clear need to diversify forest income streams by enhancing remuneration for alternative FES, as also suggested by Lovrić et al. (2025). This need is particularly pronounced for close-to-nature forestry in our case studies as these systems are highly reliant on subsidies and/or PES. While profit maximization is not the primary objective for all forest owners and managers (Ficko and Boncina, 2013; Hugosson and Ingemarson, 2004; Lovrić et al., 2025), the results nonetheless highlight a significant opportunity for close-to-nature forestry to strengthen economic resilience through a more diversified mix of income sources.

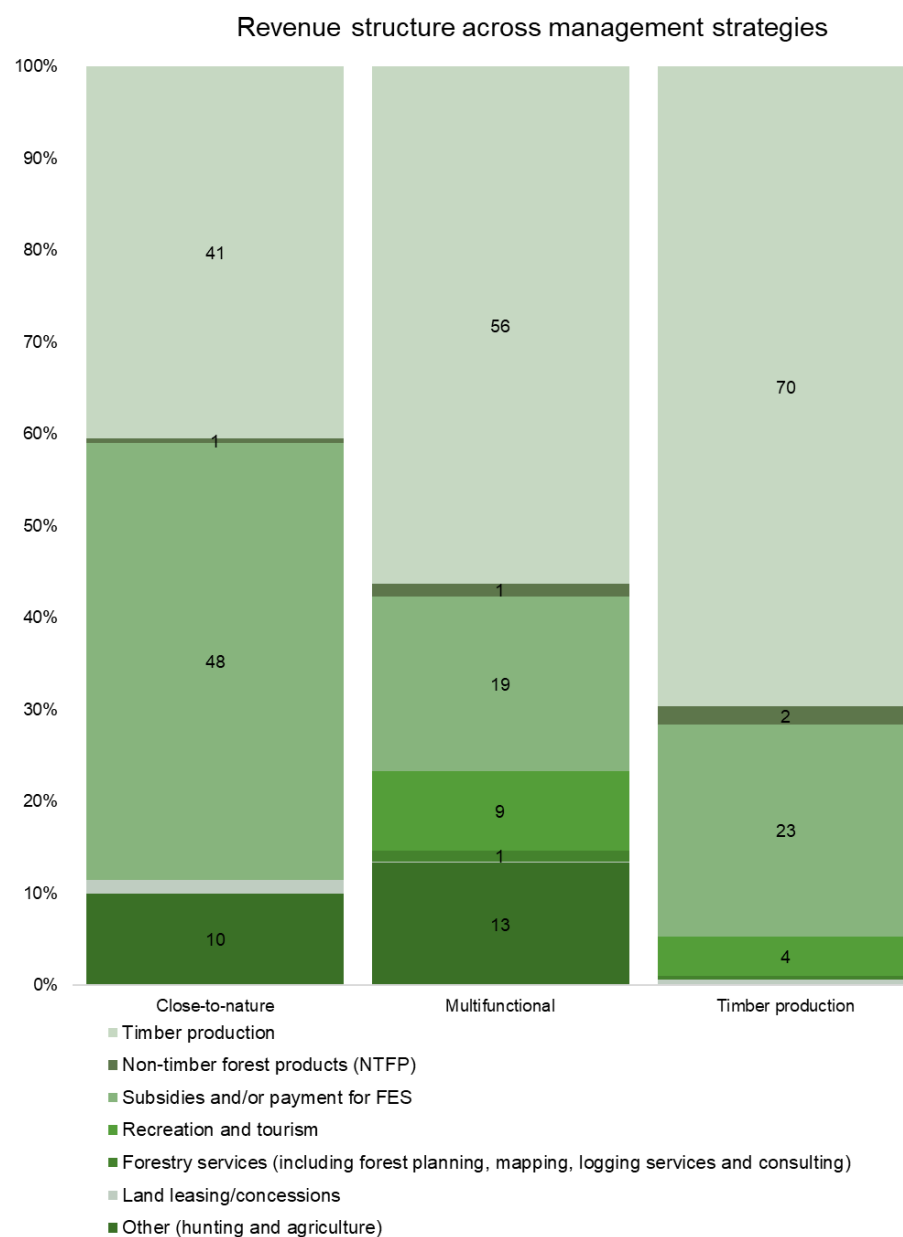
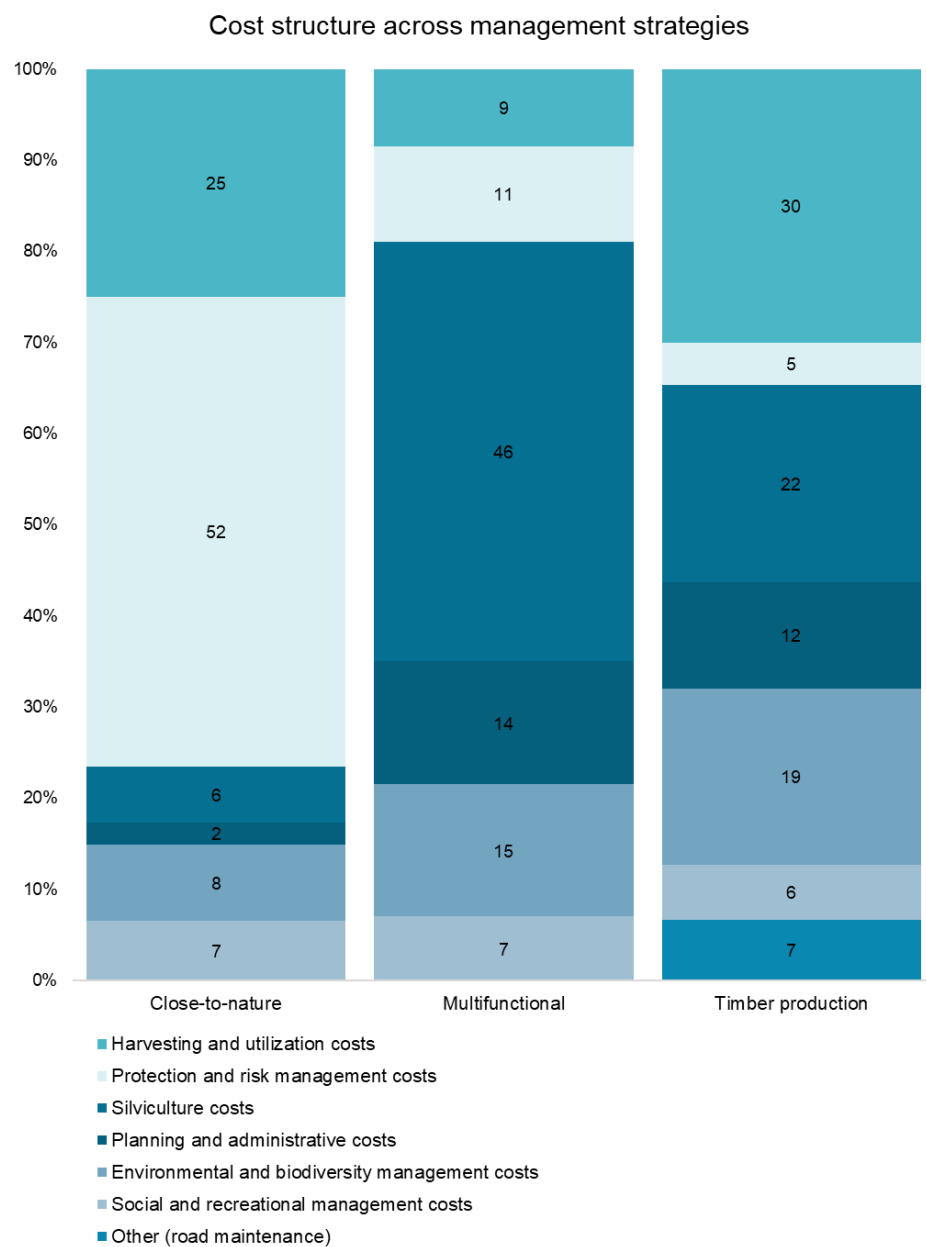


Figure 4: Average cost and revenue structure across management strategies



Based on the above-described cost and revenue data, private profitability under a BAU scenario was estimated for each observation, expressed in euros per hectare per year (EUR/ha/year; Table 8). Due to data restrictions on costs and revenues, private profitability could only be estimated for one observation under close-to-nature forestry in Spain (S3), four observations under multifunctional forestry across Flanders (BF3, BF4 and BF5) and Spain (S1) and three observations under timber production forestry across Flanders (BF6) and Norway (N1 and N2). The results, presented in Table 8, suggest significant heterogeneity in the sample with regard to profit levels.

Table 8: Estimated private profitability

Interview Code	Forest management strategy	Profit BAU (EUR/ha/year)
S3	Close-to-Nature	-17
S1	Multifunctional	-43
BF3	Multifunctional	-70
BF4	Multifunctional	15
BF5	Multifunctional	250
BF6	Timber production	350
N1	Timber production	1528
N2	Timber production	-504

The second step in assessing the feasibility of adopting a PES scheme is to estimate the opportunity costs faced by forest owners and managers when transitioning from their current (BAU) management to less intensive forest management strategies. In this context, opportunity costs refer to the change in private profits associated with adopting a different management approach and represent the minimum level of compensation required for forest owners and managers to be willing to make such a transition. To capture these potential profit changes, interviewees were asked how their costs and revenues would change under less or more intensive management strategies. The results indicate that, when transitioning towards alternative management strategies, profit can either decrease, stay largely the same, or increase. The direction in which profits shift is determined by the underlying costs and revenue structures. Generally, since the transitions being considered reflect a shift towards less intensive management strategies, profits are most often seen to either stay the same or decrease due to loss of revenues from timber. In the exceptional case (BF5), profits may increase when shifting towards less intensive if revenue streams are more diversified to start with, for example through hunting. We use insights from the interviews to determine whether profits are likely to increase, stay the same, or decrease in each specific study region. Once the direction of change has been determined, we estimate profit change for two scenarios, an upper and a lower bound. The upper bound represents a maximum increase/decrease of profit at $\pm 60\%$ of the current profit level. The lower bound represents a minimum increase/decrease of profit change at $\pm 20\%$. When profits were indicated to stay largely the same, the upper and lower bound represent a $+10\%$ and -10% change in profit respectively. Table 9 presents the estimated private profitability of each observation under the BAU scenario, as well as the corresponding profit change associated with a transition to less intensive management.

Table 9: Economic feasibility of PES scheme to transition towards less intensive management strategies

Obs.	BAU	Alternative management scenario	Profit BAU (EUR/ha/year)	Change in Profits	Opportunity Cost (EUR/ha/year)		Compensating surplus (EUR/ha/year)
					Lower Bound	Upper Bound	
S3	Close-to-Nature	Unmanaged	-17	Stay largely the same	-3	1	-342
S1	Multifunctional	Close-to-Nature	-43	Stay largely the same	-4	4	41
BF3	Multifunctional	Close-to-Nature	-70	Stay largely the same	-7	7	2696
BF4	Multifunctional	Close-to-Nature	15	Decrease	-3	-9	2696
BF5	Multifunctional	Close-to-Nature	250	Increase	50	150	2696
BF6	Timber production	Multifunctional	350	Decrease	-210	-70	15399
N1	Timber production	Multifunctional	1528	Decrease	-917	-306	0.28
N2	Timber production	Multifunctional	-504	Decrease	-302	-101	0.28

Note: Stay largely the same implies a -10% and +10% change in profits at the upper and lower bound, decrease implies a -60% and -20% change in profits at the upper and lower bound, and increase implies a +20% and +60% change in profits at the upper and lower bound.

The third step to assess the economic feasibility of a PES scheme aimed at promoting transitions towards less intensive management strategy is to estimate how much beneficiaries are willing to pay for changes in FES. We measure this willingness to pay using the CS, which captures the change in citizens' welfare associated with a given management transition expressed in euros per hectare (EUR/ha/year). In the context of PES, the CS represents the maximum amount that beneficiaries would be willing to contribute to finance a management change and therefore defines an upper bound for a feasible PES scheme. For a PES scheme to be economically viable, the compensation required by forest owners and managers (i.e. the opportunity cost of transitioning) must be less than or equal to the corresponding CS.

A full overview of the estimated CS for scenarios representing shifts between all considered forest management strategies across all study regions is available in Table 14 in Appendix B. In Table 9 we summarize only the CS values for the relevant² management transitions in each study region. To illustrate, for observation S3, the CS associated with a transition from close-to-nature forestry to unmanaged forestry in Spain is – €342 . This negative CS indicates that citizens experience a welfare loss following the management change. In other words, rather than being willing to pay for this transition, citizens would need to be compensated for the reduction in perceived benefits. This implies that citizens are not willing to finance a transition towards unmanaged forests in Spain. Table 14 in Appendix shows that the CS for a transition from close-to-nature forestry to unmanaged forestry is also negative in Belgium and Norway. This suggests that citizens in these countries similarly do not support such a transition through financial contributions. The underlying reason is that citizens place a higher value on the bundle of FES provided by close-to-nature forestry than on those provided by unmanaged forest systems.

² A transition was considered relevant if it represented a shift from more towards less intensive, and when enough cost and revenue data was available to make a meaningful profit estimation. More information on this selection procedure is included in the Materials and Methods section.

Our findings indicate several contexts in which PES scheme could be economically viable, particularly where demand for FES exceeds supply. In **Flanders**, all analysed transitions from multifunctional forestry towards less intensive forestry yields a substantial CS of €2696, while the shift from timber production forestry to multifunctional forestry results in an exceptionally high CS of €15399. These values significantly exceed the opportunity cost faced by forest owners when faced with such a transition. This strong feasibility is explained by the imbalance between demand and supply of FES. With 6.86 million inhabitants and only 152,600 hectares of forest (approximately 0.02 hectares per inhabitant) (Govaere and Leyman, 2024; Statbel, 2024), Flanders experiences high demand pressure on limited forest resources. As a result, citizens demonstrate a high willingness to pay for enhanced FES.

In **Spain** (Valencia case study), the transition from multifunctional forestry to close-to-nature forestry also appears feasible, although under more constrained conditions. The estimated CS of €41 is sufficient to compensate forest owners under current cost structures. Importantly, opportunity costs are already negative (i.e., forest management generates losses), and these are expected to remain relatively stable under less intensive management. However, this feasibility is sensitive to changes in costs. If losses per hectare were to exceed €84, the CS would no longer be sufficient and PES schemes would become economically unviable. While context-specific, this finding aligns with evidence from Catalonia (Górriz-Mifsud et al., 2016), where PES schemes have proven viable in terms of both social acceptance and forest owner participation.

In contrast, the results suggest that PES schemes are unlikely to be viable in contexts where the supply of FES exceeds demand, or where institutional frameworks reduce the need for market-based incentives. This is particularly evident in **Norway**, where the estimated CS is close to zero across all management scenarios. As a result, societal support fails to compensate forest owners and managers for the opportunity costs associated with changing forest management practices.

The limited feasibility of PES schemes in Norway can be explained by both structural and institutional factors. The country has a high forest availability relative to its population, approximately 2.2 hectares per inhabitant based on 5.5 million inhabitants and 12.07 million hectares of forest (SSB, 2025a, 2025b), resulting in low demand pressure. Additionally, the Norwegian Outdoor Recreation Act (Act of 28 June 1957 No.16) guarantees public access to forests through the “right to roam”, allowing individuals to freely benefit from a wide range of FES (Helseth et al., 2022; Ministry of Climate and Environment, 1957). Because these services are already available as common-pool resources, citizens have little incentive to pay for their provision, as suggested by Winkel et al. (2022). Together, these factors result in low willingness to pay, and consequently, insufficient financial incentives for forest owners, making PES schemes economically unfeasible in the Norwegian context.

It bears noting that transitions towards more intensive forest management were excluded from the feasibility analysis, as they consistently generate negative CS values (Table 14 in Appendix). This suggests that citizens perceive such transitions as welfare-reducing and are therefore unwilling to finance them. Consequently, a citizen-financed PES scheme promoting increased management intensity cannot be considered theoretically feasible in any of the cases examined.

Adoption constraints and perception of subsidies and PES schemes

Although a wide range of financial instruments are available to support forest management, uptake remains limited (Feliciano et al., 2017). This subsection therefore explores the experiences of forest owners and managers with existing subsidies and PES schemes, focusing particularly on the factors that constrain their accessibility and adoption.

Forest owners and managers operate within a multi-level system of forestry subsidies. As noted by Haeler et al. (2023), forestry subsidy schemes in Europe typically combine funding from European, national, and regional sources, a pattern that is also reflected among the thirteen interviewees involved in forestry subsidy schemes. In Belgium for example, where most interviews were conducted, forest owners and managers referred to a wide range of support schemes operating at different governance levels. At the EU level, the Common Agricultural Policy (CAP) and the European Agricultural Fund for Rural Development (EAFRD) grants were repeatedly mentioned, as well as several EU-related funds such as LIFE and Interreg programs. At the regional level, interviewees in Flanders mentioned the *Subsidies natuurbeheerplan* (nature management plan subsidies), *Natuurstreefbeeld: basissubsidie* (nature targets: basic subsidies) and the *Subsidies bebossing en herbebossing* (subsidies for afforestation and reforestation), and the Blue Deal program, while in Wallonia the *Plan de Relance* (Recovery Plan) and the *Forêt résiliente* (Resilient forest) program were highlighted. At the province level, some subsidies were also mentioned such as the *Functioneel ecologisch network* in Antwerp.

A common pattern emerging from forest owners' and managers' experiences with subsidy schemes concerns administrative complexity, with **53% of interviewees stating that administrative burden is a key impediment to participate in subsidies or PES schemes**. When asked about areas of improvements for subsidy and PES schemes, the interviewees highlighted once again that administrative procedures for subsidies and PES are overly complex, time-consuming, and particularly difficult for small forest owners. Similar results were reported by Feliciano et al. (2017) and Quiroga et al. (2019), claiming that a key constraint for the uptake of forest subsidies among small and medium forest owners was the bureaucracy and administrative burden of such schemes. Thus, to improve accessibility, interviewees suggested simplified processes and that administrative complexity align with the capacity of those asking for the subsidies.

Another key issue repeatedly highlighted by interviewees concerns the **uncertainty surrounding the long-term continuity** of subsidy and PES schemes. This lack of predictability limits forest owners' and managers' ability to develop a clear long-term management vision and acts as a constraint to engagement, as also noted by Quiroga et al. (2019). At the same time, perceptions of short-term schemes diverge among stakeholders. On the one hand, a forest manager emphasised that frequent changes in short-term subsidies increases administrative burdens for advising organizations, requiring continuous communication with forest owners and repeated application processes. On the other hand, another interviewee suggested that short-term schemes can provide greater flexibility, which may facilitate initial engagement. This latter perspective is reflected in our findings: 37% of stakeholders identified long-term commitments as an impediment to participation in subsidy and PES schemes, while 32% highlighted limited management flexibility as a key challenge.

A Belgian interviewee highlighted the **limited access of small forest owners to economic support instruments**, suggesting that eligibility criteria linked to holding size restrict access to financial support. This observation is consistent with Haeler et al. (2023), who show that small-scale forest owners (i.e. holdings smaller than 20 ha) rarely make use of EAFRD funding and receive a disproportionately low share of subsidies relative to the forest area they manage. Size-related constraints further interact with additional impediments, such as administrative burden and limited participation in policy and forest-management networks, which reduce awareness of and access to available funding opportunities among forest owners.

Similarly, amongst the forest owners and managers interviewed in this study, **limited awareness of subsidy and PES schemes** emerged as a broader challenge overall, with nearly half of the interviewees identifying a lack of information as a key constraint to uptake. This finding aligns with existing research highlighting low awareness among landowners as a persistent constraint for incentive-based policy instruments (Lawrence et al., 2020; Lawrence and Dandy, 2014). Addressing these impediments requires not only improved communication about available schemes, but also clearer guidance on how they can be combined and applied in practice, as suggested by an interviewee. More broadly, a forest manager also emphasised the need to

strengthen communication between the scientific community and forest owners and managers regarding management practices, particularly through more accessible formats such as summary reports. This is consistent with recent studies stressing the importance of translating scientific knowledge into practical guidance (Nikinmaa et al., 2024), although some authors suggest that one-way communication methods should be complemented with interactive learning approaches to better engage diverse forest owner groups (Wilkes-Allemann et al., 2021).

Building on these findings, interviewees further emphasised that **improving communication between policy-makers and forest owners and managers** is key to overcoming uptake constraints. Existing research shows that communication in the forestry sector is still largely dominated by one-way approaches, such as newspaper articles, websites, or informational campaigns (Wilkes-Allemann et al., 2021). While these methods can support the dissemination of information about available subsidies and PES schemes, they remain limited in their ability to address specific concerns or contextual needs. Our results suggest that complementing these methods with more proactive information exchange between policy-makers and forest owners and managers could help bridge uptake impediments by fostering dialogue and clarifying requirements.

Finally, an interviewee in Poland emphasized that, beyond implementing PES schemes, there is an urgent need to **strengthen forest owners' and managers' capacity to adapt to climate change through knowledge dissemination**. Next to pointing to communication and knowledge gaps, it also points to the importance of complementing market-instruments with non-market instruments such as capacity building to achieve EU strategy goals (Feliciano et al., 2017; Lawrence, 2018; Quiroga et al., 2019; Sotirov et al., 2015). As shown by Sotirov et al. (2015), engagement with PES schemes is shaped not only by economic factors, such as dependence on forest resources, but also by forest owners' values and motivations. Given that forest owners and managers do not always respond to financial incentives alone (Feliciano et al., 2017; Quiroga et al., 2019), effective policy approaches should adopt a more integrated perspective, combining economic incentives with advisory support and knowledge exchange tailored to local social, ecological, and institutional contexts (Lawrence, 2018).

Limitations

This study has several limitations that should be considered when interpreting the results. First, the participation in our interviews across study regions was unbalanced: Belgium (9), the Czech Republic (1), France (2), Norway (2), Poland (2), and Spain (3). The over-representation of Belgian stakeholders may have introduced a regional bias in the results, with findings more strongly reflecting the institutional, ecological, and socio-economic conditions specific to Belgium. The sample was also unbalanced in terms of forest management strategies, with two observations for close-to-nature forestry, thirteen for multifunctional forestry, and four for timber production. This imbalance suggests that the results for close-to-nature and timber production systems are less robust, particularly for the analysis on the barriers to transition towards alternative management strategies. Additionally, the limited number of observations per management strategy prevented the use of statistical tests such as t-test or ANOVA to compare perceived barriers across management strategies (Smalheiser, 2017).

Second, although Likert-type scales are frequently used as measurement tools, their application in this study introduces several methodological limitations. The main limitation is that interviewees categorized the barriers using four ordinal labels (strong, medium, weak, and not a barrier), while the corresponding 4–1 numerical scale was not presented to them. Thus, although an ordinal approach guided the interviews, an interval-level interpretation was applied during data analysis to facilitate descriptive comparison. This decision was largely due to the small sample size, which restricted the application of ordinal methods such as medians and modes. However, treating these categories as interval data assumes equal distances between adjacent points, even



though interviewees may not perceive the spacing between categories uniformly (Crask and Fox, 1987; Heo et al., 2022). Moreover, rating tasks often involve central-tendency bias, where individuals avoid extreme categories (Heo et al., 2022). In this study, only a few barriers were classified as “strong” or “not a barrier,” suggesting that interviewees may indeed have avoided choosing the extreme options.

Third, the economic feasibility analysis of adopting a PES scheme relied on interviewee’s informal reports of the cost and revenue structures of the forests they manage. In the forestry sector, these parameters can fluctuate substantially from year to year and a robust economic assessment require long-term valuation periods. For example, standard approaches such as the annuity method described by Möhring and Rüping (2008) are specifically designed to account for costs and revenues across longer timeframes. While some interviewees provided averages over a ten-year period, others reported figures from a single year, and several did not specify the reference period at all. These inconsistencies, combined with general uncertainty in the estimates provided, introduce limitations to the external validity of our results. Furthermore, although transaction costs are central in the design and implementation of environmental policy instruments (Coggan et al., 2010), they were not considered in this study. This omission rests on the assumption that any new PES scheme would operate within existing institutional arrangements (Coggan et al., 2010; Górriz-Mifsud et al., 2016). However, this assumption is restrictive, as current institutional frameworks do not always support the development or functioning of PES schemes.

Fourth, ecological complexity is often simplified in valuation exercises because DCE attributes and levels must be both ecologically meaningful and easily understood by respondents (Bateman et al., 2002). Consequently, the resulting CS estimates may overlook key ecological dynamics and threshold effects, and they remain sensitive to the social, cultural, and economic contexts in which preferences are expressed (Kumar, 2010). In addition, using valuation techniques and stated preferences approaches instead of actual consumer behaviour could introduce hypothetical bias (Murphy et al., 2005). As the CS is built on the marginal WTP estimates, this bias can result in higher CS than the actual value since respondents are not faced with the financial consequences of their decision.

Conclusion

This deliverable has as objective to identify the factors that forest owners and managers perceive as barriers in transitioning towards alternative forest management strategies, and assess the feasibility of implementing a PES scheme to support such a transitions. Overall, our results show that the adoption of alternative forest management strategies is hindered by a wide range of interconnected economic, institutional, knowledge-related, social and environmental factors.

Economic considerations constitute an important influence on forest management decisions. In particular, the lack of financial incentives for conservation consistently emerges as a key barrier to transitions towards less intensive forest management. This highlights the need to better understand how non-productive FES can generate economic value, as well as to develop and strengthen market mechanisms that effectively remunerate their provision. Beyond economic constraints, institutional and policy-related factors also shape the scope for management change. While the EU Biodiversity Strategy for 2030 includes the ambition to allocate 10% of forest area to strictly protected or unmanaged forests, our results indicate that current policy momentum and forest owners and managers preferences and practices converge more strongly around transitions towards close-to-nature and multifunctional forestry than towards fully unmanaged regimes. Combined with evidence from the CS analysis, indicating welfare losses associated with transitions to unmanaged forest scenarios, these findings suggest an implicit agreement among policymakers, society, and forest managers that a minimum level of management is required.

Knowledge and capacity-related barriers further restrict transitions towards alternative management strategies. Insufficient technical knowledge to manage uneven-aged forestry systems, together with limited access to low-impact machinery, constitutes a major constraint when transitioning from timber-oriented forestry to less intensive management systems. In addition, uncertainty about effective climate-adaptation strategies, combined with broader climate-related uncertainty, indicates that climate change acts not only as an environmental constraint but also as a knowledge and capacity barrier. Together, these findings point to a dual challenge for forest owners and managers: increasing ecological uncertainty associated with climate change discourages substantial departures from current practices, while limited guidance and technical capacity constrain their ability to adapt management accordingly.

Lastly, social barriers underline that transitions between forest management strategies are not purely economic, ecological or technical decisions. Forest owners' and managers' preferences, societal expectations and norms tend to constrain transitions towards more intensive management. From a welfare-economic perspective, consistently negative CS values for transitions towards more intensive management further underscores the lack of societal support of such transitions. Thereby, the lack of societal acceptance suggest that implementing citizen-financed PES schemes aimed at intensification is not socially optimal.

The economic feasibility analysis of adopting a PES scheme to transition towards less intensive management strategies illustrates how demand- and supply-side dynamics shape the viability of such instruments. In Flanders, where demand for FES is high relative to forest supply and the timber sector is comparatively small, a PES scheme could be both economically viable and socially supported. In southern Spain, a PES scheme appears feasible only for transitions from multifunctional to close-to-nature forestry, and even there, feasibility remains sensitive to variations in foresters' opportunity costs and citizens' CS. In contrast, our findings indicate that a citizen-financed PES scheme is unlikely to be feasible in Norway for transitions from timber-oriented to multifunctional forestry, given that the supply of FES exceeds demand and legislation already allows free access to many FES. Our findings highlight that PES schemes to transition towards less intensive management strategies must be considered at a local scale, considering economic, institutional, social and



ecological factors. Importantly, our results show that economic feasibility alone does not determine the success of PES schemes. The experiential dimension, encompassing forest owners' and managers' experiences, perceptions, and capacities, plays a decisive role in uptake. Administrative burden, long-term contractual commitments and limited awareness of subsidy and PES schemes, all emerge as critical non-economic barriers to participation, particularly for small holders.

Taken together, these findings suggest that incentivising forest management transitions in line with EU forest policy objectives requires a combination of complementary mechanisms rather than reliance on a single instrument. Given the strong context dependency of PES feasibility, EU-wide PES schemes may be less effective than approaches tailored to regional or local conditions. Beyond the implementation of PES schemes, effective policy design should therefore adopt an integrated approach that combines economic incentives with advisory support, capacity building, and strengthened knowledge exchange. Such approaches should consider:

- Strengthening vertical and horizontal communication between policymakers and forest owners and managers to design subsidy and PES schemes that better account for adoption constraints, such as administrative burden, limited access for small forest owners, long-term continuity requirements, and limited awareness of funding opportunities.
- Consolidating vertical and horizontal communication between the scientific community and forest owners and managers to improve access to practical knowledge on forest management and climate adaptation strategies.
- Expanding capacity-building efforts, particularly to support timber-oriented foresters in adopting alternative management practices, while recognising that forest owner preferences play a decisive role in behavioural change.
- Improving communication towards citizens regarding the importance of forests and forest management practices, thereby strengthening societal understanding and support for sustainable forest transitions.

References

- Acharya, R.P., Maraseni, T., Cockfield, G., 2019. Global trend of forest ecosystem services valuation – An analysis of publications. *Ecosystem Services* 39, 100979. <https://doi.org/10.1016/j.ecoser.2019.100979>
- Aggestam, F., Konczal, A., Sotirov, M., Wallin, I., Paillet, Y., Spinelli, R., Lindner, M., Derks, J., Hanewinkel, M., Winkel, G., 2020. Can nature conservation and wood production be reconciled in managed forests? A review of driving factors for integrated forest management in Europe. *Journal of Environmental Management* 268, 110670. <https://doi.org/10.1016/j.jenvman.2020.110670>
- Appiagyei, B.D., Belhoucine-Guezouli, L., Bessah, E., Morsli, B., Fernandes, P.A.M., 2022. A Review on Climate Change Impacts on Forest Ecosystem Services in the Mediterranean Basin. *Journal of Landscape Ecology* 15, 1–26. <https://doi.org/10.2478/jlecol-2022-0001>
- Başkent, E.Z., Kašpar, J., 2022. Exploring the effects of management intensification on multiple ecosystem services in an ecosystem management context. *Forest Ecology and Management* 518, 120299. <https://doi.org/10.1016/j.foreco.2022.120299>
- Bateman, I., Carson, R.T., Day, B., Hanemann, W.M., Hanley, N., Großbritannien (Eds.), 2002. Economic valuation with stated preference techniques: a manual. Elgar, Cheltenham.
- Blattert, C., Eyvindson, K., Hartikainen, M., Burgas, D., Potterf, M., Lukkarinen, J., Snäll, T., Toraño-Caicoya, A., Mönkkönen, M., 2022. Sectoral policies cause incoherence in forest management and ecosystem service provisioning. *Forest Policy and Economics* 136, 102689. <https://doi.org/10.1016/j.forpol.2022.102689>
- Blennow, K., Persson, J., Tomé, M., Hanewinkel, M., 2012. Climate Change: Believing and Seeing Implies Adapting. *PLoS ONE* 7, e50182. <https://doi.org/10.1371/journal.pone.0050182>
- Bolte, A., Ammer, C., Löf, M., Madsen, P., Nabuurs, G.-J., Schall, P., Spathelf, P., Rock, J., 2009. Adaptive forest management in central Europe: Climate change impacts, strategies and integrative concept. *Scandinavian Journal of Forest Research* 24, 473–482. <https://doi.org/10.1080/02827580903418224>
- Brunette, M., Hanewinkel, M., Yousefpour, R., 2020. Risk aversion hinders forestry professionals to adapt to climate change. *Climatic Change* 162, 2157–2180. <https://doi.org/10.1007/s10584-020-02751-0>
- Bruzzese, S., Blanc, S., Merlino, V.M., Massaglia, S., Brun, F., 2022. Civil society's perception of forest ecosystem services. A case study in the Western Alps. *Front. Psychol.* 13, 1000043. <https://doi.org/10.3389/fpsyg.2022.1000043>
- Buttoud, G., Kouplevatskaya-Buttoud, I., Slee, B., Weiss, G., 2011. Barriers to institutional learning and innovations in the forest sector in Europe: Markets, policies and stakeholders. *Forest Policy and Economics* 13, 124–131. <https://doi.org/10.1016/j.forpol.2010.05.006>
- Ciesielski, M., Stereńczak, K., 2018. What do we expect from forests? The European view of public demands. *Journal of Environmental Management* 209, 139–151. <https://doi.org/10.1016/j.jenvman.2017.12.032>
- Coggan, A., Whitten, S.M., Bennett, J., 2010. Influences of transaction costs in environmental policy. *Ecological Economics* 69, 1777–1784. <https://doi.org/10.1016/j.ecolecon.2010.04.015>
- Crask, M.R., Fox, R.J., 1987. An exploration of the interval properties of 3 commonly used marketing-research scales-a magnitude estimation approach. *Journal of the Market Research Society* 29, 317–329.
- Czech Statistical Office (CZSO), 2024. Selected data on Forestry.
- Daily, G., Postel, S., Bawa, K., Kaufman, L., 1997. *Nature's Services: Societal Dependence On Natural Ecosystems*. Bibliovault OAI Repository, the University of Chicago Press.
- Dawson, L., Glass, J., Widman, U., Friman, J., Holmgren, S., 2025. Unlocking a transition to alternative forest management in intensive management contexts: Stakeholder perceptions of constraints and opportunities in Sweden. *Forest Policy and Economics* 178, 103560. <https://doi.org/10.1016/j.forpol.2025.103560>
- De Groot, R., Brander, L., Van Der Ploeg, S., Costanza, R., Bernard, F., Braat, L., Christie, M., Crossman, N., Ghermandi, A., Hein, L., Hussain, S., Kumar, P., McVittie, A., Portela, R., Rodriguez, L.C., Ten Brink, P., Van Beukering, P., 2012. Global estimates of the value of ecosystems and their services in monetary units. *Ecosystem Services* 1, 50–61. <https://doi.org/10.1016/j.ecoser.2012.07.005>
- Deuffic, P., Sotirov, M., Arts, B., 2018. “Your policy, my rationale”. How individual and structural drivers influence European forest owners’ decisions. *Land Use Policy* 79, 1024–1038. <https://doi.org/10.1016/j.landusepol.2016.09.021>

- Duncker, P.S., Barreiro, S.M., Hengeveld, G.M., Lind, T., Mason, W.L., Ambrozy, S., Spiecker, H., 2012. Classification of Forest Management Approaches: A New Conceptual Framework and Its Applicability to European Forestry. *E&S* 17, art51. <https://doi.org/10.5751/ES-05262-170451>
- European Commission, 2023. Guidelines on closer-to-nature forest management. Publications Office, LU.
- European Commission, 2021. New EU Forest Strategy for 2030 (No. COM(2021) 572 final). European Commission, Brussels, Belgium.
- European Commission, 2019. The European Green Deal (No. COM(2019) 640 final). Brussels, Belgium.
- Eurostat, 2025. Population by age and NUTS 2 region. https://doi.org/10.2908/CENS_21AGR2
- Eyvindson, K., Duflot, R., Triviño, M., Blattert, C., Potterf, M., Mönkkönen, M., 2021. High boreal forest multifunctionality requires continuous cover forestry as a dominant management. *Land Use Policy* 100, 104918. <https://doi.org/10.1016/j.landusepol.2020.104918>
- Feliciano, D., Bouriaud, L., Brahic, E., Deuffic, P., Dobsinska, Z., Jarsky, V., Lawrence, A., Nybakk, E., Quiroga, S., Suarez, C., Ficko, A., 2017. Understanding private forest owners' conceptualisation of forest management: Evidence from a survey in seven European countries. *Journal of Rural Studies* 54, 162–176. <https://doi.org/10.1016/j.jrurstud.2017.06.016>
- Ficko, A., Boncina, A., 2013. Probabilistic typology of management decision making in private forest properties. *Forest Policy and Economics* 27, 34–43. <https://doi.org/10.1016/j.forpol.2012.11.001>
- Food and Agriculture Organization of the United Nations (FAO), 2012. Forest Management and Climate Change: stakeholder perceptions, Forests and Climate Change Working Paper 11. Rome, Italy.
- FOREST EUROPE, 2020. State of Europe's Forests 2020.
- Górriz-Mifsud, E., Varela, E., Piqué, M., Prokofieva, I., 2016. Demand and supply of ecosystem services in a Mediterranean forest: Computing payment boundaries. *Ecosystem Services* 17, 53–63. <https://doi.org/10.1016/j.ecoser.2015.11.006>
- Govaere, L., Leyman, A., 2024. Flemish forest inventory Agency for Nature and Forests (VBI1: 1997-1999; VBI2: 2009-2018; VBI3: 2019-2023).
- Gregory, S.A., Christine Conway, M., Sullivan, J., Gregory, S.A., 2003. Econometric analyses of nonindustrial forest landowners: Is there anything left to study? *JFE* 9, 137–164. <https://doi.org/10.1078/1104-6899-00028>
- Griess, V.C., Acevedo, R., Härtl, F., Staupendahl, K., Knoke, T., 2012. Does mixing tree species enhance stand resistance against natural hazards? A case study for spruce. *Forest Ecology and Management* 267, 284–296. <https://doi.org/10.1016/j.foreco.2011.11.035>
- Haeler, E., Bolte, A., Buchacher, R., Hänninen, H., Jandl, R., Juutinen, A., Kuhlmeier, K., Kurttila, M., Lidestav, G., Mäkipää, R., Rosenkranz, L., Triplat, M., Vilhar, U., Westin, K., Schueler, S., 2023. Forest subsidy distribution in five European countries. *Forest Policy and Economics* 146, 102882. <https://doi.org/10.1016/j.forpol.2022.102882>
- Haines-Young, R., 2023. Common International Classification of Ecosystem Services (CICES) V5.2 and Guidance on the Application of the Revised Structure.
- Hallberg-Sramek, I., Reimerson, E., Priebe, J., Nordström, E.-M., Mårald, E., Sandström, C., Nordin, A., 2022. Bringing “Climate-Smart Forestry” Down to the Local Level—Identifying Barriers, Pathways and Indicators for Its Implementation in Practice. *Forests* 13, 98. <https://doi.org/10.3390/f13010098>
- Hallikainen, V., Hyppönen, M., Pernu, L., Puoskari, J., 2010. Family forest owners' opinions about forest management in northern Finland. *Silva Fenn.* 44. <https://doi.org/10.14214/sf.158>
- Hanemann, W.M., 1984. Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses. *American J Agri Economics* 66, 332–341. <https://doi.org/10.2307/1240800>
- Hatcher, J., Straka, T., Greene, J., 2013. The Size of Forest Holding/Parcelization Problem in Forestry: A Literature Review. *Resources* 2, 39–57. <https://doi.org/10.3390/resources2020039>
- Häyriinen, L., Kaseva, J., Pouta, E., 2025. Forest Owners' Intentions to Implement Environmentally Oriented Forest Management Practices: A Case from Eastern Finland. *Small-scale Forestry* 24, 59–88. <https://doi.org/10.1007/s11842-025-09584-8>
- Helseth, E.V., Vedeld, P., Framstad, E., Gómez-Baggethun, E., 2022. Forest ecosystem services in Norway: Trends, condition, and drivers of change (1950–2020). *Ecosystem Services* 58, 101491. <https://doi.org/10.1016/j.ecoser.2022.101491>
- Heltorp, K.M.A., Kangas, A., Hoen, H.F., 2018. Do forest decision-makers in Southeastern Norway adapt forest management to climate change? *Scandinavian Journal of Forest Research* 33, 278–290. <https://doi.org/10.1080/02827581.2017.1362463>
- Heo, C.Y., Kim, B., Park, K., Back, R.M., 2022. A comparison of Best-Worst Scaling and Likert Scale methods on peer-to-peer accommodation attributes. *Journal of Business Research* 148, 368–377. <https://doi.org/10.1016/j.jbusres.2022.04.064>



- Hertog, I.M., Brogaard, S., Krause, T., 2022. Barriers to expanding continuous cover forestry in Sweden for delivering multiple ecosystem services. *Ecosystem Services* 53, 101392. <https://doi.org/10.1016/j.ecoser.2021.101392>
- Hlásny, T., Zimová, S., Merganičová, K., Štěpánek, P., Modlinger, R., Turčáni, M., 2021. Devastating outbreak of bark beetles in the Czech Republic: Drivers, impacts, and management implications. *Forest Ecology and Management* 490, 119075. <https://doi.org/10.1016/j.foreco.2021.119075>
- Hoeben, A.D., Lautrup, M., Willig, J., García-Jácome, S.P., Jankovský, M., Toppinen, A., Vuletić, D., Peltoniemi, M., Stern, T., 2025. Stakeholder views of adaptation measures to improve climate resilience: Case study evidence from European wood value chains. *Forest Policy and Economics* 170, 103379. <https://doi.org/10.1016/j.forpol.2024.103379>
- Högbom, L., Abbas, D., Armolaitis, K., Baders, E., Futter, M., Jansons, A., Jögist, K., Lazdins, A., Lukminė, D., Mustonen, M., Øistad, K., Poska, A., Rautio, P., Svensson, J., Vodde, F., Varnagirytė-Kabašinskienė, I., Weslien, J., Wilhelmsson, L., Zute, D., 2021. Trilemma of Nordic–Baltic Forestry—How to Implement UN Sustainable Development Goals. *Sustainability* 13, 5643. <https://doi.org/10.3390/su13105643>
- Hueth, D.L., Just, R.E., 1991. Applied General Equilibrium Welfare Analysis: Discussion. *American J Agri Economics* 73, 1517–1519. <https://doi.org/10.2307/1242414>
- Hugosson, M., Ingemarson, F., 2004. Objectives and motivations of small-scale forest owners; theoretical modelling and qualitative assessment. *Silva Fenn.* 38. <https://doi.org/10.14214/sf.430>
- IPCC, 2019. Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems (IPCC Special Report). Intergovernmental Panel on Climate Change.
- Jactel, H., Branco, M., Duncker, P., Gardiner, B., Grodzki, W., Langstrom, B., Moreira, F., Netherer, S., Nicoll, B., Orazio, C., Piou, D., Schelhaas, M.-J., Tojic, K., 2012. A Multicriteria Risk Analysis to Evaluate Impacts of Forest Management Alternatives on Forest Health in Europe. *E&S* 17, art52. <https://doi.org/10.5751/ES-04897-170452>
- Juutinen, A., Kurttila, M., Pohjanmies, T., Tolvanen, A., Kuhlmeier, K., Skudnik, M., Triplat, M., Westin, K., Mäkipää, R., 2021. Forest owners' preferences for contract-based management to enhance environmental values versus timber production. *Forest Policy and Economics* 132, 102587. <https://doi.org/10.1016/j.forpol.2021.102587>
- Juutinen, A., Tolvanen, A., Koskela, T., 2020. Forest owners' future intentions for forest management. *Forest Policy and Economics* 118, 102220. <https://doi.org/10.1016/j.forpol.2020.102220>
- Kleinschmit, D., Püzl, H., Secco, L., Sergeant, A., Wallin, I., 2018. Orchestration in political processes: Involvement of experts, citizens, and participatory professionals in forest policy making. *Forest Policy and Economics* 89, 4–15. <https://doi.org/10.1016/j.forpol.2017.12.011>
- Kneeshaw, D.D., Sturtevant, B.R., DeGrandpé, L., Doblas-Miranda, E., James, P.M.A., Tardif, D., Burton, P.J., 2021. The Vision of Managing for Pest-Resistant Landscapes: Realistic or Utopic? *Curr Forestry Rep* 7, 97–113. <https://doi.org/10.1007/s40725-021-00140-z>
- Konczal, A.A., Derks, J., De Koning, J.H.C., Winkel, G., 2023. Integrating nature conservation measures in European forest management – An exploratory study of barriers and drivers in 9 European countries. *Journal of Environmental Management* 325, 116619. <https://doi.org/10.1016/j.jenvman.2022.116619>
- Krumm, F., Schuck, A., Rigling, A., 2020. How to balance forestry and biodiversity conservation? - A view across Europe. <https://doi.org/10.16904/ENVIDAT.196>
- Kumar, P. (Ed.), 2010. The economics of ecosystems and biodiversity: ecological and economic foundations, Online-Ausg. ed. Earthscan, London Washington, D.C.
- Larsen, J.B., Angelstam, P., Bauhus, J., Carvalho, J.P.F., Diaci, J., Dobrowolska, D., Gazda, A., Gustafsson, L., Krumm, F., Knoke, T., Konczal, A., Kuuluvainen, T., Mason, B., Motta, R., Pötzelsberger, E., Rigling, A., Schuck, A., 2022. Closer-to-nature forest management. European Forest Institute, S. I.
- Lawrence, A., 2018. Do interventions to mobilize wood lead to wood mobilization? A critical review of the links between policy aims and private forest owners' behaviour. *Forestry: An International Journal of Forest Research* 91, 401–418. <https://doi.org/10.1093/forestry/cpy017>
- Lawrence, A., Dandy, N., 2014. Private landowners' approaches to planting and managing forests in the UK: What's the evidence? *Land Use Policy* 36, 351–360. <https://doi.org/10.1016/j.landusepol.2013.09.002>
- Lawrence, A., Deuffic, P., Hujala, T., Nichiforel, L., Feliciano, D., Jodlowski, K., Lind, T., Marchal, D., Talkkari, A., Teder, M., Vilkriste, L., Wilhelmsson, E., 2020. Extension, advice and knowledge systems for private forestry: Understanding diversity and change across Europe. *Land Use Policy* 94, 104522. <https://doi.org/10.1016/j.landusepol.2020.104522>

- Liebhold, A.M., Brockerhoff, E.G., Kalisz, S., Nuñez, M.A., Wardle, D.A., Wingfield, M.J., 2017. Biological invasions in forest ecosystems. *Biol Invasions* 19, 3437–3458. <https://doi.org/10.1007/s10530-017-1458-5>
- Lovrić, M., Torralba, M., Orsi, F., Pettenella, D., Mann, C., Geneletti, D., Plieninger, T., Primmer, E., Hernandez-Morcillo, M., Thorsen, B.J., Lundhede, T., Loft, L., Wunder, S., Winkel, G., 2025. Mind the income gap: Income from wood production exceed income from providing diverse ecosystem services from Europe's forests. *Ecosystem Services* 71, 101689. <https://doi.org/10.1016/j.ecoser.2024.101689>
- Maier, C., Winkel, G., 2017. Implementing nature conservation through integrated forest management: A street-level bureaucracy perspective on the German public forest sector. *Forest Policy and Economics* 82, 14–29. <https://doi.org/10.1016/j.forpol.2016.12.015>
- Mason, W.L., Diaci, J., Carvalho, J., Valkonen, S., 2022. Continuous cover forestry in Europe: usage and the knowledge gaps and challenges to wider adoption. *Forestry: An International Journal of Forest Research* 95, 1–12. <https://doi.org/10.1093/forestry/cpab038>
- Mattijssen, T., Buijs, A., Elands, B., 2018. The benefits of self-governance for nature conservation: A study on active citizenship in the Netherlands. *Journal for Nature Conservation* 43, 19–26. <https://doi.org/10.1016/j.jnc.2018.01.006>
- Mayer, A.L., Tikka, P.M., 2006. Biodiversity conservation incentive programs for privately owned forests. *Environmental Science & Policy* 9, 614–625. <https://doi.org/10.1016/j.envsci.2006.07.004>
- Mederski, P.S., Borz, S.A., Đuka, A., Lazdiņš, A., 2021. Challenges in Forestry and Forest Engineering: Case Studies from Four Countries in East Europe. *Croat. j. for. eng. (Online)* 42, 117–134. <https://doi.org/10.5552/crojfe.2021.838>
- Ministry of Climate and Environment, 1957. Outdoor Recreation Act [WWW Document]. Government.no. URL <https://www.regjeringen.no/en/documents/outdoor-recreation-act/id172932/> (accessed 11.14.25).
- Möhring, B., Rüping, U., 2008. A concept for the calculation of financial losses when changing the forest management strategy. *Forest Policy and Economics* 10, 98–107. <https://doi.org/10.1016/j.forpol.2007.06.004>
- Morin, M.B., Kneeshaw, D., Doyon, F., Le Goff, H., Bernier, P., Yelle, V., Blondlot, A., Houle, D., 2015. Climate change and the forest sector: Perception of principal impacts and of potential options for adaptation. *The Forestry Chronicle* 91, 395–406. <https://doi.org/10.5558/tfc2015-069>
- Murphy, J.J., Allen, P.G., Stevens, T.H., Weatherhead, D., 2005. A Meta-analysis of Hypothetical Bias in Stated Preference Valuation. *Environ Resource Econ* 30, 313–325. <https://doi.org/10.1007/s10640-004-3332-z>
- Nagel, T.A., Rodríguez-Recio, M., Aakala, T., Angelstam, P., Avdagić, A., Borowski, Z., Bravo-Oviedo, A., Brazaitis, G., Campagnaro, T., Ciach, M., Curovic, M., Doerfler, I., Fotakis, D., Govedar, Z., Gregor, K., Gültekin, Y.S., Heilmann-Clausen, J., Hoffmann, J., Hofmeister, J., Jansone, D., Jansons, Ā., Kepfer-Rojas, S., Lachat, T., Lapin, K., Löhmus, A., Manton, M., Mikac, S., Mikoláš, M., Mohren, F., Nordén, B., Odor, P., Oettel, J., Paillet, Y., Panayotov, M., Roibu, C.-C., Sitzia, T., Svoboda, M., Tanács, E., Trentanovi, G., Vacchiano, G., Van Der Sluis, T., Zlatanov, T., Burrascano, S., 2025. Can triad forestry reconcile Europe's biodiversity and forestry strategies? A critical evaluation of forest zoning. *Ambio* 54, 632–641. <https://doi.org/10.1007/s13280-024-02116-2>
- Neuner, S., Albrecht, A., Cullmann, D., Engels, F., Griess, V.C., Hahn, W.A., Hanewinkel, M., Härtl, F., Kölling, C., Staupendahl, K., Knoke, T., 2015. Survival of Norway spruce remains higher in mixed stands under a dryer and warmer climate. *Global Change Biology* 21, 935–946. <https://doi.org/10.1111/gcb.12751>
- Nikinmaa, L., De Koning, J.H.C., Derks, J., Grabska-Szwagrzyk, E., Konczal, A.A., Lindner, M., Socha, J., Muys, B., 2024. The priorities in managing forest disturbances to enhance forest resilience: A comparison of a literature analysis and perceptions of forest professionals. *Forest Policy and Economics* 158, 103119. <https://doi.org/10.1016/j.forpol.2023.103119>
- Pastén H., R., Contreras S., M., Thiers E., Ó., 2025. Impacts caused by the traffic of ground-based forest harvesting machinery: State of the art and future guidelines for Chile. *Geoderma Regional* 40, e00939. <https://doi.org/10.1016/j.geodrs.2025.e00939>
- Pinto-Correia, T., 2000. Future development in Portuguese rural areas: how to manage agricultural support for landscape conservation? *Landscape and Urban Planning* 50, 95–106. [https://doi.org/10.1016/S0169-2046\(00\)00082-7](https://doi.org/10.1016/S0169-2046(00)00082-7)
- Podrázský, V., Zahradník, D., Remeš, J., 2014. Potential consequences of tree species and age structure changes of forests in the Czech Republic - Review of forest inventory data. *Wood Research* 483–490.
- Pynnönen, S., Paloniemi, R., Hujala, T., 2018. Recognizing the Interest of Forest Owners to Combine Nature-Oriented and Economic Uses of Forests. *Small-scale Forestry* 17, 443–470. <https://doi.org/10.1007/s11842-018-9397-2>



- Quiroga, S., Suarez, C., Ficko, A., Feliciano, D., Bouriaud, L., Brahic, E., Deuffic, P., Dobsinska, Z., Jarsky, V., Lawrence, A., Nybakk, E., 2019. What influences European private forest owners' affinity for subsidies? *Forest Policy and Economics* 99, 136–144. <https://doi.org/10.1016/j.forpol.2018.08.008>
- Roitsch, D., Abruscato, S., Lovrić, M., Lindner, M., Orazio, C., Winkel, G., 2023. Close-to-nature forestry and intensive forestry – Two response patterns of forestry professionals towards climate change adaptation. *Forest Policy and Economics* 154, 103035. <https://doi.org/10.1016/j.forpol.2023.103035>
- Scherpenhuijzen, N., West, T., Debonne, N., Oostdijk, S., Verburg, P., 2023. A forest management map for Europe. <https://doi.org/10.34894/HQIJN5>
- Scherpenhuijzen, N., West, T.A.P., Debonne, N., Oostdijk, S., Adame, P., Astrup, R., Verburg, P.H., 2025. Mapping forest management regimes in Europe. *Forest Ecology and Management* 594, 122940. <https://doi.org/10.1016/j.foreco.2025.122940>
- Schröter, M., Rusch, G.M., Barton, D.N., Blumentrath, S., Nordén, B., 2014. Ecosystem Services and Opportunity Costs Shift Spatial Priorities for Conserving Forest Biodiversity. *PLoS ONE* 9, e112557. <https://doi.org/10.1371/journal.pone.0112557>
- Sheppard, J.P., Chamberlain, J., Agúndez, D., Bhattacharya, P., Chirwa, P.W., Gontcharov, A., Sagona, W.C.J., Shen, H., Tadesse, W., Mutke, S., 2020. Sustainable Forest Management Beyond the Timber-Oriented Status Quo: Transitioning to Co-production of Timber and Non-wood Forest Products—a Global Perspective. *Curr Forestry Rep* 6, 26–40. <https://doi.org/10.1007/s40725-019-00107-1>
- Sing, L., Metzger, M.J., Paterson, J.S., Ray, D., 2018. A review of the effects of forest management intensity on ecosystem services for northern European temperate forests with a focus on the UK. *Forestry: An International Journal of Forest Research* 91, 151–164. <https://doi.org/10.1093/forestry/cpx042>
- Smalheiser, N.R., 2017. ANOVA, in: *Data Literacy*. Elsevier, pp. 149–155. <https://doi.org/10.1016/B978-0-12-811306-6.00011-7>
- Sotirov, M., Storch, S., Aggestam, F., Giurca, A., Selter, A., Baycheva-Merger, T., Ljusk Ola Eriksson, Sallnäs, O., Renats Trubins, Schüll, E., J. G. Borges, McDermott, C.L., Marjanke Hoogstra-Klein, Hengeveld, G., Pettenella, D., 2015. Forest Policy Integration in Europe: Lessons Learnt, Challenges Ahead, and Strategies to Support Sustainable Forest Management and Multifunctional Forestry in the Future. <https://doi.org/10.13140/RG.2.1.2099.9288>
- Sousa-Silva, R., Ponette, Q., Verheyen, K., Van Herzele, A., Muys, B., 2016. Adaptation of forest management to climate change as perceived by forest owners and managers in Belgium. *For. Ecosyst.* 3, 22. <https://doi.org/10.1186/s40663-016-0082-7>
- Sousa-Silva, R., Verbist, B., Lomba, Á., Valent, P., Suškevičs, M., Picard, O., Hoogstra-Klein, M.A., Cosofret, V.-C., Bouriaud, L., Ponette, Q., Verheyen, K., Muys, B., 2018. Adapting forest management to climate change in Europe: Linking perceptions to adaptive responses. *Forest Policy and Economics* 90, 22–30. <https://doi.org/10.1016/j.forpol.2018.01.004>
- Statbel, 2024. Structure of the Population [WWW Document]. URL <https://statbel.fgov.be/en/themes/population/structure-population> (accessed 11.21.25).
- Statistics Norway (SSB), 2025a. Population and land area in urban settlements [WWW Document]. SSB. URL <https://www.ssb.no/en/befolkning/folketall/statistikk/tettsteders-befolkning-og-areal> (accessed 11.21.25).
- Statistics Norway (SSB), 2025b. The National Forestry Inventory.
- Stritih, A., Lecina-Diaz, J., Mohr, J., Schattenberg, C., Ammer, C., Anselmetto, N., Bauhus, J., Bončina, A., Garbarino, M., Hlásny, T., Lindner, M., Lingua, E., Knific, E., Krüger, K., Marangon, D., Morresi, D., Mulec, K., Nagel, T.A., Potterf, M., Stritih, J., Thom, D., Welling, D., Seidl, R., 2026. Can “Closer-to-Nature” Forest Management Sustain Biodiversity and Ecosystem Services in an Uncertain Future? Lessons from Central Europe. *Curr. For. Rep.* 12, 1. <https://doi.org/10.1007/s40725-025-00264-6>
- Tiebel, M., Mölder, A., Plieninger, T., 2022. Conservation perspectives of small-scale private forest owners in Europe: A systematic review. *Ambio* 51, 836–848. <https://doi.org/10.1007/s13280-021-01615-w>
- Torralba, M., Lovrić, M., Roux, J.-L., Budniok, M.-A., Mulier, A.-S., Winkel, G., Plieninger, T., 2020. Examining the relevance of cultural ecosystem services in forest management in Europe. *E&S* 25, art2. <https://doi.org/10.5751/ES-11587-250302>
- Truffer, O., Lieberherr, E., Van Ruymbeke, K., Chimisso, C., Rowe, T., Vranken, L., Ohmura, T., 2025. Mapping the research of Forest ecosystem Services in Europe: A review. *Forest Policy and Economics* 181, 103663. <https://doi.org/10.1016/j.forpol.2025.103663>
- Vacek, Z., Vacek, S., Slanař, J., Bílek, L., Bulušek, D., Štefančík, I., Králíček, I., Vančura, K., 2019. Adaption of Norway spruce and European beech forests under climate change: from resistance to close-to-nature silviculture. *Central European Forestry Journal* 65, 129–144. <https://doi.org/10.2478/forj-2019-0013>

- Van Ruymbek, K., Moens de Hase, D., Vranken, L., 2025. Report on the demand side: Citizens' preferences/demand for forest ES and biodiversity and consumers preferences/demand for long-lived wood products (Deliverable No. D3.3).
- Van Zanten, B.T., Verburg, P.H., Espinosa, M., Gomez-y-Paloma, S., Galimberti, G., Kantelhardt, J., Kapfer, M., Lefebvre, M., Manrique, R., Piore, A., Raggi, M., Schaller, L., Targetti, S., Zasada, I., Viaggi, D., 2014. European agricultural landscapes, common agricultural policy and ecosystem services: a review. *Agron. Sustain. Dev.* 34, 309–325. <https://doi.org/10.1007/s13593-013-0183-4>
- Varela, E., Jacobsen, J.B., Mavsar, R., 2017. Social demand for multiple benefits provided by Aleppo pine forest management in Catalonia, Spain. *Reg Environ Change* 17, 539–550. <https://doi.org/10.1007/s10113-016-1038-8>
- Vauhkonen, J., Packalen, T., 2019. Shifting from even-aged management to less intensive forestry in varying proportions of forest land in Finland: impacts on carbon storage, harvest removals, and harvesting costs. *Eur J Forest Res* 138, 219–238. <https://doi.org/10.1007/s10342-019-01163-9>
- Wang, C., Ren, Z., Chang, X., Wang, G., Hong, X., Dong, Y., Guo, Y., Zhang, P., Ma, Z., Wang, W., 2023. Understanding the cooling capacity and its potential drivers in urban forests at the single tree and cluster scales. *Sustainable Cities and Society* 93, 104531. <https://doi.org/10.1016/j.scs.2023.104531>
- Weger, J., Vávrová, K., Knápek, J., Králík, T., Outrata, D., Janota, L., Rybářová, D., 2025. Complex aspects of development of bioenergy with regard to the impacts of climate change in conditions of the Czech Republic. *Energy Reports* 14, 3860–3877. <https://doi.org/10.1016/j.egyr.2025.10.010>
- Weidlich, E.W.A., Flórido, F.G., Sorri, T.B., Brancalion, P.H.S., 2020. Controlling invasive plant species in ecological restoration: A global review. *Journal of Applied Ecology* 57, 1806–1817. <https://doi.org/10.1111/1365-2664.13656>
- Westin, K., Bolte, A., Haeler, E., Haltia, E., Jandl, R., Juutinen, A., Kuhlme, K., Lidestav, G., Mäkipää, R., Rosenkranz, L., Triplat, M., Skudnik, M., Vilhar, U., Schueler, S., 2023. Forest values and application of different management activities among small-scale forest owners in five EU countries. *Forest Policy and Economics* 146, 102881. <https://doi.org/10.1016/j.forpol.2022.102881>
- Wilkes-Allemann, J., Deuffic, P., Jandl, R., Westin, K., Lieberherr, E., Foldal, C., Lidestav, G., Weiss, G., Zabel, A., Živojinović, I., Pecurul-Botines, M., Koller, N., Haltia, E., Sarvašová, Z., Sarvaš, M., Curman, M., Riedl, M., Jarský, V., 2021. Communication campaigns to engage (non-traditional) forest owners: A European perspective. *Forest Policy and Economics* 133, 102621. <https://doi.org/10.1016/j.forpol.2021.102621>
- Willig, J., Häublein, S., Sorge, S., Brudermann, A., Cantarello, E., Espelta, J.M., Häyri, L., Hlasny, T., Horstmann, N., Krajter Ostoić, S., Lautrup, M., Ostrogović Sever, M.Z., Peltoniemi, M., Picos, J., Poskakukhina, Y., Reineking, B., Short, I., Spazzi, J., Vaney, M., Vuletić, D., Bauhus, J., 2025. Information access, governance support and operational flexibility are needed to drive adaptation of European forests to global change. *Forest Policy and Economics* 181, 103654. <https://doi.org/10.1016/j.forpol.2025.103654>
- Wilson, M.C., Chen, X.-Y., Corlett, R.T., Didham, R.K., Ding, P., Holt, R.D., Holyoak, M., Hu, G., Hughes, A.C., Jiang, L., Laurance, W.F., Liu, J., Pimm, S.L., Robinson, S.K., Russo, S.E., Si, X., Wilcove, D.S., Wu, J., Yu, M., 2016. Habitat fragmentation and biodiversity conservation: key findings and future challenges. *Landscape Ecol* 31, 219–227. <https://doi.org/10.1007/s10980-015-0312-3>
- Winkel, G., Lovrić, M., Muys, B., Katila, P., Lundhede, T., Pecurul, M., Pettenella, D., Pipart, N., Plieninger, T., Prokofieva, I., Parra, C., Pölzl, H., Roitsch, D., Roux, J.-L., Thorsen, B.J., Tyrväinen, L., Torralba, M., Vacik, H., Weiss, G., Wunder, S., 2022. Governing Europe's forests for multiple ecosystem services: Opportunities, challenges, and policy options. *Forest Policy and Economics* 145, 102849. <https://doi.org/10.1016/j.forpol.2022.102849>
- Wunder, S., 2005. Payments for environmental services: Some nuts and bolts.
- Wunder, S., Brouwer, R., Engel, S., Ezzine-de-Blas, D., Muradian, R., Pascual, U., Pinto, R., 2018. From principles to practice in paying for nature's services. *Nat Sustain* 1, 145–150. <https://doi.org/10.1038/s41893-018-0036-x>
- Yousefpour, R., Hanewinkel, M., 2015. Forestry professionals' perceptions of climate change, impacts and adaptation strategies for forests in south-west Germany. *Climatic Change* 130, 273–286. <https://doi.org/10.1007/s10584-015-1330-5>
- Zafra-Calvo, N., Ortega, U., Sertutxa, U., Moreaux, C., 2024. Identifying key actors, barriers and opportunities to lead a transition towards sustainable forest management: an application to the Basque Country, Spain. *Trees, Forests and People* 18, 100727. <https://doi.org/10.1016/j.tfp.2024.100727>

Zhu, Z., Xu, Z., Shen, Y., Huang, C., 2020. How forestland size affects household profits from timber harvests: A case-study in China's Southern collective forest area. *Land Use Policy* 97, 103380. <https://doi.org/10.1016/j.landusepol.2018.04.055>



Appendix

Appendix A: Theoretical Framework PES

Following Van Zanten et al. (2014), we adopt The Economics of Ecosystems and Biodiversity (TEEB) rationale for linking ecosystems and human well-being. Specifically, Van Zanten et al. (2014) conceptualizes ESs in a manner analogous to supply and demand within a socio-ecological system perspective, in which the ecological dimension supplies ESs and the socio-economic dimension demands them. This framework highlights that the supply of ES depends not only on the biotic and abiotic conditions of the ecosystem, but also on land management decisions (Van Zanten et al., 2014; Winkel et al., 2022).

In the forestry sector, forest management intensity is associated with different levels of FES provision. To account for synergies and trade-offs across management strategies, we define FES supply scenarios based on evidence from Bařkent and Kařpar (2022), Sing et al. (2018) and Wang et al. (2023). These FES provisioning levels are presented in Table 4. Changes in management intensity can therefore alter ES supply in ways that may better align with societal preferences (Ciesielski and Stereńczak, 2018; Varela et al., 2017). However, such transitions often impose opportunity costs on forest managers (Schröter et al., 2014). Therefore, bridging the gap between societal demand for ESs and the costs borne by forest managers requires mechanisms that incentivise management changes. PES offer one such mechanism by channelling monetary flows from ES beneficiaries to ES providers (Górriz-Mifsud et al., 2016).

The rationale behind PES mechanisms lies in the Kaldor-Hicks compensation principle which defines a Pareto improvement as a situation where the maximum amount the winners would be willing to pay is greater than the minimum amount the losers would require as compensation (Hueth and Just, 1991). This principle implies that ES beneficiaries would be willing to give up part of the ES value in order to compensate forest owners and managers for the costs of adopting forest management practices that enhance ES (Górriz-Mifsud et al., 2016). The feasibility of a PES scheme is then defined, on the supply side, by the opportunity cost of changing management strategies, and on the demand side by the willingness of beneficiaries to pay for ES improvement (Compensating Surplus), as shown in Figure 3.

Appendix B: Tables

Table 10: Semi-structured interview questionnaire format.

Block	Topic	Questions
1	General questions about you and your occupation in function of (the) forests	1.1 Which of the following best describes your primary role within the forestry sector?
		1.2 Is this your primary occupation?
		1.3 Are you involved in the management of any forests or forest plots in your area?
		1.4 How many forests or forest plots do you own/manage?
2	General questions to contextualise (the) forest(s) you are involved with,	2.1 Where is this forest (plot) located?
		2.2 Approximately how large is this forest plot (in ha)?
		2.3 Which ownership structure best describes this forest (plot)?
		2.4 How many years have you owned/managed this forest (plot)?



	particularly related to their current and historical management	2.5 Is anyone else involved in the management activities of this forest (plot)?
		2.6 How did you become involved in the management/ownership of this forest?
		2.7 What did the previous ownership/management structure look like?
		2.8 What are the main sources of information you use when making management decisions for this forest (plot)? Select all that apply.
		2.9 What type of activities currently take place in this forest?
		2.10 What type of management approach currently best describes this forest (plot)?
		2.11 What, if anything, would you like to change regarding the management/function of this forest (plot)?
3	Barriers to transitions towards alternative forest management strategies	3.1 Classify the following list of barriers into four (strong, medium, weak, not a barrier) categories based on how strongly they (may) act as a barrier in shifting to a less intensive forest management approach. We have identified five categories of barriers: Economic (E1-E4), Regulatory and legislative (R1-R4), Knowledge and capacity (K1-K2), Social (S1-S5), and Environmental (N1). If there is a significant barrier missing, you can add it to the list.
		3.1 Classify the same list of barriers into four (strong, medium, weak, not a barrier) categories based on how strongly they (may) act as a barrier in shifting to a more intensive forest management approach. If there is a significant barrier missing, you can add it to the list.
4	Basic costs and revenues structure	4.1 Please estimate the total costs associated with your current forest management approach, indicating the order of magnitude (e.g., €1000-10000, €10000-€50000,...)
		4.2 What percentage of the costs for your current management fall within each of the following cost categories. If no costs fall within a particular category, indicate 0 on the slider.
		4.3 If you were to shift you management strategy to a less intensive management strategy, what would happen to your overall costs?
		4.4 If you were to shift you management strategy to a less intensive management strategy, how do you anticipate this cost structure would change?
		4.5 If you were to shift you management strategy to a more intensive management strategy, what would happen to your overall costs?
		4.6 If you were to shift you management strategy to a more intensive management strategy,, how do you anticipate this cost structure would change?
		4.7 Please estimate the total annual revenue generated from your current forest management approach, indicating the order of magnitude (e.g., €1000-10000, €10000-€50000)
		4.8 What percentage of your revenue derived from your current management approach falls within each of the following categories. If a revenue category is not relevant, indicate 0.
		4.9 If you were to shift you management strategy to a less intensive management strategy, what would happen to your overall revenue?
		4.10 If you were to shift you management strategy to a less intensive management strategy, how do you anticipate this revenue structure would change?
		4.11 If you were to shift you management strategy to a more intensive management strategy, what would happen to your overall revenue
		4.12 If you were to shift you management strategy to a more intensive management strategy, how do you anticipate this revenue structure would change?
5	A short set of questions on your	5.1 Are you currently, or have you previously been, involved in a payment for ecosystem services schemes or forest-related subsidy scheme?

	experience with payment schemes (e.g., PES and subsidies)	5.2 If yes, which scheme(s) have you participated in? Please specify the name(s) of the schemes and the duration of participation
		5.3 If no, what are the main reasons you have not participated in any payment for ecosystem services or subsidy schemes?
		5.4 How challenging do you find the following aspects of payment for ecosystem services or subsidy schemes?
		5.5 Have these challenges influenced your willingness to participate (or continue participating) in payment for ecosystem services or subsidy schemes
		5.6 What improvements would you suggest to make payment for ecosystem services or subsidy schemes more accessible and effective for forest managers/owners?

Table 11: Overview of forest management activities by interviewee and resulting management strategy classification

Activities / Code	BW1	BW2	BW3	C1	BF3	BF5	BF2	BF6	BF4	BF1	F1	F2	N1	N2	P1	P2	S2	S1	S3
Selective cutting	1	1	1	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1	0
Group selection or group cutting	0	1	1	1	1	1	1	1	1	1	0	0	1	0	0	1	0	1	0
Clearcutting for timber production	1	1	1	1	0	0	1	1	0	1	0	1	1	1	0	1	1	0	0
Clearcutting for biomass production	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coppicing	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	1	0
Thinning (pre-commercial or commercial)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
Natural regeneration (e.g. seed-tree; shelterwood; gap regeneration)	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Assisted natural regeneration (e.g. site preparation; weed and competing vegetation control; fencing/protection; thinning overstorey)	0	1	1	1	1	0	1	1	1	0	1	1	1	1	0	1	1	0	0
Artificial regeneration (e.g. direct planting; direct seeding; base-root seedlings; species selection)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0
Deadwood retention	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	0
Chemical pest control	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Invasive species control	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0
Controlled burning or fire prevention	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1
Biodiversity conservation or habitat restoration	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0
Recreation or tourism development	1	1	1	1	1	0	0	1	1	1	0	1	1	0	1	1	1	1	0

Non-timber forest product collection (e.g. mushroom; berries; honey)	1	1	1	0	0	0	0	0	1	0	0	1	0	1	0	0	1	1	0
Monitoring, inventory or research activities	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0
No active management	1	1	1	1	1	1	0	1	1	1	0	1	0	0	1	1	0	1	0
Hunting	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Grazing	0	0	0	0	0		0	1	0	0	0	0	0	0	0	0	0	0	0
Management Strategy (best fit)	MF ¹	MF	MF	MF	MF	MF	TP ²	MF	MF	MF	MF	TP	TP	TP	CTN ³	MF	MF	MF	CTN

Note: For each activity, a binary coding was applied to indicate whether the activity is implemented in the forest(s) owned or managed by the interviewee. A value of 1 indicates that the activity takes place, while a value of 0 indicates that it does not. The coding reflects the presence or absence of activities at the forest or management-unit level, based on interview responses. This binary classification was subsequently used to characterise and assign each case to the forest management strategy that best fits the observed combination of practices.

1 – Multifunctional Forestry; 2 – Timber Production Forestry; 3 – Close-to-Nature

Table 12. Population (pop) count and forested area (ha) used to calculate CS per management regime per study region

Management strategy	Belgium (Flanders)		Czech Republic		Norway		Spain	
	Pop (0-50km)	Forested area (ha)	Pop (0-50km)	Forested area (ha)	Pop (0-50km)	Forested area (ha)	Pop (0-50km)	Forested area (ha)
Unmanaged	0	0	7838318	3900	3945689	60400	0	0
Close-to-nature	6735861	26300	10526962	338700	4934285	3001300	42144852	3264300
Multifunctional	6735861	108200	10526962	2233600	4934366	4375500	43639375	7231200
Intensive for timber	6534110	14100	10526962	406800	4935017	3386300	43512920	2740200
Intensive for bioenergy	2897878	1600	10455993	53900	4864786	488400	32464544	1414200

Table 13: Classification of additional barriers to transition towards less and more intensive management strategies

Category	Barriers	Additional barriers to transition towards less intensive	Additional barriers to transition towards more intensive
Economic	E1 Pressure to meet timber demand		
	E2 Lack of financial incentives for conservation	- Revenue uncertainty for forest owners (BF3) STRONG	
	E3 High ongoing operational costs		
	E4 High transition/implementation costs		
	Volatile timber prices		- Low timber prices and volatile timber markets (N2) STRONG
Regulatory and legislative	R1 Weak legislative support for alternatives	- Too much bureaucracy and paperwork to make changes (BF6) STRONG	- Strong legislation not to move towards more intensive/plantation (N1) STRONG
	R2 Conflicting or incoherent policies	- Increasing pressure from the community/ regulatory (e.g., distance from the river) towards a more natural approach to forestry, forces zoning of management through the forest (N1) STRONG - Monetary support in forestry focuses on fire prevention and not management (S3) STRONG	
	R3 Uncertainty about future political/institutional conditions		
	R4 Fragmented forest ownership		



	Regulatory frameworks in protected areas		- The forests are located in Natura 2000 areas. (BF4) STRONG - Location in natural park dictates low intensity management and focus on biodiversity conservation (S1) STRONG
Knowledge and capacity	K1 Limited access to specialized machinery and/or labour		
	K2 Insufficient technical knowledge	- Insufficient theoretical knowledge of the forest owners (BF6) MEDIUM - Lack of practical knowledge regarding management (N2) STRONG	
Social Barriers	S1 Weak demand for non-productive services		
	S2 Public opposition to visible management		- Not the historical way to manage, from a political and social perspective (N1) STRONG
	S3 (Your own) established preferences and practices		
	S4 Strong social norms and pressure to conform		
	S5 Low trust and weak collaboration among peers		
	Lack of trusts between foresters and institutions	- Mistrust between institutions and forest owners (BW2) MEDIUM	
	Human-related risks	- Over frequentation (human related risks) (BW2) MEDIUM	
Environmental	N1 Ecological suitability and constraints of the site	- Overpopulation of ungulates (BW2) STRONG	



Climate Change	Climate Change: hazards and uncertainty	- Natural hazard risk (or idea that this may be higher) - specifically forest fires (BF2) MEDIUM - Climate Change uncertainty (water availability for example) (F1) STRONG - Climate Change Uncertainty (P1) STRONG - Uncertainty about future climatic conditions and implications for management (strategy) (N2) MEDIUM - Climate Change (S3) STRONG - Forest fire management (higher risk due to drought). There are no incentives to tackle this issue (BF4) MEDIUM	- Experiences from past catastrophic events (bark beetle outbreak) (C1) STRONG - Climate Change Uncertainty (pests, microclimate, soil quality, water uncertainty, wind changes) (BF3) STRONG - Climate change (BF2) STRONG - Forest fire management (higher risk due to drought). There are no incentives to tackle this issue (BF4) STRONG - Climate Change Uncertainty, biodiversity collapse consequences on forest resilience and productivity (F1) STRONG - Climate Change (N2) MEDIUM
	Lack of knowledge regarding climate change adaptation measures	- Climate Change Uncertainty (selection of tree species or assisted introduction for example) (C1) MEDIUM - Scientific input about species choice for artificial regeneration in the context of climate change. (BF4) STRONG	



Table 14: Compensating Surplus (EUR/ha/year) calculated for a shift between forest management strategies

FLANDERS

From\to	1	2	3	4	5
No active management (1)	-	0	0	0	0
Close-to-nature (2)	-19623	-	-11090	-19601	-78042
Multifunctional (3)	-2074	2696	-	-2069	-16274
Intensive timber (4)	-39	35466	15399	-	-105741
Intensive biomass (5)	413122	551886	473460	413274	-

CZECH REPUBLIC

From\to	1	2	3	4	5
No active management (1)	-	92998	70942	-747	-76170
Close-to-nature (2)	-1438	-	-341	-1450	-2616
Multifunctional (3)	-166	52	-	-168	-345
Intensive timber (4)	10	1207	923	-	-971
Intensive biomass (5)	7352	16328	14199	7280	-

NORWAY

From\to	1	2	3	4	5
No active management (1)	-	798	1246	1233	-153
Close-to-nature (2)	-20	-	11	11	-24
Multifunctional (3)	-22	-8	-	0	-31
Intensive timber (4)	-28	-28	0	-	-31
Intensive biomass (5)	23	23	213	211	-

SPAIN

From\to	1	2	3	4	5
No active management (1)	-	0	0	0	0
Close-to-nature (2)	-341	-	-87	-312	-788
Multifunctional (3)	-119	41	-	-105	-327
Intensive timber (4)	-36	384	276	-	-585
Intensive biomass (5)	794	794	1246	846	-

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