ForestPaths

Co-designing holistic forest-based policy pathways for climate change mitigation

D1.2 Key factors influencing forest practitioners' decisions

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Key takeaway messages

- Previous research on factors influencing forest practitioners' decisions mainly presents views from private forest owners in Northern and Central Europe. This research gap limits the certainty that factors found in the literature are relevant across different geographic and sociodemographic contexts.

- Few research studies attempt to conceptualize interrelationships between the factors influencing forest practitioners' decision-making; instead, most studies are explorative in nature. A logical next step for researchers is to identify interrelationships among key factors influencing forest practitioners' and develop a predictive behavioural model to operationalize these relationships.

- Based on a qualitative interview study, eight subcategories of factors are found to influence the forest management decisions of European forest practitioners. These factors can be grouped as *agent-based factors* (i.e., values, resources, and organizational structures), *structural factors* (i.e., governance, markets, and social norms) and *ecological factors* (i.e., biophysical, disturbance regimes).

- Interviews with European forest practitioners show it is possible to assess the directionality that influential factors have upon different forest management decision (e.g., enabling factors versus hindering factors). However, interviews alone are insufficient for ascertaining the relative strength that factors have towards influencing the forest practitioner's decisions.

- Through the interviews, it was possible to operationalize factors that influence management decisions as behavioural factors in a predictive model guided by the theory of reasoned action.

Summary

This report seeks to improve the understanding about factors and processes influencing forest practitioners' management decisions by presenting the findings of (i) a literature review on factors influencing forest practitioners' decisions and (ii) a qualitative interview study.

The literature review applied a thematic grouping of key factors influencing forest management decisions. The primary outcome of the review are descriptions of the three *internal factors* (i.e., factors related to the characteristics of the forest practitioners) and seven *external factors* (i.e., factors related to the socioecological context in which the forest practitioner operates). In addition, two knowledge gaps emerged from the literature review. Firstly, studies are limited in scope in that they typically only represent private forest owners from Northern and Central Europe. Secondly, few studies conceptualize the interrelationships between the factors that influence forest management decisions.

The interview study targeted 19 forest practitioners from 6 European countries (i.e., Finland, Italy, Latvia, the Netherlands, Portugal, and Romania). The study answered the following research questions:

1. What objectives do European forest practitioners have?
2. What forest management practices do European forest practitioners implement?
3. Which factors influence these objectives and management decisions?

Qualitative Content Analysis (QCA) was used to analyse the data. The analysis resulted in a coding framework listing the different (i) forest management objectives, (ii) forest management activities, and (iii) factors influencing forest decisions discussed across the interview cases. Several forest practitioner objectives were identified from the data. These could be typified as five different categories (i.e., *regulatory objectives*, *provisioning objectives*, *cultural objectives*, *biodiversity objectives*, *climate objectives*). Twenty-nine forest management activities were identified from the data. These were subsumed into seven subcategories (i.e., *regeneration*, *harvest*, *conservation*, *stand management*, *land-use change*, population *control, agroforestry*). Twenty-one factors influencing forest decisions were identified from the data. These were subsumed into eight subcategories and grouped as *agent-based factors* (organizational structure, values, resources), *structural factors* (societal norms, governance, markets), and *ecological factors* (disturbances, biophysical). Crosstabulation between the influencing factors and management objectives and activities shows that all eight subcategories influenced a wide variety of forest management decisions. No single factor was uniquely influential to any one specific management activity or objective.

Lastly, descriptive summaries of each interview were drafted to deepen the understanding between influential factors and forest management decisions and determine if factors were enabling or hindering forest management objectives and activities. However, the summaries could not ascertain the strength that factors had towards influencing the forest management decision. Therefore, in the proposed next steps, the research will operationalize the influential factors as behavioural factors in a predictive behavioural model guided by the theory of reasoned action. The model will be tested using data from a survey study targeting forest practitioners across 13 European countries.

List of abbreviations

NTFP	Non-timber forest product
QCA	Qualitative content analysis

1 Introduction

Forest management is becoming increasingly complex due to the widening portfolio of ecosystem goods and services, rising uncertainties concerning climate change, and growing societal demand for a rational and transparent decision processes (Malovrh et al., 2022; Quiroga et al., 2019; de Bruin et al., 2015). It is well understood that a forest practitioner's[1] forest management decisions directly impact timber supplies and other forest-based ecosystem services demanded by European society (Malovrh et al., 2022; Eggers et al., 2014). Sustainable forest management requires careful consideration to achieve socially acceptable and ecologically sound outcomes (Juutinen et al., 2020; Joshi and Arano, 2019). The factors that influence forest management decisions are various, (Marey-Pérez and Rodríguez-Vicente, 2011). Forest practitioners do not make their management decisions in isolation, but within a set of policy and socioeconomic factors (Sotirov et al., 2019). Several policy instruments have been developed to influence forest practitioners towards sustainable forest management. For example, there are policies for encouraging the adoption of climate smart forestry schemes (Husa and Kosenius, 2021; Harry et al., 2016), optimal timber and ecosystem services production (Kolo et al., 2020), and biodiversity conservation practices (Thomas et al., 2022; Husa and Kosenius, 2021). Yet the success of such policy instruments hinges on an accurate understanding of the factors that influence a forest practitioner's decision-making process.

One objective of *ForestPaths* WP1 is to improve understanding about the factors and processes influencing forest practitioners' management decisions. This report addresses this objective by i) presenting the findings of literature review on factors influencing forest practitioners' decisions, and ii) presenting the findings of an interview study with 19 forest practitioners from 6 European countries. The aim of the interview study was to answer the following research questions:

1. What objectives do European forest practitioners have?
2. What forest management practices do European forest practitioners implement?
3. Which factors influence these objectives and management decisions?

2 Literature review

2.1 Data collection

This section reviews what the literature says are the key **factors that shape decision-making behaviour of forest practitioners across Europe.** In addition, it highlights the **knowledge gaps and research needs** with respect to factors influencing forest management decisions in Europe.

A thematic grouping of key factors influencing forest management decisions was undertaken by following de Bruin et al.'s (2015) conceptual framework (see: Figure 1). De Bruin et al. reviewed factors influencing forest practitioners' decision-making to investigate perceptions of Dutch forest managers. These authors consider that **internal and external factors** influence forest practitioners' decisions. **Internal factors** relate to the characteristics of the forest practitioner

[1]In this study, a forest practitioner is defined as (i) a private forest owner, (ii) a person that manage a forest on behalf a public or private owner, (iii) the employee of an organization that manages a forest on behalf of a public of private owner.

(e.g., age, socioeconomic status, gender, type of ownership, and cognitive abilities of the forest practitioner). **External factors** relate to the socioecological context in which the forest practitioner operates.

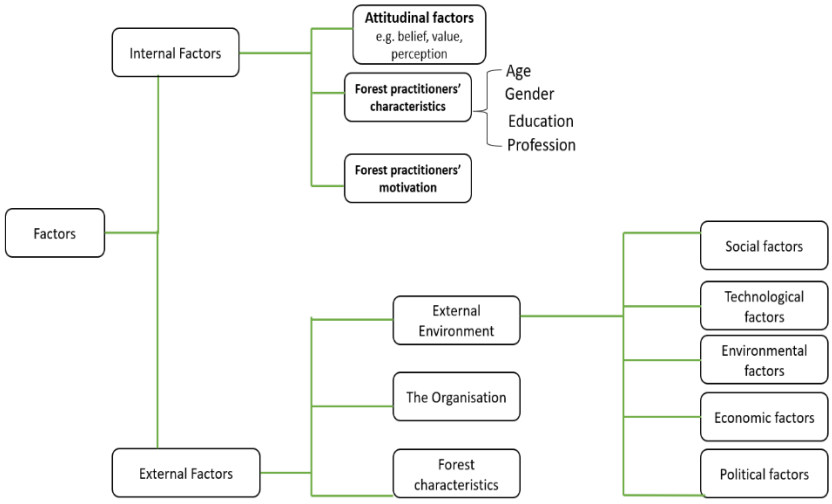

Figure 1. Factors influencing forest management decisions, adapted from de Bruin et al. (2015).

The search on literature to cover each individual factor was conducted using the following databases: AGRIS, ISI Web of Science, Scopus, Emerald, Google Scholar, Open Access Theses and Dissertations, and Directory of Open Access Journals. The selection of articles was limited to literature published between **2000 and 2024**. Additionally, an extensive search for published reports, policy briefs, and working papers was conducted by exploring databases and organization websites as for example the Food and Agriculture Organisation of the UN or the International Fund for Agricultural Development.

To find the articles selected, the following search terms were used (Forest* OR Trees*) AND (Management* OR Decisions*) AND (Specific Factor*) AND (Practitioners* OR Owners*) AND (Europe). Relevant empirical research studies were identified, categorized, and their main findings extracted. The main criteria to select scientific papers were: 1) the geographic area of focus (i.e., Europe); and 2) the element being investigated in the articles (i.e., Key factors influencing forest management decisions, and the processes through which the factors influence forest management decisions).

2.2 Results

2.2.1 Internal factors

2.2.1.1 Practitioner's characteristics

Forest practitioners' characteristics such as **gender, age, education level, and profession** have been observed to have diverse influence on their forest management decisions (Duesberg et al., 2014; Duesberg et al., 2013). The effect of **age** on forest practitioner decision varies according to

the forest management practice. In Finland, Juutinen et al. (2020) observed that older forest practitioners tended to allocate a smaller proportion of their forest area to uneven-aged forestry compared to younger practitioners. Also in Finland, Husa and Kosenius et al. (2021) reported that older practitioners are less willing to extend the rotation period of their forest stand. In Sweden, Eggers et al. (2014) reported that older forest owners were less likely to harvest or actively manage their forests than younger owners. In Beach et al. (2005) review, which included studies in Finland and Norway, age appears to be negatively related to investment in silvicultural activities, with 67% of the studies that included age finding significant effects.

Gender influence on forest practitioners' management decisions have also been reported. Husa and Kosenius (2021), and Juutinen et al. (2020) reported that **female owners** in Finland are more nature-oriented in their forest management than males, and they prefer continuous-cover forestry (CCC) and leaving set-aside areas more often than males. Also in Finland, female forest practitioners were observed to have less harvesting frequency and/or probability of harvesting than male forest practitioners (Kuuluvainen et al., 2014; Ripatti 1999). In Lithuania and Latvia income generation is more important to male owners than to female owners, while wildlife habitat protection is more important to female owners than to the male owners (Follo et al., 2017). Overall, gender plays a substantial role in shaping the motivation for forest ownership among practitioners. Specifically, female forest owners prioritize contributing to the natural landscape and nature conservation, while their male counterparts place greater emphasis on leisure activities (Follo et al., 2016). Pröbstl-Haider et al. (2020) highlight that female owners in Austria express a significantly higher importance in minimizing interventions in the natural development of the forest. In Norway, the involvement of women in active management and self-employment within forestry operations is lower than men (Follo, 2001). Similarly, Eggers et al. (2014) reported that, in Sweden, forests owned by men are managed more actively than those owned by women, with more frequent harvesting, cleaning, and supplementary planting. However, the owner's gender has been found to have no effect on planting and mechanized scarification (Eggers et al., 2014). These findings are corroborated by Lidestav and Lejon (2012), who reported that harvesting and silvicultural activities in Sweden are less common on properties owned by women.

Forest practitioner **educational level** have been observed to have varying effect on their management decisions. Husa and Kosenius et al. (2021) reported that in Finland forest practitioners with higher education level are more likely to be willing to adopt various forest management practices that promote carbon sequestration, climate change adaptation, or biodiversity smart practices e.g., extended rotation. Similarly, Juutinen et al. (2020) reported that in Finland, an increase in forest practitioners' education level is associated with their willingness to convert monocultures into mixed broadleaved stands and adopt deadwood retention. Forest practitioners with higher education level were also reported to be less willing to adopt shortened rotation, reflecting the possibility that highly educated forest owners tend to value forest amenities higher and consider short rotation too intensive (Juutinen et al., 2020). Janova et al (2022) inferred that educational and financial resources are two crucial factors for encouraging private landowners in Czech Republic to implement conservation practices. Beach et al. (2005) found out that owners' education was significant and positive in the likelihood of conducting silvicultural treatments in 75% of the studies reviewed, which included Finland and Norway.

2.2.1.2 Attitudes

Attitudinal factors are for example, the **values and beliefs** of forest practitioners. Environmental values tend to guide management practices towards nature conservation, whereas an economic-oriented values tends to steer management towards increased production. Given the diverse use of forests, it is not unusual for forest owners to hold multiple values simultaneously (Westin et al., 2023). In Sweden, Blennow and Persson (2009) observed a significant and positive association between forest owners who had adapted their forest management to climate change and their strength of belief in climate change. More specifically, Blennow (2012) found out that, 98% of forest owners who had taken measures to adapt to climate change perceived increased risk due to climate change for one or more of the ten listed risk factors in the study, and perceptions of much higher risk due to climate change usually associated to the risk of damage by wind, drought, fungi. Also in Sweden, Vulturius et al. (2018) observed that personal level of trust in climate science, belief in the salience of climate change and risk assessment are the only statistically significant factors explaining the forest practitioner's intention to adapt to climate change. Similarly, Thomas et al. (2022) observed that, in France, forest practitioners' subjective perception of climate change impacts greatly influences their adaptation decisions. Brunette et al. (2020), showed that being French and being risk-averse have a significant and negative impact on the number of adaptation strategies selected by forest managers. In Ireland, Duesberg et al. (2013) concluded that most farmers decide on afforestation based on intrinsic, expressive, and social values about farming rather than on profit maximisation. In Denmark, Vedel et al. (2015) observed that forest practitioners with positive perceptions on Natura 2000 policies were more willing to allow old trees to decay naturally, set aside forest areas, accept a fixed percentage of broadleaves, and increase access for the public. In Germany, Joa and Schraml (2020) found that forest practitioners' perceived benefits (e.g., enhanced biodiversity) of deadwood retention increased the probability of forest owners' leaving deadwood in the forest. On the other hand, negative perceptions related to an increasing amount of deadwood in forests, such as concerns of decaying timber, and risk of pest invasions, are common among forest practitioners' who are less willing to adopt this practice. In Finland, Husa and Kosenius (2021) found that a positive attitude towards deadwood retention practices, leaving set-aside areas, selective cuttings, natural regeneration, broadleaved mixtures, and retention trees is positively correlated with biodiversity and climate smart forest management strategies. Other reported attitudinal factors influencing forest practitioners' management decisions include positive feelings towards nature. Nature-related experiences, such as enjoying nature and relaxing (Coll et al., 2018; Follo et al., 2017; Eggers et al., 2014). Westin et al. (2023), examined the value orientations (economic, environmental, and social values) and management behaviour of private small-scale forest owners in five European Union countries, namely Austria, Finland, Germany, Slovenia, and Sweden, via survey. They found that respondents in all countries who considered all values to be very important were the most active in all management activities compared to those who considered all values to be somewhat important. More specifically, in Austria and Germany, most respondents considered all values to be very important, aligned with the long tradition of sustainable, multifunctional forestry in these countries. In Finland, they found a high proportion of respondents valuing all three categories high, aligned with the current discourses that forest production and nature could be maintained in parallel. In Sweden, respondents were equally divided in their view that all values are very important, all values tend to be important, and social and environmental values are paramount, aligned with forest policy, which emphasises that high and valuable timber production and environmental sustainability are equally important. In Slovenia the proportions of forest owners in all forest value groups (environmental, social, and

economic) were evenly distributed, which is consistent with the national forest strategy, which promotes the protection, silviculture, utilization, and use of forests based on the principles of close-to-nature forest management, and introduces the economic, ecological, and social forest functions as the main tool of multipurpose forest management.

The influence of forest practitioner's **motives and objectives** on management decisions have been widely studied. The motives and objectives of forest practitioners have been used to develop typologies of forest owners across Europe. Countries for where forest owners' typologies were developed include **Sweden** (Ingemarson et al., 2006), **Denmark (**Boon et al., 2004), **Finland** (Matilainen and Lahdesmaki, 2023), **Austria** (Hogl et al. 2005; Mostegl et al., 2019), and **Lithuania** (Stanislovaitis et al., 2015). Most of the typologies are based on stated objectives or preferences rather than observed behaviours. However, there is an implicit assumption that the stated objectives affect the actual forest management behaviour (Ní Dhubháin et al., 2007). Although several typologies of forest practitioners have been developed across Europe, the most common groups are: Economic oriented forest owners, tradition-oriented forest owners, environmentalist, non-active forest owners, and multi-objective forest owners (Feliciano et al., 2023). More information about forest owner typologies is available in the *ForestPath* report Deliverable 1.1 (Feliciano et al., 2024).

2.2.1.3 Previous behaviors

Previous forest management experience of a forest practitioner can be a predictor of their future forest management decisions. Juutinen et al (2020) observed that forest practitioners that have applied natural regeneration are more likely to apply uneven-aged management in the future. They also observed that forest practitioners who have previously applied clearcutting are more likely to adopt short rotation management in the future. Mäntymaa et al., (2018) found that, in Finland, the probability of forest owners to participate in Payment for Environmental Services programme requiring temporary set-aside was positively associated with previous clearcutting. Also in Finland, Juutinen et al. (2020) found that forest practitioners who implement clearcutting regime are less willing to delay harvest in the future and that intentions to undertake long rotation management decreases with previously undertaken harvesting activities for firewood purposes. These authors also reported that forest practitioners who considered that forests were currently well managed for different benefits such as timber production for industry and biodiversity maintenance preferred to use traditional management and were less likely to use uneven-aged management. Many forest practitioners thought that forests were generally managed from the perspective of biodiversity maintenance, climate mitigation, and recreation. These forest practitioners were reported to be less likely to change their management practices (Juutinen et al., 2020).

2.2.2 External environment

2.2.2.1 Social factors

Societal demand

Societal perspectives on forest management objectives and outcome have been observed to be a significant influencing factor on forest practitioners' management decisions (Rametsteiner et al., 2009). Dynamic demographic factors such as urbanisation, ageing populations and changing

household composition can trigger new expectations from society towards different forest management outcomes (e.g., increasing demands for nature-based solutions), which in turn can influence forest management decisions towards climate and biodiversity smart forest management strategies (Aggestam et al., 2020). For instance, growing societal demand for multifunctional forest use, especially in or near urban areas, where more products and services need to be simultaneously provided by forests, such as recreation, provision of green space and public health (Aggestam et al., 2020), can provide an enabling environment for the adoption of climate and biodiversity smart forest management strategies. Deuffic et al. (2018), and Maier and Winkel, 2017) observed that changing and competing demands on forests by different societal groups (e.g., forest owners vs. tourists, urban population vs. rural population, foresters vs. conservationists) are shaping decisions on forest management.

2.2.2.2 Technological factors

Access to advisory services

Access to forestry advisory services and membership in forestry associations have been widely reported to significantly influence forest practitioners' management decisions across Europe (Lawrence et al., 2020). A review undertaken by these authors assessed that landowners prefer one-to-one site visits with professional advisors and that outcomes can improve when financial incentive mechanisms are combined with active advice (Kilgore et., Lawrence and Dandy; Ovaskainen et al., cited in Lawrence et al. 2020). In Finland, Husa and Kosenius (2021) noted that membership in forest owners' association decreases the probability to have unmanaged forests. In Sweden, Eggers et al. (2014) found that "soft" factors, such as membership in a forest owners' association and an interest in and knowledge of forestry issues, had a stronger impact on the choice of management strategy than most hard factors related to the owner or the property, such as gender and distance between the owner's residence and the property. Beach et al. (2005) found out a positive effect of technical assistance on reforestation in the studies reviewed which included Finland and Norway.

Access to knowledge

Scheller and Parajuli (2018) identified a lack of information about the best strategies for mitigating climate change risks, lack of education and awareness, and perceived client costs as the primary barrier to climate adaptive management by forest managers. Bjärstig, (2013) found that participation in multi-stakeholder processes, involving diverse stakeholders, including government agencies, NGOs, businesses, and local communities, in decision-making processes significantly influence forest practitioners' management decisions and ensure a more comprehensive approach to forest management.

Janova et al (2022) found that increased awareness and better knowledge of forest managers can increase their willingness to consider other motivations in decision-making than those usually undertaken. Sousa-Silva (2018) investigated the role of climate change awareness and improved knowledge and information in shaping adaptive forest management in Europe and found that managers had little awareness of how to respond to threats and of how to implement adaptive management measures. Sousa-Silva et al. (2016) showed that in Belgium, private owners are, on average, less likely to have adapted their management practices to climate change than public managers, due to the lack of information. Coll et al. (2018) also found that forest managers lack knowledge regarding adaptability and trade-offs to environmental change in mixed-species

forests. In Sweden, Blennow and Persson (2009), observed that some forest owners did not adapt to climate change not because they did not believe it, but because they felt they lacked understanding on how to adapt to climate change.

2.2.2.3 Environmental factors

Climate change

In the recent decade, climate change has been one of the most influencing factors on forest management decisions (Felton et al., 2016). According to Jandl (2019), the uncertainty related to climate change risks, impacts, and responses of forests and the limited findings of interpretations of climate-change experiments leave forest managers with a wide range of practical options, but few clear recommendations for management decisions. In Austria, due to management practices after extreme weather events such as storms and droughts and their consequent damages, the proportion of broadleaves in forest stands has significantly increased compared to the proportion of conifers (Johann, 2021). It is expected that the proportion of deciduous forests (adaptation strategy), will increase further because of continuing global warming due to the associated risks related of coniferous forests caused by insect infestation, and drought and storm damages (Johann, 2021). Forest management systems with shorter rotation periods, such as coppices and coppices with standards, are becoming increasingly important (Gotsmy and Baumgartner; Hochbichler et al., cited by Johann, 2021). Blennow et al. (2012) investigated private forest owners' response to climate change in Europe and concluded that the combination of personal experience and belief must be considered to explain and predict the implementation of climate change adaptation practices.

2.2.2.4 Economic factors

Grants and subsidies

Marey-Pérez and Rodríguez-Vicente, (2011) reported that annual investment in agroforestry improvement, in Spain, were key determinants in the involvement of farmers in forestry and their commitment to the practice. On the other hand, in Ireland, forest practitioners' profit goals did not significantly influence their decision to engage with afforestation programmes (Duesberg et al., 2014) and this has been identified as one reason as to why the current incentive scheme failed to deliver the outlined afforestation targets. In Finland, forest owners show a willingness to participate in payment for environmental services (PES) schemes aimed at reducing wider landscape risks of pests and diseases, if it provides some management flexibility and does not unnecessarily prohibit forest operations that produce revenue (Bowditch et al., 2020).

Income from the forest

The amount/level of income that a forest practitioner earns from his/her forests can be a significant factor influencing management decisions. Income from forest has been observed to be positively associated with practitioners' increased willingness to extend forest rotations (Khanal et al, 2017). In Czechia, Janova et al (2022) found that decision-making of forest managers to convert even-aged spruce monocultures in mixed stands was affected by a combination of multiple economic-related factors namely, long-term experience with spruce profitability, and this species' capability of providing long-term income and short-term yields; stable high spruce-timber tradability; a steady business-as-usual mindset of forest managers; and missing effective measures for preventing damage by wild ungulates. These authors also found that financial dependence on

forest income was the main factor causing negative attitude towards biodiversity conservation. In Lithuania, Mizaras et al. (2020), found that economic-related factors such as the owner's view of the forest's economic importance (correlation coefficient: 0.862), income per hectare (0.840) or the importance of forestry in the common activity of the owners (0.525) strongly influence small-scale forestry. Timber prices also influence harvesting decisions (Howley et al., 2013). Husa and Kosenius (2021) reported that forest practitioners who are more dependent on timber sales are less likely to extend the rotation period. Forest practitioners may consider the potential economic value of non-timber forest products (NTFPs) (e.g., nuts, fruits, medicinal plants) as well. The economic profitability of joint production of timber and NTFPs have been reported to have significant influence on decisions on choice of forest management regime (Miina et al., 2020; Turtiainen et al., 2023; Pukkala et al., 2011). Harvesting NTFPs can generate additional income for forest owners when compared to relying solely on timber production. According to Rodríguez-Vicente and Marey-Pérez (2009), forest management primarily aligns with investment goals and the enhancement of land productivity as a capital asset. In their review which included two European countries (Norway, Finland), Beach et al. (2005) found out that the effects of sawtimber and pulpwood prices on reforestation were generally positive but only statistically significant in 69% of the studies where these were included.

New and emerging markets

Emerging bioenergy markets present new opportunities for forest practitioners to generate income by producing feedstocks for bioenergy production (Beach et al., 2005), and this is likely to impact the choice of management regime adopted by forest owners across Europe (Dale et al., 2011).Dorning et al. (2015) observed that the management regimes adopted by forest practitioners interested in the bioenergy markets was stand thinning, followed by conventional harvest and short-rotation plans, and they were mostly interested in high economic return. These authors found that forest practitioners uninterested in the bioenergy markets were mainly concerned about impacts in the quality of the forest for their own use and in terms of wildlife protection (Dorning et al., 2015; Cope et al., 2011). Bioenergy markets have contributed to the displacement of other land use types such as timberland (Dale et al., 2011; White et al., 2014). Carbon markets and payments for ecosystem services have provided new opportunities for increasing nature conservation while also increasing revenues for forest owners (Kalonga et al., 2016). Forest management decisions may be influenced by emerging carbon markets, where forests play a role in carbon sequestration and offsetting emissions. Ecosystem services such as watershed protection and biodiversity conservation for example can become marketable, as for example through the Biodiversity Net Gain (BNG) in England[2]. Other new emerging forestry-related markets that can influence decisions on forest management include, markets of sustainable products and of pharmaceutical nutraceutical (e.g., medicinal plants) markets and the bioeconomy.

2.2.2.5 Political factors

Regulations

Forest management decisions are often guided by local, national, and international regulations. Compliance with environmental laws and sustainable forestry standards can be a crucial aspect. In Czech Republic, conversion from mono species stands to mixed species forests has been

[2] https://www.legislation.gov.uk/ukpga/2021/30/schedule/14/enacted

promoted as a strategy to enhance ecological sustainability. Nevertheless, the speed of conversion has been slow despite establishment of several national and European Union mechanisms to support the conversion process. Janova et al. (2022) found that the conversion rate of mono species stands to mixed species forests corresponds mostly to legal requirement on forest structure for legal reforesting obligations, with conversion above the legally binding limits being rare. In this case, legal requirement seems to be the only significant factor influencing forest practitioners' decisions to convert mono stands to mixed species forests. Craciunescu et al. (2014) reviewed the implementation of European forest legislation for sustainable development and noted regulations for compulsory reforestation in most countries and limitations to management exist to protect replanted or naturally regenerated forest stands.

Certification

Certification programs can influence forest practitioners' decisions by setting standards for sustainable and responsible forest management. Certification is well established in many European countries (e.g., Sweden, Norway, Switzerland, Belgium, Portugal, Baltic countries, Poland, Croatia) and it is acknowledged as "*one of the most important initiatives of the last two decades to promote better forest management*" (UNECE/FAO report, 2020).

Subsidies, grants, and incentives

Forest subsidies are widely used to achieve policy objectives aimed at maintaining and supporting the provision of the forest ecosystem services. A strong positive correlation exists between a business-oriented perspective of forest management and a preference for subsidies (Quiroga et al., 2019). These authors found that forest owners who allocate more time to forest activities, particularly those fully dedicated (i.e., full-time dedication), are more inclined to support subsidy policies compared to those with less time committed to forest activities or those without direct dedication to the forest (Quiroga et al., 2019). Forest owners in Western Europe show less favourability towards subsidies compared to their counterparts in East Europe (Quiroga et al., 2019). In Austria, the impact of increasing monetary incentives, such as funding, on forest owners' decision-making is minimal, which reveals their ineffectiveness in motivating owners to undertake climate change adaptation measures (Mostegl et al., 2019). In the absence of a mature market, incentives play a crucial role in facilitating the adoption of community-based adaptation management approaches (Bond et al., 2009). They enable profit-oriented forest owners to invest in nature conservation, particularly in situations involving trade-offs (Rode et al., 2015). This suggests that the introduction of new and innovative incentive mechanisms, such as tax reforms (e.g., tax breaks), and the provision of social benefits (e.g., health insurance) in conjunction with basic payment schemes, can further enhance conservation efforts.

2.2.2.6 The Organisation

The **organisational structure** of a forest-based organisation, institution, and industry can significantly impact its ability to address environmental, economic, and social aspects of sustainable forest management (Dayneko and Gustafson, 2013). One way the organisational structure affects forest management decisions is via communication channels. The flow of information can vary depending on the hierarchical, flat, or matrix structure of the organisation. Effective communication is essential in the context of sustainable forest management, as it involves coordinating activities among various departments, stakeholders, and external partners.

A well-designed organisational structure ensures that clear communication and relevant information reaches decision-makers in a timely and accurate manner while a poorly structured organisation may suffer from communication blockages, leading to delays in decision-making and potentially constraining the implementation of sustainable forest management practices (FAO, 2024; Dayneko and Gustafson, 2013). The hierarchical nature of many forests governing organisations can result in centralised decision-making, where top-level executives hold significant decision-making power (FAO, 2024; Dayneko and Gustafson, 2013). This can lead to a more efficient decision-making process but may also limit the input from lower-level staff who possess valuable on-the-ground insights. In contrast, organisations with a more decentralised structure may involve a broader range of stakeholders in decision-making, fostering collaboration and ensuring that diverse perspectives are considered and consequently are better positioned to address sustainable forest management (FAO, 2024; Dayneko and Gustafson, 2013).

2.2.2.7 Forest characteristics

The characteristics of a forest landscape (e.g., its size, its ecological condition) have been reported to have significant influence on forest practitioners' management decisions (Janova et al., 2022; Eggers et al., 2014). **Property size** has been shown to correlate with harvest intensity. In Sweden, Eggers et al (2014) observed forest owners with larger properties and on higher quality sites are more likely to undertake frequent forest harvesting operations/forest removal management operations. Similarly, they reported that forest landscapes/properties under single ownership are more likely to undergo tree removal management operations than those under joint ownership, despite their smaller size. Lönnstedt (1997) suggests that small scale forest owners' decisions extend beyond the bounds of a single generation and this long-term perspective means that decisions made are not always in harmony with forest policy or occasional changes in the timber market. Furthermore, Eggers et al. (2014) reported property size to be the most important factor in determining the choice of management strategy, with owners of larger properties usually undertaking a more production-oriented management strategy compared to owners of small properties. Husa and Kosenius (2021) reported forest practitioners with larger forest estates are more likely to delay harvest, retain unmanaged areas within their forest estate, and convert monocultures to mixed broadleaved stands (Husa and Kosenius, 2021). Størdal et al., (2008) found that forest management plans and property size increase both the propensity to harvest timber and the harvesting levels (Størdal et al., 2008). Quiroga et al. (2019) also reported that forest practitioners with **higher number of plots** per forest holding are more likely to allocate less time to their forest management activities. They either partially manage their forest estate or not carry out any direct management activity on their forest properties.

It has also been reported that the **site capability** (ecological condition) for timber production has significant influence on forest practitioners' management decisions (Husa and Kosenius, 2021). Husa and Kosenius (2021) found that poor site-specific characteristics for timber production are strongly related to the willingness to leave unmanaged areas. Joa and Schraml (2020), instead found that lower site capability for timber production have a positive effect on the probability to adopt various forest management practices promoting carbon sequestration, climate change adaptation, and biodiversity. Similarly, Thomas et al (2022) observed that in France, the characteristic of a forest landscape greatly influences the forest practitioners' adaptation decisions.

3 Interview methods

3.1 Data collection

Interviews were conducted by researchers (i.e., "Interview Leads") associated with the *ForestPaths* and *Forwards* projects. A *maximum variation sampling*[3] approach was taken, in that a target population was defined alongside a key number of background factors known to create variation among the population. The study targeted *forest practitioners* with a high degree of management power over their forest holding. *Forest practitioners* were defined as (i) private forest owners, (ii) employees of organizations that manage either private- or state- owned forests, or (iii) employees of organizations responsible for certain segments of forest management. This definition was chosen to ensure that both private and publicly owned forest holdings were included in the research. To capture variability among the key informants, Interview Leads were asked to avoid repeated interviewing of forest practitioners with similar sociodemographic characteristics (e.g., gender, age) and forest holding characteristics (e.g., holding size, ownership types).

To ensure a systematic data collection process, an interview protocol was drafted in English and distributed to each of the Interview Leads. The protocol outlined a step-by-step procedure for conducting the interviews. The protocol included ethical guidelines, an interview guide, and a template for preliminary summarization and analysis of the interview. The interview guide was drafted by a research expert in the field of forestry and refined according to input from forestry research experts. The interview guide is available in Annex A.

Key informants were contacted for an interview at the discretion of the Interview Leads. Interviews were conducted between May-August 2023 and held in local languages. Interview Leads recorded the interviews and drafted preliminary interview notes in English summarizing the content of the recorded interviews. The lead author received the preliminary notes and requested clarification or additional information when appropriate. Interview Leads subsequently addressed the comments before returning the finalized notes for analysis. A total of 19 sets of interview notes satisfying the interview protocol criteria were collected (see: Table 1). Some interview notes were excluded from the analysis if they did not satisfy the protocol criteria (e.g., insufficient information, incorrect target group).

[3] For more information about maximum variation sampling see, Schreier (2018).

Table 1. Forest characteristics and sociodemographic information of key informants.

Country	Age	Gender	Holding size (ha)	Ownership	Management
Finland 1[T]	50-59	Female	249,000	Public	Manager
Finland 2[T]	60-69	Female	20	Private	Owner
Italy 1[T]	50-59	Male	15	Private	Owner
Italy 2	70-79	Male	60	Private	Owner
Italy 3	80-89	Male	40	Private	Owner
Italy 4	40-49	Female	60	Private	Owner
Italy 5	60-69	Male	2,000	Private/Public	Manager
Italy 6	50-59	Male	2,000	Private/Public	Manager
Latvia 1	50-59	Female	2	Private	Owner
Latvia 2	50-59	Female	450	Private	Owner
Netherlands 1[T]	30-39	Male	380	Public	Manager
Netherlands 2	50-59	Female	1,400	Public	Manager
Netherlands 3	30-39	Female	3,000	Private	Manager
Romania 1[T]	40-49	Male	7,000	Private	Manager
Romania 2[T]	50-59	Male	15,000	Public	Manager
Romania 3	40-49	Male	10,000	Public	Manager
Portugal 1[T]	40-49	Male	40	Private	Owner
Portugal 2[T]	60-69	Female	10	Private	Owner
Portugal 3	40-49	Female	<1	Private	Owner

[T] subsample of data used to develop the coding framework.

3.2 Qualitative content analysis

The interview notes were analysed following Schreier's (2012) approach to *Qualitative Content Analysis* (QCA). Schreier's method applies a two-step approach that includes 1) developing a coding framework using a subsample of the data and 2) applying the finalized coding framework across all the data. Schreier's QCA leads to two outputs. The first output is the coding framework developed from the data; it represents a hierarchical list of themes relevant to answering the research questions. The second output is a tabulation of each theme of the coding framework across the data; essentially, the tabulation permits the researcher to compare the presence or absence of different themes across the data and thereby assess if themes are contextual to unique cases in the data. Schreier's QCA is suitable for this study because the research questions require a comparative analysis of how one group perceives a particular phenomenon. This contrasts with other qualitative analysis approaches that aim to build new theories based on how different groups perceive a phenomenon (e.g., conceptual coding analysis) (see: Schreier 2012: pg. 42).

3.2.1 Coding framework development

The first step of Schreier's (2012) QCA is to develop a coding framework from a subsample of the data that helps answer the study's research questions. In essence, a coding framework is a hierarchical list of major categories with nested subcategories. The development of these categories is flexible, in that it may be done either inductively, deductively, or through a mix of both approaches. In other words, it is possible to develop the coding framework using previous

literature, the interview data, or a mix of both. In this study, the coding framework works to answer the research questions by identifying 1) *forest management objectives*; 2) *forest management practices*; and 3) *factors influencing forest practitioners' forest management behaviours*. The strategy for developing the framework categories included mixing inductive and deductive approaches.

As per Schreier's (2012) guidelines, only a subsample of the data is used to develop the framework. Nevertheless, the subsample should strive to ensure the development of a saturated framework by incorporating a variety of respondents into the subsample. This helps ensure that relevant information is not excluded from the coding framework and the subsequent tabulation process, as no new codes are developed during the tabulation phase. In this study, a subset of eight interview cases were used to build the coding framework (i.e., Finland 1, Finland 2, Netherlands 1, Italy 1, Romania 1, Romania 2, Portugal 1, and Portugal 2). The subsets represented various countries (i.e., Finland, Italy, Netherlands, Portugal, and Romania) and ownership types (i.e., four public forests and four private forests).

To identify *forest management objectives*, categories were developed in a purely deductive fashion using the classification system for ecosystem services applied by the Common International Classification of Ecosystem Services (CICES, see: Haines-Young and Potschin, 2018) and various other scholars (Brockerhoff et al., 2017; Daniel et al, 2012; Schalmz et al., 2016; Villamagna et al., 2013).

To identify *forest management practices*, categories were developed inductively from the data using a grounded theory approach. Essentially, the grounded theory approach identifies reoccurring topics of discussion and conceptualizes them into categories through open coding (Schreier, 2012: Chapter 6). This process included a line-by-line analysis of eight interview transcripts to identify reoccurring topics of discussions about forest management practices. Similar management practices were grouped together into subcategories, and as new subcategories emerged, these categories were subsumed into conceptually distinct major categories. Thus, the iterative development and subsumption of categories led to a hierarchical framework of subcategories nested within major categories.

To identify the *factors influencing forest management behaviours*, categories were developed using a mixed inductive and deductive approach. The inductive portion of the work included a line-by-line analysis of eight interview transcripts to identify reoccurring discussion on the rationale underlying the implementation of either forest activities or management objectives. The deductive portion of the work occurred during the process of grouping and subsuming the emergent topics into meaningful subcategories and major categories. Conceptualizing discussion into meaningful groups was informed by previous literature on factors influencing forest owner decisions (e.g., de Bruin et al., 2015; Sotirov et al., 2018, 2019).

3.2.2 Coding framework application

The second step of QCA included applying the finalized coding framework to all interview cases. This step follows a systematic approach, where interviews are segmented into units of code and the units are subsequently labelled with the appropriate subcategory from the coding framework.

Labelling is restrictive in that a unit of code may only apply one subcategory label from each of the major categories. This procedure ensures a mutually exclusive tabulation that quantifies how frequently each subcategory comes up across the data. It also permits crosstabulation between sub-categories to create uniquely comparative information. The process of applying the coding framework was carried out using the software *MAXQDA2022*.

4 Interview results

4.1 The coding framework

The final coding framework is the first result of the QCA. It directly answers the study's research questions at the conceptual level. This section provides an overview of the coding framework. The coding framework has three major dimensions: forest management objectives, forest management practices, and factors influencing management practices and objectives. The full coding framework with definitions and coding rules for each category is available in Annex B.

4.1.1 Forest management objectives

A total of five subcategories were defined in the coding framework (labels below in **bold**). These subcategories represent 5 distinct forestry objectives. None of the subcategories are subsumed into larger groups, although objectives related to regulatory services and maintenance services are merged into a singular category (i.e., regulating objectives). Furthermore, climate objectives and biodiversity objectives are explicitly placed in distinct groups although they are typically classified as regulating objectives (Brockerhoff et al., 2017). This decision was justified on the basis that a large component of the interview guide focuses climate and biodiversity smart forestry activities, meaning that climate change and biodiversity objectives were a central feature of the interviews. Aggregating biodiversity and climate change objectives into a singular category would have limited the possibility to analyse if these objectives have distinct drivers.

1. ***Provisioning*** *objectives*, referring to tangible ecosystem goods (e.g., food, raw materials, genetic resources, energy, minerals, other resources).

2. ***Regulating*** *objectives*, referring to both regulating and maintenance ecosystem services (e.g., nutrient cycling, water filtration, erosion control, flood regulation forest resilience and adaptation). The category excludes climate change and biodiversity objectives.

3. ***Climate*** *objectives* referring to the use of forest for climate change mitigation goals (e.g., carbon sinking or carbon nutrient cycling).

4. ***Biodiversity*** *objectives* referring explicitly to the maintenance or enhancement of biodiversity.

5. ***Cultural*** *objectives* referring to the use of forest for intangible or immaterial ecosystem services (e.g., recreational activities, science and education, therapy, conservation of historical or traditional knowledge or identity, and spiritual activities).

4.1.2 Forest management practices

A total of twenty-nine subcategories were defined in the framework (below in **bold**). These subcategories represent twenty-nine distinct forest management activities. The subcategories were subsumed under seven broader categories of activities:

1. *Regeneration activities* includes different aspects related to forest regeneration, including the number of species regenerated (i.e., **monospecies**, **mixed species**), the types of species material used in regeneration (i.e., **native species**, **adapted species**), and the regeneration techniques (i.e., **natural regeneration**, **artificial regeneration**).

2. *Harvesting activities* includes different approaches for harvesting timber or non-timber forest products (i.e., **clearcutting**, **selection cutting**, **coppicing**, **shelterwood**, **salvage logging**, and **NTFP cultivation**[4]).

3. *Conservation activities* includes different silvicultural practices that attempt to preserve the natural environment (i.e., **forest edges**, **retention trees**, **buffer zones**, **deadwood**, **set-aside areas**, **terrain preservation**)

4. *Stand management activities* include different silviculture practices and regimes for maintaining a stand (i.e., **continuous cover forestry**, **fertilization**, **thinning**, **cleaning**, **stand rotation**)

5. *Land use change activities* include developing infrastructure or buildings in a forest *(*i.e., **development**), converting forest to a new land type *(*i.e., **deforestation**), or converting previously non-forested land to forest (i.e., **afforestation**).

6. *Population control activities* include activities that are intentionally meant to change either the behaviours or population composition of wildlife or pest in a forest (i.e., **pest control**, **wildlife management**).

7. ***Agroforestry activities*** includes activities associated with the coproduction of agriculture and forest.

4.1.3 Factors influencing forest management

A total of 21 subcategories were defined in the coding framework (below in **bold**). The subcategories represent 21 factors influencing forest management practices and objectives. The subcategories were subsumed into three broader factors: 1) *agent-based factors*, 2) *structural factors*, and 3) *ecological factors*.

1. *Agent based factors* include the roles of the individual's environmental values (e.g., **conservationist**, **climate smart**), traditional values (i.e., **traditionalism**), utilitarian

[4] Note NTFP in this context refer to any provisions that do not require felling a tree; hence, cork and products are categorized as NTFP. This criterion was implemented to facilitate the creation of a coding framework that parses factors associated with the harvest of a tree.

values (i.e., **economizing**, **utilitarianism**), organizational factors (**the organization**, in the case of managers working for forest management organizations), and the availability of **resources** (e.g., time, money, knowledge).

2. *Structural factors* include the impact of governance mechanisms (e.g., **voluntary instruments**, **information agreements**, **regulations**, **market-based instruments**, and the effect of **public administration** processes), markets (e.g., **timber markets**, **NTFP markets**, and **other markets**), and societal norms (e.g., **public pressure**, **forestry networks**, **neighbours**, and **public goods**).

3. *Ecological factors* include the role of **biophysical** features (e.g., geographic features and biotic features) and **disturbance** regimes (e.g., pests, fire, dieback, drought, etc).

4.2 Crosstabulations

The tabulations quantifying how frequently each subcategory comes up across the data is the second result of the QCA. This section provides crosstabulation between different subcategories of the coding framework. The first crosstabulation compares influential factors against forest management objectives. The second crosstabulation compares influential factors again forest management activities.

4.2.1 Factors influencing forest management objectives

Table 2 provides an overview of how frequently different factors were found to influence forest management objectives. The values represent the total number of interview specific instances where the factor was found to influence the forest management objective. For example, *traditionalist values* were found to influence *cultural objectives* in 10 of the 19 interviews. Note that the directionality of the factor effect on the objective is not visible.

Table 2 – Crosstabulation depicting relationship between factors influencing forest management objectives. The value represents the number of interview cases wherein a factor was found to influence a forest management objective.

	Traditionalist values	Economizing values	Utilitarian values	Climate-wise values	Conservationist values	Organizational structure	Resource availability	Information instrument	Voluntary agreement	Market instrument	Public administration	Regulations	Timber markets	NTFP market	Other markets	Forestry networks	Public goods	Public pressure	Neighbours	Biophysical	Disturbances
Cultural	10	2	7	0	2	8	1	1	0	1	3	1	1	1	2	5	6	5	1	0	0
Provisioning	6	14	7	1	1	8	11	4	2	8	8	8	11	3	3	7	8	7	3	8	2
Regulating	1	4	2	2	8	8	4	4	5	10	3	9	1	0	0	10	4	10	3	7	10
Biodiversity	2	1	1	0	8	8	1	0	3	4	2	9	0	0	0	2	1	1	0	1	2
Climate	0	2	0	7	3	6	2	2	1	4	0	1	0	1	2	0	0	0	0	2	0

4.2.2 Factors influencing forest management activities

Table 3 provides an overview of how frequently different factors were found to influence forest management activities.

Table 3 – Frequency crosstabulation of factors influencing forest management activities.

	Organizational factors	Resource availability	Traditionalist values	Economizing values	Utilitarian values	Climate-wise values	Conservationist values	Information instrument	Voluntary agreement	Market instrument	Public administration	Regulations	Timber markets	NTFP market	Other markets	Forestry networks	Public goods	Public pressure	Neighbours	Biophysical	Disturbances
Regeneration activities																					
Monospecies regeneration	2	4	2	1	2	3	4	1	2	3	3	4	2	1	0	3	2	3	1	3	3
Natural regeneration	4	8	4	6	4	4	5	4	4	8	5	8	6	2	2	7	5	7	2	6	6
Artificial regeneration	4	8	4	6	1	3	4	7	4	7	7	6	7	1	2	6	6	8	2	7	7
Native species regeneration	2	6	5	5	4	2	4	3	4	6	4	6	4	3	2	5	3	6	1	5	5
Adapted species regeneration	3	7	4	5	6	7	7	2	0	6	4	6	5	2	2	7	3	4	3	7	5
Harvesting activities																					
Salvage Logging	2	5	4	3	4	4	5	2	0	4	4	4	3	2	3	5	2	3	2	5	5
Shelterwood	2	3	2	2	1	1	2	0	3	3	2	3	1	1	0	2	2	3	0	2	2
Selection Cutting	4	7	4	7	4	4	5	3	2	7	4	6	5	1	3	7	3	5	1	6	5
Clearcutting	6	12	7	9	7	8	10	4	4	10	8	10	7	3	3	10	6	9	2	11	8
Coppicing	4	8	5	7	5	3	5	4	4	8	6	8	6	4	4	7	5	7	4	6	7
NTFP Cultivation	3	12	10	12	7	6	8	8	6	12	7	10	10	5	7	12	5	10	6	9	11
Conservation activities																					
Forest edges	1	3	1	3	2	3	3	1	1	3	1	3	3	0	0	3	1	2	0	3	1
Set-aside areas	5	11	7	10	6	6	9	3	5	10	6	9	7	3	4	9	5	9	2	9	7
Retention trees	3	5	1	4	3	3	4	1	2	4	3	4	3	1	0	3	3	4	0	4	1
Terrain preservation	6	9	5	7	4	5	7	4	3	8	7	7	5	2	2	7	5	8	0	8	6
Buffer zones	3	6	3	5	2	3	4	2	4	5	3	5	3	1	0	4	3	5	0	5	3
Deadwood	5	9	4	6	4	6	7	3	4	7	6	8	5	1	0	7	5	7	1	8	5
Continuous cover forestry	4	7	4	6	2	3	4	3	5	6	5	5	4	2	0	5	5	7	1	6	4
Stand treatments																					
Stand rotation	3	4	2	3	1	1	2	1	3	3	3	3	1	1	0	2	3	4	0	3	2
Tending / Clearing	4	13	10	11	7	7	9	9	5	12	9	11	11	4	7	13	6	10	7	11	13
Fertilization / Liming	4	6	3	5	3	5	5	4	0	5	4	4	4	1	1	5	3	5	1	6	4
Thinning	2	5	3	5	3	4	4	3	0	4	2	3	3	1	1	4	1	3	1	5	3
Land use change																					
Deforestation	0	5	4	4	3	4	5	1	1	4	3	5	4	1	2	5	1	3	3	4	4
Afforestation	2	6	4	4	2	4	5	2	3	5	4	6	4	0	0	5	2	4	1	6	5
Development	5	10	6	9	4	2	5	6	6	10	9	9	9	2	5	9	7	9	4	8	9
Population control																					
Wildlife management	4	7	4	4	3	4	5	2	3	6	5	5	4	1	1	6	4	4	2	7	6
Pest control	3	4	3	4	2	1	2	2	1	4	3	3	2	1	3	4	2	3	1	3	4
Agroforestry																					
Agroforestry	3	7	4	6	3	2	3	7	3	7	7	6	7	2	4	7	5	6	3	6	7

The values in the tables represent the total number of interview specific instances where the factor was found to influence the forest management objective. For example, *resource availability* was

found to influence *coppicing* activities in 8 of the 19 interviews. Note that the directionality of the factor's effect on the objective is not presented in the table but can be found in the individual summaries of each interview case (Section 4.3).

4.3 Interview summaries

The following section provides a short summary introducing each case study. Each summary provides granular information about ***management objectives***, **management activities**, and the *factors influencing management objectives and activities*. Brief tables visualizing the factors facilitating and/or impeding forest management objectives and activities are provided at the end of each summary. Expanded tables detailing the relationship between factors according to management objectives and activities are provided in Annex C.

4.3.1 Finland

4.3.1.1 Finland 1.

The interview was conducted with a regional public forest manager responsible for 249,000 hectares of the State's commercial forest, hence the informant primarily discusses forest management objectives centring around ***provisioning*** timber as a means of revenue for the State. However, the role of *public pressure*, the *public administration's* political agenda, and the *organization's* determination to provide *social goods* to citizens also result in awareness towards ***cultural***, ***regulatory***, ***climate***, and ***biodiversity objectives***. Reconciling between the objective to provision timber is occasionally at odds with other objectives. Specifically, the organization opts to **set aside** forest areas that exhibit poor productivity and growth, such as peatland forest. Nevertheless, there is increasing *public pressure* to **set aside** additional commercial areas for conservation. The informant doubts whether it is possible to continue setting aside commercial forest in their region because then the *public administration* would need to examine alternative sources of revenue outside of forestry.

In terms of management activities, the organization primarily manages their forest under a ***clearcutting*** regime, but social and political pressure resulted in the uptake of *continuous cover forestry*. Harvesting is implemented using large machinery and the informant believes this reduces the organization's capacity to ***preserve the terrain***. The informant believes a better solution would be to use smaller machinery, but such technology is unavailable (*resources*). The informant also discusses the ***artificial regeneration*** of saplings but believes this number should be increased due to the large degree of sapling mortality (*biophysical*). Likewise, the informant views the current ***thinning*** regime as too intensive, hindering possibilities for mixed species forest (*climate-wise*). The informant also expresses interest for simple and accessible data to facilitate decision-making (*information instruments),* such as whether the fertilization of peatland forest indeed contributes to climate change mitigation or if an alternative approach is wiser.

Table 4. Finland 1 – Summary of factors influencing the forest practitioner's decisions.

	Organizational	Economizing	Climate-wise	Resources	Public goods	Public pressure	Information instruments	Public administration	Bio-physical
Provisioning objectives	✓	✓			✓	X		✓	
Cultural objectives									
Regulating objectives									
Biodiversity	X			X	X			X	
Climate	✓						X		
Mixed-species regeneration	X								
Artificial regeneration									✓
Clearcutting	✓								
Set-aside areas						✓			✓
Terrain preservation	X			X		✓			
Continuous cover forestry	✓								
Fertilization / Liming	✓						X		
Thinning						✓			X

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.

4.3.1.2 Finland 2.

The interview was conducted with a private forest owner maintaining 20 hectares of forest in Central Finland inherited from her family. The informant has a history of involvement in Finnish politics, particularly within the environmental party of Finland (Greens Party). The informant expresses her management objectives are chiefly driven by internal values and the desire to address growing concerns over climate change and biodiversity loss (*climate wise, conservationist*). Her primary forest objectives include improving the forest's ***regulatory*** services. ***Provisioning*** was not a key objective because the informant has economic sufficiency through her primary profession (*resources*) and the stands are too young to fell (*biophysical*). Nevertheless, there is acknowledgement that the forest can contribute to financial security in a pinch. The informant also shares she is experimenting with **cultivating NTFPs**, specifically chaga mushrooms as a possible source of revenue (*economizing*).

In terms of management activities, the informant describes implementing **mixed-species regeneration** because she believes it provides the best living environment for biodiversity (and protects against bark beetle outbreaks (*conservationist*, *disturbance regimes*). She **artificially regenerated** the stand using larch and pine due to the tendency for spruce outcompete other species through natural propagation (*biophysical*). She **afforested** one hectare of abandoned land with larch to support climate change mitigation (*climate-wise*). Some of these regeneration activities were supported through government subsidies (*market instruments*). In addition, the informant expresses a high degree of self-sufficiency by actively **clearing and tending** her own stands; however, limited time and the large distance between her primarily dwelling and forest property restrict these activities (*resource availability*). In addition to active management activities, a few hectares of the forest are **set aside** in a voluntary reserve (*voluntary agreement*, *conservationist*). There are also legally mandated **buffer zones** around the forest lakes (*regulations*), and she retains **deadwood** after forest disturbances and stand cleanings (*conservation value*).

In the future, the informant expresses willingness to implement **uneven forest edges** to improve biodiversity (*conservation value*). In the case of future harvest, she emphasizes a deep aversion to **clearcutting** and is instead interest in practicing **continuous cover forestry** through **selection cuttings** (*conservationist*). She adamantly opposes her family's history of **clearcutting** the forest (*traditional values*) and criticizes Finnish society's approach to **clearcutting** (*societal pressure*). She reflects that the norm to clearcut is also tethered to a larger issue surrounding whether Finland's forest industries can cope with Finnish owners transitioning towards **selection cutting** over **clearcutting** regimes (*timber markets*).

Table 5. Finland 2 – Summary of factors influencing the forest practitioner's decisions.

	Resources	Climate-wise	Conservationist	Economizing	Traditionalist	Information instruments	Voluntary agreements	Market instruments	Regulations	Timber markets	Social pressure	Biophysical	Disturbances
Provisioning objectives	X			✓								✓X	
Regulating objectives						X							
Biodiversity			✓		✓								
Carbon		✓				X		X					
Mixed species regeneration		✓	✓										✓
Artificial regeneration								✓				✓	
Afforestation*													
Selection Cutting			✓							X			✓
Clearcutting (opposed)		X	X		✓						✓		
NTFP Cultivation				✓								✓	
Forest edges			✓										
Set-aside areas			✓				✓	X					
Buffer zones									✓				
Deadwood			✓										
Continuous cover forestry			✓							X			✓
Tending / Clearing	✓X												

X: represents factors hindering the management activity. **✓**: represents factor enabling the management activity.

4.3.2 Italy

4.3.2.1 Italy 1

The interview was conducted with a private forest owner holding 15 hectares of family-owned forest. The owner inherited from the property from his father. The property is primarily a mix of holm oak, downy oak, and cork oak. There is also a 2.5-hectare cork oak stand and two chestnut stands. According to owners, the objectives of the forest are to produce goods for household consumption and income (***provisioning objectives***), to maintain forest health and hydrological functions of the land (***regulatory objectives***), and to increase the value of his chestnut stands (***provisioning***). Although not a self-stated objective, the informant indirectly discusses his desire to preserve the forest management traditions and regional heritage tied to the land (***cultural objectives***). No climate or biodiversity objectives are mentioned outright, but the owner connects the effects of forest management to both climate change and biodiversity.

The management activities in the chestnut stands consist of **coppicing.** Coppicing is implemented to facilitate the **cultivation of NTFPs** (i.e., chestnut fruits) alongside the provisioning of timber with appropriate dimensions to meet sawmill demand (*biophysical, timber markets*). In addition, the owner shares this is the typical management approach for the region (*tradition*). The owner also states he grafts **local native varieties** of chestnuts perceived to have desirable commercial characteristics (*NTFP market*) to increase the fruit's retail value (*economizing*). He also believes this enhances biodiversity (*conservationist*). To combat the fungus responsible for ilk disease (*disturbances*), the owner implements phytosanitary treatments with potassium phosphite (**pest control**). This work is carried out with a university and funded by the Rural Development Fund (*forestry networks, market instruments*). He implements **tending and clearing** of the understory by hiring help from qualified employs, such as from his chestnut producer's association (*forestry networks*, *resources*). He believes this work helps reduce wildfire risk (*disturbances*). The work is occasionally supported by grants (*market instruments*).

The management activities in the oak stands consist of **selective cutting** techniques taught by his father (*tradition*). The practice is also encouraged by regional forest authorities (*information instruments*). He and his father never practiced **clearcutting** in the oak stands (*tradition*), although he engages in **salvage logging** in the event of a *disturbance*. For example, a recent snow *disturbance* led to **salvage logging** and the **re-development** of fences. The surrounding fences are perceived as important towards limiting grazing pressure (*biophysical*). The owner has **set-aside areas** at high altitudes to **preserve the terrain** and prevent soil erosion (*disturbances*. He also **sets aside** chestnut trees deemed commercially valuable (*economizing*) or of unique biodiversity (*conservationist*). According to the owner, another important feature of the forest is its use beyond timber provisioning (*utilitarianist*). For example, the informant engages in **agroforestry** by keeping "semi-free range" pigs within the forest, although this practice is not entirely radical given the strong regional *tradition* to manage cork oak forest through grazing. The owner would also like to consider **NTFP cultivation** of mushrooms but notes there are insufficient *regulations* surrounding this practice (e.g., to prevent trespassers from picking the mushroom).

Table 6. Italy 1 – Summary of factors influencing the forest practitioner's decisions.

	Traditionalist	Economizing	Utilitarianism	Conservationist	Resources	Information instrument	Market instrument	Regulations	Timber markets	NTFP market	Other markets	Public pressure	Forest networks	Public administration	Neighbours	Biophysical	Disturbances
Cultural objectives	✓			X							X						
Provisioning objectives	✓	✓	✓						✓	✓				X		✓	
Regulating objectives					✓X		✓	✓				X	✓				X
Biodiversity																	
Climate					X												
Native species		✓		✓						✓							
Development																✓	X
Agroforestry	✓	✓															✓
Salvage Logging																	✓
Selection Cutting	✓					✓											
Clearcutting (opposed)	✓																
Coppicing	✓	✓														✓	
NTFP Cultivation								X			X						
Set-aside areas		✓		✓						✓							
Terrain preservation																	
Tending / Clearing					✓		X						✓				✓
Pest control													✓				✓
Thinning									✓							✓	

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.

4.3.2.2 Italy 2

The interview was conducted with a private forest owner holding two forest properties of 30 hectares each. The first forest property is an artificially planted forest purchased 40 years ago. The second property was purchased in the 1990's. The informant is a forestry technician with a long history practicing cork cultivation. He belongs to the local Cork Producers Association. Hence, his main objective is producing cork, acorns, and timber for income (***provisioning objective,*** *economizing*). The informant also maintains that active management of cork oak forest supports ***regulatory functions*** of the area. While not directly stated, the preservation of the cork profession is an objective stemming from the owner's deeply rooted professional identity, as it binds him to the region's history (***cultural objective***, *traditionalism*).

The informant mentions only a few management practices associated with his forest and instead dedicates the interview to discussing larger structural issues threatening the cork profession – these issues are fatalistically perceived as threats cementing the demise of his profession and the region's livelihood. The situation appears to combine two separate feedback loops. The first feedback loop relates to the high cost of cork oak forest maintenance coupled with limited government financial support resulting in an economically untenable profession with high rates of professional abandonment and land abandonment. This land abandonment subsequently leads to deterioration of cork quality and wildfire risk that threatens neighboring cork oak forests with increased maintenance cost and a reduced quality cork that lowers market price. The second feedback loop is that professional abandonment reduces the workforce availability, which in turn lowers the cork supply, which leads to fewer artisanal producers, which further reduces cork demand, and so on[5].

In terms of management activities, he describes at length how his approach to the **NTFP cultivation** of cork is driven by the physiological properties of cork oak in conjunction to the quality of cork desired in the market (*biophysical, timber market*). He describes **artificially regenerating** a cork oak stand using public funds (*market instruments*) but no further views towards **artificial regeneration** are provided (c.f., Italy 5). There is discussion around the property requiring **development** of fencing, roads, and firebreaks to reduce wildfire risks (*disturbances*). Similarly, the role of **cleaning and tending** is discussed as a critical component for reducing wildfire risk and maintaining the health of local cork forests (*disturbances*, *biophysical*). From his perspective, **continuous cover forestry** is a poor management regime due to its increased propensity for wildfires (*disturbances*). Instead, he supports combining **agroforestry** grazing and **NTFP cultivation** of oak acorns to ensure the **cleaning and tending** of the understory. Thus, these activities prevent wildfire risks while also providing multiple economic uses of the land (*disturbances, economizing*).

The informant perceives multiple barriers to executing his management activities. He expresses that interventions are expensive (*resources*) and there is limited government support for the management of cork oak forest (*market instruments*). Furthermore, the owner has received multiple environmental complaints accusing him of damaging vegetation during the **development** of roads and fences and for the **tending** of his cork oak forest (*resources, public administration*).

[5] For more information see Annex C, Table 36

Table 7 – Italy 2. Summary of factors influencing the forest practitioner's decisions.

	Resources	Traditionalist	Economizing	Information instrument	Market instrument	Voluntary agreements	Public administration	Timber markets	NTFP market	Forestry networks	Public goods	Public pressure	Neighbours	Biophysical	Disturbances
Cultural objectives		✓		✓						✓					
Provisioning objectives	✓X	✓	✓			✓	X	✓X	X	X	X	X		X	X
Regulating objectives	X				✓X		X	X		✓		X		X	X
Climate														X	
Artificial regeneration					✓										
Continuous cover forestry															X
Development	✓						X								✓
Agroforestry			✓				X	✓					✓		✓
NTFP Cultivation			✓												
Tending / Clearing			✓				X	✓						✓	

X: represents factors hindering the management activity. **✓**: represents factor enabling the management activity.

4.3.2.3 Italy 3

The interview was conducted with a private forest owner holding two 40-hectare properties of cork oak dominated forest. His primary objective is producing cork for income (***provisioning objective***, *economizing*) and collecting firewood and mushrooms (*utilitarianism*). He also preserves the property because he feels sentimental attachment to the land as it is an object of family history – he hopes his children inherit the land and fears that their physical distance to the property will result in an inability to maintain the land and subsequent decision to sell (***cultural objective***, *resources*).

In terms of management activities, he discusses the importance of maintaining the **mixed-species** composition of his forest and the intensive **tending and clearing** of undergrowth to ensure high-quality cork (*economizing*). Implementing this activity is challenged by the terrain and highly competitive downy oak and holm oak species that outcompete cork oak (*biophysical*). This same limitation also makes regeneration of cork oak forest challenging. Furthermore, uncontrolled populations of wild boars destroy regenerations (*biophysical*). To this end, the informant discusses that although cork oak is a **native species,** cork oak forests are referred to as "artificial forest" since they require massive human intervention to survive. Indeed, the informant has engaged in some **artificial regeneration** by planting to support production in his cork forest (*economizing*).

In addition to active stand interventions, the owner also discusses structural issues that affect forest management practices in cork forest overall. First, there is a large need to mitigate wildfire *disturbances*. This is primarily approached through the **development** of emergency access roads and firebreaks. The cost of roads (*resources*), challenging terrain (*biophysical*), and various *regulations* surrounding implementation impedes development of such projects. The regional situation is so dire that insurance companies no longer cover wildfire losses (*timber market*). Second, the **NTFP cultivation** of cork is *regulated* by legislations requiring timed extraction of cork every 10 years. These regulations in theory support forest health by preventing disease and protecting the quality of the cork. However, the *timber market* functions such that cork is sold while still on the tree and the buyer will arrange extraction of the cork. If prices are unfavorable, an owner may [illegally] delay sale of cork, in turn delaying extraction of cork. According to the informant, this mismatch between *regulation* and the *timber market* is not necessarily always catastrophic – a two-year delay can at times benefit the maturity of the cork oak (*economizing*). In addition to this mismatch, the owner also perceives that certification of cork oak forest is misleading as it includes the possibility to certify **artificially regenerated** cork oak; however, he believes that **naturally regenerated** cork oak produces a higher quality of cork (*voluntary agreements*).

Table 8. Italy 3 – Summary of factors influencing the forest practitioner's decisions.

	Resources	Traditionalist	Economizing	Utilitarian	Information instrument	Market instrument	Voluntary agreement	Public administration	Regulations	Timber markets	Other markets	Forestry networks	Public goods	Public pressure	Biophysical	Disturbances
Cultural	X	✓								X	X	✓				
Provisioning			✓	✓	X	✓	X	X	X	X		✓		✓	X	X
Regulating					X	X			✓			✓		X		X
Biodiversity																
Climate																
Mixed species			✓													
Natural regeneration							✓									
Artificial regeneration			✓												X	
Development	X															✓
Agroforestry														X		
NTFP Cultivation				✓					X	X					X	
Tending / Clearing	X														X	✓

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.

4.3.2.4 Italy 4

The interview was conducted with a pair of siblings that are private forest owners holding a 60-hectare property. The self-described objective of the forest is to generate income from cork production across the whole forest (***provisioning objective,*** *economizing*). They also engage in a side venture **cultivating NTFPs** and producing essential oils from a one-hectare plot of medicinal and aromatic plants. This venture is primarily motivated by a desire to spend time in the countryside and enjoy nature – it is a hobby rather than a profitable venture (***cultural objective***). Although not a self-described objective, it also appears that the siblings are tied to preserving the cork oak forest due to their childhood connection to the countryside and desire to preserve their father's property (***cultural objective***, *traditionalist*). Both siblings gave up their previous professions to become cork producers and now refuse to sell the land. While they believe that cork production allows multifunctional objectives like mitigating climate change and providing habitat for biodiversity, no active objectives to enhance either function are stated *per se*. Rather, most of the interview describes activities to preserve the health of the cork oak forest (***regulatory objectives***) through wildfires and disease preventions.

A large portion of the interview described the structural issues associated with their extensive **afforestation** project, where they **artificially planted** a **mixed-species** forest composed of cork oak and downy oak at a ratio of 20/80. The ratio approach was originally described by their father and funded by a government grant (*tradition, resources, market instrument*). The grant funded estimated loss of income from agriculture and prohibited the implementation of **agroforestry** for 20 years (*public administration*). This conflicted with the typical regional approach to combine livestock, agriculture, and forestry – something the siblings support for traditional reasons and because they believe it a gentler method of management practically suited to the physiological conditions of forest regeneration in the area (*tradition*, *conservation, biophysical*). In addition, barriers emerged due to regional land use planning legislation excluding artificially planted cork forest from categorization as forest, thereby preventing access to forest grants for **cleaning and tending** the understory (*regulations, market instruments*). On the other hand, the siblings successfully registered their enterprise as a forestry company and are now eligible for forestry expense grants (*forestry networks*).

From this context, financial aspects were regarded as critical because of the high maintenance cost associated with a newly established cork oak forest that remains unprofitable until the first **NTFP cultivation** of cork, approximately 25 years after establishment (*resources, biophysical*). The siblings discuss various interwoven issues resulting from limited financial support. For example, that *regulations* prohibiting prescribed burnings in the understory resulted in the desire to invest in a chipper for mulching understory shrubbery and **fertilizing** their stands; however, they cannot afford the equipment (*resources*). The unstable price fluctuations for cork constrain the design of long-term management plans for **cork extraction** and **agroforestry activities**. According to the siblings, the issue is exacerbated by the scarcity of cork extractors, linked to the declining agroforestry traditions, both of which make it difficult to find experienced labourforce willing to perform the extraction work. This forces the siblings to go through cork traders that have their own cork extraction labor force. The monopolistic ownership of the labourforce gives the traders greater leverage to decide on extraction prices and creates further price instability (see: Annex C, Table 38).

Table 9. Italy 4 – Summary of factors influencing the forest practitioner's decisions.

	Resources	Traditionalist	Economizing	Conservationist	Climate wise	Information instrument	Market instrument	Public administration	Regulations	Timber markets	Forestry networks	Public pressure	Biophysical	Disturbances
Cultural services		✓												
Provisioning services	X	✓	✓				X	X		X	✓		X	
Regulating Services	X					X								X
Biodiversity				✓					X					
Carbon Sinks					✓									
Mixed species regeneration	X	✓					✓							
Artificial regeneration	X													
Afforestation							✓		X					
Deforestation													✓	
Development	X													
Agroforestry	X	✓		✓						X			✓	
NTFP Cultivation	X		✓				X						X	
Terrain preservation				✓										
Tending / Clearing	X						X		X		✓			
Fertilization / Liming	X													

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.

4.3.2.5 Italy 5.

The interview was conducted with a municipal public official responsible for land use management in the municipality. The work of the informant includes overseeing forest lands managed under a community cooperative. The cooperative totals 2000 hectares: 450 hectares are municipal forest lands of the interviewed municipality, and 350 hectares are privately owned. The remaining 1200 hectares are from the other involved municipalities (1000 hectares) and are privately owned (200 hectares). The cooperative totals 2000 hectares, with 1450 hectares of municipal forest land and 550 hectares are private forest land. Major objectives for municipal forest land include reinvigorating the regional economy by valorizing the production of cork, mushroom, and fruit (**provisioning objective**). Of equal significance is enabling recreation and tourism in the forest (**cultural objective**). These objectives require enhancing forest through the management of forest disturbances; but also addressing biodiversity conservation, water reservoir protection, and carbon sequestration through FSC forest certification (**regulating objectives**, *voluntary agreements*).

The interview is partially dedicated to contextualizing the impetus for the community cooperative. The decision stemmed from a combination of serendipitous factors. Essentially, the administration created a forest management plan for cork production in the municipal forest to facilitate the administration's future financial management (*resource, public administration*). This coincided with an Agricultural Ministry's funding call supporting territorial planning (*market instrument*). Two private forest companies associated with environmental planning approached the municipality and local forest owners to participate in the call (*market instruments, forest networks*). This required convincing private forest owners in the areas surrounding the municipal forest to join a cooperative by granting a minimum land area (*neighbors, regulation*). The municipal campaign highlighted the importance of creating a unified forest management plan tailored to the region (*information instruments*). Developing the cooperative forest management plan required administrative planning and consensus among the private landowners (*public administration, voluntary agreements*). The plan's feasibility required a lengthy research study conducted by a local forest technician prior to approval by the forestry department (*public administration, resources, information instruments*). From the municipality's perspective, the cooperative's forest management plan addresses barriers to the production of cork oak, including labor management and tendering issues (*resources*). Given the municipality's experience with managing private forests, the informant does not view the management of the cooperative forest as particularly challenging (*forestry networks*) but acknowledges a lack of experience in facilitating complex communication between private and public entities (*organizational factors*).

In terms of management activities, the civil servant discusses the municipality's approach to managing downy oak, holm oak, and cork oak forest. They reject the use of **coppicing**, citing the poor climatic conditions for the prevalence of downy oak and holm oak. The civil servant maintains that only **cleaning** and pruning of less productive trees is necessary (*biophysical*). The municipality also engages in the **development** of forest roads and firebreaks to mitigate wildfires (*disturbances*). Wildfire management was traditionally mitigated through the historic connection between **agroforestry** grazing and cork **cultivation** within the common municipal cork oak forest (*forestry networks, regulations*). The regional collapse of agricultural professions diminished grazing on common lands and increased the need to **develop** forest roads and firebreaks (*other markets*). In addition, the municipality established "green sites" for actively **clearing** underbrush.

On the other hand, the reduced pressure for grazing has diminished land use conflicts between herders (*resources*). The informant is adamant that municipal forest provides opportunities beyond cork production, hence the municipality continues to engage in the concession of common lands and ensures that these sites are well-maintained for citizen use (*public goods*). These cites continue to support grazing, and the extraction of mushroom and fuelwood. He notes however that fuelwood **cultivation** within common lands has diminished since the onset of the pellet stove (*timber market*). Meanwhile, mushroom **cultivation** lacks formal regulations, but the community adheres to a set of informal guidelines (*regulations*).

Table 10. Italy 5 – Summary of factors influencing forest practitioners' decisions.

	Organizational factors	Resources	Economizing	Utilitarian	Conservationist	Information instrument	Voluntary agreement	Market instrument	Public administration	Regulations	Timber markets	Other markets	Forestry networks	Public goods	Neighbours	Biophysical	Disturbances
Cultural														✓			
Provisioning	✓x	✓x	X			✓	✓	✓x	✓	✓x	✓x		✓	✓	✓		
Regulating		✓		✓			✓										X
Biodiversity	✓						✓		✓								
Carbon																	
Development												✓					✓
Agroforestry		✓								✓		X	✓				
Coppicing (opposed)																X	
NTFP Cultivation							✓			X							
Tending / Clearing																✓	✓

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.

4.3.2.6 Italy 6

The interview was conducted with a municipal public official responsible for the land use management of a municipality. The work of the informant includes overseeing forest lands managed under a community cooperative. The cooperative totals 2000 hectares: 1000 hectares are municipal forest lands of the interviewed municipality, and 200 hectares are privately owned. The remaining 800 hectares are from the other municipality involved (450 hectares) and are privately owned (350 hectares). The cooperative totals 2000 hectares, with 1450 hectares of municipal forest land and 550 hectares are private forest land. The primary objective of the municipality is to enhance the overall value of the municipal territory through active participation in securing funding opportunities to implement forest management initiatives (*organizational, economizing, market instruments*). The forest management initiatives include participating in the cork oak forest cooperative (**provisioning objective**) and community activities that support traditional land-use and recreation (**cultural objective**). Maintaining forests free from disease is also a key concern (**regulating objective**).

A large portion of the interview discussed the evolution of the municipality's participation in the cork oak forest cooperative [for more information see: Annex C, table 40]. The informant discusses challenges with creating partnerships between the private and public sectors (*information instruments*) and convincing owners to join the cooperative (*neighbors, public pressure*). The need for a cooperative result from challenges with permitting and streamlining cork extraction (*public administration, regulation, timber markets*). Forest legislation requires that the municipality extract 30% of their cork (*regulations*) but there are few professional cork extractors (*timber market*). The professional decline is blamed on the collapse of the local dairy industry, as cork extractors were typically local shepherds that obtained a secondary income from cork production (*other markets*). On the positive side, the informant believes the recent increase of cork prices is a positive sign (*timber market*). In the meantime, the cooperative sustains itself with funding from the Ministry of Agriculture (*market instruments*)

In terms of management activities, the municipality implements **coppicing** and **natural, mixed regeneration** within the downy oak and holm oak forest. No elaboration is given as to why these intervention methods are preferred, only that they are implemented to support forest health and productivity (**regulatory objectives**). There is ongoing **pest control** of *Coroebus florentinus* through mechanical treatments implemented with the help from research organizations (*forestry networks*, *disturbances*). Meanwhile, **selective cutting** of unvaluable or unhealthy trees are implemented within the legally defined common lands so citizens can readily engage in **agroforestry** (e.g., grazing and crop cultivation), timber harvesting, or recreational activities (e.g., hiking and camping) (*regulations, public goods*).

The largest barrier to these management activities occurs in the forest areas previously managed by a defunct state-owned company in charge of implementing forest intervention, developing the construction of ditches and fences, and granting public concessions. The liquidation of the company resulted in management responsibilities falling on the municipality who remains without necessary resources to implement these activities (*resources, public administration*). Despite the financial difficulties, the municipality views itself as actively supporting the community by **developing** forest trails that showcase archaeological projects – this is supported by European Union Rural Development Grants acquired through Local Action Groups (*organization*, *market*

instruments, *forestry network*). Given the recent collapse of the livestock farming, the municipality is also adamant about supporting younger generations interested in continuing with **agroforestry** and agricultural practices within common lands (*organization*, *other markets, public goods*)

Table 11. Italy 6 – Summary of factors influencing the forest practitioner's decisions.

	Organizational factors	Resources	Information instrument	Market instrument	Public administration	Regulations	Timber markets	Other markets	Forestry networks	Public goods	Public pressure	Neighbours	Disturbances
Cultural objectives	✓			✓			X			✓		X	
Provisioning objectives	✓	X	✓	✓	✓X	✓	✓	X	✓X	✓	X	✓X	
Regulating objectives	✓			✓					✓	✓		X	
Biodiversity				✓									X
Climate													
Natural regeneration	✓												
Artificial regeneration	✓												
Monoculture regeneration	✓												
Mixed species regeneration	✓												
Development	✓			X									
Agroforestry	✓							X		✓			✓
Pest control									✓				
Coppicing	✓												
NTFP Cultivation						✓	X	X					
Tending / Clearing				✓					✓				X

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.

4.3.3 Latvia

4.3.3.1 Latvia 1.

The interview was conducted with a small-scale private forest owner managing 2 hectares of pine dominated forest with spruce as a secondary species. The property was obtained through restitution after Latvia's Land Reform Act. The informant and her family live on the plot and express that the forest property is their home. As such, the main forestry objectives centre maintaining the natural environment for personal use (*cultural objectives*). There is no desire to profit from the forest by any means, including timber or otherwise. She is also aware that national forest law prohibits felling timber in her property due to the mandatory rotation lengths of over 100 years for pine forest (*regulation*).

Overall, few management activities are implemented in the forest. Only approaches perceived to benefit forest resilience or health are viewed acceptably (*conservationist*). For example, after obtaining the property, the family *afforested* a small half-hectare parcel of abandoned farmland with pine (*conservation value*) and reforested the areas that were partially harvested. *Monospecies regeneration* was undertaken because the land was perceived to have poor soil quality (*biophysical*). In addition, Latvian forestry law prohibits the regeneration of species other than pine due to a soil classification system that predetermines permissible species (*regulations*).

Since the regeneration activities, the family has only engaged in *game management* and *stand tending*. *Game management* is perceived necessary to prevent overgrazing on the stand (*conservation value, biophysical*) and occurs with the help of a local hunting association (*forestry network*). Stand tending is implemented to improve the scenery and recreational opportunities and fuelwood to the family (*utilitarian values*). The family implements tending without contractors since the plot is small and they live nearby (*resources*). Forest management capacitation is provided by the local forest service (*forestry networks*). *Clearcutting* is viewed poorly but she is willing to *salvage log* if necessary. This acceptance for salvage logging may be linked to the stand's propensity for bark beetle outbreaks (*disturbance regimes*), which the respondent blames on the large quantity of *deadwood* retention taking place in the bordering national park (*neighbours*). Thus, the informant disapproves of *deadwood* and thinks the local administration should intervene with the park's policies (*public administration*).

Ultimately, the only management activities perceived approvingly are those associated with *regeneration*, *afforestation*, *wildlife management*, *stand tending*, and *salvage logging* (when strictly necessary). She is dubious about new practices because she believes "*nature takes care of everything naturally*". She is not a passive owner but instead places a high degree of importance on values during the decision-making process (i.e., best method to conserve forest; what is best for the family). Notably, conservation values are important, but climate change was undiscussed. Therefore, resilience is not necessarily perceived to include adaptation, although this is an important dimension of forest resilience. Ultimately, the informant values and beliefs lead to an active decision to implement few management activities.

Table 12. Latvia 1 – Summary of factors influencing the forest practitioner's decisions.

	Resources	Conservation (values)	Utility (values)	Tradition (values)	Public admin.	Regulations	Forestry networks	Neighbours	Bio-physical	Disturbances
Cultural objectives			✓	✓						
Provisioning objectives			✓			✕	✓			
Regulating objectives			✓						✓	
Monospecies regeneration						✓			✓	
Mixed species regeneration		✓				✕			✕	
Afforestation		✓								
Wildlife management			✓				✓		✓	
Salvage Logging									✓	
Clearcutting (opposed)		✕								
Deadwood (opposed)				✕	✕			✕		✕
Tending / Clearing	✓	✓	✓				✓			

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.

4.3.3.2 Latvia 2.

The interview was conducted with a private forest owner holding 450 hectares of forest in Latvia. The first forest plot was purchased in 2002, with an additional 20 plots purchased since the original purchase. The informant is a forestry expert both by education and profession. The main objective of the forest is **provisioning timber** for profit (*economizing*), although some scenic plots of are sets aside from harvesting for recreational use by the family (*utilitarianism values*). In this sense, these personal areas provide **cultural benefits** for the family.

As a large-scale forest owner focused on provisioning timber for profit, the informant points to adequate forest machinery and labor force (*resources*) as the key factors necessary for implementing management objectives. Knowledge acquired through forestry professionals like university researchers (*forestry networks*) improve management decisions; however, the ultimate decision is still made according to her own knowledge (*resources*). The informant explained she respects sustainable forestry issues and believes multifunctional objectives are possible when the characteristics of the plot are appropriate (*biophysical*). She does not specific outright which activities aim to support multifunctional objectives; however, she mentions that timber is harvested predominantly by *clearcutting* and that some *selection cutting* occurs. It is possible that the implementation of *selection cutting* is one such activity supporting her multifunctional objectives.

It is worth noting that management activities typically associated with preserving biodiversity (e.g., *set aside areas, deadwood,* r*etention trees*) are in part legally mandated (*regulations*). Furthermore, she discusses that some *set aside* areas are unmanaged due to challenges in accessing the sites (*biophysical*) and that *deadwood* accumulates naturally rather than being an intentional objective (*biophysical*). From this perspective, activities supporting "multifunctionality" are primarily implemented out of convenience. This logic also appears to drive the ongoing *afforestation* that aims to consolidate the several forest properties she purchased (*resources*) – navigating Latvian forest law is easier if the property is a single forest (*regulations*). The consolidation also permits *deforestation* if it does not lead to a net-loss of forest area (*regulation*).

Ultimately, this owner's primary objective is timber for income. *Knowledge*, *economizing*, and *resource availability* predominantly guide the decision-making process. Arguably, the uptake of multifunctional objectives (e.g., enhancing biodiversity) are due to *regulations* more so than intrinsic *environmental values*. This framing is corroborated by 1) stated unwillingness to implement CSF activities deemed costly (*economizing*) and 2) beliefs that conservation is not readily implemented by forest owners due to limited funding mechanisms (*market instruments*).

Table 13. Latvia 2. – Summary of factors influencing the forest practitioner's decisions.

Private forest owner 450 hectares Purchased	**Regulations**	**Economizing(values)**	**Utilitarianism (values)**	**Market instruments**	**Resources**	**Bio-physical**
Cultural services			✓			
Provisioning services		✓	✕		✓	✕
Regulating services	✓				✓X	✓
Biodiversity	✓			✕		✓X
Natural regeneration	✓					
Afforestation	✓				✓	
Deforestation	✓				✓	
Forest edges (uneven)						✕
Set-aside areas	✓			✕		✓
Retention trees	✓					
Buffer zones	✓					
Deadwood	✓					✓
Thinning					✓	
Tending / Clearing					✕	
Wildlife management						✓
Clearcutting*						
Selection logging*						

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.

4.3.4 Netherlands

4.3.4.1 Netherlands 1.

The interview was conducted with a private consultant managing 380 hectares of publicly owned municipal forest in the Netherlands. The municipal administration has multifunctional objectives (***cultural, regulatory, provisioning***) with goals including sustaining biodiversity, enhancing forest resilience and soil health, capturing CO_2, provisioning timber, and providing the public with recreational activities and nature education. Biodiversity is stated as the most important municipal goal (*public administration*). Notably, several of these activities coincide with the regulatory directives associated with participation under the Dutch National Ecological Network and the NATURA 2000 bird and habitat directive (*regulations*).

In terms of management activities, the municipal administration supports **continuous cover forestry** of **mixed species forest** through targeted **selective cuttings.** The administration is opposed to **clearcutting** (*public administration*). According to the informant, continuous cover forestry supports forest resilience and biodiversity (*climate-wise*, *conservationist*). Possession of chainsaws, a small crane, tractor, and GPS equipment facilitate these management activities. In addition, carrying out the work in-house without subcontractors is perceived to facilitate responsible management, like **terrain preservation**. The downside is that small scale interventions are more expensive than using harvesters or forwarders (*resources*). There are also ongoing rock flour **fertilization** projects implemented with partnering institutes and funded by national grants (*forestry networks, market instruments*). As the informant sees it, collaborative demonstration sites facilitate knowledge exchange on management alternatives supporting multifunctional objectives.

The informant is clear to delineate that there are no **set aside areas** free of management – "*they are not a forest reserve*" – as there should always be an opportunity to harvest high quality timber to support the local economy (*public administration*, *economizing, public good*). However, some old growth areas are [at least for the foreseeable future] protected to provide refuge for biodiversity (*conservationist*). In addition, the municipality has given the informant sufficient leeway to pursue activities he deems beneficial to the forest. In one example, the informant toys with an idea to implement a project where wooden poles from old cities are brought to the forest as **deadwood** (*conservationist, organization*).

Table 14. Netherlands 1 – Summary of factors influencing the forest practitioner's decisions.

	Climate-wise	Utilitarianism	Economizing	Conservationist	Public goods	Public pressure	Organizational factors	Public administration	Resources	Market instruments	Forestry Networks	Timber markets	Regulations
Cultural		✓			✓	✓							
Provisioning		✓	✓		✓		✓		✕				
Regulating	✓			✓	✓				✓		✕		
Biodiversity										✓	✓		✓
Carbon Sinks	✓						✓						
Adapted species				✓									
Development					✓	✓							
Selection Cutting				✓					✓				
Clearcutting								✓X					
Forest edges				✓									
Set-aside areas (opposed)			✕	✓				✕					
Terrain preservation							✓		✓				
Deadwood											✓		
Continuous cover forestry	✓			✓			✓		✓				
Fertilization / Liming										✓	✓		
Mixed species regeneration*													
Retention trees*													

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.

4.3.4.2 Netherlands 2.

The interview was conducted with a municipal civil servant managing 1400 hectares of publicly owned municipal land in the Netherlands. The forestland is situated on 1200 hectares of dry sandy soils and there are an additional 120 hectares of heather fields. Objectives of the forest include producing timber to support *public administrative* costs (***provisioning objective***) enhancing soil quality and forest resilience (***regulatory objective***), and sequestering CO_2 (***climate objectives***). The informant maintains that ***regulatory objectives*** come before ***provisioning objectives***. Importantly, the informant shares that management decisions are made according to their own judgement, therefore *agent-based values* impact the decision-making alongside *organizational factors*.

Several of the ongoing management activities aimed at improving forest resilience are responses to previous management interventions (*biophysical*). The previous management regime included **monoculture** rotations of 80 years, while the current administration is engaged in integrative forest management to support forest resilience (*public administration*). To support forest resilience the informant attempts to rejuvenate monoculture stands by **regenerating mixed species**. However, there is a natural tendency for pine **monocultures** to propagate given their adaptability in sandy soils with low pH. As a result, the informant is experimenting with different approaches to shift the regime towards mixed-species forest. In one example, she describes how the **salvage logging** due to acid rain (*disturbances*) resulted in a 9-hectare, even aged pine stand. The informant experimented with rejuvenating 2-hectares of the stand through **clearcutting** and promoting **natural** and **artificial mixed species regeneration** of deciduous trees. The 2-hectare clearing caused scorching of the deciduous seedlings, and she believes also released large quantities of CO_2 emissions (*biophysical*, *climate wise*). Ultimately, she does not believe these activities were suitable approaches, but struggles with how to proceed (*resources*). On the one hand, there is a desire to experiment further with small-scale interventions and on the other, she acknowledges that the soil quality is untenable for deciduous shade tolerant species (*biophysical*). She hopes to enhance soil quality by **regenerating adapted** litter rich-species and implementing **rock flour fertilization**. She believes that improving soil quality indirectly supports biodiversity enhancement and contributes to CO_2 capture (*conservationist, climate-wise*). Some of these activities are funded by national grants (*market instruments*).

Apart from the rejuvenation experiments, management activities include **clearcutting regimes** wherein plots are delineated for felling according to tree species and age, with plots varying between 1 to 9 hectares. She appreciates that harvest occurs "in-house" because her colleague is familiar with the forest and avoids **damaging the terrain** (*organizational*). While implementing **natural regeneration** with **mixed species**, they clear approximately one-third of the plot to give space to the regenerating species. She believes mixed species forest enhances forest resilience (*conservationist*). They practice **wildlife management** by lacing casings around the seedlings to reduce grazing pressure from deer (*biophysical*). They do not resort to hunting. Other activities require the employment of contractors. In the case of small scale **tending and clearing,** they hire help from a local "care farm" that employs disabled workers (*public good*). The heather fields are managed through sheep grazing with the support of national grants (i.e., **agroforestry***, market instruments*). Plots exhibiting degradation are appointed as **deadwood** islands and retained; however, if an ecological tipping point is observed, she would reconsider this practice

(*biophysical*). Importantly, she acknowledges deadwood retention is the only activity directly supporting ***biodiversity objectives*** in the administration (*conservationist*).

Table 15. Netherlands 2 – Summary of factors influencing the forest practitioner's decisions.

	Organizational factors	Resources	Climate-wise	Conservationist	Market instruments	Public Administration	Public pressure	Public goods	Neighbours	Forestry Networks	Regulations	Timber markets	Biophysical	Disturbances
Cultural				X			✓							
Provisioning	✓×		✓		✓	✓×						✓		
Regulating	✓	X		✓	✓	✓×		X	X	✓	X		X	X
Biodiversity				✓	✓						✓		X	
Carbon			✓	✓										
Monospecies regeneration						✓×							✓	
Mixed species regeneration	✓			✓									✓	
Natural regeneration	✓													
Adapted species				✓									✓	
Agroforestry					✓									
Wildlife management		X												✓
Salvage Logging			X										X	✓
Deadwood	✓												✓	
Terrain preservation	✓			✓										
Fertilization / Liming					✓					✓			✓	
Buffer zones	✓													
Thinning	✓													
Clearcutting	✓													
Artificial regeneration*														

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.

4.3.4.3 Netherlands 3.

The interview was conducted with the manager of a 3000 hectares forest in the Netherlands owned by a private foundation. The foundation wishes to preserve the historic objectives of the founding father, including preserving the character of the area, providing an aesthetic recreational area for visitors who pay to see the park (***cultural objective*****,** *economizing*), and maintaining and enhancing the ***biodiversity*** of the area *(organization)*. Notably, climate objectives are not stated outright but are believed to follow indirectly through biodiversity management. The informant believes the foundation is a forerunner in biodiversity conservation (*conservationist*) and maintains that timber **provisioning** is not an objective but a byproduct of restoration work; however, she acknowledges that budgeting limits the restoration activities carried out (*resources*). Nevertheless, the organization is eligible for the national Nature and Land Subsidy and previously benefitted from subsidies supporting the **pest control** of bark beetles (market instrument).

In terms of management activities, the informant explains they apply the *toekomstbomen*[6] system, where worthwhile trees are promoted through successive **thinning** operations. Trees are promoted for their commercial quality[7], aesthetics, or biodiversity characteristics (*economizing, utilitarian, conservationist*). The foundation supports **selective cuttings** and opposes the historic use of **clearcutting,** except in the case of drastic *disturbances* forcing **salvage logging** *(organization)*. **Selective cuttings** take into consideration multiple stand criteria and only experienced managers with extensive knowledge guaranteed to provide continuity to forest treatments may mark trees for **selective cutting;** this work is further supported through GIS-systems enabling long-term learning from past management activities (*resources, organization*). The **selective cutting** approach is preferred due to the historically unsuccessful [**mixed species**] **regeneration** of broadleaves resulting from high browsing pressure and poor sandy soil conditions favouring pine **monocultures** (*biophysical*). From another perspective, the informant believes **selective cuttings** keeps the soil microclimate intact thereby reducing soil carbon decomposition and emission (*climate wise*).

Some 86% of the forest is dominated by pine but the foundation wishes to increase the diversity of tree species in the park to support forest adaptation (***regulatory objectives*****,** *organization*). In response, the manger works to regenerate the forest by regenerating exotic **adapted species** and litter rich species. She also cooperates with scientists to soil **fertilization** through soil transplants and rock flour (*forestry network*). However, high browsing pressure by deer present an additional limitation requiring that **wildlife management** occur through the **development** of costly fences that must remain in place to protect the slow growth regeneration for at least 20 years (*biophysical, resources*). In addition to active management, about two percent of the forest land is **set-aside** – this occurred organically, and the *organization* adopted it as an official measure.

[6] Toekomstbomen: is also known as a "crop tree". For more information see Miller et al. (2007).
[7] This is somewhat at odds with previous statement that provisioning is not an objective but a byproduct of restoration works.

Table 16. Netherlands 3 – Summary of factors influencing the forest practitioner's decisions.

	Organizational factors	Resources	Economizing	Utilitarianism	Climate values	Conservationist	Traditional values	Market instruments	Market factors	Forestry Networks	Biophysical	Disturbances
Cultural	✓		✓	✓			✓					
Provisioning			✓			✓						
Regulating	✓	✓×				✓				✓	X	X
Biodiversity	✓					✓	✓					
Carbon					✓	✓			X			
Mixed species regeneration					✓	✓					X	
Adapted species												
Wildlife management		X									✓	
Pest control								✓				
Salvage Logging												✓
Selection Cutting	✓				✓						✓	
Clearcutting	✓											
NTFP Cultivation									X			
Set-aside areas	✓			✓								
Fertilization / Liming										✓		
Thinning			✓	✓		✓						
Terrain preservation*												
Tending / Clearing*												

X: represents factors hindering the management activity. ✓: represents a factor enabling the management activity.

4.3.5 Portugal

4.3.5.1 Portugal 1.

The interview was conducted with a forest owner holding various dispersed plots totaling approximately 10 hectares. The plots originally belonged to the grandfather and were inherited after death of parents in 2016. The plots include even-aged monoculture stands of eucalyptus, stone pine, walnut, and white poplar. There is a mixed stand with cork and strawberry[8] trees. The owner's main objectives are producing income from forest goods (***provisioning objectives***), utilizing the land for recreation, and preserving the family history and land for future inheritance (***cultural objectives***).

The informant aims to derive income from timber, as well as **NTFP cultivation** of cork, walnuts, and pine nuts (*economizing*). No harvesting or regenerations activities were implemented since the stands have not reached optimal rotation age since acquiring the inheritance (*biophysical*). Similarly, the stone pine stand has not produced any harvest (*biophysical*). Ongoing management activities include **coppicing** and **fertilization** of the Eucalyptus stands, **thinning** of the stone pine stands, mechanical weeding of walnut stands to avoid pesticide use (*conservation value*), and legally mandated bush ***cleanings*** to prevent the risk of forest fires (*disturbances, regulations*). Sometimes external laborers are contracted to carry out these operations (*resources*). Occasionally, she receives free or reduced cost assistance for **bush cleaning** operations from the local forest owner associations who manage Forestry Intervention Areas[9] (ZIFs) (*forestry network*). She prefers contracting forest sappers from her local forest owners associations because after being fined for not cleaning her stands according to regulations, she perceives they have the most updated knowledge on policy and regulations (*market instruments*, *resources*).

She openly acknowledges that she does not have active ***biodiversity objectives***, although she understands the value of forests to biodiversity. For example, she recognizes that Eucalyptus is not the best tree for biodiversity. She is more concerned with ***climate change*** and the future productivity of the forest (***regulatory objectives***, *climate-wise, conservationist*). In the future, she is willing to reforest stands with species she perceives as **adapted** to climate change if there are economic incentives to support this activity (*economizing, market instruments*). She perceives that **native species** are more adapted than hybrid species based on her own observation that the hybrid walnut stands planted by her father are suffering from increased beetle *disturbances* (*climate wise*).

[8] Strawberry trees, also known as chorleywood in the UK,
[9] For more information about Forest Intervention Areas, see: FOALEX (2024).

Table 17. Portugal 1 – Summary of factors influencing the forest practitioner's decisions.

Private forest owner 10 hectares Inheritance	Resources	Economizing	Utilitarianism	Climate-wise	Conservationist	Traditional values	Information Instruments	Market instruments	Regulations	Timber markets	NTFP markets	Forestry Networks	Public pressure	Neighbours	Bio-physical	Disturbances
Cultural			✓			✓										
Provisioning	✓	✓	✓					✓X		✓	X	✓			X	
Regulating					✓		X	✓				✓	X	✓		✓X
Carbon		X		✓				X								
Biodiversity				X					✓			✓				
NTFP Production		✓						X				✓			X	
Coppicing																
Thinning	✓X							X	✓							
Tending/Clearing	X				✓		X	✓	✓			✓	✓	✓		✓
Fertilization								✓								
Adapted species		X		✓												X
Native species				✓												
Natural regeneration						✓										

X: represents factors hindering the management activity. ✓: represents a factor enabling the management activity.

4.3.5.2 Portugal 2.

The interview was conducted with a forest owner holding 40 hectares of forest in Portugal. His grandparents were the original landowners and forest stands planted by them are still visible today (*traditional values*). His primary objective is to use the forest as a complementary source of income from eucalyptus and stone pine nuts and domestically consuming firewood (***provisioning objective***). Since he lives on the property, he finds various enjoyments in the land, such as planting a small arboretum of **native** and **exotic** cultivations to teach himself which species are adapted to the area (*utilitarianism, resources*). In other words, he experiences nonmaterial benefits that enrich his life and knowledge (***cultural objective***). He does inherently support **biodiversity** or **climate objectives** and expresses a negative outlook on implementing such activities without compensation. He supports PES and believes he should be compensated for the carbon sequestration services in his forest (*economizing, resources, market instruments*).

In terms of forest management, he has various forest plots with varying management activities. There is a strip of Stone pine he maintains to isolate his home (*utilitarian*). When he finds cork oak growing spontaneously in parts of the property he wants for other tree species rather than cork, , he **clears** it from the understory as soon as he notices them. Two eucalyptus plots previously rented to forest industries are managed via **coppicing** and require reforestation or reconversion as they reach their final rotation (*biophysical, timber markets*). He plans to **clearcut** these eucalyptus stands. He converted a Maritime pine plot to Eucalyptus based on previous experiences with citrus fruits that were troublesome and less profitable (*economizing, resources*). He is also concerned about reforesting with Maritime pine due to previous issues with Nematode roundworm that resulted in **salvage logging** (*disturbances*) – one Maritime pine plot remains uncultivated. He planted a Stone pine plot because he believes it is an **adapted species** able to outcompete invasive *Accacia spp.* while providing high revenue from the **NTFP cultivation** of pine nuts (*economizing, biophysical*). However, he is concerned about planting more Stone pine due to an ongoing pest attack that forced him to **salvage log** some of the trees (*disturbances*). Apart from these actively managed areas, he owns [**set aside**] uncultivated lands with *Acacia spp*. – he perceives these to have no utility and wants to develop the land for production once he has more money (*economizing*, *resources*)

Apart from current management activities, the interviewee shares several thoughts for diversifying the uses/activities in the future, so long as they yield a feasible income (*economizing*). Most of these considerations include whether to change the land use of his property in response to projected economic gains agricultural production-, renewable energy production-, and eco-tourism-. The only case in which *afforestation* is considered in lieu of deforestation is to support an eco-tourism activity that render a higher income than the timber industry [For more information, see: Annex C, table 31].

Table 18. Portugal 2 – Summary of factors influencing the forest practitioner's decisions.

	Resources	Economizing	Utilitarianism	Conservation	Traditional	Market instruments	Public administration	Regulations	Timber markets	NTFP market	Other markets	Forestry networks	Public goods	Public pressure	Biophysical	Disturbances
Cultural	✓	✓	✓		✓		✓			✓				X		
Provisioning	✓X	✓X	✓		✓	✓X			✓X		X	X	✓			
Regulating						X									✓X	
Biodiversity		X		✓		X		✓X								
Carbon Sinks						X										
Adapted species		✓	✓			X									✓	✓
Salvage Logging																✓
Clearcutting															✓	
Unauthorized access							✓							✓		
NTFP Cultivation	X	✓				X										
Set-aside areas	X	✓		✓		X		✓								
Tending / Clearing								✓								
Deforestation*																
Coppicing*																

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.

4.3.5.3 Portugal 3.

The interview was conducted with a private forest owner holding three half-hectare plots of forest in Portugal. She inherited the property at the age of seven and obtained legal rights when she became eighteen years old. The plot consists of a Maritime pine stand originally planted by the grandfather – a professional resin extractor – when the region produced crude resin from this species (*tradition*) for the export markets. The second plot contains various species like walnut, olive, almond, and strawberry trees.

The property was historically managed by the father who views the land as an important family property (*traditionalist*). Unlike her father, the interviewee lacks an emotional connection to the land and finds the property a troublesome source of work (*resources*). She explains that her objectives were those of her father. She recalls when he ***provisioned*** olives for olive oil and informally gave full usufruct of the land to a worker who tended the forest (*forestry network*); Today, the only management activity includes mandatory **bush cleaning** required by national legislation (*regulations*). Up to recently, her father implemented this intervention because he owns a house nearby, which he often visits. In addition, he owns the necessary tractor to implement the intervention. However, he cannot continue with the activities due to his age (*resources*).

The future use of the land is a source of anguish for the interviewee. She oscillates between selling the land and finding it an alternative use. In fact, she and her father recently tried to sell the land but did not receive a viable offer relative to the regional increase in land value (*economizing, other markets*). Her uncertainty in selling the land also stems from her awareness that the region is experiencing **deforestation** and changing land use away forest to either real estate development or high-value agricultural production; she sees this as a threat to her forest, the ecosystem services provided by her forest (e.g., carbon sequestration) and the loss of regional tradition and culture (*climate-wise,* traditionalist). Hence, she opposes any **deforestation** resulting from selling her land (*public pressure, other markets*). To make matters worse, she is aware that her property is zoned under the Council Development Plan that permits development of the land for the built environment (*regulations*). Lamentably, she notes her neighbors converted their forest to vineyards and blueberry production causing the forest area to fragment (*neighbors*). She wishes she could pass the forest management to a local forest owners association, but she is not aware of any such opportunities (*forestry networks, voluntary agreements*). She reflects on the possibility of **developing** a tiny eco-home on the property for herself and children but acknowledges this is rather farfetched given the distance between her forest and her primary residence (*resources*). Arguably, this owner would theoretically support both ***cultural*** and ***regulatory objectives*** due to her *conservationist* and *traditionalist* attitude.

Table 19. Portugal 3 – Summary of factors influencing the forest practitioner's decisions.

Private forest owner 1.5 hectares Inherited	**Resources**	**Economizing**	**Conservationist**	**Traditional values**	**Timber market**	**NTFP cultivation**	**Voluntary Agreements**	**Market instruments**	**Regulations**	**Other markets**	**Forestry Networks**	**Public pressure**	**Neighbours**
Cultural objectives	X			✓X									
Provisioning objectives	✓X	✓X	✓	✓	✓					✓			
Regulating objectives	✓X	✓	✓	X			X				X	X	
Biodiversity	✓X								✓X				
Carbon Sinks								X					
Tending / Clearing	✓X												
NTFP Cultivation	X		✓	✓									
Deforestation			X						✓	✓		✓	✓
Developing	X												
Thinning	X												

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.

4.3.6 Romania

4.3.6.1 Romania 1.

The interview was held with a forest practitioner who works for a private company owning 7000 hectares of forest in Romania. The land was acquired after restitution and afterwards sold to a private company. The land was purchased by the company's owner to generate a viable long-term revenue through high-quality timber (***provisioning objectives***). This approach emphasizes sustainable management (***regulatory objectives***). ***Biodiversity*** is not a primary objective, and to the chagrin of the owner, part of the site came under legislative mandates to protect biodiversity; however, the company is able to collect compensation for this income loss (*market instruments*, *regulations*). In addition, 300 hectares of the forest are **set aside** to protect scenery the owner finds beautiful – this indirectly promotes biodiversity conservation (***cultural objectives***, *utilitarian)*.

Most of the forest are characterized as deciduous, with mixed stands at high altitude and sessile oak at lower altitudes. The forest is primarily managed with **natural regeneration** under **shelterwood**. In some cases, **continuous cover forestry** is applied (i.e., irregular **shelterwood**). **Coppicing** only occurs on a nonsignificant area comprised of black locust plantations (*regulations*). They carry out legislatively mandated restoration activities the owner believes will support climate change adaptation (*regulations, climate-wise*). In their case, this includes restoring **monoculture**[10] hornbeam stands towards a **mixed** deciduous forest with oak species. The typical approach to this would include **clearcuttings** followed by regeneration**,** but the owners oppose this in lieu of **shelterwood** with **natural regeneration** of oak because they believe **shelterwood** better emulates the natural behavior of the forest (*conservationist, social pressure*)

Romanian forest law also mandates a variety of activities to support environmental services (*regulatory*). This includes the **preservation of terrain** by preventing erosion, landslides, and protection of water catchments. According to the informant, terrain preservation and soil health are likewise key values of the owner because the owner perceives these aspects as fundamental to sustainable forest management (*conservationist*). For this reason, the owner also supports the certification of their forest, wishing to prove the sustainable management of their forest (*public pressure, conservationist, voluntary agreement*). The informant explains the certification has yet to provide added value to their timber, although they may receive better prices in the future (*timber markets*).

[10] Note these hornbeam monocultures should not be confused with artificially regenerated monoculture plantations. They developed from an attempted mixed natural regeneration with hornbeam and oak species; however, hornbeam is extremely competitive and due to inappropriate and untimely tending operations ultimately excluded the oaks from the mixture.

Table 20. Romania 1 – Summary of factors influencing the forest practitioner's decisions.

	Resources	Economizing	Utilitarian	Climate-wise	Conservationist	Voluntary agreement	Market instruments	Regulations	NTFP market	Public goods	Public pressure
Cultural objectives			✓								
Provisioning objectives		✓									✓
Regulating objectives				✓		✓	✓	✓		✓	
Carbon	✓			✓					X		
Biodiversity			✓			✓		✓			
Monoculture regeneration (opposed)				X				X			
Mixed regeneration								✓			
Natural regeneration				✓							
Native species				✓							
Shelterwood					✓						
Clearcutting					X						✓
Coppicing											
NTFP Cultivation	✓								X		✓
Set-aside areas			✓			✓	✓	✓			
Retention trees						✓					
Terrain preservation					✓			✓			
Buffer zones					✓	✓					
Deadwood						✓					
Continuous Cover Forestry											
Stand rotation		✓						✓			

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.

4.3.6.2 Romania 2.

The interview was conducted with a forest manager responsible for 15,000 hectares of municipal forest. The forest is primarily described as a mixed deciduous-conifer forest (i.e., European beech with Silver fir and Norway spruce), with pure spruce forests at upper altitudes, and mixed beech-sessile oak forest down below. Management objectives center **cultural objectives** like the developing recreational services and ensuring citizens the possibility to provision fuelwood from the forest (*public goods, social pressure*). In addition, the municipality wishes to support various ***regulatory objectives*** and must engage in the provisioning timber to cover administrative costs (***provisioning objectives***).

In terms of management activities, all forests are managed under a high forest regime, meaning **natural regeneration** under a **shelterwood** system. The dominant approach is group shelterwood with natural regeneration. The drivers for these activities are not stated within the interview; however, Romanian forestry legislation mandates natural regeneration under shelter for most forest types. On the other hand, the informant explains that they also implement **continuous cover forestry** through **natural regeneration** under **irregular shelterwood**. The purpose is to enable ecosystem services (e.g., recreation) (*public pressure*) and the approach is supported by collaborations with forest researchers (*forestry networks*). **Clearcutting** is an exceptional activity occurring only where legally permissible (i.e., pure spruce stands but limited to 3 ha and forbidden on steep slopes) (*regulations*).

A variety of activities associated with the protection of the forest's regulatory functions are discussed. Forest managers have **set aside** 437 hectares of old-growth forest, while national and international legislations impose an additional 1160 hectares (*organization*, *regulations*). National legislations also mandate the **protection of terrain** through soil protection on slopes, water protection over catchment areas, and air quality protection (*regulations*). Some of these activities overlap with the administration's decision to pursue forest certification. The underlying motivation for this decision was to signal they are performing sustainable forest management (*public pressure*). The certification requires the implementation of **buffer zones** around bodies of water, **deadwood** retention, and the **protection of terrain,** specifically soil protection (*voluntary agreement*)**.**

In addition to protecting the forest's regulatory functions, the *organization* actively seeks to purchase neighboring marginal farmlands for the purpose of **afforestation** and increasing municipal forestland; however, this activity is limited by lack of funds and a complex financing mechanism that relies on income from timber sales and land purchase approvals by the local council (*resources, organizational, public administration*). The access to funds is an especially key factor in decision-making. For example, access to public grants has supported the **development** of forest roads and a tree nursery. On the other hand, as the municipality constitutes a public entity, the mechanisms for national public funding resulted in the municipality's ineligibility to receive national funds for compensation of economic losses resulting from national legislation.

Table 21. Romania 2 – Summary of factors influencing the forest practitioner's decisions.

	Organizational	Resources	Traditionalist	Voluntary agreement	Market instrument	Public administration	Regulations	Other markets	Forestry networks	Public goods	Public pressure	Biophysical
Cultural objectives			✓			✓			✓	✓	✓	
Provisioning objectives	✓									✓		
Regulating objectives	✓	X			X		✓		✓	✓		
Biodiversity	✓			✓			✓					
Climate				✓			✓					
Native species							✓					
Afforestation	✓	X				✓	✓			✓		
Development					✓				✓			
Wildlife management*												
Pest control									✓			
Shelterwood							✓					
Selection Cutting												✓
Set-aside areas	✓						✓					
Terrain preservation				✓			✓					
Buffer zones				✓								
Deadwood				✓								
Continuous cover forestry									✓			
Stand rotation							✓					

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.*No specific factors given for wildlife management but stated to support regulatory objectives.

4.3.6.3 Romania 3.

The interview was conducted with a forest manager responsible for 10,000 hectares of state-owned forest. The informant frames the main objectives of the forestry department to be in line with those of the state. This includes balancing ***regulatory objectives*** (e.g., maintaining and/or restoring the natural forest type of the forest, protecting soil and water ecosystem services, maintaining the ecological balance of the forest), ***cultural objectives*** (e.g. ensuring recreational activities), and ***provisioning objectives*** (e.g., ensuring economic viability of the National Forest Administration through timber sales). ***Biodiversity*** preservation is also stated as a goal. The informant perceives there is occasionally conflict between regulatory and provision objectives.

In terms of management activities, the organization aims to restore the **artificially planted** spruce **monocultures** to a natural **mixed species** stand of beech and conifer as required by *regulations*. As such, they apply **group shelterwood** in lieu of **clearcutting** because beech is sensitive to summer droughts and winter frost (*biophysical*). In conjunction to the **natural regeneration** of spruce, this approach ensures a mixed species beech and conifer stand. The informant muses that the replacement of the economically productive monocultures is an example of environmental goals hindering economic profitability. He believes replacing the stands with Douglas fir would bring about greater economic benefits (*economizing*). These economic losses are exacerbated by the historic ineligibility of state forest administrations to apply for grants compensating the loss of income due to restrictions imposed by regulations (*market instruments*)

In the lowlands, restoration work is carried out through **clearcutting** and **artificial planting** of oak, although future forestry regulations demand **group shelterwood** (*regulations*). **Continuous cover forestry** is applied in forests with special protection functions (*regulations*). **Coppice** is applied in black locust plantation – this is permitted by forestry law (*regulations*). Bear **wildlife management** occurs through costly relocation efforts because legislation prohibits hunting (*regulations*, *resources*). In terms of forest protection, there are **set aside** areas to preserve the quality of local drinking water (*public good*).

In addition to the restoration projects, the informant describes various management activities in support of biodiversity that are mandated by their participation in forest certification and by national legislation (*regulations, voluntary agreement*). This includes **preserving terrain**, **setting aside** biodiversity rich areas, maintaining **deadwood**, preserving **retention trees**, establishing shrubs at **forest edges, applying long rotations**, **native species regeneration**, **natural regeneration**, and **shelterwood management**.

Table 22. Romania 3 – Summary of factors influencing the forest practitioner's decisions.

	Organizational factors	Economizing	Resources	Conservationist	Market instrument	Public administration	Regulations	Voluntary agreements	Timber markets	Public goods	Neighbours	Public pressure	Biophysical	Disturbances
Cultural objectives						✓								
Provisioning objectives	✓								✓	✓				
Regulating objectives			X	✓	X		✓			✓	X			
Biodiversity	✓						✓							
Climate														
Monoculture		X												
Mixed species				✓										
Artificial restoration														✓
Natural regeneration							✓						✓	
Native species							✓							
Afforestation			X			X					X			
Development					✓									
Wildlife management			X				X							X
Shelterwood							✓						✓	
Clearcutting	✓													✓
Coppicing							✓x							
Set-aside areas						✓		✓		✓				
Continuous cover forestry							✓							
Deadwood								✓						
Forest edges								✓						
Retention trees								✓						
Terrain preservation								✓						

X: represents factors hindering the management activity. ✓: represents factor enabling the management activity.

5 Discussion and next steps

5.1 Main findings

Forest practitioners play a major role in the delivery of forest-based ecosystem services to society, given that forest management objectives and activities directly impact the availability of ecosystem services (Malovrh et al., 2022; Eggers et al., 2014). The management decisions of forest practitioners are bounded by various factors, and some researchers have proposed frameworks to structure these different factors (e.g., Sotirov et al., 2019; de Bruin et al. 2015). Based on the De Bruin et al.'s (2015) framework, we conducted a systematic literature review on fifteen factors influencing forest practitioners' decisions. The primary outcome of the literature review are thick descriptions of three internal factors and seven external factors that influence forest practitioners' management decisions (see: Section 2).

Two outstanding gaps in the literature emerged during the literature review. First, there is a lack of representativeness among different types of forest practitioners. Studies typically targeted private forest owners and excluded forest managers, therefore views from public forest managers and managers of private forest are largely missing. Similarly, most studies targeted forest practitioners from Northern Europe (i.e., Finland, Sweden, Norway, Denmark, Lithuania) and Central Europe (i.e., Germany, Belgium). As a result, it is unclear to what extent the factors represented in the literature are relevant across different geographical and sociodemographic contexts. Future research would benefit from validating existing factors through more purposeful sampling[11].

The second gap was the limited degree of conceptualization between how influential factors interrelate to one another. While forest management decisions are clearly bounded by numerous complex contextual factors—many of which are becoming more and more complex—the literature provides little recourse towards structuring influential factors together into meaningful behavioural model that can predict forest owner decisions. Instead, factors are typically conceptualized as nested groups that form mutually exclusive categories (e.g., Sotirov et al., 2019; de Bruin et al. 2015). This is not to diminish the importance of such work, as it is a fundamental first step towards scoping a phenomenon. A logical next step in the research would therefore be to identify the interrelationships between key factor driving forest owner decisions and subsequently operationalize these into a behavioural model for predicting forest owners' decisions.

Considering these gaps, we conducted qualitative study interviewing with 19 forest practitioners across 6 European countries. The overarching aim of the research was to identify the factors influencing forest practitioners' management decisions. To achieve this aim, we asked the following three research questions:

1. What objectives do European forest practitioners have?
2. What forest management practices do European forest practitioners implement?
3. Which factors influence these objectives and management decisions?

These research questions were carefully selected to guide the approach used to analyse the interview data. We applied Schreier's QCA to develop a coding framework that identifies

[11] For more information about purposeful sampling, see Schreier (2018)

instances within the interviews where forest owners discussed: (i) management objectives, (ii) management activities, and (iii) factors influencing management objectives and activities.

The first output of the QCA was a data-driven coding framework of forest management objectives, forest management activities, and factors found to influence forest management objectives and practices (see: Section 4.1.3). The coding framework of key factors can be visualized as nested hierarchical framework with four levels. There were 21 distinct factors identified from the data. It was possible to group these 21 factors into 8 subcategories and nest the subcategories under 3 major categories (see: Figure 2). As with conceptual frameworks presented in the literature (e.g., Sotirov et al., 2019; de Bruin et al. 2015), the coding framework does not show interrelations between the different subcategories. Instead, it works to structure the data from the interviews into mutually exclusive groups.

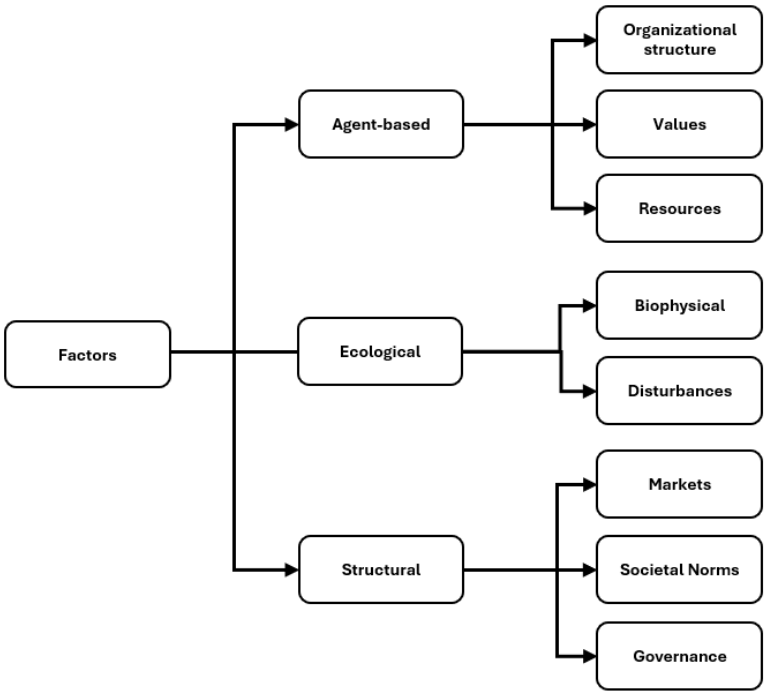

Figure 2 – Visualization of the coding framework of factors influencing forest practitioners' decisions

The second output of the QCA were tabulations quantifying how frequently subcategory from the coding framework came up across the data. Through this frequency tabulation, it was also possible to cross-tabulate the (i) influential factors against (ii) management objectives and (iii) forest management activities (see: Section 4.2). Based on the crosstabulation, it appears that all eight subcategories of factors influence a wide variety of forest management decisions. Furthermore, no single factor was uniquely influential to any one specific management activity or objective. An exception might be debated in the case of the "**market**" factor, given that the factor is chiefly found to only influence provisioning objectives. On the other hand, the factor appears to influence almost all management activities. This high degree of occurrence between the key factors and the management objectives and activities also suggests a high degree of saliency among the various factors. In other words, the factors are relevant across a variety of contexts.

The third and final output of the QCA were descriptive summaries of each interview case (Section 4.3; Annex C). The summarization process deepened the understanding between influential factors and forest management decisions. For example, the summaries assessed the directionality of influence factors had upon different forest management objectives and activities. In other words, it was possible to determine if factors enable or hinder certain forest management objectives and activities. However, the interviews could not ascertain the relative strength that the various factors had towards influencing the forest practitioners' decision-making process.

5.2 Limitations

One potential limitation of the study is the possibility of acquiescence bias among the key informants. Almost all the respondents claimed to have biodiversity or climate mitigation objectives, but in some cases, it was unclear how these goals manifested, and which management activities supported the goals. It is possible that respondents simply claimed to have these goals since the interview protocol was heavily designed around the concept of "climate and biodiversity smart forestry". Given the complexity of the terminology (e.g., see: ForestPaths Deliverable report 1.1, Chapter 5), interviewees unfamiliar with the term or unable to provide appropriate answers may have responded affirmatively that they indeed engage in climate and biodiversity smart forestry. Future qualitative research on climate and biodiversity smart forestry should first work to identify how forest practitioners understand this terminology before asking if practitioners engage in such practices.

5.3 Next steps

The interviews study presented in this report served to identify the key factors influencing forest management objectives and activities across six European countries. The coding framework derived from the study was used to design a national-level survey targeting forest practitioners across 13 European countries. The interview summaries provided knowledge for the preparation of upcoming workshops with forest practitioners. Both these activities are discussed further below.

5.3.1 European-wide national scale survey

The aim of the survey is to complement the knowledge acquired during the key expert interviews. The literature review and interview study revealed that there are still several knowledge gaps related to research on the factors influencing forest practitioners' decisions. One major gap is that research has focused on scoping and classifying different types of factors that influence forest management decisions, while little work has been done to conceptualize the interrelationships between factors into predictive behavioural models. The interview study also suffered from this shortcoming. While the study could identify whether factors enabled or hindered forest management decisions, it was impossible to comment on how factors interrelated and how strongly factors impacted the decision-making process. The survey study therefore seeks to address these shortcomings through three objectives:

1. Develop a behavioural model by applying the key factors derived from the coding framework
2. Test the proposed behavioural model to test if the proposed interrelationships are valid

3. Measure the strength factors on the forest practitioner's decision-making process.

As the survey study seeks to provide information on conditions for modifying forest owner behaviours, a theoretical framework for predicting behavioural action was selected to guide the survey research and design process. The theory of reasoned action (Fishbein and Ajzen, 2010; Ajzen, 1991) was selected as the most suitable framework because it is highly validated across several disciplines, and it overlapped satisfactorily with several concepts in the coding framework.

In a nutshell, the theory of reasoned action measures *beliefs*, *attitudes*, *subjective norms*, *perceived behavioural control* and *behavioural intentions* (see: Figure 3). *Behavioural intention* measures an individual's intention to engage in a behaviour. Behavioural intention is driven by attitudes, subjective norms, and perceived behavioural control. *Attitudes* reflect an individual's positive or negative assessment of performing a behaviour. Attitudes are formed from *behavioural beliefs*, (i.e., the perceived positive or negative outcome associated with engaging in the behaviour). *Subjective norms* reflect social pressure to engage in a behaviour. Subjective norm is formed from *normative beliefs* (i.e., perception that important referent groups either approve or disapprove of the engaging in the behaviour). *Perceived behavioural control* is the sense of ability to perform the behaviour. Perceived behavioural control is formed from *control beliefs (i*.e., the individual beliefs that they will have access to the necessary resources needed to engage in the behaviour). The power of the theory lies in its ability to measure the "why" (i.e., the beliefs) underlying intentions to engage in a behaviour.

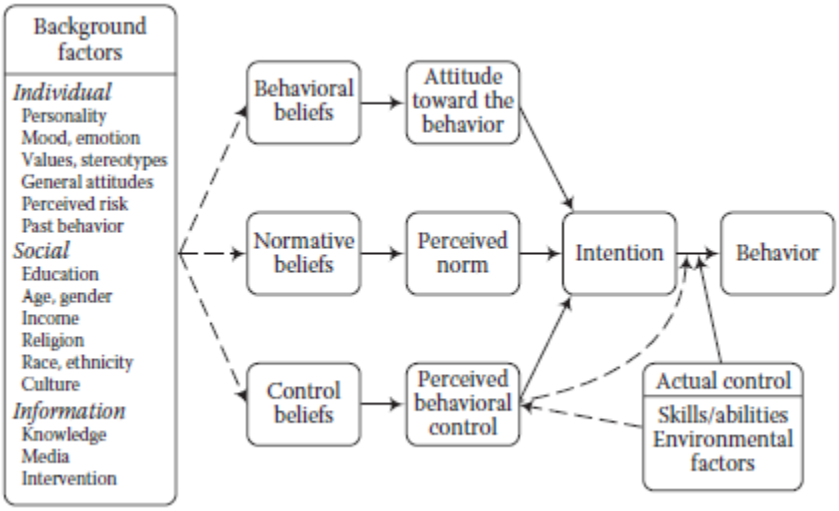

Figure 3. The reasoned action behavioural model (Fishbein and Ajzen, 2010).

The theory of reasoned action was therefore used to organize the various key factors derived from the coding framework as behavioural factors in a causal behavioural model. In essence, this first entailed categorizing key factors as either attitudes, subjective norms, or perceived behavioural control. Then, the salient topics derived from the coding framework were operationalized as different sets of behavioural, normative, or control beliefs. Lastly, survey questions were developed to measure the different sets of behavioural, normative, or control beliefs. The survey is planned to target forest practitioners from 13 European countries (Croatia, Czechia, Finland, France, Germany, Italy, Latvia, Netherlands, Romania, Spain, Sweden,

Switzerland, and the United Kingdom). The results of the survey will be presented in *ForestPaths* Deliverable report 1.3.

5.3.2 Workshops

A series of workshops will be organized between March and May 2024 as an activity within *ForestPaths* Task 1.2 *Key factors and processes influencing forest practitioners' decisions on the choice of conventional and alternative forest management approaches*. The workshops will be held in the four *ForestPaths* Demo Case countries. The target of the workshops are forest owners, forest managers, and forestry experts. The results of the workshops will be presented in the *ForestPaths* Deliverable report 1.3.

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7 References

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: 1-9.

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behaviour and Human Decision Processes* 50 (2): 179–211.

Beach, R.H., Pattanayak, S.K., Yang, J.C., Murray, B.C., Abt, R.C., (2005). Econometric studies of non-industrial private forest management: a review and synthesis. *Forest Policy Econ*. 7(3): 261–281.

Bjärstig, T.; Keskitalo, E.C.H. (2013). How to Influence Forest-Related Issues in the European Union? Preferred Strategies among Swedish Forest Industry. *Forests* 4: 693-709. https://doi.org/10.3390/f4030693

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

Blennow, K. (2012). Adaptation of forest management to climate change among private individual forest owners in Sweden. *Forest Policy and Econ*. 24: 41-47. https://doi.org/10.1016/j.forpol.2011.04.005

Blennow, K.; Persson, J. (2009). Climate change: Motivation for taking measure to adapt. *Glob. Environ. Change* 19(1): 100-104. https://doi.org/10.1016/j.gloenvcha.2008.10.003

Bond et al. (2009). Incentives to sustain forest ecosystem services: A review and lessons for REDD. Natural Resouce Issues No. 16. International Institute for Environment and Development, London, UK, with CIFOR, Bogor, Indonesia, and World Resources Institute, Washington D.C., USA.

Boon, T.E., Meilby, H., Thorsen J.B. (2004). An Empirically Based Typology of Private Forest Owners in Denmark: Improving Communication Between Authorities and Owners. *Scandinavian Journal of Forest Research* 19: 45-55.

Bowditch E, Santopuoli G, Binder F et al (2020) What is climate-smart forestry? A definition from a multinational collaborative process focused on mountain regions of Europe. *Ecosyst Serv* 43. https://doi.org/10.1016/j.ecoser.2020.101113

Brockerhoff EG, Barbaro L, Castagneyrol B et al. (2017) Forest biodiversity, ecosystem functioning and the provision of ecosystem services. *Biodiversity Conservation* 26: 3005–3035. https://doi.org/10.1007/s10531-017-1453-2

Brunette, M., Hanewinkel, M., Yousefpour, R. (2020). Risk aversion hinders forestry professionals to adapt to climate change. *Climate Change* 162: 2157-2180.

Coll L, Ameztegui A, Collet C, Löf M, Mason B, Pach M, Verheyen K, Abrudan I, Barbati A, Barreiro S, Bielak K, Bravo-Oveido A, Ferrari B, Govedar Z, Kulhavu J, Lazdina D, Metslaid M, Mohren F, Pereira M, Pedic S, Rasztovits E, Short I, Spathelf P, Sterba H, Stojanovic D, Valsta L, Zlatanov T, Ponette Q. (2018). Knowledge gaps about mixed forest: What do European forest managers want to know and what answers can science provide? *For Ecol Manag* 407:106–115.

Cope, M.A., McLafferty, S., Rhoads, B.L., 2011. Farmer attitudes toward production of perennial energy grasses in East Central Illinois: implications for community-based decision making. *Ann. Assoc. Am. Geogr*. 101: 852–862.

Dale, V.H., Kline, K.L., Wright, L.L., Perlack, R.D., Downing, M., Graham, R.L. (2011). Interactions among bioenergy feedstock choices, landscape dynamics, and land use. *Ecol. Appl.* 21: 1039–1054.

Daniel TC, Muhar A, Arnberger A et al. (2012). Contributions of cultural services to the ecosystem services agenda. *Proceedings of the National Academy of Sciences* 109(23):8812-8819. https://doi.org/10.1073%2Fpnas.1114773109

Dayneko D.V., Gustafson E.J. (2013). Institutional innovations in the Forest industry in Russia: a case study of Irkutsk province. *Miscellanea Geographica – Regional studies on development*.18(4): 17-23. https://sciendo.com/article/10.2478/mgrsd-2014-0027

de Bruin, J.O., Hoogstra-Klein, M.A., Mohren, G.M.J., and Arts, B.J.M. (2015). Complexity of Forest Management: Exploring Perceptions of Dutch Forest Managers. *Forests* 6: 3237-3255.

Deuffic P., Sotirov M., and 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 ,.

Dorning, M.A., Smith, J.W., Shoemaker, D.A., Meentemeyer, R.K. (2015). Changing decisions in a changing landscape: How might forest owners in an urbanizing region respond to emerging bioenergy markets? *Land Use Policy* 49: 1-10. https://doi.org/10.1016/j.landusepol.2015.06.020

Duesberg, S., O'Connor, D., and Ní Dhubháin, A. (2013). To plant or not to plant—Irish farmers' goals and values with regard to afforestation. *Land Use Policy, 32* 155 – 164. *https://doi.org/10.1016/j.landusepol.2012.10.021*

Duesberg, S., Upton, V., O'Connor, D., and Ní Dhubháin, A. (2014). Factors influencing Irish farmers' afforestation intention. *Forest Policy and Economics 39:* 13–20. *http://dx.doi.org/10.1016/j.forpol.2013.11.004*.

Eggers, J., Lämås, T., Lind, T., and Öhman, K. (2014). Factors Influencing the Choice of Management Strategy among Small-Scale Private Forest Owners in Sweden. *Forests 5*: 1695-1716.

Food and Agriculture Organizations (FAO) (2024). *Factors influencing organizational structures and institutional choice*. Retrieved from Options for the organization of small forest owners in Central and Eastern Europe for sustainable forest management: https://www.fao.org/3/x7566e/X7566e07.htm

FAOLEX (2023). Decree-Law No. 127/2005 regulating the Forestry Intervention Areas (ZIF), principles for their constitution, functioning and extinction. Accessed on 29 February 2024. https://leap.unep.org/en/countries/pt/national-legislation/decree-law-no-1272005-regulating-forestry-intervention-areas-zif#:~:text=In%20particular%2C%20the%20main%20objectives,forest%20and%20natural%20areas%20when

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. *J. Rural. Stud.* 54: 162–176.

Feliciano, D., Schelhaas, M.J., Starcevic, A., Staritsky, I., Uzquiano, S., Boonen, S., Lindner, M., Franzini, F., Lovric, M., Tiongco, J., Ofoegbu, C., Peltoniemi, M., Stancioiu, T., (2023). Forest management approaches across Europe. ForestPaths project deliverable D1.1.

Felton, A., Gustafsson, L., Roberge, J. M., Ranius, T., Hjältén, J., Rudolphi, J., Lindbladh, M., Weslien, J., Rist, L., Brunet, J., & Felton, A. M. (2016). How climate change adaptation and mitigation strategies can threaten or enhance the biodiversity of production forests: Insights from Sweden. Biological Conservation 194: 11–20. https://doi.org/10.1016/j.biocon.2015.11.030

Fishbein, M., and I. Ajzen. (2010). Predicting and Changing Behavior: The Reasoned Action Approach. New York: Psychology Press.

Follo, G. (2001). A hero's journey: young women among males in forestry education. Journal of *Rural Studies* 18(3): 293-306. https://doi.org/10.1016/S0743-0167(02)00006-2

Follo, G., Lidestav, G., Ludvig, A., Vilkriste, L., Hujala, T., Karppinen, H., Didolot, F., Mizaralte, D. (2017). Gender in European forest ownership and management: reflections on women as "new forest owners". *Scand. J. For. Res*. 32(2): 174–184.

Haines-Young R, and Potschin MB. (2018). Common International Classification of Ecosystem Services (CICES) V5.1 - Guidance on the Application of the Revised Structure. https://cices.eu/

Harry W. Nelson, Tim B. Williamson, Casey Macaulay, Colin Mahony. (2016). Assessing the potential for forest management practitioner participation in climate change adaptation. *Forest Ecology and Management* 360*:* 388–399.

Hogl, K., Pregernig, M. and Weiss, G. (2005). What is new about new forest owners? A typology of private forest ownership in Austria. *Small-scale Forestry* 4: 325–342. https://doi.org/10.1007/s11842-005-0020-y

Husa, M., and Kosenius, A.K. (2021). Non-industrial private forest owners' willingness to manage for climate change and biodiversity. *Forest Research* 36:7-8

Ingemarson, F., Lindhagen, A. & Eriksson, L. (2006). A typology of small-scale private forest owners in Sweden. *Scandinavian Journal of Forest Research* 21: 249 -259

Janova J., Hampel D., Kadlec J., Vrska T. (2022). Motivations behind the forest managers' decision making about mixed forests in the Czech Republic. *Forest Policy and Economics* 144: 1-12.

Joa, B., Schraml, U. (2020). Conservation practiced by private forest owners in Southwest Germany–The role of values, perceptions and local forest knowledge. *For Policy Econ*. 115: 102141.

Johann, E. (2021). Coppice forests in Austria: The re-introduction of traditional management systems in coppice forests in response to the decline of species and landscape and under the aspect of climate change. *Forest Ecology and Management* 490. https://doi.org/10.1016/j.foreco.2021.119129

Joshi, S., Arano, K.G. (2019). Determinants of private forest management decisions: A study on West Virginia NIPF landowners. *Forest Policy and Economics* 11: 118 – 125.

Juutinen, A., Tolvanen, A., and Koskela T. (2020). Forest owners' future intentions for forest management. *Forest Policy and Economics 118*: 1-10. *https://doi.org/10.1016/j.forpol.2020.102220*

Karppinen, H., Berghäll, S. (2015). Forest owners' stand improvement decisions: Applying the Theory of Planned Behavior. *Forest Policy and Economics*: 50, 275-284. https://doi.org/10.1016/j.forpol.2014.09.009

Kalonga, S.K., Midtgaard, F., and Klanderud K. (2016). Forest certification as a policy option in conserving biodiversity: An empirical study of forest management in Tanzania. *Forest Ecology and Management* 361: 1-12. https://doi.org/10.1016/j.foreco.2015.10.034

Khanal, P.N., Grebner, D.L., Straka, T.J., Adams, D.C. (2019). Obstacles to participation in carbon sequestration for nonindustrial private forest landowners in the southern United States: a diffusion of innovations perspective. *For. Pol. Econ*. 100: 95–101.

Kolo H., Kindu M., and Knoke T. (2020). Optimizing forest management for timber production, carbon sequestration and groundwater recharge. *Ecosystem Services 44,* 101147*:* 1-11.

Kuuluvainen J, Karppinen H, Hänninen H, Uusivuori J. (2014). Effects of gender and length of land tenure on timber supply in Finland. *J For Econ*. 20:363–379

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: 1-14 https://doi.org/10.1016/j.landusepol.2020.104522

Lidestav, G., Lejon, B. S. (2012). Harvesting and silvicultural activities in Swedish family forestry – behaviour changes from a gender perspective. *Scandinavian Journal of Forest Research* 28 (2): 136-142; https://doi.org/10.1080/02827581.2012.701324

Lönnstedt, L. (1997). Non-industrial private forest owners' decision process: A qualitative study about goals, time perspective, opportunities and alternatives. *Scandinavian Journal of Forest Research*, 12(3): 302-310.

Navrátil R., Brodrechtová Y., Sedmák R., Smreček R.., and Tuček J. (2016). Structural analysis of the drivers and barriers to forest management in the Slovak regions of Podpoľanie and Kysuce. *Canadian Journal of Forestry Research*: 62, 152–163.

Nichiforel, L., Keary, K., Deuffic, P., Weiss, G., Thorsen, B. J., Winkel, G., ... Bouriaud, L. (2018). How private are Europe's private forests? A comparative property rights analysis. *Land Use Policy* 76: 535-552. https://doi.org/10.1016/j.landusepol.2018.02.034

Ní Dhubháin, Á., Cobanova, R., Karppinen, H. et al. (2007). The Values and Objectives of Private Forest Owners and Their Influence on Forestry Behaviour: The Implications for Entrepreneurship. *Small-scale Forestry* 6: 347–357. https://doi.org/10.1007/s11842-007-9030-2

Malovrh, S.P., Krajnc, N., Triplat, M. (2022). Factors Influencing Private Forest Owners' Readiness to Perform Forest Management Services Within a Machinery Ring. *Small-scale Forestry*, *21*: 661–679.

Mäkipää, R., Linkosalo, T., Niinimäki, S., Komarov, A., Bykhovets, S., Tahvonen, O., Mäkelä, A. (2011). How forest management and climate change affect the carbon sequestration of a Norway spruce stand. Journal of Forest Planning 16, 107–120. https://doi.org/10.20659/jfp.16.Special_Issue_107

Mäntymaa E., Juutinen A., Tyrväinen L., Karhu J., and Kurttila M. (2018). Participation and compensation claims in voluntary forest landscape conservation: The case of the Ruka-Kuusamo tourism area, Finland. Journal of Forest Economics, 33:14-24. https://doi.org/10.1016/j.jfe.2018.09.003

Marey-Pérez M.F., and Rodríguez-Vicente V. (2011). Factors determining forest management by farmers in northwest Spain: Application of discriminant analysis. *Forest Policy and Economics* 13: 318–327.

Matta, J.R., Alavalapati, J.R., Mercer, D.E. (2009). Incentives for biodiversity conservation beyond the best management practices: are forestland owners interested? *Land Econ*. 85 (1): 132–143.

Matilainen A., and Lahdesmaki M. (2023). Passive or not? – Examining the diversity within passive forest owners. Forest Policy and Economics 151: 1-11. https://doi.org/10.1016/j.forpol.2023.102967

Miina J, Kurttila M, Calama R, de Miguel S, Pukkala T. (2020) Modelling non-timber forest products for forest management planning in Europe. *Curr for Rep* 6(4):309–322

Miller, G.W., Stringer, J.W., Mercker, D.C., (2007). Technical guide to crop tree release in hardwood forests. Publication PB1774. Knoxville, TN: University of Tennessee Extension. 24 p. [Published with the University of Kentucky Cooperative Extension and Southern Regional Extension Forestry]

Mizaras S., Doftarte A., Lukminie D., and Šilingiene R. (2020). Sustainability of Small-Scale Forestry and Its Influencing Factors in Lithuania. *Forests* 11(6): 619. https://doi.org/10.3390/f11060619

Mostegl N.M., Pröbstl-Haidera U., Jandl R., and Haider W. (2019). Targeting climate change adaptation strategies to small-scale private forest owners. *Forest Policy and Economics* 99: 83-99. https://doi.org/10.1016/j.forpol.2017.10.001

Ostrom, E. (2007). Institutional rational choice: An assessment of the Institutional Analysis and Development Framework. *In* Theories of the Policy Process, 2nd ed., P.A. Sabatier (ed.). Cambridge, MA: Westview Press.

Pommerening, A., and Murphy S.T. (2004). A review of the history, definitions and methods of continuous cover forestry with special attention to afforestation and restocking. *Forestry* 77 (1): 27-44.

Pommerening, A., and Grabanik. P. (2019). Individual-based Methods in Forest Ecology and Management. Springer Nature: Switzerland.

Pröbstl-Haider U., Mostegl N.M., and Haider W. (2020). Small-scale private forest ownership: Understanding female and male forest owners' climate change adaptation behaviour. *Forest Policy and Economics* 112: 1-12. https://doi.org/10.1016/j.forpol.2020.102111.

Pukkala T, Lähde E, Laiho O, Salo K, Hotanen J-P (2011) A multifunctional comparison of even-aged and uneven-aged forest management in a boreal region. *Can J Forest Res* 41:851–862.

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.

Rametsteiner, E. (2009). Governance concepts and their application in forest policy initiatives from global to local levels. *Small-Scale Forestry* 8 (2) 143-158. https://doi.org/10.1007/s11842-009-9078-2

Ripatti P. (1999). Profile of Finnish female forest owners and their timber sales behaviour. In: Lohmander P, editor. Proceedings of the Biennal Meeting of the Scandinavian Society of Forest Economics; May–June. 1998; Umeå, Sweden. *Scand For Econ*. 37.

Riska, A., Saleh, M., Hendrayanto, H. (2016). The Forest Resources Information System to Support Sustainable Forest Management: Case Study Perum Perhutani. *Jurnal Manajemen Hutan Tropika* [Journal of Tropical Forest Management] 22: 213-223.

Rode J., Gómez-Baggethun E., and Krause T. (2015). Motivation crowding by economic incentives in conservation policy: A review of the empirical evidence. *Ecological Economics Volume* 117: 270-282. https://doi.org/10.1016/j.ecolecon.2014.11.019

Schmalz B, Kruse M, Kiesel J, Müller J, Fohrer N (2016). Water-related ecosystem services in Western Siberian lowland basins − analysing and mapping spatial and seasonal effects on regulating services based on ecohydrological modelling results. Ecological Indices 71: 55-65. https://doi.org/10.1016/j.ecolind.2016.06.050

Scheller RM, Parajuli R. (2018) Forest Management for Climate Change in New England and the Klamath Ecoregions: Motivations, Practices, and Barriers. *Forests*: 9(10): 626. https://doi.org/10.3390/f9100626

Stanislovaitis, A., Brukas, V., Mozgeris, G., (2015). Forest owner is more than her goal: a qualitative typology of Lithuanian owners. *Scand. J. For. Res*. 30: 478–491. https://doi.org/10.1080/02827581.2014.998706.

Schreier M. (2012). Qualitative content analysis in practice. Sage Publishing, Los Angeles, California, USA. 280pp.

Schreier, M. (2018). Sampling and generalization. In *The SAGE Handbook of Qualitative Data Collection* (pp. 84-97). SAGE Publications Ltd, https://doi.org/10.4135/9781526416070

Shivan G.C., and Mehmood, S.R. (2012). Determinants of nonindustrial private forest landowner willingness to accept price offers for woody biomass. *Forest Policy and Economics 25*: 47–55. *http://dx.doi.org/10.1016/j.forpol.2012.09.004*

Størdal, S., Lien, G., and Baardsen, S. (2008). Analyzing determinants of forest owners' decision-making using a sample selection framework. *Journal of Forest Economics* 14(3): 159-176. http://dx.doi.org/10.1016/j.jfe.2007.07.001

Sotirov, M., Sallnäs, O., Eriksson, L.O. (2019). Forest owner behavioral models, policy changes, and forest management. An agent-based framework for studying the provision of forest ecosystem goods and services at the landscape level. *Forest Policy and Economics*: *103*79–89 *; http://dx.doi.org/10.1016/j.forpol.2017.10.015*.

Sousa-Silva R., Verbist B., Lomba A., Valent P., Suškevičs M., Picard O., Hoogstra-Klein M.A., Cosofret V.C., Laura Bouriaud, 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.

Sousa-Silva, R., Ponette, Q., Verheyen, K. *et al.* (2016). Adaptation of forest management to climate change as perceived by forest owners and managers in Belgium. *For. Ecosystems.* 3: 22. https://doi.org/10.1186/s40663-016-0082-7

Thomas, J., Brunette, M., and Leblois, A. (2022). The determinants of adapting forest management practices to climate change: Lessons from a survey of French private forest owners. *Forest Policy and Economics* 135*,* 102662*:* 1 – 15. *https://doi.org/10.1016/j.forpol.2021.102662*,

Turtiainen, M., Nuutinen, T. (2012). Evaluation of Information on Wild Berry and Mushroom Markets in European Countries. *Small-scale Forestry* 11: 131–145. https://doi.org/10.1007/s11842-011-9173-z

UNECE/FAO (2020). Who owns our forests? Forest ownership in the ECE region. United Nations Publication; Vol. ECE/TIM/SP/43). United Nations Publications.

Vedel, S.E., Jacobsen, J.B., Thorsen, B.J. (2015). Forest owners' willingness to accept contracts for ecosystem service provision is sensitive to additionality. *Ecol Econ*. 113:15–24.

Villamagna AM, Angermeier PL, Bennett EM (2013) Capacity, pressure, demand, and flow: a conceptual framework for analyzing ecosystem service provision and delivery. *Ecological Complexity* 15: 114-121. https://doi.org/10.1016/j.ecocom.2013.07.004

Vulturius, G., André, K., Swartling, Å.G. et al. (2018). The relative importance of subjective and structural factors for individual adaptation to climate change by forest owners in Sweden. *Reg Environ Change* 18*:* 511–520. *https://doi.org/10.1007/s10113-017-1218-1*.

Westin, K., Bolte, A., Haeler, E., Haltia, E., Jandl, R., Juutinen, A., Kuhlmey, K., Lidestav, G., Mäkipää, R., Rosenkranz, L. (2023). Forest values and application of different management activities among small-scale forest owners in five EU countries*. For. Policy Econ.* 146, 102881

White, E.M., Latta, G., Alig, R.J., Skog, K.E., Adams, D.M. (2014). Biomass production from the U. S. Forest and agriculture sectors in support of a renewable electricity standard. *Energy Policy* 58: 64–74.

Yousefpour, R., Didion, M., Jacobsen, J. B., Meilby, H., Hengeveld, G. M., Schelhaas, M., Thorsen, B. J. (2015). Modelling of adaptation to climate change and decision-makers behaviours for the Veluwe forest area in the Netherlands. *Forest Policy and Economics, 54:* 1-10. 10.1016/j.forpol.2015.02.002

8 Annex A. Interview Guide.

No.	Description
1.1.	Please state the size of your forest area
1.2.	Please describe your forest
2.1.	Do you actively manage your forests? How?
2.2.	Do you set aside some parts of the forest from active forest management? Do your forests have some protection status?
2.3.	Is your forest certified?
3.1.	What objectives do you have from your forest?
3.2.	Why do you have these objectives?
4.1.	Which factors are most important when deciding how to manage forests?
5.	Have you received or are you applying for public grants for forest management or tree planting or other forest practices?
6.	Is there something in your current forest management that you'd consider to be supportive to biodiversity and combating climate change?
7.1.	Is there something that you would be willing to implement in your forest management that would be supportive to biodiversity and combating climate change?
7.2.	Under which circumstances would you be willing to implement these practices?
8	Is there something else that you consider to be important but that we did not cover?

9 Annex B. Coding Guide.

1. **Forest Management Objectives**: The landowner's goal for the forest and outcomes they seek to fulfil through their forest.

1.1. Ecosystem Services: Referring to tangible or intangible benefits accrued by the management goal (i.e., explicit impact on human welfare), that can be further categorized as outcomes of various ecosystem services (see: Haines-Young and Potschin, 2018). In other words, what is generated by the service and leads to a change in human well-being. This classification is understood to be utilitarian and beneficial for humans, meaning that while non-humans can benefit from ecosystem services, this classification scheme does not capture that positionality.

1.1.1. **Provisioning**: Referring to the provisioning of tangible ecosystem goods either biotic or abiotic (e.g., food, raw materials, genetic resources, energy, minerals, other resources). This tag is used when the informant specifies an ecosystem good as a management goal of the forest.

1.1.2. **Regulating and maintaining**: Referring to nutrient cycling, water filtration, erosion control, or flood regulation. *This tag is used when the informant specifies a regulatory or maintenance service as a goal of forest management. Exception Rule 1: If the goal is to manage a forest so that it is resilient to disturbances, this qualifies as the improvement of regulatory services, given that the pressures caused by disturbances are mitigated through regulatory services (Villamagna et al., 2013; Schalmz et al., 2016). This also includes discussions on forest adaptation.*

1.1.2.1. **Climate change**: When the goal is to manage a forest to mitigate climate change, this qualifies as regulatory service, because carbon sinking is a regulatory service associated with carbon nutrient cycling. *This tag is used when the informant specifies climate change mitigation or carbon sinkage as a goal of forest management.*

1.1.2.2. **Biodiversity**: When the goal is to explicitly maintain or improve biodiversity. Biodiversity may refer to either flora or fauna. Biodiversity is nested under regulating and maintaining services because it impacts all aspects of ecosystem service functioning and provisioning (Brockerhoff et al., 2017*). This tag is used when the informant specifies biodiversity conservation or enhancement as a goal of forest management. Exception Rule 1: If maintaining biodiversity is stated explicitly in reference to acquiring a provisioning benefit (e.g., access to timber, access to food) or a cultural benefit (e.g., access to recreational activities like hiking, fishing), then the statement should be classified under the appropriate respective ecosystem service benefit.*

1.1.2.3. **Other regulating services**: when the goal is to explicitly maintain or improve the regulatory services of forest other than climate change or biodiversity. *This tag is used when the informant specifies*

regulatory and maintenance services other than biodiversity and climate change as a goal of forest management.

1.1.3. **Cultural**. Referring to intangible or immaterial objectives that tend to benefit human activities. Usually challenging to quantify monetarily, or otherwise. Examples include recreational activities, science and education, therapy, conservation of historical or traditional knowledge or identity, spiritual activities, or cultural activities. Can also indirectly benefits human values and ideas (e.g., artistic inspiration) (for additional examples see: Daniel et al. 2012). *This tag is used when the informant specifies one of the aforementioned cultural service benefits to be the primary management goal of the forest. Note the commodification of cultural services does not make the service a provisioning service.*

1.2. **Unauthorized Objectives**: Forest objectives of a party who does not own the forestland. Unauthorized objectives may or may not conflict with the landowner's objectives. *This tag is used when the informant specifies that the forest is used for benefits unauthorized by the forest owner or manager.*

2. **Forest management behaviours:** Silvicultural practices whose implementation are under the control of the forest manager. *The following tags are applied when the informant specifies one of the following activities occurring within the forest that they own or manage.*

2.1. Population control: *Activities associated with managing the behaviour or controlling the population of wildlife and pests.*

2.1.1. Wildlife management: Activities associated with controlling the population or behaviour of wild animal.

2.1.2. Pest control: Activities associated with controlling the population of insects, fungi, or bacteria considered as pest.

2.2. Harvesting activities: *Discussions about different silvicultural activities related to the felling of forest stands.*

2.2.1. Salvage logging: when the forest is logged after a disturbance regime.
2.2.2. Selection cutting: when individual trees or groups of trees are felled.
2.2.3. Clearcutting: when all trees in a designated area are felled.
2.2.4. Coppicing: when a tree is cut so that new shoots will grow from the stump.
2.2.5. Shelterwood: a series of progressive fellings that provide new seedlings with cover.

2.3. Conservation: *Discussions about different silvicultural activities supporting conservation.*

2.3.1. Set-aside areas: when a forest area is set aside from any sylvicultural activities.
2.3.2. Retention trees: a tree left permanently standing in connection with a regeneration felling.
2.3.3. Terrain conservation: when efforts are taken to minimize the impact of sylvicultural activities on forest land.
2.3.4. Buffer zones: when a segment of land is spared from management activities, usually in connection with watersheds and bodies of water.
2.3.5. Deadwood retention: when standing or fallen trees are left in the forest rather than cleared.

2.4. Land use change: *Discussion about different activities that result in land use change.*
- 2.4.1. Development**:** Construction of infrastructure or edifices on the forest property.
- 2.4.2. Afforestation: The planting of forest in previously unforested sites.
- 2.4.3. Deforestation: The conversion of forest to a non-forested area.

2.5. Stand tending activities: *Discussion about different silvicultural techniques related to tending a forest stand. Does not include harvesting activities.*
- *2.5.1.* Clearing and tending: sylvicultural activities associated with clearing shrubs or precommercial thinning.
- 2.5.2. Fertilization: the application of
- *2.5.3.* Thinning: *the selective removal of trees from a stand for the purpose of improving quality of remaining trees. Exception rule 1: clearing of bushes and non-commercial should be tagged as 2.5.1 Clearing and tending. Exception rule 2:*
- 2.5.4. Rotation: *Activities associated with increasing the typical rotation length of the forest.*
- 2.5.5. Continuous cover forestry: "the use of silvicultural systems which involve continuous and uninterrupted maintenance of forest cover and which avoid clearcutting" (Pommerening and Murphy, 2004)

2.6. Regeneration activities: *Discussion about different silvicultural techniques related to forest regeneration.*
- 2.6.1. Monocultures: activities promoting monoculture forest stands.
- 2.6.2. Mixed species: activities promoting mixed species forest stands
- *2.6.3.* Natural regeneration: activities promoting the establishment of trees through natural methods.
- *2.6.4.* Artificial regeneration: activities promoting the establishment of trees through artificial methods like planting seedlings or sowing seeds.
- 2.6.5. Native species : when the informant promotes regeneration of native tree species.
- 2.6.6. Adapted species: when the informant promotes the regeneration of tree species that are adapted to climate change or disturbances.

2.7. Agroforestry: *Activities related with the coproduction of domestic animals and forest.*

3. Influencing factors: *Discussions about the underlying rationale or causes for why a forest management behaviour or forest management objective occurs in the informant's forest.*

3.1. Agent-based Factors: *Discussion related to internal factors motivating the forest practitioner's objectives or management behaviours. May be internal to the individual or the individual's organization.*

3.1.1. Organizational Structure: *The effect of the management entity's organizational structure on objectives and management behaviours. Only for use with forest managers in private companies or public organizations – not for use with private forest owners.*

3.1.2. Resource Availability: *The effect of resource availability on objectives and management. Resources can include the respondent's size of land parcel, access to time, money, knowledge, labour, availability of modern technologies, forest management plans, data, etc.*

3.1.3. Internal Values: *The effect of the owner's or manager's values or beliefs on objectives and management behaviours.*

3.1.3.1.* Environmentalism*: *Environmental concerns that drive objectives or management behaviour.*

***3.1.3.1.1.*Climate wise:** *beliefs about climate change drive objectives or management behaviours.*

3.1.3.1.2.Conservationist: *beliefs about biodiversity drive objectives or management behaviours.*

***3.1.3.2.* Utilitarian:** *Forest for utilitarian use drives objectives or management behaviours.*

***3.1.3.2.1.*Economizing:** When the c*ommercialization of forest products or services drives objectives or management behaviours.*

***3.1.3.2.2.*Utilitarianism**: *Personal, non-commercial use of forest drives objectives or management behaviours.*

3.1.3.3. Traditionalist: *When intergenerational practices or historic traditions drive objectives or management behaviours.*

3.2. Structural factors: Externalities that create pressure on the behaviours and management objectives of the forest practitioner**.**

3.2.1. Governance: Rules and norms sanctioned by political decision-makers, public administration, and non-state organizations through various instruments.

3.2.1.1. Information Instruments: When government provide information or technical knowledge signalling government aims to the forest practitioner that influences forest objectives or management behaviours. Also includes when governments require information disclosure from the forest practitioner that influence the forest objective or management behaviours. For example, the role of local forestry services to promote specific management behaviours.

3.2.1.2. Voluntary Agreements: Non-binding and non-prescriptive schemes such as voluntary conservation areas. *Exception Rule 1: Although typically voluntary, payments for ecosystem service schemes should be labelled as 3.2.1.3 Market-based instruments since they provide economic incentives.*

3.2.1.3. Market-based Instruments: When the availability of economic incentives or disincentives drive forest objectives or management behaviours. This can include public grants and subsidies, taxes, trading schemes.

3.2.1.4. **Regulations:** Command and control legislations that are prescriptive. Examples include legislation prescribing conservation zones or prescriptive forestry codes drive forest objectives or management behaviours. *Exception Rule 1: If a fine is stated as a rational for avoiding a practice, it should be labelled as 3.2.2.3 Market-based instrument.*

3.2.1.5. **Public Administration:** The role of public administration impacts the forest objectives or management behaviours. For example, local political processes, permitting, etcetera.

3.2.2. **Markets:** Where the role of the market creates pressure on forestry objectives or management behaviours.

3.2.2.1. **Timber**: When direct changes in timber market supply or demand, or when indirect changes to market (e.g., technological innovations) that impact supply and demand of timber, which in turn impacts the forest practitioner's forest objectives or management behaviours.

3.2.2.2. **Non-timber forest products:** Changes in supply or demand for NTFP impact forest objectives or management behaviours.

3.2.2.3. **Other ecosystem service markets:** Changes in supply or demand for ecosystem services other than forestry provisioning impacting forest objectives or management behaviours.

3.2.3. **Norms**: Where public opinion and societal pressure (represented by civil society groups, citizens' initiatives, and social media) drive objective or management behaviours

3.2.3.1. **Public Goods:** Ensuring provisioning of public goods and services impacts the practitioners forest objectives or management behaviours. *Exception Rule 1: If personal use of public goods and services drives the objective or management behaviour, it should be tagged under 3.1.3.1.2 Usufruct*

3.2.3.2. **Public pressure**: When the public's opinion of forestry objectives or management behaviours impact the practitioner's forest objectives or management behaviours. Includes the behaviours and action of neighbouring or surrounding farmers and forests. For example, the public voices opinions about how to manage the forest, or if trust is mentioned as a factor swaying decision-making.

3.2.3.3. **Forestry Networks:** When the opinion of forestry associations, research institutions, or organizations impacts the practitioner's forest objectives or management behaviours. *Exception Rule 1: the role of neighbours should be labelled as 3.2.3.3. Norms.*

3.2.3.4. **Neighbour**: When the adjacent landowner's opinion or land use management decisions impacts the objectives or management

behaviours of the informant. *Exception Rule 1: If a neighbouring community is discussed, it should be labelled as "Social Norms".*

3.2.4. Ecological factors: Where abiotic and biotic ecological characteristics of the forest holding influence the forest objectives or management behaviours.

3.2.4.1. Biophysical: When geological features or biological features of the property impact the forest objectives or management behaviours. For example, soil composition impacting silvicultural management practices. *Exception Rule 1: The role of human-induced forest fragmentation should be labelled as 3.2.3.3. Norms*

3.2.4.2. Disturbance: When disturbance regimes impact the forest objectives or management behaviours. For example, the role of pests, drought, windfall, etc. *Exception Rule 1: the role of grazing should be labelled as 3.2.4.1 Biophysical*

10 Annex C. Expanded tables

The following tables are descriptive summaries of the interviews. They explicate instances in the interviews where segments of discussion were coded with a "Management Objective" *or* "Management Activity" **and** "Factor" label. The tables provide a comprehensive summary of the factors driving management objectives or management activities. Furthermore, the factors are listed as either barriers or drivers to the respective management activity/objective.

Note: "Management Objectives" appear in grey cells. "Management Activities" appear in white cells. "Management activities" opposed by the informant appear in red. All "Management Activities" discussed by the informant appear in the summary table, however, some "Management Activities" were not given rationale for their implementation, so the respective "Driver" and "Barrier" cell may appear blank.

It is important to recall that the information provided by the respondent is based on their perceptions. Not all the information discussed is therefore correct or true.

Table 23. Finland 1.

Objectives / Activities	Drivers	Barriers
Cultural services Areas for recreation	--	--
Provisioning services Timber	• **Public administration:** income to the State is important State objective and the reason for why this state-owned commercial forest management company exists • **Organizational:** instructions from the institution guide provisioning activities • **Economizing:** believes role of institution as commercial forest manager suggests economic factors are the most important to guiding how to manage the forest • **Public good**: socioeconomic benefit to society i.e., rural jobs	**Public pressure**: there are set aside "dialogue areas" restricting harvesting; believes state owned forest receive more scrutiny than privately owned forest, especially regarding fellings – there is a demand from the public that state forest prioritize multifunctionality over timber provisioning
Regulating services	--	--
Biodiversity Halting biodiversity loss	--	• **Public administration**: if additional conservations areas needed, then the government should have lower expectations for financial revenues, or more State revenues should come from elsewhere than forestry • **Public goods**: believes timber provides livelihood to community so conservation areas may limit employment opportunities • **Resources**: believes more research is needed on the benefits of further increasing conservation areas in the north where there is already a relatively very high degree of forest conservations • **Organization**: the companies forest management objectives and activities can lag behind state level discussions and political agendas (mismatch between what is taken into practice and what is discussed politically)
Carbon Enhancing carbon sinking	• **Organization**: there are goals for increasing carbon sinks (see: *fertilization*)	• **Information instruments**: need more research and data to support making a decision on best forest management activities for enhancing carbon sinkage (see: *fertilization*)
Mixed species regeneration	--	• **Organizational:** mixed forest was a prominent political agenda item, but organizational instructions to implement these activities was delayed relative to the political agenda (1 year)
Artificial regeneration	• **Biophysical**: believes more saplings should be planted to compensate for the large natural loss of saplings.	--
Clearcutting	• **Organizational:** the institutional goal largely supports clearcutting; there was originally an institutional ban on clearcutting on peatlands, but these are now relaxed	--
Set aside areas	• **Public pressure**: environmental conservation NGO's have demanded more state forest areas be set aside from commercial forestry; these are known as "dialogue areas"	--

	• **Biophysical**: areas with unproductive growth are set aside	
Terrain preservation	• **Public pressure:** believes that reducing soil damage would promote social acceptability of forest management work carried out within the organization	• **Resources:** limited access to adequate machinery that would support goal to reduce soil compaction; believes current forest road network does not seem to satisfy the large forest roadway network demand, that in turn will result in larger machinery and less soil protection • **Organization:** the local public forest managers have no say in which types of forest machinery would be most appropriate for use to preserve terrains (e.g., sensitive landscapes)
Continuous cover forestry	• **Organizational**: the institutional goal is managing 18% of forest using continuous cover forestry methods	--
Fertilization	• **Organization:** an activity implemented to meet the organization's climate goals	**Information instrument**: believes there is unclear technical information on best approach to fertilize swamps or restore swamps
Thinning	• **Public pressure:** a desire to keep with the expectation of well-groomed forest areas; citizens desire aesthetically pleasing forest – this is achieved through thinning	**Biophysical**: believes the current high intensity of thinning is irreconcilable with goals to produce more mixed species forest (i.e., too much thinning of spruce and birch)
Retention trees	*No driver explicitly stated but form part of management activities aiming at forest restoration (i.e., regulating objective)*	--
Buffer zones	*No drivers explicitly stated but forest legislation in Finland demands buffer zones*	--
Deadwood	*No drivers explicitly stated by possibly linked to the objective to halt biodiversity loss*	--

Table 24. Finland 2.

Activities	Drivers	Barriers
Provisioning services Berries; Mushroom Timber; Fuelwood	• **Biophysical**: mushrooms for income since forest too young to fell • **Economizing**: forest provides economic security in a pinch; mushroom cultivation as income security	• **Resources**: no urgency to sell timber because she has a job • **Biophysical**: stand too young to be felled (<60 years old)
Regulating services Forest resilience	--	• **Information instruments**: limited information and/or targeted policy and plans for her forest; charged political debates and contradictions among experts
Biodiversity Nature conservation;	• **Tradition**: family ownership made her aware of forestry issues, like biodiversity conservation • **Conservationist**: believes biodiversity conservation is important	--
Carbon Sinking carbon in wood products	• **Climate wise**: believes climate change mitigation is important; wishes that her forest would contribute to pool of long-lived wood products;	• **Market instrument**: awaiting carbon compensation policy; believes a tool could facilitate carbon sequestration in Finland; • **Information instruments**: information on carbon sink calculations at private versus state forest level are missing and could be helpful tools
Clearcutting (opposed)	• **Traditionalist (opposed)**: clearcutting historically carried out by family, but she does not follow in this tradition • **Public pressure**: clearcutting is the status-quo among Finnish NIPFS and within the Finnish forest sector	• **Conservationist:** believes clearcutting results in climate change, thus she opposes clearcutting
Selection cutting	• **Conservationist:** believes this is the best way to ensure forest cover, and in turn creates best living environment for biodiversity • **Disturbances:** believes forest cover will reduce bark beetle outbreaks	• **Timber markets:** wonders if changing management towards selection cutting is reconcilable with the Finnish forest sector's aim towards efficient pulp production;
Continuous cover forestry	• **Conservationist:** see *selection cutting* • **Disturbances**: see *selection cutting*	• **Timber markets:** see *selection cutting*
Set aside area	• **Voluntary agreements**: 1 ha voluntary private forest conservation area • **Conservationist**: forest ditches set aside to protect biodiversity	• **Market instruments**: not compensated for voluntary protection areas
Buffer zones	• **Regulations:** legally mandatory buffer zone next to lakes	---
Clearing / Tending	• **Resource**: has knowledge, skills, technology to carry out stand work	• **Resources**: lacks time; distance prevent stand work
Mixed species regeneration	• **Disturbances**: believes mixed species reduces bark beetle outbreaks • **Environmental values**: believes mixed species promotes biodiversity • **Climate-wise**: believes mixed species mitigate climate change	---
Artificial regeneration	• **Biophysical**: natural propagation of spruce outcompetes larch so artificially regenerates larch seedlings to ensure a mixed species forest • **Market Instruments:** KEMERA grant support seedling work	---
NTFP cultivation	• **Economizing / Biophysical**: timber unavailable as income since stands too young to fell; chaga mushrooms a possible alternative source of income	---
Afforestation	*Not explicitly stated but appears connected to both conservationist and climate wise beliefs*	---
Deadwood	• **Conservationist**: believes deadwood retention improves biodiversity	---

Forest edges	• **Conservationist**: could consider doing this to improve biodiversity	---

Table 25. Italy 1.

Management	Drivers	Barriers
Cultural services Preserving land for sentimental value; family traditions	**Tradition**: wishes to uphold family traditions on the property; manages sisters land on her behalf; cares for land for sentimental reasons; wants his children to share his love of the land; worries future generation of region disinterested in caring for land and concerned about land abandonment	**Conservationist**: believes forest health more important than recreational use of forest **Other Marke**t: believes his region unprepared to cope with tourism sector so will not consider tourism services on property
Provisioning services Fuelwood; timber; chestnuts	**Resources**: forest road access facilitates logging on property **Tradition**: continues with fuelwood provisioning tradition taught by father; provides family with annual firewood **Economizing**: income is one objective of forest goods and is willing to explore various opportunities (see: agroforestry, NFTP) **Utilitarian**: forest goods also produced for household consumption **Timber market**: timber industries demand for certain specific dimensions and quality of wood guide different provisioning practices (see: coppicing, thinning; NTFP) **NTFP market**: chestnut industries demand for chestnut's commercial characteristics guide management of chestnut stands (see: thinning) **Biophysical**: several biophysical properties of chestnut groves motivate specific management activities	Public administration: process of permitting for felling wood is complex due to inclusion of forestry department authorities leads to informal procedures for felling wood in the region
Regulating Services Forest health; hydrological services; mitigating fire disturbance; forest adaptation	**Resources**: roads provide opportunity to manage disturbances that threaten regulatory services (e.g., fire) **Market instruments**: grants funding activities that support forest regulatory services (e.g., restoration activity for chestnut bark cankers) **Regulations**: permitting system for felling was implemented to maintain the hydrological functions of the region **Forest networks**: various forestry actors assist in carrying out management in forest, and support management of pests and disease affecting chestnuts groves **Terrain preservation**: carry out preservation in slopes with stone bases around plants to prevent soil erosion on steep terrain	**Resources**: distance to one of the plots diminishes possibility to maintain and manage forests, threatening plots regulatory services **Public pressure**: rampant land abandonment in the regions disturbs regulatory services in neighbouring properties (e.g., overgrazing, spread of disease; believes communal management opportunities could address these issues but such scheme are not accepted in the region **Disturbance**: chestnut bark canker, wildfires, ink disease and wither all affect forests in the region **Resources**: believes forest management plan are costly, but also critical for ensuring management under the impacts of climate change
Biodiversity	*No direct biodiversity objectives state per se but believes regenerating with native species of chestnut promotes biodiversity (conservationist)*	--
Carbon	--	--
Native species	**Economizing**: chestnut income derived from commercial properties come from local varieties of chestnut **Conservation**: believes native species promote biodiversity	--
Development	**Biophysical**: grazing goats and cows can damage coppices and good fencing is necessary to prevent the problem	**Disturbances**: weather events have destroyed fence infrastructure; hunters have destroyed fences to get into property
Agroforestry	**Tradition**: region uses goats to graze oak stands and he does the same **Economizing**: is experimenting with semi-free-range pigs in forest to have better quality pig production	**Disturbance**: overgrazing of coppices can be a negative effect of agroforestry if done without appropriate fencing and grazing controls
Salvage Logging	**Disturbances**: snowfall uprooted several trees and they were salvage logged	--

Selection Cutting	**Tradition**: father taught him to use selective cutting on cork and holm oak when procuring firewood **Information instrument**s: regional forest authorities promote use of selective cutting on mature downy oak	
Clearcutting (opposed)	**Tradition**: father never used clearcutting and did not teach him to use this method	--
Coppicing	**Tradition**: the approach used in chestnut forest management in the region **Economizing**: the coppicing approach also supports provisioning timber in chestnut management **Biophysical**: the biophysical properties of the chestnut support the use of coppicing as a management approach	--
NTFP Cultivation	--	**Regulations**: no regulations on management of mushroom picking industry so trespassing occurs **Other market**: tourism industry undeveloped in their region so mushroom cultivation would be an unsuitable tourism activity
Set-aside areas	**Conservation**: chestnut trees of unique biodiversity set aside from harvest **Economizing**: chestnut trees of commercial value set aside from harvest	--
Terrain preservation	*Mentions setting aside certain areas in the forest from management but does not explicate driver although practice indirectly leads to erosion control*	--
Tending / Clearing	**Resources**: promotes maintenance of forest roads and infrastructure; can hire qualified personal for forest management **Forestry network**: can hire qualified labour from chestnut forestry association	**Market instruments**: European Union grants provided from 2004-2007 to clear and tend certain chestnut plots; common agriculture policy grants supported development of the firebreak through removal of excessive plants
Pest control	**Disturbance:** ink disease causing withering in chestnut grove requires treatment with potassium phosphite **Forestry networks**: collaboration with the University for implementation of potassium phosphite to carry out phytosanitary treatments on ink disease in chestnut grove	--
Thinning	**Timber markets**: guides the thinning practices implemented on chestnuts based on the quality measures for the wood that is procured from thinning **Biophysical**: chestnut physiology guides the thinning practices implemented in the chestnut stands	--

Table 26. Italy 2

Management	Driver	Barrier
Cultural objectives Preserving historic landscapes; recreation; family traditions; regional traditions	**Tradition**: preserves forests with historic centennial trees; well managed cork forest also provides opportunities for recreational activities; hopes that his inheritors preserve the management customs and that they do not sell the land (is opposed to "unknowledgeable daughters" inheriting for fear they will sell the land unlike son who is forest professional). **Information instruments**: cork association has provided plan for regions cork oaks with outlining associations objectives to political parties; this is tied to work lobbying the continued presence of the profession in the region as it has historic and traditional presence **Forest network:** the cork association works to promote the professions preservation at regional and national levels	
Provisioning objectives Cork production	**Resources**: son an expert in forest certification and is knowledgeable and able to support forest management and objectives **Tradition**: lifelong forestry technician **Forestry network**: he represents cork producers association; **Economizing**: he provisions high quality cork to sell **Timber market**: there are new opportunities in the market for the use of *sugherone*, the lowest quality of cork; **Voluntary agreement**s: certification also leads to better management practices that improve quality of the product Public goods: extraction of cork employs over 1500 people in the region	**Market instruments**: absence of incentives and public funds to support the provisioning of cork, which leads to reduced maintenance of cork forest and larger ecological disturbances **Public administratio**n: some administrators perceive the thinning of cork and tending of stands are environmental destruction which makes provisioning cork difficult because it must be maintained adequately to have a good quality **Timber markets**: reduction of available cork supply has reduced the number of artisanal professional relying on cork supply; high quality cork timber requires a specific type of management approach (thinning, pruning, compaction of plant); abandonment of cork oak leads to larger phytosanitary problems that devalue cork in the market **Public pressure**: high rates of professional abandonment **Biophysical**: unmanaged oak forest lead to the replacement of cork oak by holm oak; leads to vegetation around trunk that causes poor ventilation and deteriorates quality of cork: lack of tending and overgrown weeds can make it challenging to extract cork from bark **Disturbances**: invasive plants cause pathological issues and mould lowering quality of cork product;
Regulating objectives	**Market instrument**: recent rural development program funds offered seem funds for specific measure: **Forestry networks**: the forestry association does manage cork oak of some clients but only a small fraction of total land area in region (e.g., signalling land abandonment) Disturbance: believe that mixed oak forest with grazing areas are the best way to prevent forest fires	**Resources**: lack of proper income results in professionals who are unlikely to harvest cork and then change profession thus leading to loss of management and plethora of regulatory issues (pathogens, disease, fire disturbances, etc.) associated with land abandonment **Public administration**: lack of political support for cork oak forestry since 1990's leading to widespread abandonment and regulatory issues connected with lack of oak forest management, does not believe officials understand the connection between land abandonment and loss of regulatory services **Market instruments**: lack of public investment leads to land abandonment and increasing forest-related issues Timber markets: insurance companies not providing coverage for fire damage signalling issues with fire prevention infrastructure **Public pressure**: cork oak forest, although resilient to climate change, now

		struggles with neglect due to land abandonment issues resulting in a loss of a forest perceived to be adapted to climate change ; does not believe environmental pressure is sufficient for resolving a larger issue at stake and finds environmentalist to at times be counterproductive in their demands for hard conservation which he perceives lead to loss of oak forests regulatory services **Biophysical**: cork oak forest regulatory services threatened by several biological factors like undergrowth infestation, damage from wild boar grazing, dense shrubs that limit regeneration of oak forest and threaten the loss of the cork oaks regulatory services (which by insinuation are perceived better than other forests) **Disturbances**: forest fires increasingly threatening cork oak forest
Climate		**Biophysical**: Despite cork oak being a symbol for climate change, the biological properties of cork oak result in holm oak and shrubland outcompeting and expanding in the region.
Artificial regeneration	**Market instrument**: artificial planting of cork oak on his plot was carried out using public funds	
Development	**Resources**: development firebreak and roads possible due to own funds **Disturbances**: wildfires require development of firebreak	**Public administration:** received complaints for damaging vegetation when carrying heavy equipment required for the development of fencing in his forest
Agroforestry	**Economizing**: grazing perceived to be the best management technique for high quality cork **Timber market**: high quality cork is achieved using grazing techniques **Neighbours** believes agreements with shepherds are key and why the region has such good cork is because of this coexistence **Disturbances**: wildfire risk is reduced through grazing management of cork oak	**Public administration:** believes administration does not understand the importance of human presence in the management of oak forest (e.g., activities such as grazing)
NTFP Cultivation	**Economizing**: actively carries out cork extraction for commercial gain	
Tending / Clearing	**Economizing**: believes tending improves yield of cork production; **Timber market:** pruning and tending also important in ensuring a appropriate high quality timber that produces uniform planks of wood **Biophysical**: weeding and clearing promote health of cork oak	**Public administration:** has received official complaint alleging environmental damage for the pruning and cutting performed to tend cork oak forest (does not explicate which species he cut or why it was not allowed) -- he argued he has no reason to destroy his profession and charges were dropped but he remains demoralized

Table 27. Italy 3

Management	Drivers	Barriers
Cultural objectives	**Tradition**: preserves forest land since it has long family history; refuses to sell the land due to the sentimental attachment; **Forestry network:** participates in association that recovers abandoned unmanaged cork forest [this serves his indirect objective to preserve the tradition of cork production]	**Resources**: believes children's distance from property may inhibit their desire to continue managing the land **Timber market:** the price drop in cork threatens the profession and seen as a personal problem **Other markets:** land prices have increased significantly, and he worries this will drive children to sell the forest land
Provisioning objectives Cork production; firewood; mushrooms	**Economizing**: actively manages forest for cork production **Utilitarian**: cork oak forest can also provide other provisions than cork, like mushroom cultivation or firewood **Market instrument:** has received funding for tending operation in the past **Public pressure:** main economic activities in region have shifted away from agroforestry and agriculture to emphasize cork production [does not reflect on if this is barrier or driver, but more a fact of the matter] **Forestry network:** provides support to the cork oak producers and provide recommendations for interventions	**Information instrument**: diminishment in public services to help manage a cork oak forest and believes regional management could help address this issue **Public administration**: finds public co-funding mechanism unsuitable due to financial inefficiency in the management process; **Regulations**: can place undue burden on cork producers, such as high cost of fire roads that are at times mandatory **Timber market:** price of cork has dropped and resulted issues with cork harvesting; is concerned about the cork supply competition with Portugal leading to the loss of professionals who must be highly qualified in order to extract cork **Disturbances**: pathogens threaten quality of cork production **Biophysical**: cork production takes a long time (once every ten years) **Voluntary agreement:** does not see certification process as beneficial to promoting high quality cork
Regulating objectives	**Regulations**: limits for cork extraction to reduce risk of disease and disturbances **Forestry network**: founded a association promoting cork oak sector that provides recommendations for carrying out interventions (interventions perceived to improve regulatory services)	**Information instruments**: insufficient territorial scale projects on fire prevention put region at risk for wildfire disturbances **Market instrument**: insufficient subsidies and high cost on forest owner despite forest offering public assets and regulatory services **Public administration**: finds management of publicly funded projects for forestry intervention on property to be inefficiently managed resulting in higher cost if owner could manage funds independently **Disturbances**: believes largest risk to forest is fire disturbances
Biodiversity	*does not directly discuss biodiversity objectives*	
Climate	*does not directly discuss climate change objectives*	
Mixed species regeneration	**Economizing**: believes a diverse composition of tree species improves cork quality	
Natural regeneration		**Voluntary agreement**: certification does not require naturally grown cork although believes that naturally grown cork is of higher quality -- therefore does not see certification as a source of ensuring quality of cork (note cork is planted in the stand and he plans to certify his forest)
Artificial regeneration	**Economizing**: Expanding his cork oak forest through planting rather than natural regeneration **Biophysical**: planting is more efficient than natural regeneration due to cork oak being easily outcompeted by other species of holm oak and downy oak	

Development		**Resources**: limit the capacity to create firebreaks and fire roads **Disturbances**: need for firebreak development and road networks to respond to forest fire risk
Agroforestry		**Public pressure**: there has been a shift from traditional management systems where shepherds and local agriculture occurred in conjunction with forestry in "Stazzi" estates that practiced subsistence farming -- now there is a forest-oriented vocation with cork as main resource and most houses in traditional estates are abandoned; thus a decline in agroforestry practices in cork oak forestry [*does not reflect on if is positive or negative just a matter of fact*]
NTFP Cultivation	**Utilitarian**: his cork oak forest also provides mushrooms	**Regulation**: legal limit for cork extraction is 10 years **Timber market:** cork production highly influenced by the market and industry -- cork is sold while on tree and unfavourable prices can lead to (illegal) delays of extractions threatening the health of cork tree and quality of cork product **Biophysical**: cork is slow to reach production
Tending / Clearing	**Disturbances**: tending interventions critical for protecting against wildfires	**Resources**: tending interventions for cork oak are expensive **Biophysical**: tending interventions for cork oak are challenging due to terrain, interventions can be short lived due to other tree species being highly competitive

Table 28. Italy 4

	Drivers	Barriers
Cultural objectives Preserving rural identity tied to land	**Traditionalist**: wants to preserve her childhood way of living; as a rural community member	
Provisioning objectives Cork; husbandry	**Traditionalist**: objectives as oak forest producers come from sense of identity and passion for the countryside **Forestry networks**: involvement in forestry networks helped with creation of management plan for cork management and production; the company is registered as a forest company now allowing acquisition of (forest) subsidies Economizing: engage in provisioning for profit	**Resources**: the majority of barriers to cork production discussed relate to barriers associated with the various resources (time, money, labour shortage, difficult work environment, harsh work condition, lack of knowledge around "planted cork" versus "natural cork" production, access to appropriate equipment for interventions) Information instruments: lack of comprehensive planning within the cork industry sector and management within the sector threaten funding and labour availability **Market instrument**: desire grants during the initial management phase since there is a high initial investment and capital demand until the first harvest (10-20 years before profits); threatens production if cannot afford correct management choices **Public administration**: decisions to not include cork oak as forest in regional planning creates disappoint and also issues with acquiring grants Regulations: legislative definition of cork oak forest not well defined - not forest; not farm - causes issues with funding impacting management choices crucial to production **Timber market**: describe various issues within the cork production sector such as labour right issues, exploitation; describes threats from external cork production in Portugal causing prices to fluctuate impacting management choices crucial to production; describe capital acquisition in cork market (high initial capital) is challenging to optimize income and discuss alternative management strategies **Biophysical**: cork oak production is slow thanks to biophysical properties of oak - first extraction between 10-20 years; have troubles with managing dense understory - accessibility threatens management and production;
Regulating objectives		**Resources**: cost is a barrier to maintaining appropriate regulatory functions (see: *agroforestry*) **Disturbances**: canker and black plague have affected cork oak forest **Information instruments**: few discussions around oak diseases
Biodiversity	**Conservation**: owner views regulatory functions as important; believes understory cleaning benefits biodiversity	**Regulatory**: cork oak forest not included in understory cleaning measures; this is perceived to impact biodiversity negatively; prescriptive burning for understory cleaning are not allowed so more challenging interventions must be used
Carbon Sinks	**Climate wise**: owner views carbon mitigation as important function of forest	
Mixed species regeneration	**Tradition**: father passed on knowledge that best to have a mixed species forest of cork and downy oak **Market instrument**: the possibility to afforest the mixed forest was due to the 80/20 law subsidies	**Resources**: Challenging to executing the initial planting of a mixed species cork oak and downy oak forest
Artificial regeneration		**Resources**: limited knowledge and experience about artificial cork oak forest as forest young (27 years) and first extractions just starting to take place

		Information instruments: would like more info, forestry department have been working with artificial cork producers only in some areas
Deforestation	**Biophysical**: poorly developed cork oak plots on property are converted to pastures or agricultural land	
Afforestation	**Market instrument**: possibility to afforest the mixed forest was due to the 80/20 law subsidies	**Regulations**: issues with classification of "afforestation" and conversion from forest to pasture (and vice versa) causes problems with management and receiving loss of income from compensation schemes
Development		**Resources**: infrastructure is expensive, especially in tandem to agroforestry
Agroforestry	**Conservation**: believe grazing in a gentler method that prevents devastating the forest **Tradition**: agroforestry is the historic practice of the region **Biophysical**: agroforestry is an appropriate management based on the composition of downy oak and cork oak that results from cork production	**Resources**: difficult to plan management because capital from cork does not coincide with agroforestry management timelines; hard to create a comprehensive management plan that balances cork and grazing **Timber market**: fluctuating market prices exacerbate challenges with financial management
NTFP Cultivation	**Economizing**: engage inside ventures on the property such as essential oil extraction and contemplate future production of olives for olive oil	**Market instrument**: see *Provisioning objectives* **Biophysical**: see *Provisioning objectives* **Resources**: see *Provisioning objectives*
Terrain preservation	**Conservation**: believes it's important to preserve soil health and use appropriate tools rather than heavy machinery	
Tending / Clearing	**Forestry network**: as a registered forest company she is able to access grants for understory clearing and she has succeeded in registering as a forest company	**Resources**: costly (but necessary) to clear undergrowth and brambles but they cannot afford appropriate machinery to facilitate the workload (e.g., a chipper) **Regulations**: issues with undergrowth exacerbated by fire regulations limiting possibility to implement prescribed burnings (thus why the machinery so expensive) **Market instruments**: no subsidies for clearing activities Regulations: subsidies unavailable due to legislation not recognizing planted oak forest as forest
Fertilization / Liming		**Resources**: would like to buy a chipper to convert understory cleanings to mulch but cannot afford this
Thinning	*[thinning and clearing used interchangeably in this management regime; all interventions for undergrowth labelled as clearing in this contextual setting]*	

Table 29. Italy 5.

	Drivers	Barriers
Cultural objectives	**Public goods**: believes people should have opportunities to use the forest also for activities apart from cork production, including recreation and tourism	
Provisioning objectives Utilizing Forest for regional development Forest cooperative for cork production	**Organizational**: administration of cooperative facilitates implementation of regional planning for cork production **Resources**: forest management plan for cork forest facilitates production in a fragmented sector; forest certification increases price of products **Information instruments**: the municipality used campaigns and information to successfully convince private owners participate in the forest cooperative **Voluntary agreement**: use of cooperative management scheme to facilitate cork production; there are informal community guidelines to monitor mushroom harvests **Market instruments**: Ministry funding was impetus of cooperative; there are green job initiatives supporting regional development **Public administration**: administrative processes successfully support the creation of the cooperative **Regulations**: the cooperative is recognized officially through notarial deed; common land use laws foster multifunctional household use of forest (non-cork) **Timber market:** cork prices increasing and demand has improved; **Forestry network**s: support the development of the cooperative **Public good:** supports people use the land as a source of economic activity **Neighbours**: reaction of neighbours positive enough to start the cooperative	**Organizational**: regarding the cooperative discussions complex and limited participation of private entities **Economizing**: believes human resources lead to new ways to use the forest for economic development -- sees there is a current issue with the low population; believes production should expand the current norm of cork **Market instruments**: Perceives an overall lack of funding instruments to support regional development **Regulations:** poor regulations surrounding mushroom picking **Resources**: a minimum contribution of land needed to join the cooperative; no way to mechanize the work of cork oak extractors whose labour is otherwise manual and very difficult **Timber market:** change to pellet stoves reduces demand for firewood
Regulating objectives	**Resources**: cork oak extractors work very sustainably since they cannot use heavy machinery to carry out their work **Utilitarian**: wishes to promote forest benefits beyond economic valorisation; **Voluntary agreement**: Certification boosted forest management activities that support regulating objectives; participate in UNESCO MAB program that supports regulating objectives	**Disturbances**: wildfire risks jeopardizes regulating objectives
Carbon	*No direct carbon related goal discussed but indirectly supported by CSF certification and UNESCO MAB*	
Biodiversity *Preserving local biodiversity*	**Organizational factor:** support biodiversity preservation; **Voluntary agreement** certification also to enable biodiversity conservation **Public administration**: the municipality certified their cork oak forest	
Development	**Disturbances**: wildfire risk result in need for forest roads and firebreaks **Other market:** loss of grazing agricultural market led to a shift in the management activities for maintain understory growth clear	
Agroforestry	**Resource**: low land use and number of farmers ensures there are no grazing conflicts **Regulations**: common land for herding supports agroforestry **Forestry network**: there is a traditional and historic connection between grazing and cork oak forest so there are no conflicts between the professions	**Other market**: the agricultural sector has become less profitable leading to a loss in agroforestry activities
Coppicing (opposed)		**Biophysical**: coppicing is not a management strategy in cork oak forest due to the unsuitability of doing this in this particular climate
NTFP Cultivation	see: *Provisioning Objectives, Voluntary Agreements*	see: *Provisioning Objectives, Regulations*

Tending / Clearing	**Biophysical**: cork oak forest requires active management of understory **Disturbances**: wildfire risk promote the need to clear the understory	

Table 30. Italy 6.

	Driver	Barriers
Cultural objectives	**Organization**: municipality wants to enhance tourism, recreations, community engagement, and use of traditional forest management methods -- supports this through development projects such as trail constructions etc; support preserving traditional methods of land use (see: *agroforestry*) **Market instrument**: secured funding to redevelop trails, signs, and develop archaeology sites **Public goods**: want to ensure availability of recreation and new opportunities through forest management	**Timber market:** changes to cork production market negatively impacting historic and traditional practices **Neighbours**: despite decline in traditional professions, some remain to carry on these practices
Provisioning objectives Domestic fuelwood; cork	**Organization**: municipality wants to enhance territorial value with diverse opportunities beyond cork extraction; cooperative forest for cork production **Information instruments**: use of seminars to educate owners about certification due to high amount of misinformation among owners as to how certification benefits the owner; campaigning to convince owners to join the cooperative (this campaign was largely unsuccessful initially) **Market instrument:** Cork cooperative funded through the Ministry of Agriculture **Public administration**: Cork cooperative facilitates communication and permitting **Regulation**: There is a minimum yield of cork extraction legally required **Timber market:** Complex externalities in the cork supply industry, in particular with an increase in demand for cork grindings by Portuguese companies. They are currently seen to improve the price of cork and production of cork in the area **Forestry network**: the cork forest cooperative seen as a starting point for achieving production and management goals **Public goods**: forest should support the public's domestic consumption of timber and NTFP; cooperative improves the public's opportunities for production **Neighbours**: there are still some locals who continue with the family tradition of grazing and/or cork production; more landowners are now contacting the municipality with interest to join the cooperative	**Resources**: economic constraints reduce possibility of cork production; cork production extraction is fragmented and lacks streamlining **Public administration**: Municipal lands previously operated by state-owned company that went bankrupt and forced land management onto municipality **Other market:** changes to dairy market making grazing untenable destabilized the profession and these farmers typically making secondary income from cork production are no longer around **Forestry network**: the cork forest cooperative also has challenges and needs improvement in communication between the public and private authorities **Public pressure**: resistance to the cooperative project from locals; ; nevertheless informant optimistic this negative perceptions will change **Neighbours**: only two landowners participated in the cooperative; herders on communal lands have destroyed and altered fencing projects on public oak forest lands
Regulating objectives Forest health; Forest sustainability	**Organization**: manager perceives the municipality is active in developing projects for supporting forest health, such as establishing forest work sites and a forest enhancement plan (see: *coppicing, artificial regeneration, natural regeneration*); support multifunctional forest use (see: *agroforestry*) **Market instruments**: grants from European Union and Ministry of Agriculture support implementing measures in forest enhancement plan **Forestry networks**: Make use of collaboration with research institutes to tackle issue with cork oak disease (*Coroebus Florentinus* and *Phytophthora*) **Public goods**: ensure that lands rented under concession are healthy by removing of sick trees	**Neighbours**: land abandonment leads to deterioration of forest
Biodiversity	**Market instruments:** seeking additional funding to expand their project that supports biodiversity to another region -- *"Ongoing projects" unclear which*	**Disturbances**: management of forest with agroforestry reduce wildfire risks

Climate	*not explicitly mentioned but says actions indirectly lead to climate change mitigation*	
Natural regeneration	**Organization**: have forest work sites that implement natural regeneration in downy and holm oak forest	
Artificial regeneration	**Organization**: artificial regeneration of pine plantation for reforestation efforts	
Development	See ***Cultural Objectives, Organization***	see: ***Cultural objectives, Market instrument***
Agroforestry	**Organization**: municipality supports the traditional use of agropastoral system as a way of preserving culture and creating value in lands **Public good:** municipality upkeeps the communal lands for agroforestry activities such as grazing and cork production **Disturbances**: the agroforestry systems are appreciated also for their perceived ability to mitigate wildfires, as grazing results in understory cleaning	**Other markets:** traditional farmers transitioned to other professions leading to a closure of farms and agroforestry practices
Pest control	**Forestry network**: work with private agencies to address issue of pests attacking	
Coppicing	**Organization**: some of the forest work cites implement coppicing as an intervention ; the practice includes selective cutting with coppice	
NTFP Cultivation	**Regulations**: legislation requires 30% of cork yield extracted in municipal lands	**Timber market**: loss of cork extractors has affected other professions for the worse, such as the shepherds that use to rely on cork extraction as secondary income -- loss of professionals driven by Portuguese companies taking up the market **Other market**: collapse of dairy industry resulted in loss of shepherds in region and extraction of cork significantly reduced; demographic changes in household (smaller household) leads to less people becoming cork extractors
Tending / Clearing	**Market instruments**: external sources provide financial support for clearing of areas susceptible to forest fire **Forestry networks**: combating disease in oak forest through mechanical pruning of diseased oaks with help of forestry networks	**Disturbances**: historic wildfires devasted communal lands and pose a threat so understory requires management and clearing

Table 31. Latvia 1.

Activities / Objectives	Drivers	Barriers
Cultural services Aesthetics; Recreation; Hunting; Family traditions	• **Utilitarianism**: enjoy making personal use of forest for recreation and other activities (e.g., hunting) • **Forestry network**: give local hunting association rent-free access to the forest – linked to *wildlife management* • **Tradition**: family values important, e.g., logging own Christmas tree	---
Provisioning services Fuelwood Wild forest products	• **Utilitarianism**: owner uses fuelwood from clearing stands – linked to *tending/clearing*	• **Regulations**: cannot consider timber production since forest law prohibits stand felling for another 60 years (fixed rotation management)
Regulating services Forest resilience Forest biodiversity	• **Utilitarianism**: maintain and regenerate the forest to use it -- linked to *tending/clearing*; *afforestation*	• **Regulations**: forest law limits regenerate to soil type classification, limiting opportunities for mixed-species forest and forest resilience • **Biophysical**: grazing pressure from wildlife damages stand
Monospecies regeneration	• **Regulations**: legally obliged to plant a stand only with pine – linked to *afforestation* • **Biophysical**: poor soil only suitable for pine forest ecosystem – linked to *afforestation*	---
Mixed species regeneration	• Conservationist : believe mixed species forest are more resilient	• **Regulations**: legally obliged to regenerate some stands only with pine • **Biophysical**: poor soil suitable only for pine forest ecosystem – linked to afforestation, monospecies regeneration
Adapted species	---	---
Afforestation	• **Conservationist** : forests regeneration is positive for nature	---
Wildlife management	• **Utilitarianism**: sometimes family participates in hunting • **Biophysical**: hunting is necessary to control population and prevent stand from damage • **Forest network**: local hunting association provides the service; hunting is rent-free on their property	---
Salvage logging	• **Biophysical**: they see this as an unavoidable activity for forest health otherwise they would not do it	---
Clearcutting (*opposed*)	• **Environmental values**: believes in non-intensive forest management with minimum management activities; clearcutting is out of the question	---
Deadwood (*opposed*)	---	• **Disturbances**: oppose deadwood due to bark beetle outbreak • **Neighbours (norms)**: deadwood retention in neighbouring state park perceived as the culprit to bark beetle outbreaks in their forest • **Public administration**: perceive local authorities in neighbouring forest should have better communication and regulatory process to discuss and manage bark beetle outbreaks
Tending / clearing	• **Conservation value**: seen as important to ensure unnecessary tree competition and promote forest resilience • **Utility**: makes forest more accessible recreational uses • **Forestry networks**: State Forest Services provides helpful advice for managing the stand; seen as very supportive	---

	• **Resources**: family carries out tending work since forest is small and they live on property so they can access it easily	

Table 32. Latvia 2.

Management behaviour	Drivers	Barriers
Provisioning services Timber	**Economizing**: timber is main objective **Resources**: own knowledge guides provisioning methods – links to *Forest Networks*: cooperation with researchers to acquire new knowledge and Thinning's --	**Biophysical:** some stand characteristics inhibit combining conservation and provisioning – links to *Wildlife management* challenges balancing biodiversity preservation and timber production **Utilitarianism**: areas set aside from harvesting for family recreation
Regulating services Forest productivity Forest resilience Biodiversity	**Regulation:** Natura 2000 mandates biotope protection and limits intensive management activities; Buffer zones nearby water is required by national law; 21 hectares designated under Natural 2000; legally required to leave 5-8 retention trees per hectare **Resources**: own knowledge guides stand protection and resilience approach	**Biophysical:** stand characteristics can inhibit multifunctional objectives – – links to *Wildlife management* challenges balancing biodiversity preservation and timber production **Market Instruments:** believes lack of compensation for NATURA 2000 limits forest conservation in society on general level **Resources**: won't implement CSF activities for which she lacks technology or workforce
Cultural services Aesthetics Recreation	**Utilitarianism:** beautiful areas set aside for family recreation	---
Thinning	**Resources:** forestry degree, professional and technical knowledge; self-motivated to learn; living near property contribute to which thinning practices to use – linked to *Forestry Networks*: cooperation with researchers to develop and implement management activities	---
Clearcutting (major)	---	---
Selective felling (minor)	---	---
Afforestation (10 ha)	**Resources:** land consolidation allows for easier management so she afforest to consolidate land **Regulations**: Forestry law is simpler to navigate when having one consolidated plot rather than multiple smaller plots, so she afforest to consolidate land	
Natural regeneration	**Regulations:** seed trees mandatory by legislation with permissible species according to soil class	
Set aside areas	**Regulations:** forestry law and NATURA 2000 restricts silvicultural activities **Biophysical:** hard to reach areas are left unmanaged **Utilitarianism**: beautiful areas left aside for personal enjoyment	**Market instrument:** believes lack of compensation for NATURA 2000 limits forest conservation in society on general level
Buffer Zones	**Regulation:** Buffer zones nearby water is required by national law	---
Retention Trees	**Regulations** legally required to leave 5-8 trees per hectare	---
Forest edges (opposed)	---	**Resources**: from knowledge believes this does not reduce bark beetle because they can fly to the sites
Deadwood	**Regulations** (required by national legislation) **Biophysical**: occurs naturally in forest [perhaps because of large forest size]	---
Wildlife management	**Biophysical**: grazing damages the commercial stands	---

Table 33. Netherlands 1.

Management Behaviour	Drivers	Barriers
Regulating services Resilient / Adaptation; Soil enhancement; Air quality	**Resources**: technology helps facilitate sensitive management work -- links to *terrain preservation* **Climate-wise**: engaged with various management activities for climate mitigation/adaptation **Conservation value**: sustainable forest and biodiversity stated as more important than timber provisioning **Public goods**: believe forest should provide cooling effect for nearby city	**Forestry networks**: believes more knowledge exchange in professional networks may improve activities
Biodiversity	**Regulations:** forest cites under multiple protected areas **Organizational factors:** first focus of management is enhancing biodiversity **Market instruments:** multiple subsidies supporting biodiversity and restoration -- links to *fertilization / liming* **Forest networks:** cooperative research on biodiversity enhancement	
Climate change	**Climate-wise:** manager finds personally important, and spearheads climate mitigation projects in forest -- links to *deadwood* **Organizational:** manager can influence forest management practices towards own preferences	
Cultural services Access for people; Education; Recreation; Aesthetics: Historic preservation	**Public good:** supporting public's nature education experiences **Public pressure:** adjusting park services according to visitor needs -- links to *development*. **Utilitarianism:** believes forest should provide recreation to people	
Provisioning services Timber	**Economizing:** forest has present value for nature, but personally believes if there is high timber quality, it should be harvested. **Public good** : timber sold should benefit local economy **Utilitarianism**: manager wants to provide timber needed in market	**Organizational** timber harvest only to cover organizational management cost (non-profit) **Resources**: small scale harvesting and interventions more costly
Clearcutting (past/opposed)	**Public administration**: previous admin. engaged in intensive management	**Public administration:** current administration prioritizes guidelines for sustainable forestry
Continuous cover forestry (mixed forest with uneven age classes)	**Climate-wise:** seen to promote forest resilience and health **Conservationist** seen as environmentally sustainable **Resources** :municipality owns necessary equipment for carrying out selective cuttings; GPS technology facilitates work **Organizational factors:** management activities are coordinated internally rather than with external contractors and this is viewed to ensure a continuous cover forestry, otherwise believes contractors might be reckless about trees to cut -- links to selection cuttings	
Mixed species regeneration	see: *continuous cover forestry*	

Selection cuttings	**Conservation:** believed to promote resilience and forest health **Resources:** municipality owns necessary equipment; GPS technology facilitates work	
Deadwood (future)	**Conservation**: personally, interest in experimenting with new methods to enable carbon sequestration using deadwood (i.e., future driftwood project)	
Development	**Public good:** important to support public's experience with nature; build paths, educational buildings, adventure park, etc.) **Public pressure**: public's use of forest paths and trails guides choice to add new trails and development	
Adapted species	**Conservationist** : believes adapted species improves forest resilience	
Forest edges	Internal value: biodiversity (improves forest structure)	
Set aside areas	**Conservationist** : nothing is *permanently* set aside, but areas with old growth indicators are protected as refugia	**Public administration**: municipality supports low-intensity management, but nothing is permanently set aside completely **Economizing**: believes timber that is good should be sold so even areas with designated protection at some point could be harvested later
Retention Trees		
Terrain preservation	**Resources**: municipality owns small-scale harvesting equipment that ensures soil protection **Organizational factors**: no external subcontractors -- facilitating execution of work that prevents damaging soil during harvest	
Fertilization	**Forest networks**: attempts to improve soil conditions through research and experimentation with partner institute by applying rock flour **Market Instrument**: supported by national grants to carry out the work	

Table 34. Netherlands 2.

Management Behaviour	Drivers	Barriers
Regulating services	**Organizational factors** changes in organizational management approaches geared towards supporting regulatory ES objectives **Conservation** forest health through soil management is the primary concern for the informant; forest resilience emphasized; **Market Instrument** SNL grant supports several activity **Pubic administration** municipality supports regulatory over provisioning **Forestry networks** support climate and biodiversity smart activities	**Resources** experimenting with non-hunting solutions but challenging e.g., create cases to protect trees but they have significant disadvantages **Neighbours:** dairy farms pollute the forest soils **Public administration:** municipality granting too many dairy permits to neighbouring farms leading to pollution of forest soils **Regulations**: cannot buy out neighbouring dairy farms causing pollution due to regulatory restrictions **Biophysical:** forest soil is of poor quality and needs improvement **Disturbances:** acid rain resulted in salvage logging that negatively impacted regulatory services; there is heavy browsing in the forest causing issues with forest health
Biodiversity Deadwood islands	**Regulations:** 70 ha of the site protected under legislations **Market Instrument:** government grant supporting protected areas **Conservation:** manager has strict beliefs about classification system for "mixed forest" with higher criteria than the municipality; believes deadwood increases biodiversity; believes soil health is key to all forest health	**Organizational factor** municipality has different, lower, criteria for classification of mixed forest [could this leads to lower mixed-species regeneration and management] **Biophysical** soil in forest is of poor quality to naturally support mixed forest regime that improve biodiversity
Climate Change CO2 capture Rich litter species (soil health)	**Conservation:** believes soil health is key to all forest health	**Climate change:** believes clearcutting 2 ha monocultures released too much CO2 and would not do clearcutting again – motivated to reduce CO2
Cultural services	**Public pressure:** local groups are welcome to organize recreational projects; municipality willing to provide some funds and regulations but not labour to project	**Conservation:** believes forest health comes before recreational needs
Provisioning services High quality timber	**Climate-wise:** wants to achieve wood of a quality sufficient for production of long-lived products that can impact carbon storage e.g., furniture **Public administration**: harvest needed to cover municipal operation costs **Organizational factor** harvesting implemented by civil servant rather than contractors requiring -- legacy facilitates work **Timber market**: they are not certified and companies are happy to buy their uncertified timber because it reduces workload for the company **Market instruments**: subsidies partially pay for costs of harvesting wood	**Public administration**: municipality flexible with activities; forest health comes first, and some years money deficit is possible; no conflicts in budgeting issues **Organizational factor:** municipality gives her the lead on taking forest management decisions and trusts her
Monoculture stands (past/opposed)	**Biophysical:** soil quality (sandy with low pH) leads to unwanted monospecies regeneration of pine and hornbeam **Public administration** past goal of management was "farming the forest" through monocultures	**Public administration:** long-rotation monocultures opposed since 1999; transitioned to integrative forest management (see: *mixed-stand*)
Mixed stands	**Conservationist :** manager believes mixed forest stands promotes resilience and soil health **Biophysical:** due to poor soil quality, they actively plant new species to develop mixed species stand with litter-rich tree species **Organizational:** the municipality transitioned to regeneration away from monocultures and actively planted some new stands to mix the composition	**Biophysical:** soil quality (sandy with low pH) leads to monocultures of pine and hornbeam in naturally regenerated stands
Natural regeneration	**Organization:** municipality transitioned to integrative forest management; it includes more natural regeneration (see: *mixed-species regeneration*)	

Artificial regeneration	*[Not specified in interview: possibly due to soil conditions promoting monocultures]*	
Salvage logging – *clearcutting* (opposed)	**Disturbances:** due to acid rain, some stands required salvage logging. Clearcutting approach was used.	**Climate-wise:** believes clearcutting released too much CO2 thus would not implement salvage logging this way again **Biophysical**: species that come in are shade intolerant and sun "burns them"
Continuous cover forestry	Market Instrument SNL grant supports this activity Economic harvest needed to cover operation costs	
Adapted species	**Biophysical**: feature soil quality in area is low PH; poor **Conservation:** believe will improve forest resilience and biodiversity	
Deadwood	**Conservationist :** improves biodiversity	**Biophysical:** if tipping point is seen where too much deadwood exacerbates degeneration, she would reconsider deadwood strategy
Agroforestry	**Market Instrument**: they have goats that help regulate the local heather fields and this activity is supported by government grant	
Fertilizer	**Market Instrument** SNL grant supports this activity **Forestry network** rock flour experiments in collaboration with a forestry organization **Biophysical feature** the soil has poor health and low pH they try to treat through different methods, such as the rock flour fertilization	
Wildlife management	**Biophysical**: herbivores have no predators; population large; high browsing of deciduous trees – to control the behaviour of wildlife without hunting, the informant attempts to experiment with casing around seedlings	**Resources:** experimenting with non-hunting solutions but mainly failing e.g., create cases to protect trees but they have significant disadvantages in terms of effectiveness – lack the correct technological solutions
Terrain preservation	**Conservationist** : manager wants fixed harvester routes to protect soil **Organizational factor:** harvesting work done internally by municipal workers so there is trust unintended terrain damage won't occur	

Table 35. Netherlands 3.

Management Behaviour	Drivers	Barriers
Cultural services Heritage; recreation	**Organizational:** goal of foundation is to maintain heritage of park's founder **Utilitarianism**: criteria for setting aside trees can include the scenic value of the tree for the park **Economic:** maintain services to attract visitors for park revenue **Tradition**: historic objective to maintain scenic history of the area are maintained through the foundation	
Provisioning High quality timber	**Economizing:** good quality timber promoted for felling	**Conservation:** timber provisioning a byproduct of restoration work
Biodiversity Soil microbiota improvement; biodiversity enhancement	**Tradition** main historic goal of foundation was biodiversity **Conservationist** : consider themselves forerunners in biodiversity conservation; thus why implementing activities like *toekomstbomen, regeneration, selective cuttings, etc.*	
Climate change Adaptation	**Conservation:** carbon sequestration not explicit goal but manager believes it is an indirect effect of biodiversity measures; enabling adaptation an explicit aim thus why they plant mixed species forest	**Market factors:** unwilling to sell carbon credits because it is too restrictive for management decisions
Regulating services **Soil preservation** **--Selection cutting** **--Harvestor tracks** **--Soil fertilization**	**Conservation:** preservation of soil and microclimate **Forestry networks**: collaborate with forest researchers on fertilization experiments to improve soil quality in park **Organizational** : management has adopted protocols for establishing reserves; management has opted for regeneration work at smaller scales to preserve soil regulating services **Resources**: restoration work facilitated by technologies, e.g., all historic management activities recorded in GIS to learn from past actions	**Resources:** budget restricts implementation of regeneration activities, for example cost of fencing for overgrazing **Biophysical** poor quality soil impedes restoration work; high browsing pressure of deciduous trees impedes restoration work
Clearcutting (opposed)	**Organizational:** opposed to clearcutting; however**,** large clearings for regeneration purposes are sometimes made (see: *salvage logging*)	
Selection cutting	**Organizational factors:** selection of trees for cutting or sparring made on a case-by-case basis within organization by considering stand properties **Conservationist :** believe the approach is better for soil and microclimate preservation **Biophysical:** higher browsing pressure in site previously clearcut	
Salvage logging	**Disturbances:** there was need for clearcutting after bark beetle infestation	

Mixed tree regeneration	**Climate-wise**: want to improve forest adaptation through broadleaves **Conservationist :** believe that increasing tree diversity with broadleaves will promote adaptation in the forest	**Biophysical:** poor quality soil prevents broadleaves from growing **Disturbances:** high browsing pressure of deciduous trees – links to ***resources***: high cost of limiting browsing pressure through e.g., fences
Pest control	**Market instruments:** receive subsidy for treating bark beetle infestation	
Wildlife management		**Resources:** high cost of long-lived fencing reduces capacity to manage the high amount of grazing occurring in the forest **Biophysical:** severe amount of grazing pressure from deer population
Thinning (*toekomstbomen)*	**Economizing:** a byproduct of the *toekomstbomen* system is the ability to promote high quality timber for felling **Utilitarianism**: the *toekomstbomen* system used to manage preservation of historic trees **Conservationist** : the *toekomstbomen* system used to manage species with high biodiversity value	
Set aside areas	**Organizational:** it happen organically and was adopted as official policy to leave reserved areas aside permanently (about 2% of the forest)	
Built environment	**Conservationist :** reduces soil compaction/deterioration	
Fertilization	**Forestry networks:** various experimentations with new fertilization methods to improve soil quality occur in collaboration with forest researchers	
NTFP -- carbon credits (opposed)		**Market factors**: concerned carbon credit schemes would be too restrictive for management purposes, so they will not participate
Adapted species	**Conservation** exotic species planted for sake of biodiversity/broadleaf improvement	

Table 36. Portugal 1.

Management	Drivers	Barriers
Cultural services Preserving family traditions Beauty and landscape	**Utilitarianism:** enjoys the forest as it is beautiful; aesthetic; sentimental **Tradition** keeps grandmother's trees (i.e., strawberry stand); wants to pass forest onto family; shares knowledge with children	
Provisioning services strawberry sherry; pine nuts; cork; walnuts; fuelwood	**Economic:** manages forest for economic gain **Utilitarianism:** household consumption of strawberries and firewood **Market instrument:** benefited from grants for management activities **Timber markets**: certified eucalyptus because has higher market value **Forestry network:** FOA provides advice for when to harvest cork trees **Resources**: hires external help to carry out activities	**NTFP market**: currently a low demand for walnuts **Biophysical:** stone pine stand has stopped producing pine nuts; no timber harvests since none of the trees have come into rotation **Market instrument:** hopes to gain benefit from carbon market to offset expensive thinning activities
Regulating services	**Conservation:** wants to ensure future forest productivity; omits pesticide use **Market instrument:** grants covered bush clearing to prevent fires **Forestry Network:** FOA technicians help with clearing activities **Neighbours**: national park bordering her property suffered from forest fire **Disturbances**: clears forest to mitigate fire risk	**Information instruments**: State a poor examples of good fire management **Public pressure:** media broadcasts wildfires causing pressure to clear stand **Disturbances**: thinks hybrid trees suffer from more pest than unimproved
Carbon	**Climate-wise:** believes stone pines are good carbon sinks; keep trees believes are better adapted for climate change (e.g., strawberry trees); willing to plant alternative species (e.g., cork for pine)	**Market instruments: n**o existing carbon credit market instrument yet, hopes they will emerge to cover lack of productivity in pine nut stand)
Biodiversity	**Regulations**: her forest is under the ZIF zone in Portugal **Forestry networks**: ZIF zones managed by local FOA	**Economizing:** needs economic incentive for biodiversity management **Conservationist :** is aware that eucalyptus not best for biodiversity
NTFP production	**Economizing:** pine nuts are highly valued with low maintenance cost **Forestry network:** FOA technicians provide info on when to harvest Climate change (believes cork adapted to climate change)	**Biophysical** pine nuts no longer produce harvest; cork not ready for harvest **Market instruments** (no existing carbon credit market, hopes they will emerge to support lack of productivity in pine nut stand)
Coppicing (eucalyptus)	*[No driver given per se but undertaken as provisioning operation*	
Thinning	**Resources:** based on own knowledge, believes it's better to thin trees **Regulations**: thinning of Stone pine is mandatory	**Resources:** stone pine thinning cited as costly **Market instruments**: wishes for alternative income to support costly thinning activities in unproductive stone pine plot, such as carbon credits
Tending / Clearing	**Conservation:** weeds walnut stands mechanically to avoid pesticides **Regulations:** (cleaning shrubs in ZIF is compulsory due to forest fires **Forestry Network:** (FOA supports bush clearings in ZIP **Neighbour:** (neighbouring state forest has suffered from forest fires) **Disturbances:** (risk of forest fires if shrubs are not cleaned) **Market instruments:** regulatory fines: was fined twice for not clearing shrubs; in ZIF zone FOA clears shrubs for free under European Union grants **Public pressure**: media discussion on clearing forests to avoid forest fires	**Information instrument:** looks to the State to give examples of proper maintenance, although disappointed it does not **Resources**: prefers help that is more knowledge
Fertilization	**Market instrument:** European Union funds supported the fertilization of Eucalyptus stands	
Adapted species	**Climate-wise**: willing to plant more adapted species, such as replacing evergreen with broadleaves, especially cork) [*based on own perception of species that are more adapted*]	**Disturbances:** believes hybrid trees more susceptible to pests than unimproved trees so she appears opposed to hybrid species **Economizing**(unwilling to plant adapted species if maintenance cost too high
Native species	**Climate-wise:** believes native trees better adapted to climate change	

Natural regeneration	**Tradition**: allows natural regeneration of strawberry trees since it reminds of grandmother	

Table 37. Portugal 2.

Management Behaviour	Drivers	Barriers
Cultural services Current: Aesthetics; Leisure; Education Knowledge Future: ecotourism services	**Utilitarian**: (planted stone pine to isolate home from exterior; planted Thuja trees for aesthetics; several experiments and ornamental trees simply there for his aesthetic pleasure **Economic:** possible future planting of aesthetic trees for ecotourism rather than provisioning, **Unauthorized access:** 4x4 competition sanctioned by municipality **Tradition** (discusses with son about property; hopes to leave him property) **Resources:** (has time, money, and interest to experiment e.g., creating a botanical garden for aesthetics) **Public pressure**: thinks society finds diverse forest more attractive than pine monoculture he uses for provisioning **NTFP**: open to hosting ecotourism services in the future	**Public pressure**: there has been unauthorized access for offroad 4x4 while he was absent from the estate, a recreational use he forbids on his property
Provisioning Timber production; gourmet fruit production;	**Economic:** the forest is primarily managed as compliment to his primary profession cost benefit of maintenance to sale makes Eucalyptus more profitable than alternatives (e.g., fruit orchids); **Biophysical** (believes property is rich in water and more suited for agriculture, so wants to convert some unproductive forest land to agriculture) **Timber market** considers whom to sell timber to according to best market prices and species to reforest; pulp and paper industry rents lands **Resources** (knowledge-he reads up on management practices) **Public pressure:** confers with NIPFs on wood prices and management **Public good** (believes his property provides the region with socioeconomic benefits e.g., jobs for technicians and raw material for economy) **Market instruments:** received grant to plant Acacia and Eucalyptus Utilitarianism**:** he gets his own firewood from the forest Tradition: some areas of eucalyptus, walnut, strawberry originally planted by grandfather who was a tenant farmer --	**Market factors**: price for land in Portugal has increased dramatically, diversifying revenue potential beyond forestry; if more revenue derived from agriculture, will convert forest to agriculture lands; **Timber market** (pulp and paper compensate less for land leases than agriculture, thus wants to convert forest to agriculture) **Resources**: unable to procure adequate labour force for his large holding; knowledge limitation keep him from procuring grated Stone Pine stands) **Economic**: willing to engage inland use change away from forest if it provided him with more money; has a long-term cost benefit analysis between initial investments for timber versus agriculture **Forestry network**: part of FOA so he can get technical help with certification
Regulatory services	**Biophysical:** planted stone pine because he believes it's an adapted species that can outcompetes invasive species affecting area	**Biophysical**: parcels with better water supply converted to agricultural use [*loss of regulatory services*] **Unauthorized access:** (4x4 competition causing soil erosion and compaction on property) **Market instruments** (wants payments for other ES like oxygen)
Carbon sinks		**Market instruments:** believes carbon market a triggers for re/afforestation **Economic:** (admits he believes triggers for climate change come from money; which is implied as insufficient)
Biodiversity	**Conservation:** tries to promote some biodiversity by feeding birds and creating watered areas **Regulations**: has land under the Coastal Protection Zone and National Ecological Reserve (see: set-aside areas)	**Regulations** clears spontaneous Quercus suber growth to avoid command and control regulations on cork oak biodiversity preservation program **Economic:** (thinks biodiversity and highly productive forest are irreconcilable; believes in supporting biodiversity for ecotourism profiting **Market instruments:** willing to create water reserves for birds if subsidized
Coppicing	*[No specific driver given but undertaken as park of provisioning for sale, previously rented land to forest industry who provisioned eucalyptus (Timber markets)]*	

Clearcutting	**Biophysical:** eucalyptus coming to last rotation period will be clear felled	
Adapted species	**Biophysical:** Stone pine planted because he believes it is an adapted species that outcompetes invasive *Accia sp.* affecting land) **Economic**: willing to plan more stone pine if economically beneficial **Utilitarianism**: is experimenting with various tree species in a "botanic garden" that he keeps for personal interest and enjoyment	**Disturbance** (threat of nematode keeps him from planting more Stone Pine **Market instruments**: is willing to implement new species adapted for climate change if there are market instruments to incentivize the practice (e.g., Carbon credit mechanisms)
Mixed species stand	**Market instrument:** received grant subsidizing the planting of a mixed stand	
Salvage logging	**Disturbances**: had to salvage log Maritime Pine due to Nematode roundworm and foreign fungus attacking maritime pine)	
NTFP cultivation	**Economic**: planted gourmet agricultural fruits for high value; planted high value stone pine to sell pine nuts; contemplating future sale of mushrooms; considers replacing eucalyptus with stone pine if it was economically feasible	**Resources:** knowledge keeps him from investing into mushroom cultivation)
Deforestation	**Market factors**: open to renting out land for agricultural production **Other markets/regulations**: revenue from solar power market is poor and restricted, so he has not installed solar panels	
Tending/ Clearing	**Regulations:** clears spontaneous *Quercus suber* growth to avoid mandatory protection of cork oak; clears bushes on unproductive land due to fire regulations	
Unauthorized access	**Public pressure**: 4x4 competition on property **Public administration:** local council authorized 4x4 competition on property	
Set aside area	**Conservation** (has some areas set aside with water to benefit birds) **Economizing**(believes set aside areas that are rich in biodiversity attract ecotourism and could create profit) **Regulations**: has land under the Coastal Protection Zone and National Ecological Reserve (see: set-aside areas)	**Resources:** some set aside areas are merely unmanaged due to limited funds rather than conservation values or regulations **Market based instruments**: willing to create set aside water areas if government funds were available

Table 38. Portugal 3.

Management	Drivers	Barriers
Cultural Future: small eco-house for the family	**Tradition:** father managed the property due to its importance as a family property;	**Resources**: has limited time and lives far from property; too much trouble to implement minimum mandatory maintenance of forest **Tradition:** she does not feel emotional connections to the property resulting in minimal willingness to spend resources towards keeping the land
Provisioning No harvests whatsoever Previously: maritime pine timber and resin; olives; thinning Future: mushrooms; selling land	**Resources:** in the past, father would harvest olives for olive oil **Tradition**: maritime pine stands originally planted by grandfather, who was tar extractor, when region produced tar from this species; some mature pines were previously harvested and sold; father historically harvested olive oil **Timber market:** owner aware of new micro biomass plant in the region (i.e., a pellet factor) buying thinning and forest clearings, although does not appear **Conservation:** would rent land out for mushroom cultivation if trees are preserved from land use change; more willing to sell land to vineyard or blueberry producer -- believes have less environmental impact than other uses **Other markets**: strong presence of developers looking to buy land **Economic:** *extremely* lucrative financial incentive would cause her to rent land,	**Resources:** no need to provision since she has primary income **Economizing**: has tried to sell the property in the past **NTFP Market**: maritime pine traditionally exploited for resin, but market now non-existent so clearcut pine was never reforested
Regulatory Tending and clearing only; Refusal to sell forest for development resulting in loss of regulatory services	**Resources**: happy to maintain property without need for economic gain since she has a primary profession; she would engage more actively is she lived closer **Economizing**: would be willing to consider a PES-scheme since she currently makes no money from the land **Conservation**: unwilling to sell land if it leads to land use change and loss of environmental services; she is aware the forest provides ecosystem services; she does not want to cut any timber and is upset by father previously cutting a forest stand to build a log house	**Tradition:** no connection to the land and its history therefore no interest in actively engaging with the property in such a way that enables management **Resources:** she lives too far away and is uninterested in personally carrying out maintenance of forest **Voluntary agreements:** she would like to participate in a collective where 3rd party arbitration of property could occur so the party would carry out management activities to support forest **Public pressure:** local forest is becoming vineyards or developed for housing; land prices have increased dramatically; creates doubt in her mind whether her forest is worth preserving if it is just one small, fragmented forest **Forestry network:** interested in FOA services that help absentee owners run forest, but unavailable
Carbon sinks		**Market instrument:** it never occurred to her that she could receive payments for ecosystem services
Biodiversity	**Regulation:** part of property is under the National Ecological Reserve **Resources:** the current cost of maintaining the property is low so she does not see need to sell land if it leads to land use change	**Resources:** property is very small but hard to manage independently and from far away; wonders if there is a way to have self-maintaining forest that provides space for biodiversity; would like to have a collective management scheme

Clearing / tendering	**Resources**: father tended to clearing bushes for her since his property is adjacent to hers; father has tractor to carry out bush cleanings, father now hires labour to carry out the activities; **Tradition**: managed according to how father implements the activity **Economic**: wanted to sell property and thought property more attractive clean **Forestry networks**: informal arrangement for worker who managed property in exchange for full right of usufruct; no longer part of a forestry network **Resources** (although she does not want to carry out cleaning, she can afford to contract this service out to someone else) **Regulations**: it is mandatory to clear bushes, brambles, and invasive species	**Resources**: fathers old age means he can no longer manage the forest; her distance from property/inability to find time to carry out the activity
NTFP	**Conservation**: would rent land for mushroom cultivation if no deforestation **Tradition**: in the past, grandfather exploited pine for resin	**Resources**: in the past when father had time, he harvested olives for olive oil
Deforestation (opposed)	**Public pressure:** the region is deforestation and changing land use from forest to real estate developments or high value agricultural production; she sees this as a threat to her forest and opposes deforestation on her property **Neighbours**: many converted their forest to vineyards and blueberry producers **Regulations**: part of property is zoned under Council Development Plan that allows development of built environment (land use change) **Other markets**: land value has increased in the area due to agriculture and real estate markets blooming	**Conservation**: opposes land use change of forest to agriculture of building development because of low environmental value; opposed to felling of forest stand by her father so he could build a log house **Tradition**: old traditions associated with forestry in the region are dying out due to forest land use change to build environment and agriculture
Thinning		**Resources** (No interest to carry out; does not need money)

Table 39. Romania 1

Management	Drivers	Barriers
Cultural objectives **Scenic landscape**	**Utilitarian**: 300 ha perceived as beautiful set aside from management	
Provisioning objectives High quality timber; fuelwood; concession	**Economizing:** land was purchased for economic viability; specifically want to harvest high quality timber with 100+ year rotations; fuelwood a side product; exclude harvesting biomass; objective is generating income with expected financial returns; continuous yield a major goal **Public pressure**: give concession to truffle collector (symbolic gesture)	
Regulating objectives	**Regulation:** National legislation has protective functions for ecosystem services like soil and water; 400 hectares under such protection; monoculture stands must be regenerated to mixed stands **Public pressure**: has FSC certification to show society they engage in sustainable forest management **Conservation:** owner values: soil protection, sustainable management using 150-year management plan; does not want profit to threaten sustainable yield of forest; wishes to have a "natural" forest that mirrors real-world forest by avoiding clearcutting in naturally regenerated stands **Voluntary agreement**: has FSC certification that requires implementation of several activities protecting regulating functions **Market instruments:** acquired compensation for economic loss of mandatory set aside areas; acquired National Rural Development Funds for restoration work	
Climate	**Resources:** assessed carbon sequestration by forest to have information **Climatewise:** goal to adapt forest to climate change; experiments with native species fit to prepare for future changes	**NTFP market:** disinterested in carbon credit schemes
Biodiversity	**Regulations:** compliance with national legislation even when disagree **Utilitarian**: 300 ha perceived as beautiful set aside from management indirectly contribute to biodiversity conservation **Voluntary agreements:** FSC require biodiversity conservation activities (e.g., deadwood retention, and conserving marginal habitat)	
Monospecies regeneration (opposed)		**Climate wise**: owner believes the hornbeam monocultures that arose from inadequate tending operations are not adapted to climate change **Regulations**: legislation requires owner to re-establish the natural forest composition (i.e., mixed species in the case of the hornbeam monoculture)

Mixed tree regeneration	**Regulations**: forestry law requires pure hornbeam stands (resulting from inadequate tending operations) to be restored to mixed stands (e.g., oak and other deciduous species)	
Natural regeneration	**Climate wise**: owner believes natural regeneration of native species contributes to climate adaptation of forest	
Native species regeneration	**Climate wise**: owner believes natural regeneration of native species contributes to climate adaptation of forest ; experimenting with mixing native species to promote adaptation	
Shelterwood	**Conservationist**: owner believes shelterwood approach better for restoration of hornbeam monocultures stand because it mimics "naturalness" of forest (compared to clearcutting)	
Clearcutting (opposed)	**Social pressure**: is the proposed approach for stand restoration of naturally occurring monoculture stands to mixed species stand	**Conservationist**: owner believes shelterwood better for because it mimics the natural structure of the forest
Coppicing	*No information given*	*[Note: Romanian forestry law prohibits in most forest types (regulation)]*
NTFP	**Resources:** assessed carbon sequestration by forest to have information **Public pressure**: give concession to truffle collector (symbolic gesture)	**NTFP market:** disinterested in carbon credit schemes
Set aside areas	**Regulation:** Forestry law demands some areas be free of production **Utilitarian**: 300 ha perceived as beautiful set aside from management **Market instruments:** acquired compensation for economic loss of mandatory set aside areas **Voluntary agreements:** forest certification requires conserving marginal habitats (e.g., ageing islands, trees with nests)	
Retention trees	**Voluntary agreements:** FSC require retention trees	
Terrain preservation	**Regulations:** National legislation has protective functions for ecosystem services like landslide and erosion management, treeline erosion etc. **Conservation**: soil protection a core value of the owner	
Buffer Zones	**Conservation:** owner requires 5m buffer strips along rivers **Voluntary agreements:** FSC require buffer zones	
Deadwood	**Voluntary agreements:** FSC require deadwood retention	
Continuous cover forestry	*Described as irregular shelterwood, no drivers given but see: shelterwood*	
Stand rotation	**Economizing**: required to meet high quality timber objectives **Regulations**: long rotations required by national legislation	

Table 40. Romania 2

Management Behaviour	Drivers	Barriers
Culture objectives	**Public administration**: admin. prioritizes some recreational services **Forest networks**: collaborations with researcher for improved silvicultural methods, pest control, and meteorology **Public good:** want to provide safe recreational opportunities to public **Public pressure:** believe public wants recreational opportunities; provide local community with fuelwood **Traditionalism:** involve local traditional groups in management choices	
Provisioning objectives Timber production	**Public good** (want to provide usufruct opportunities to the public, such as fuelwood, NTFP, etc.; provision timber to support local economy **Organizational**: provisioning needed to cover administrative cost – links to *afforestation*	
Regulatory objectives	**Regulations:** multiple national policies impose environmental protection (e.g., of soil, air, water) **Public good:** recreational provisioning reduces intensive management; focus management also towards citizen safety, actively purchase and afforest abandoned farmlands nearby **Organization:** believe forest protection is important objective **Forestry networks:** Work with researchers has facilitated uptake of new management practices deemed less intensive	**Resources:** high proportion of legislative protected forest challenges economic viability of administration **Market instruments**: there are public funds for compensation of economic loss due to restrictions imposed by national legislations – in past ineligible since only provided to private owners but funding requirements recently changed to allow public ownerships so they will reapply
Biodiversity	**Organization**: administration focuses on biodiversity as goal and actively set-aside areas of old-growth forest **Voluntary agreements**: FSC requires biodiversity protection; **Regulations**: national policy enforces several biodiversity practices	
Climate Change	*No direct objectives mentioned but several activities indirectly believed to support climate change mitigation e.g., forest certification activities and national regulations promoting setting aside / conservation of biodiverse areas*	
Native species	**Regulations**: plant native species according to national guidelines	
Afforestation	**Organizational:** Forest management unit spearheaded plan to increase community forestland through marginal lands purchase/afforestation **Public good**: want to increase forestland of local community	**Resources:** cost of project implementation challenging, as administration must create unique funding mechanisms and bank account where revenue from felling funds the afforestation of newly purchased land **Public administration:** council approves any land purchased for afforestation

Development	**Forest network:** dendrological park kept by university students **Market instruments:** European Union grants for forest roads, tree nursery machine, and electric fences	
Wildlife management	**Organization**: believe the best option for regulating forest	
Pest control	**Forestry network**: university has experimental plots for insect control	
Shelterwood	*Note: Romanian forestry law demands shelterwood in certain forest types (regulation)*	
Selection cutting	**Biophysical** (used on steep slopes only)	
Set aside	**Organizational:** managers freely make choice to set areas aside; management goal to conserve old forest for biodiversity **Regulations:** forestry law recently classified some of their forest as "quasi virgin " giving these areas maximum protection status	
Terrain preservation	**Regulation:** legislation imposes protection of soil protection **Voluntary Agreement:** forest certification rule	
Buffer Zones	**Voluntary Agreement:** forest certification rule	
Deadwood	**Voluntary Agreement:** forest certification rule	
Continuous cover forestry	**Forestry networks**: collaborations with researchers led to changes in forest management towards continuous cover forestry (i.e., irregular shelterwood)	
Stand rotations	**Regulation:** legislation mandates long rotation	

Table 41. Romania 3

Management	Drivers	Barriers
Culture Recreational opportunities (future)	**Public administration**: While recreation is not currently an objective of the state forest administration in this particular area, the village council proposed future development of recreational trails	
Provisioning Fuelwood; timber	**Organizational**: revenue from provisioning funds National Forest Administration activities, such as the salaries of the forest management staff **Public goods:** wish to provide fuelwood for community and timber for the economy **Timber market:** involved in forest certification to ensure good price for timber they procure	
Maintenance services Soil protection Water quality protection River protection Wildlife/game management Restoration projects	**Regulation:** National legislation has protective functions for ecosystem services like soil and water. **Conservationist**: want to support balance of ecosystem (see *Wildlife management*) **Public good**: want to provide regulating services to local communities (e.g., clean water from streams)	**Market instruments:** as state forest administrators, they are illegible for compensations to cover the loss due to restrictions imposed to management **Resources**: limited amount of land to afforest; many regulations can cause financial restrictions since only revenue source is provisioning timber which is also heavily restricted by regulations **Neighbours**: private landowners unwilling to afforest or sell abandoned marginal lands which inhibits goal to provide maintenance services
Biodiversity Set aside areas	**Regulations**: multiple forest areas under legislation protecting biodiversity (e.g., Romanian forestry code)	
Climate Change *No direct objectives*		
Monoculture (past/opposed)	**Economizing**: historic stands of artificially planted monoculture spruce managed for economic purposes are being restored to mixed beech-conifer	
Mixed stands	**Conservationist:** are restoring monocultures to natural mixed-species forest stands	
Artificial restoration	**Disturbances:** dieback in spruce plantation suffering from dieback are restored to natural forest type; includes clearcutting of spruce followed by planting of oak species	
Natural regeneration	**Biophysical:** in monoculture spruce stands restored to beech-conifer mix, they switch from clearcutting to shelterwood and allow beech and spruce to regenerate naturally to ensure a mixed stand	
Native species	**Regulations:** national rules impose species composition of forest, which must comply with natural forest types	
Afforestation	**Regulations:** current provisions allow land use change from forest to another function, but a compensation amount of three-times the proposed exchange is necessary	**Resources**: limited amount of land for purchase to afforest **Neighbours**: private landowners unwilling to afforest or sell abandoned marginal lands which inhibits goal to provide maintenance services **Public administration**: purchase of marginal lands for afforestation is extremely lengthy process

Development	**Market instruments:** receive funding from European Union and National Forest Administration for forest road development	
Wildlife management		**Resources**: it is not economically viable to some types of wildlife management in the forest: bear hunting is prohibited but bear management like feeding and relocation is extremely expensive **Regulations**: forest law prohibits hunting of bears further exacerbating any possible revenue associated with bear management practices **Disturbances**: wild boar population close to extinct due to African swine flu; further restricts possibilities to collect revenue from game management.
Shelterwood	**Biophysical**: switch from clearcutting to shelterwood in restoration of pure spruce to beech-conifer stand because shelterwood protects beech which is sensitive to frost and sun	
Clearcutting	**Organization**: implements as marginal activity **Disturbances**: Used in restoration works (see: *artificial restoration*)	
Coppice	*Note: no direct drivers provided; however, coppicing prohibited on most forest types excluding black locust plantations where active coppicing occurs in this case interview (regulations)*	*Note: no direct drivers provided; however, coppicing prohibited on most forest types excluding black locust plantations where active coppicing occurs in this case interview (regulations)*
Set aside areas	**Public administration**: areas decided by the state and they uphold the decisions **Public goods**: certain areas protected to ensure good quality of drinking water for local communities	
Continuous cover forestry	**Regulations**: irregular shelterwood is applied in certain protected forest areas to ensure biodiversity	