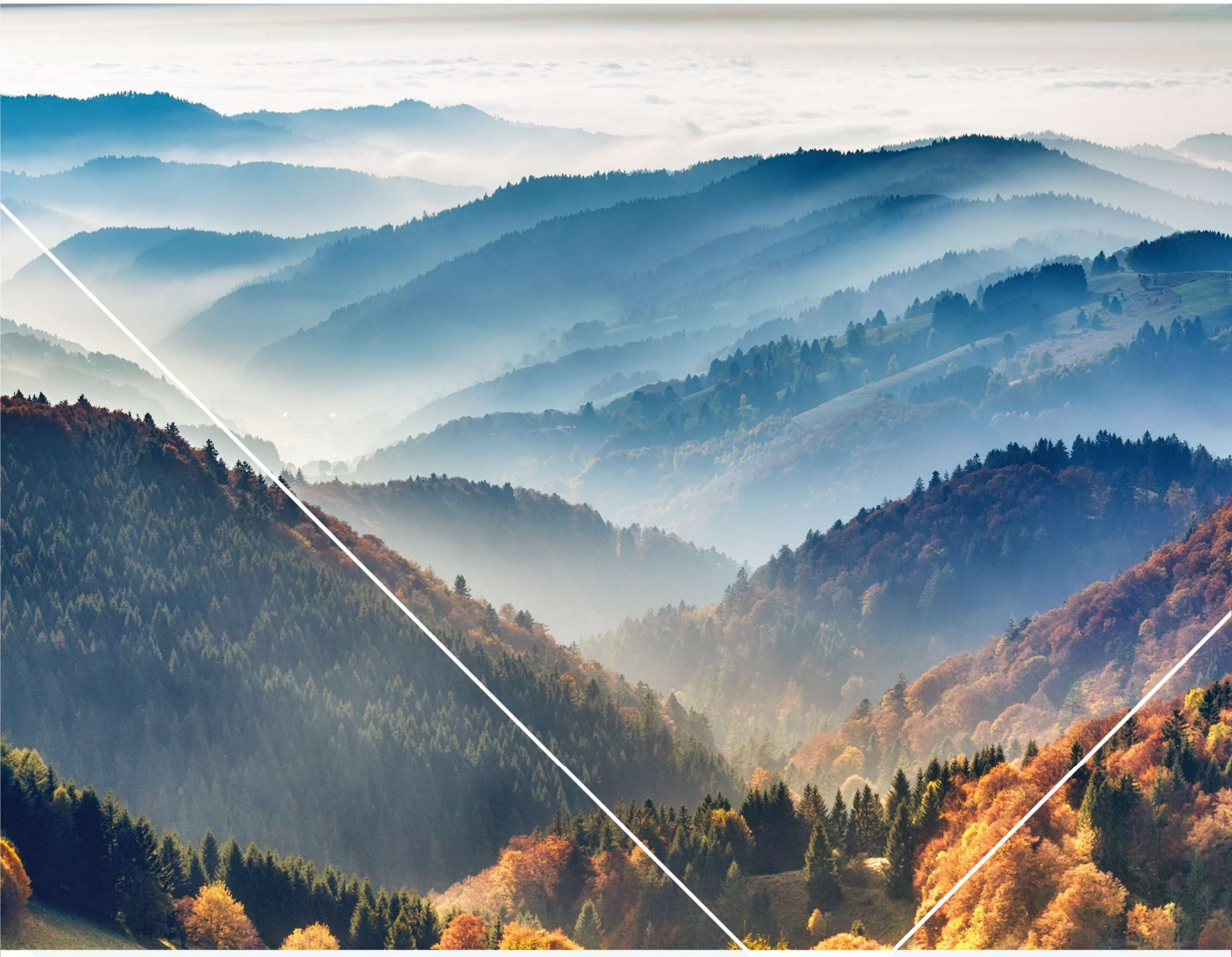

Report on current and future trends in the use of wood and demand for wood and wood properties

D3.1

CLIMB-FOREST

Deliverable title:	Report on current and future trends in the use of wood and demand for wood and wood properties
Author:	Oliver Truffer (ETH), Costanza Chimisso (KU Leuven), Tim Rowe (KU Leuven), Kato Van Ruymbeke (KU Leuven), Tamaki Ohmura (ETHZ), Eva Lieberherr (ETHZ), Liesbet Vranken (KU Leuven)
Citation:	Reference
Deliverable number:	D3.1
Work package:	WP3
Lead partner:	KU Leuven
Due date of deliverable:	31.12.2023
Submission date:	22.12.2023
Dissemination Level	Public
Reviewed by	Eva Lieberherr (ETHZ), Tamaki Ohmura (ETHZ), Liesbet Vranken (KU Leuven)

Version	Date	Modified by	Modification reasons
D0.1	14.12.2023	Eva Lieberherr, Tamaki Ohmura, Liesbet Vranken	First draft

Contents

List of Tables

Abstract/Executive Summary

Forests provide a wide range of economic, environmental and social benefits to society. Due to their potential to mitigate greenhouse gas emissions and to support and maintain biodiversity, the EU Commission is ambitiously targeting European forests in the EU Green Deal. Specifically, forests will play a pivotal role in reaching greenhouse gas emission reduction targets of 55% by 2030 and carbon neutrality by 2050. Forests and their central role in reaching these goals are highlighted in several existing EU strategies, such as the forest, the biodiversity and the bioeconomy strategy. The European Commission aims to meet these ambitious targets in part by supporting forest owners, managers and foresters to manage European forests so as to enable a forest-based bioeconomy, while balancing this with planting billions of trees, preserving biodiversity and the multi-functionality of forests. Understanding how forests are managed to meet the supply and demand of various ecosystem services (ES) is important to inform evidence-based and coherent EU policy.

In this report we contribute to this need to qualify supply and demand for forest ESs, addressing ESs categorized into three groups - provisioning, cultural, and regulation and maintenance - as well as several wood products (bioenergy, construction, and furniture). The overarching aim of this report is to identify trends in demand for wood and wood-based products, link these patterns with the forest management strategies and to identify systematic gaps in the literature related to both. Though we do not explicitly address ES supply in this report, we do reflect on its interlinkage with demand throughout the report, and more concretely in the conclusion. To assess the demand for wood and wood-based products, we conduct a systematic literature review on current and future demand for wood and non-wood based products as they relate to managed forests across Europe. This systematic literature review builds on a corpus of 155 articles spanning Europe and diverse forest management approaches. We supplement findings from the literature with interviews performed with forest-related stakeholders, including forests managers and industry actors.

We find that there is relatively little information on the quality and related challenges of specific tree species; most research in our review considers some mix of coniferous and/or deciduous trees. There is relatively scarce information on hardwood. Additionally, demand for wood products mostly comprises assessments of bioenergy, and to a much lesser extent, demand for construction or furniture. While there might be structural factors contributing to this, such as the source of information considered, the role played by different wood products in existing policy, or the inherent challenges posed by these areas of research. This poses a potential knowledge gap that needs to be addressed both for the purpose of this report but also in the wider context of policy on forest management.

To contextualize our findings, we adapt and apply the typology proposed by Winkel et al. (2011). This typology proposes three prevailing forestry paradigms driven by different forest management approaches, namely sustained yield, multipurpose forestry, and ecosystem management. Our findings are confirmed across all forestry paradigms. While carbon sequestration is mostly highlighted in research assessing the EU level or countries following the sustained yield paradigm, countries prescribing to “Multipurpose forestry” consider the relationship between forests and climate change mitigation in a more intricate manner, explicitly taking trade-offs between different ESs into account. Overall, the assessed literature suggests

that the demand for roundwood and biomass is likely to increase in the EU, especially for coniferous (soft) wood. This is mostly driven by additional demand for bioenergy that is supplied by forest biomass. Regarding cultural ESs in the form of recreational activities, there is a clear preference for mixed forest stands over monocultures. Most research also identifies a low acceptance of deadwood, which is often due to a poor understanding of the underlying ecological processes and their relevance to the ecosystem or an insufficient communication of said processes. Finally, there is a willingness to pay for regulating and maintenance services across the board.

1. Introduction

Covering nearly 35% of the total land area, forests are the second most prominent land-use type in Europe after agriculture. A vast majority of this area consists of managed forests, with only 2% of the total forested area in Europe considered undisturbed. Aside from their considerable contribution to the economy through fuel, fiber and other (non-)timber products, European forests are estimated to store 155 million tons of carbon per year, thereby contributing to the reduction of global greenhouse gas emission targets (Forest Europe, 2020). Well-maintained forest ecosystems also play a significant role in maintaining biodiversity, soil and water health, as well as socio-cultural values (Jonsson et al., 2018; Sing et al., 2018). Forests are thus seen to provide a wide range of economic, environmental, and social benefits to society. However, European forests are currently experiencing a significant amount of stress as a result of changing biotic and abiotic conditions (Forest Europe, 2020). Recent increases in frequency and intensity of droughts and heatwaves are significantly impacting tree mortality (Hanewinkel et al., 2013; Senf et al., 2020), while disturbances such as storms, wind, forest fires, and insect infestations are increasingly damaging European forest stands (Forest Europe, 2020).

Despite this increasing instability of forest stands and resulting volatility as long-term carbon stocks, the EU Commission intends to leverage European forests and their capacity to store carbon to achieve greenhouse gas emission reduction targets of 55% by 2030 and carbon neutrality by 2050 (European Commission, 2023). Creating productive and resilient forestry systems that can withstand stresses and disturbances is therefore of central importance to achieving these goals. Biodiversity has been acknowledged as playing a fundamental role in mitigating climate change effects as well as in strengthening the long-term mitigation capacities of forests (IPBES, 2019). The EU Commission thus also aims to leverage European forests to contribute to the EU biodiversity strategy for 2030 (European Commission, 2023). Aside from its contribution to climate mitigation, climate adaptation, and reversing biodiversity loss, the overarching EU forest strategy for 2030 also aims to mobilize forests to promote a bioeconomy for long-lived wood products as well as non-wood products such as ecotourism, and to ensure sustainable use of wood-based resources for bioenergy (European Commission, 2023; Jonsson et al., 2018).

To meet this wide array of demands placed on forests, the EU Commission intends forest management approaches to contribute to the EU-level priority objectives of biodiversity, water and climate change (Alliance Environnement and Directorate-General for Agriculture and Rural Development, European Commission, 2017). To do so the EU aims to support forest owners, managers and foresters to manage European forests so as to enable a forest-based bioeconomy, while balancing this with planting billions of trees, preserving biodiversity and the multi-functionality of forests (European Commission, 2023). However, to accurately quantify these incentives, a clear understanding of the various benefits forests provide to society is needed (Sing et al., 2018). With this understanding, forest management approaches that are best able to match the supply of, with the demand for, forest benefits can be pursued; thereby promoting forest management that works toward achieving the goals set out by the EU Forest Strategy for 2030.

1.1. Ecosystem services and forest management approaches

To contextualize the demand for the benefits derived from (sustainably managed) forests in Europe, we adopt the ecosystem service (ES) concept. Defined by Daily (1997, p.3) as the "conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life", ESs encompass all direct and indirect benefits provided by ecosystems to humans. Broadly, ESs are divided into three distinct categories, namely (Potschin-Young et al., 2018):

1. Provisioning services: these include all benefits that can be directly exploited (and easily marketed), such as terrestrial plant and animal foodstuffs, renewable biofuels, and biotic materials.
2. Cultural services: these include non-material benefits which influence people's mental and physical wellbeing, such as recreation and tourism, aesthetic benefits, and information and knowledge.
3. Regulation and maintenance services: these include benefits which cannot be directly exploited but which are necessary to maintain proper ecosystem functioning, such as gene pool protection, water quality regulation, and soil quality regulation.

The ES cascade framework conceptualizes ESs analogous to that of supply and demand (Van Zanten et al., 2014). This framework models a socio-ecological system, within which ESs form the bridge linking the ecological dimension of a region on the one hand to the socio-economic dimension on the other. Within the ecological dimension, the underlying biophysical structures of a region determine ecosystem functions, which in turn give rise to ESs. ESs then provide benefits to the socio-economic dimension, which are valued based on regional socio-economic, cultural characteristics as well as policy priorities (Maes et al., 2016). The ecological dimension can be interpreted as supplying ESs, while the socio-economic dimension demands them. The biophysical structures of an ecosystem are mainly determined by the biotic and abiotic conditions of the region. These may also be directly influenced by anthropogenic interventions, of which land management is the most consequential. In this sense, forest management approaches such as stand age and species composition, silviculture treatments, and harvesting techniques can be strategically leveraged to ensure supply of ESs within a forest ecosystem meets the demand for said ESs. Although we do not directly include the supply of ESs in this literature review, we use this link between forest management approaches and ESs to provide an overarching frame for contextualizing the findings on demand of wood and non-timber forest products.

Both demand and supply are inherently shaped by the intensity of human manipulation applied to the process of natural forest development through different management approaches (Duncker et al., 2012). While different societal demands for wood and non-wood products frame desirable outcomes, the supply, i.e. the physical reality in the forest, informs management choices (Winkel et al., 2011). There have been plenty of approaches to categorize forest management in Europe, all of which ultimately rely on some operationalization of the intensity by which forest management is conducted: for example, by focusing on harvest frequency and intensity (Suvanto et al., 2023), management decisions (Duncker et al., 2012), or a combination of biogeographical regions and forestry paradigms (Schulz et al., 2022). In line with the different priorities set by different forest management paradigms, the understanding and interpretation of sustainable forest management varies accordingly (Sing et al., 2018; Winkel et al., 2011). For example,

while low intensity management might be suitable for provisioning services, higher intensity management can negatively impact supply of regulating services (Sing et al., 2018).

Winkel et al. (2011) have developed a typology of three prevailing forestry paradigms that encompass different management approaches. First, ”Sustained Yield” emphasizes sustainability of timber production in terms of the maximum (quantity and quality) of timber production possible within the limits of maintaining forest ecosystem health. Second, “Multipurpose Forestry” emphasizes maximum yield of timber and other forest services, thus differing from the sustained yield paradigm in terms of the maintenance of certain other forest services such as recreation. Finally, “Ecosystem Management” emphasizes ecological sustainability, which mostly focuses on the maximum ecological quality of forest ecosystem services, and therefore, the maintenance of a minimum amount of timber.

We adapt and apply the typology proposed by Winkel et al. (2011) for several reasons. First, most countries in our literature review fit into one of the three paradigms. Second, it allows us to link future demand to current demand by contextualizing our findings within different ideas of forest management, each entailing different synergies and trade-offs between different forest ESs. The assignment of countries to different forestry paradigms is presented in Table 1.

Table 1: Countries differentiated by prevailing forestry paradigms. Numbers in brackets indicate the number of articles in the search string that focus on the respective country.

Forestry Paradigm	**Sustained Yield**	**Multipurpose Forestry**		**Ecosystem Management: Ecological Sustainability**		**Other**
		Large, partly fragmented forests	Small areas, in absolute and relative terms	Parceled forests	Small, fragmented properties	
Geographical scope of articles	**Regions** Scandinavia (1) **Countries** Finland (20) Sweden (20) Norway (14) [A] Poland(7) Austria(6) Estonia (1) Belarus (1) [B]	Germany (13) Switzerland (8) [A] France(4) Slovakia(4) Slovenia(4) Czech Republic(2) Romania (1) Turkey(8) [D] Kosovo(2) [C] Bosnia Herzegovina (1) [C] Serbia (1) [C] Croatia (1) [C] Albania (1) [C]	UK (8) England (1) Denmark (6) Ireland (5)	**Regions** Southern Europe (1) **Countries** Italy (16) Spain (13) Portugal (5)	Belgium (1) Netherlands (1)	Ukraine (1)

[A] Schulz, Lieberherr, and Zabel (2021); [B] Brukas and Weber (2009); [C] Boncina (2011); [D] Zengin et al. (2013)

We expand the cases presented in Winkel et al. (2011) by assigning Norway to the sustained yield paradigm and Switzerland to the multipurpose forestry paradigm as suggested by Schulz et al. (2022). Likewise, we assign Belarus to the sustained yield paradigm as Brukas and Weber (2009) identify a gradient in forestry paradigms between an assessed “German model” corresponding to the multipurpose forestry paradigm, as well as a “Swedish Model” corresponding to the sustained yield paradigm. For countries within the Dinaric region, namely Croatia, Serbia, Bosnia, Albania, as well as Kosovo, we expand the framework with Boncina (2011) who convincingly describes the regional development towards adapted forest management and freestyle forest silviculture, both corresponding to the multipurpose forestry paradigm. Likewise, Zengin et al. (2013) describe Turkey’s planning of their predominantly public forests as mostly concerned with the development or maintenance of productive ecosystem processes whilst addressing multiple uses desired by forest villagers. Finally, we could not identify any reliable source that enabled us to assign Ukrainian forestry to one of the forestry paradigms presented by Winkel et al. (2011). However, as there is only one paper in our corpus that addresses the demand for ES in Ukraine, we argue that this gap in our categorization will not influence our overall findings significantly.

1.2. Aim and structure of the report

The overarching aim is to identify trends in demand, link these patterns with the forest management strategies adopted through the above-mentioned paradigms, and to identify systematic gaps in the literature related to both. Our focus is on European forest systems and demand for (non-)wood-based products. Though no explicit evaluation of the literature is performed to qualify the further linkages between demand for and supply of said benefits, we acknowledge that both are highly interrelated within managed forestry systems. This is reflected in the findings and conclusion in this report. In this report we perform a systematic review of the academic, peer-reviewed literature, focusing on demand for wood and non-wood based products derived from managed forests in Europe. We supplement findings from the literature with interviews performed with forest-related stakeholders, including forest managers and industry actors from the recreational sector.

The remainder of this report is structured as follows. First, the methodology section provides a detailed description of the systematic literature review process. Following this, we present our findings from the literature review following the three forestry paradigms, namely sustained yield, multipurpose forestry, and ecosystem management. Finally, we summarize overarching trends and notable knowledge gaps in the conclusion.

2. Methods

We mapped the demand for wood and non-wood-based products in Europe based on a systematic literature review. This systematic evidence assessment procedure can be split-up into three main parts, each of which is described in more detail below. First, the evidence assessment procedure was set. Second, we fed the search string into the Web of Science and Scopus online repositories to extract the corpus of peer-reviewed articles evaluated in this review. Finally, we developed a screening strategy for the corpus, whereby we first screened at the title and abstract level, followed by a full-text screening and finally extracting the data.

2.1. Step 1: setting up the procedure

Based on the aims outlined in the introduction, we developed a PO (Population and Outcome, adapted from a PICO - Population, Intervention, Control, Outcome) to frame the systematic literature review (Table 2). The PO outlines the population of the current review, which consists of European forests actively managed for wood or non-wood production, as well as the outcome of interest, namely demand for said wood and non-wood products.

Table 2. Population and Outcome (PO) of interest for the current systematic literature review adapted from PICO.

PO component	Description
Population	European forests actively managed for wood or non-wood (e.g., recreation, carbon sequestration,…) production.
Outcome	Demand for wood and non-wood based products, for wood quality (including softwood vs. hardwood), and/or for ESs derived from managed forests (provisioning, regulation and maintenance, and cultural services). Demand may be quantified in monetary terms (EUR, USD, or other currencies), as quantitative preferences (through logistic regression analyses such as choice modelling), or qualitatively through interviews.

Prior to establishing the search string, we used the PO to establish system boundaries. We only considered the demand for wood or non-wood based products derived from actively managed forest systems in continental Europe. We did not consider demand related to imports or exports of wood or non-wood based products to/from Europe. Only peer-review articles, written in English and published in or after the year 2000 were included in the review. If an article was published in or after 2000, but the corresponding dataset was collected prior to 2000 the article was still included in the review. Both primary and secondary peer-reviewed articles were considered. Following the delineation of the system boundaries, the PO and a set of five key articles identified by the researchers involved in the review, were used in an iterative process to establish the search string. First the key words in the titles and abstracts of the five selected key articles were identified. Using these keywords as the components of the search string we checked if the key articles appeared in the hits. This iterative process was repeated and adapted until all five articles were included amongst the hits. See Table 3 for the final search string.

Table 3. Final search string used to obtain literature corpus.

Forestry systems key words		Hits
1	TI=(forest$ OR silviculture OR wood)	259,458
Interventions key words: management practices and tree species		
2	TS=("ecosystem service*" OR recreat* OR "regulation and maintenance" OR provision* OR cultur* OR "non-wood" OR "wood-based" OR product$ OR material$ OR "forest-based industr*")	8,302,771
Outcome key words		
3	(TI=(demand* OR "willingness to pay" OR "willingness-to-pay" OR "willingness to accept" OR "purchase decisions" OR preference$ OR "social assessment") OR TS = (supply NEAR/5 demand))	240,337
Geographic qualifier key words		
4	TS=(Euro* OR Temperate OR Mediterranean OR Continental OR microthermal OR Albania* OR Andorra* OR Armenia* OR Austria OR Austrian OR Azerbaijan* OR Belarus* OR Belgium OR Bosnia* OR Herzegovina* OR Bulgaria* OR Croatia* OR Cyprus OR Czech OR Danish OR Denmark OR Scandinavia* OR Estonia* OR Finnish OR Finland OR France OR Georgia* OR German* OR Greece OR Hungar* OR Iberia* OR Iceland* OR Ireland OR Ital* OR Kazakhstan* OR Kosov* OR Latvia* OR Liechtenstein* OR Lithuania* OR Luxembourg* OR Macedonia* OR Malt* OR Moldova* OR Monaco* OR Montenegr* OR Netherlands OR Norway OR Poland OR Portug* OR Romania* OR Russia* OR "San Marino" OR Serbia* OR Slovak* OR Slovenia* OR Spain OR Swed* OR Switzerland OR Turk* OR Ukrain* OR Britain OR England OR Scotland OR Wales OR "United Kingdom" OR UK)	5,143,923
Topical qualifier key words		
5	(TS=(Asia OR Africa OR China OR "South America" OR "Latin America" OR "Central America" OR tropic$ OR "tropical forest$" OR austral* OR USA OR Mexic* OR Canad* OR "middle east" OR Brazil$ OR Himalaya* OR madagascar OR "New Zealand" OR "remote sensing" OR kelp OR sea OR physiolog* OR agroforestry OR dendro* OR paleo* OR mediev* OR pyrolysis OR ancient OR "scenario$ NEAR/4 model*" OR "climate NEAR/4 model*") OR TI = (indicator*))	5,316,406
Final combination of search groups in search string		
	1 AND 2 AND 3 AND 4 NOT 5	
	Only include articles and review articles in English (publication date >2000)	196

The five key articles were identified by the researchers involved in the systematic literature review based on their own expert knowledge of the subject and were validated for their relevance to the aims and research questions of the literature review by the reviewers. The five key articles include:

1. Ciesielski, M., Stereńczak, K., 2018. What do we expect from forests? The European view of public demands. J. Environ. Manage. https://doi.org/10.1016/j.jenvman.2017.12.032
2. Grilli, G., Nikodinoska, N., Paletto, A., De Meo, I., 2015. Stakeholders' preferences and economic value of forest ecosystem services: An example in the Italian alps. Balt. For. 21, 298–307.
3. Kilchling, P., Hansmann, R., Seeland, K., 2009. Demand for non-timber forest products: Surveys of urban consumers and sellers in Switzerland. For. Policy Econ. 11, 294–300. https://doi.org/10.1016/j.forpol.2009.05.003
4. Veisten, K., 2002. Potential demand for certified wood products in the United Kingdom and Norway. For. Sci. 48, 767–778.
5. Vergarechea, M., Astrup, R., Fischer, C., Øistad, K., Blattert, C., Hartikainen, M., Eyvindson, K., Di Fulvio, F., Forsell, N., Burgas, D., Toraño-Caicoya, A., Mönkkönen, M., Antón-Fernández, C., 2023. Future wood demands and ecosystem services trade-offs: A policy analysis in Norway. For. Policy Econ. 147, 102899. https://doi.org/10.1016/j.forpol.2022.102899.

2.2. Step 2: conducting the review

The final search string was fed into two online repositories, namely Web of Science and Scopus. This resulted in 162 hits from the Web of Science repository and 156 from the Scopus repository. After duplicate deletion, 256 articles were included in the screening process. Four academic researchers, the four main authors of this report, were involved in the screening process, which was divided into two stages, a first screening at title and abstract level, followed by a second screening at full text level. Figure 1 outlines the full review flow diagram starting from the initial hits from the two considered repositories and ending at the final included corpus.

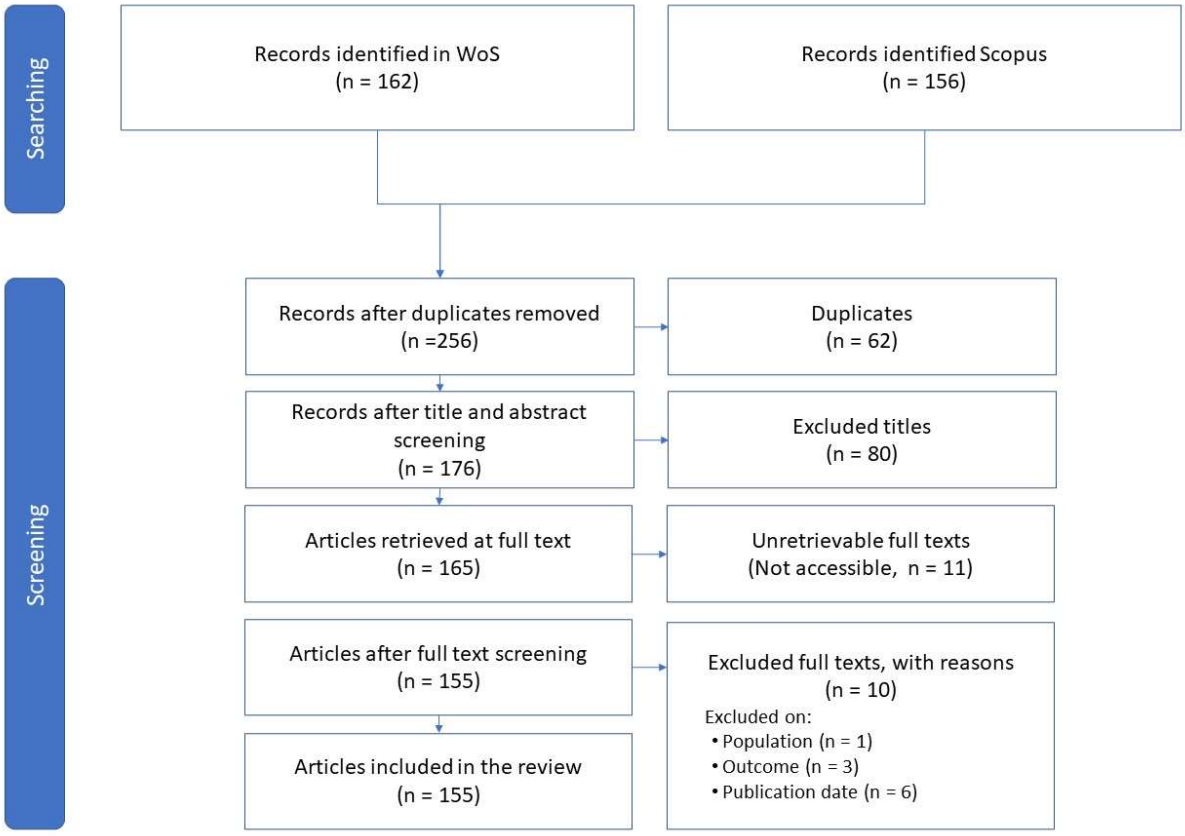

Figure 1. ROSES flow diagram.

Prior to screening, we identified a set of eligibility criteria based on the system boundaries and the PO. As described below, the eligibility criteria evaluated the relevant subject, intervention/exposure, outcomes, study design, and geographical scope that best address the research questions. These were translated into exclusion labels (Table 4) to facilitate the screening process. Using the exclusion labels articles were selected by reviewers for inclusion in the literature review. The same exclusion labels were used at both stages of the screening process.

Table 4. Eligibility criteria translated into exclusion labels: labels used to tag articles for exclusion during stage 1 (title and abstract) and stage 2 (full text) screening. Exclusion labels are listed in order of evaluation simplicity, with the eligibility criteria easiest to identify listed first.

Exclusion labels	Description
Language	The article is not in English.
Duplicate	The article is already included in the literature review.
Publication date	The article is published before 2000.
Wrong article type	The article is not a peer-reviewed article published in an academic journal. Article types to be excluded are books, book chapters, conference proceedings, working articles and early access articles.
Wrong geographic scope	The article is out of geographical scope. Only studies that at least partly include data derived from the European context are included in this literature review. As such, articles that do not include any insights related to managed European forestry systems should be excluded. The relevant location is delineated by the European continent, including Norway and Switzerland.
Wrong population	The article does not consider the relevant population, i.e., managed forestry systems. Only forestry systems that are actively managed are considered in the review.
Mismatch on outcome – demand	The article does not consider the relevant outcome, i.e., demand. Demand should be specifically linked to the (wood and non-wood) products derived from managed forestry systems in Europe (cfr. Outcome – products). Demand should be evaluated either quantitatively or qualitatively, and can be considered for all stakeholders along the value chain (e.g., consumers, managers, processors,…).
Mismatch on outcome – products	The article does not consider the relevant outcome, i.e., wood and non-wood-based products.

Following the approach suggested by Frampton et al. (2017), we tested the process of screening the articles at title and abstract level was tested to ensure consistency in article selection. This involved all four researchers independently applying the eligibility criteria to the same subset of 25 (10% of the total sample after duplicate deletion) randomly selected articles. We collectively addressed any questions noted during this process. The articles marked for inclusion in the review were compared across reviewers, results were discussed in group and changes to the screening process were made where necessary.

The full set of 318 articles (total hits from both repositories prior to duplicate deletion) were divided into four article sets. Two of the four reviewers were randomly assigned to each set, such that each review screened roughly 159 articles. Screening within each set was done blind, meaning that one reviewer could not see the decisions made by the other reviewer. After screening was completed, the blinds were lifted, and the two reviewers discussed any conflicting decisions until a consensus was reached. A record was kept of all articles screened and the final inclusion/exclusion decision that was made. If it was unclear during title and abstract screening whether an article was to be included in the literature review, the article was read at full-text level. If the relevance of the article was still unclear after full-text screening, the article was excluded from the literature review but was mentioned in appendix (Frampton et al., 2017). After testing the screening process, each reviewer was assigned a subset of articles to screen using the web-based software Rayyan (Ouzzani et al., 2016).

Following the title and abstract screening, 80 articles were excluded based on relevance to the research topic, 62 were excluded as duplicates, and an additional 11 could not be accessed at full-text level. This resulted in a set of 165 articles screened at full-text level. Full text screening consisted of reading the articles at full text level, screening for inclusion/exclusion based on the eligibility criteria, and extracting information using the pre-determined codebook. Once again, the screening process as well as the coding process was tested prior to full text screening to ensure consistency amongst reviewers. This consisted of each reviewer screening and coding the same randomly selected article (from the set of 165), followed by a comparison of the applied codes and the final eligibility decision in group. Changes were made to the codebook where necessary. During the final full text screening process regular updates were scheduled between the reviewers during which questions were addressed, uncertainties were clarified and the codebook was continuously updated. Full text screening was done using NVivo and maxQDA, with three of the four reviewers screening 50 articles each, and one screening 15 articles. After full text screening, an additional 10 articles were excluded, resulting in a final corpus of 155 articles from which data was extracted for consideration in this systematic evidence assessment.

2.3. Step 3: data extraction and analysis

Data was extracted during full-text screening following the guidelines presented in the codebook (included in Annex A). The codebook consisted of a pre-determined set of codes that were applied to paragraphs of text in each article to categorize and structure the relevant information. Two types of codes were used during this process, those used to identify the meta-data of the information (cf. Codes 1-11 in the code book) and those used to identify the content of the information (cf. Codes 12-15 in the code book). Meta-data consisted amongst others of the source of information, reference year, geographical scope, sample size, methods, population (i.e., type of wood product, such as hardwood or softwood), and the ES. The content of the information was centered around the outcome(s) discussed in the article as they relate to the demand for and/or supply of (non-)wood-based products.

Information on each ES was categorized with an individual code. Throughout the full-text screening of the articles within the corpus, the coding scheme was iteratively adapted and expanded to account for misfits where relevant information could not be easily assigned. This led to provisioning services being additionally differentiated into sub-categories regarding the provisioning of wood *per se* or the provisioning of non-wood products (e.g. mushrooms or berries). We applied the code for provisioning services if the information considers provisioning at the forest ecosystems level, e.g. biomass. Cultural ecosystem services were further differentiated into aesthetic preferences and recreational values as it quickly became evident that these were the two main units of assessment for cultural ecosystem services within our corpus. Regulation & maintenance was further refined to consider carbon sequestration, natural hazards protection, as well as water regulation and maintenance.

To assess the content of the information contained within the corpus, we broadly differentiated between wood and non-wood products. In contrast to provisioning services, we applied the code for wood products if the information considers a tradeable good that is sold as a unit to a certain price, e.g. X MW/h of bioenergy, m^3 roundwood sold at a market, etc.

Besides considering (non-)wood products, we also created a category for policy preferences and implications. As there was little explicit information on future demands of ESs, we gathered information on

policy and management preferences and implications in relation to different ESs and wood products. This enabled us to assess the impacts of different interventions regarding forest management alternatives (e.g. close-to-nature forest management), policy (e.g. energy, climate, or biodiversity policies) or specific instruments (e.g. incentives) on demand. Therefore, this code allowed us to assess future demands of forest ESs by synthesizing opportunities for action and their impacts on demand described in the literature. As we categorized information using several codes at once, the combination of codes representing different ESs with these “content codes” allowed us to categorize and compare information in a more nuanced manner, i.e. when comparing management preferences for recreational values, or the impacts of increased timber production on other ESs.

Alongside this, the journal impact factor and the quantile ranking of the journal in its primary field was recorded for each of the 155 included articles. If journals were ranked in two fields, the highest ranking was recorded. In total, 81 of the 155 articles were published in 1st quantile (Q1) journals, 36 in 2nd quantile (Q2) and 19 in 3rd (Q3) quantile journals. Finally, 11 articles came from 4th quantile (Q4) journals. The remaining 8 articles were published in journals with no impact factor.

The analysis of the data was separated into two categories: a quantitative assessment which consisted of an evaluation of the meta-data, and a qualitative assessment which consisted of an evaluation of the outcomes of demand and/or supply. During the quantitative analysis, meta-data codes were transposed into binary metrics for each coded segment by one of the four reviewers. The qualitative assessment consisted of, for each article separately, summarizing the information according to two overarching categories: demand for ESs and demand for wood-based products. To assess the demand for ESs, the CICES ES classification was used (CICES, 2018). During the qualitative assessment extra care was taken to ensure traceability of the source(s) of information. In a next step, the journal quantile was used to distinguish between more and less reliable findings. Results were aggregated across the different articles through a cumulative approach. First, all findings from Q1 journals were aggregated and summarized. Next, findings from Q2 journals were evaluated. If these results supported findings from Q1 journals, the information was given more importance. This process was repeated with information from Q3 and Q4 journals. Through this approach we identify the quality of the included information based on the number of times a particular result is reported in different sources as well as a more objective measure of evidence quality through a consideration of journal quantile ranking. If a specific piece of information was only reported once in a Q4 journal, or if no impact factor and/or journal quantile could be identified, it was not considered in the qualitative analysis.

Finally, as mentioned in the introduction, the results were summarized within this report through an *ex-post* contextualization using the geographic scope based on the forest typology proposed by Winkel et al. (2011). We thus grouped our results based on the three prevailing forestry paradigms proposed in this typology (Sustained Yield, Multipurpose Forestry, and Ecosystem Management) that encompass different management approaches which have been explicitly linked to geographic regions. Any geographic regions that were not included in the original typology proposed by Winkel et al. (2011), but which were included in the literature review, were assigned to one of the three typologies using findings from Boncina (2011); Brukas and Weber (2009); Schulz et al. (2022); Zengin et al. (2013).

2.3.1. Interviews with stakeholders

Findings from the literature review were triangulated with insights from stakeholder interviews. We interviewed stakeholders with relevant connections to the forestry sector during the Climb-Forest field visits which were organised throughout 2023 within the framework of work package 5. Specifically, two interviews were carried out with a forest manager and an industry actor active in the recreational sector, during the Spanish and Norwegian field visits.

These interviews followed a set of open-ended questions covering demand for different ecosystem services in the forestry sectors. They were then summarized after the field visits, anonymized and added to the findings of the literature, in correspondence with the respective topic they were covering. We link the findings from the interviews with stakeholders to the key takeaways from the literature review in the conclusion of this report.

3. Analysis

The analysis is sectioned into five parts. First, we present the quantitative assessment of the corpus where we provide an overview of the topics as well as the distribution of countries contained within our sample. Second, the findings of articles that addressed forest ESs at an EU level (section 3.2) are summarized as these findings might not be easily applied to one of the forestry paradigms. The following three parts follow the same structure: Data gathered at the national level is summarized within the "Sustained Yield" forestry paradigm (section 3.3), "Multipurpose Forestry" (section 3.4), as well as "Ecosystem Management" (section 3.5) as presented in Table 1 above. Within each of these paradigms, results are presented along the three ES categories, namely provisioning services (which includes both wood and non-wood products), cultural services, and finally regulation and maintenance services. Additionally, findings related specifically to policy preferences and implications are summarized within each paradigm.

3.1. Quantitative assessment

Based on the coding for geographical scope we found that the representation of Northern and Western European countries within this corpus was substantially larger than for other parts of Europe. Finland and Sweden, each appearing 20 times in the search string, were studied most frequently. They were followed by Italy (16), Norway (15), and Spain and Germany (13 each). On the other side of the spectrum, Eastern European countries like Ukraine, Romania, Serbia and Croatia only occurred in one paper each. Articles that specifically looked at more than one country were coded for each of the countries mentioned, therefore there are more country codes than the total number of articles in the final corpus. If, however, a paper looked at a substantial region of Europe or Europe as a whole, a code for the entire region was applied. In total we found 17 publications that studied demand at a European, or specifically EU, level. As explained in Table 1 the country codes are grouped into three region specific paradigms. Table 5 gives an overview of how often ESs and demand for wood-based products are covered within each paradigm. The relevant part of the table will be explained in more detail at the beginning of each paradigm.

Table 5: Quantitative division of articles within the forestry paradigms

	EU General	Sustained Yield	Multipurpose forestry	Ecological sustainability
Provisioning	4	16	13	11
Bioenergy	7	8	5	2
Construction	1	2	4	1
Furniture	1	2	3	0
Pulpwood	2	3	2	0

Cultural	3	28	24	18
Regulation and maintenance	3	15	22	15

Note: As the codes for the specific wood products were applied separately from the ESs codes the numbers of bioenergy, construction, furniture and pulpwood, will not add up to the numbers for provisioning services.

Being assessed by 61 articles across the full corpus, cultural ES were the most prevalent ES. Regulating and maintaining services were studied in 47 articles and provisioning ESs were covered in a further 38 articles. In total 97 articles looked at ESs in general. This indicates that several articles considered multiple groups of ESs. While there is information on all forest ESs considered, there were no specific results on wood demand in construction represented in the search string. A total of 47 articles present findings on wood-based products, with a further 25 studying non-wood-based products. Within the wood-based products group 19 articles looked at bioenergy. Seven articles studied wood in construction and five articles each looked at furniture and pulp applications.

We also coded the articles for the type of actors they considered. The general public was the most frequently mentioned actor (36). Recreationists were considered second most, in 33 articles. Following this were consumers (19), forest owners (12), forest managers (10) and policy makers (9). Finally, 22 articles looked at other types of actors.

3.2. Total EU demand

Of the 17 articles that looked at the overarching European level we found that four articles studied provisioning ESs, while cultural and regulating and maintaining ESs were covered in three articles each. Within the demand for wood-based products bioenergy is clearly the most studied topic, appearing in 7 articles. Pulpwood was studied in two articles while construction and furniture were both studied in one paper. Besides this, research on all forest ESs was present within this group which will be summarized in the following.

3.2.1. Provisioning Services

Through the literature search we identified little information regarding provisioning services *per se* at the EU level. However, Jonsson et al. (2018)find that future demands of provisioning services are likely to increase, causing harvests to grow up to 7% in 2030, in relation to the average consumption of ~500 million m^3 in the period between 2000 and 2012. This was mostly found to be steered by increased demands for biomass due to growing demand for bioenergy which was expected to affect the shares of coniferous and deciduous wood used for energy differently. Furthermore, for a high mobilization scenario, Jonsson et al. (2018) present the share of fuelwood on overall consumption to increase up to 46% by 2030 as compared to 20% for a business-as-usual scenario. This is expected to cause changes in consumption of coniferous and deciduous wood of up to 302% and 55%, respectively (Jonsson et al., 2018). Similarly, Sikkema et al. (2011) project an increase in pellet use, basing their projections on two different scenarios by 2020. In the

first forecast (traditional competition), based on the existing competition between the forestry and the energy sector, consumption is expected to grow over the period 2011-2020 by 105 million tons of pellet equivalents. In the second forecast (extended competition), with a rapid growth of the forest sector, a growth of 305 million tons of pellet equivalent is expected. To mitigate these increased future demands for wood pellets in the EU, some research suggests that imports could be feasible without causing disproportionate impacts overseas. If supplied by woody biomass produced within the U.S., Galik and Abt (2016) find that volumes up to 12.2 million tons could be sustainably supplied by pulpwood without reducing regional forest carbon stocks. However, this would cause prices of pine pulpwood to increase up to 50% by 2030 compared to 2009 (Galik and Abt, 2016).

3.2.2. Cultural Services

Ciesielski and Sterenczak (2018) identified the following factors that may influence preferences regarding forests at the European level: tree stand factors (e.g. age), social and demographic factors, and external factors related to human activity such as noise, external disturbances, and littering. Overall, when assessing preferences for recreational services, visitors have been found to prefer recreational facilities across multiple studies (Czajkowski et al., 2014; Doli et al., 2021; Oliveira et al., 2017). In some cases, recreation is the ES with the highest willingness to pay (Garcia-Nieto et al., 2013; Gatto et al., 2013). In addition, there is also demand for recreation in the form of provisioning of non-timber forest products (e.g. mushroom harvesting, (Di Cori et al., 2021; Garcia-Nieto et al., 2013). Regarding aesthetic preferences, there is a general tendency to prefer mixed forests rather than monocultures (Crivellaro et al., 2020; Ebenberger and Arnberger, 2019; Edwards et al., 2012).

3.2.3. Regulation and Maintenance

The literature suggests that the increased demands for provisioning services, especially the provisioning of biomass, might impede regulating services in European forests. Some evidence suggests reductions of total forest carbon stocks of 9% in 2030 compared to 2015 in case of high biomass mobilization (Jonsson et al., 2018).

3.2.4. Policy preferences and implications

Besides the expected increase in demand for biomass, the deployment of bioenergy in the EU faces some challenges. Depending on the requirements set on bioenergy, as well as how carbon sinks are considered, wood-based energy may be directly restricted by climate policies (Hanninen et al., 2018). Therefore, Hanninen et al. (2018) argue for more stringent definitions at the EU level, as well as a reduction of conflicting policy targets to facilitate investments in bioenergy. Furthermore, increased interests in provisioning services might cause conflict with forest biodiversity conservation efforts. Rosa et al. (2023) find a link between the risk of species extinction and different forest management approaches. By assessing different forest management models aimed at tackling and mitigating animal species loss in forest ecosystems the authors demonstrate that low density and close to nature forest management and EU28-internal production decrease extinction risks. However, the authors acknowledge that the forest management approach itself might not be sufficient to effectively overcome animal species loss alone. In fact, in climate change mitigation scenarios, the demand for wood products, harvesting intensity and hence pressure on forests is expected to increase. This development runs counter to the clear societal demand

for biodiversity and conservational policies as identified in several studies (Crivellaro et al., 2020; Getzner et al., 2018; Nordén et al., 2017; Paletto et al., 2014). This is further emphasized by Crivellaro et al. (2020) who report that respondents deemed biodiversity as essential for the provisioning of other ESs such as natural hazards protection.

To summarize these findings at the EU level, demand for provisioning services is likely to increase in the future. This is mostly driven by additional demand for bioenergy, and hence, forest biomass. While some of this pressure might be cushioned by additional imports, it might hinder the supply of other forest ESs such as carbon sequestration and might impede forest biodiversity if reliant on high-intensity forest management. Increased demand for provisioning services might furthermore affect coniferous wood more strongly compared to deciduous wood. This poses an additional challenge to forest management as recreational activities are preferred in forests with mixed stands over monocultures.

3.3. Sustained Yield

In the set of 59 articles that fall under the sustained yield paradigm, cultural ESs are the most studied (28 articles). Provisioning and regulating & maintaining services were covered in 16 and 15 articles respectively. Regarding the demand for wood-based products bioenergy is represented the most, appearing in 8 articles. Three articles looked at pulpwood, while construction and furniture were considered in two articles each.

3.3.1. Provisioning Services

In general, the demand for provisioning services is likely to increase in sustained yield forestry systems. This is mostly described for two products, roundwood and biomass. Some research suggests Finnish roundwood demand will increase from 70 million m³ to 90 million m³ in coming decades (Heinonen et al., 2020). Also in Finland, Makkonen et al. (2015) voice concerns over future biomass supply as they identify a disconnect in the number of policies targeting demand and supply of provisioning services.

The future supply of wood might also be influenced by the silvicultural practices preferred by the forest landowners. Heinonen et al. (2020) find harvested volumes to be reduced by 15%-19% over a 100-year planning horizon mostly due to “saver” forest owners who seldom sell timber, leading to average harvests of 74.5 - 80.7 million m³ year−1. This estimate relates mostly to Norway Spruce (*Picea abies*), Scots Pine (*Pinus sylvestris*), as well as some Silver Beech (*Nothofagus menziesii*). However, to what extent provisioning services are desired might additionally depend on the actor’s perspective. Nordén et al. (2017) report divergence in preferences for provisioning services and biodiversity depending on stakeholder type in Sweden. While the general public ascribes a positive value to biodiversity, forest managers prioritize production and hence management options are less biodiversity-oriented, for example through even aged stands and clearcuts.

These findings might be relevant for the future provisioning of biomass. For Norway, the demand for woody forest biomass is thought to increase as bioenergy reaches cost-competitiveness (Tromborg et al., 2007). However, Tromborg et al. (2007) highlight the relevance of energy prices for the development of bioenergy, and thus, the future demand for biomass provisioning.

Bioenergy

Ranta et al. (2007) project a qualitative and quantitative mismatch between demand and supply of bioenergy in Finland. Of the identified optimal 29TWh energy demand in 2010 only 11TWh could be supplied from national biomass production. Demand was highest for bark, while the supply mostly consisted of sawdust. Besides the appropriate supply, energy prices have also been found crucial for the deployment of bioenergy. Assessing the feasibility of bioenergy in Norway, Tromborg et al. (2007) find that bioenergy use will expand for prices of ~62-88 Euro/MWh. However, Börjesson et al. (2017) expects bioenergy aggregated heating (both individual and district heating) demand to decrease as energy efficiency will increase while housing demand will remain stable, compared to the current use of bioenergy. The use of biomass in individual heating systems is likely to be rather stable, varying between 9 and 12 TW h per year by 2030 and between 7 and 12 TW h per year by 2050. District heating demand is, on the other hand, expected to decrease by 10% by both 2030 and 2050. Nonetheless, it is argued that total biomass demand would increase mostly due to the use of biofuels for road transport as well as new demands for wood as feedstock in the chemical industry. While Börjesson et al. (2017) recommends improvements in energy efficiency to meet demand, Ranta et al. (2007) suggest that the integration of by-product flows as well as forest chips into the supply chain may help secure the steady supply of forest biomass to energy plants.

Another key aspect related to demand for provisioning services within the sustained yield paradigm is how the different wood products compete amongst each other and how this will evolve in the future. Jonsson et al. (2018) indicate that there may be a competition between fuelwood and wood for bioenergy on the one hand, and pulpwood on the other. The latter, i.e. demand for pulpwood, is being affected due to higher environmental concerns, a push for renewables and progress in ICT. From 2020 to 2030, the growth of wood consumption is projected to increase by 17.2%. This growth is anticipated because of projected increased economic growth in Eastern Europe, China and India, and because Eastern Europe is likely to gain importance in the supply of wood. Additionally, according to Guo and Gong (2019) an increased demand for fuel wood would make the competition between pulpwood and hardwood more intense and lead to an increase in prices. However, contrary to previous findings, Rougieux and Damette (2018) foresees less harsh competition between the different sectors of wood-based products, including bioenergy.

Furniture

Assessing customers' preferences for wooden furniture in a Norwegian Ikea, Veisten (2007) finds that price and wood species mattered more for purchasing decisions than the environmental friendliness of the product. This research reports a significant preference for pine in wooden furniture. However, Hoibo et al. (2015) report that aesthetic wooden appliances (such as interior decorations) are less preferred in Norway than their non-renewable counterparts. Furthermore, environmental awareness amongst consumers was found to be a driver of higher preference for wooden furniture.

3.3.2. Cultural Services

Some research suggests that preferences with regard to forest management approaches and associated cultural services depend on whether respondents actively visit forests for recreational purposes. Frequent visitors of Finnish state-owned commercial forests engaging in activities like nature watching or fishing, valued recreation-oriented management more highly than non-visitors (Juutinen et al., 2017). This research specifically highlights the relevance of wider scenic buffers zones along rivers and lakes, as well as less frequent clear-cut areas along hiking trails and the increased provision of habitats for game birds for citizen's welfare. Besides the management approach, socio-demographic factors of visitors also influence the demand for recreational services. While this has been repeatedly confirmed in the literature for age (Bartczak et al., 2012; Kikulski, 2021; Mandziuk et al., 2021), visitors' knowledge of ecological processes also strongly influences their demand for recreation in forests. Especially forest elements representing decay and death, such as dead wood, have repeatedly been found to have a negative effect on forests' recreational values. This holds true when visitors have a poor understanding of the ecological relevance of these elements (Gundersen and Frivold, 2011; Hansson et al., 2012).

While the literature identifies trends in visual preferences, the distribution of these preferences across different countries resembles a spectrum instead of clear categories. Nielsen et al. (2018) find that differences in the field layer significantly influenced aesthetic preferences' rankings in Nordic countries. Visual preferences were influenced gradually based on the field layer, whereby anemone would increase preference and rough field layers would decrease preference. Besides the stand and field layer, the vegetational period has been found to significantly influence aesthetic preferences Kikulski (2021). Mandziuk et al. (2021) find that respondents in Poland have a high preference for mixed stands and for undergrowth stories. There is also a preference for a higher development of leisure and recreation facilities. In Austria, Ebenberger and Arnberger (2019) illustrated that respondents enjoy diverse forests with high levels of naturalness and prefer a mix of broadleaf and coniferous stands. Juutinen et al. (2017) similarly found that roughly one third of visitors in Finland are supportive of a forest management oriented towards recreation. Individuals who value forests' recreational services were in general older (often retired), with a higher education level. Regarding clearcuts, we find different preferences in the literature. Arnberger et al. (2018) find that visitors do not particularly enjoy the presence of clearcuts. Gundersen and Frivold (2011) report that clearcuts undermine the scenic beauty of the forest.

3.3.3. Regulation and Maintenance

Some literature identifies preferences for regulation and maintenance ESs. Lehtoranta et al. (2017), report willingness to pay for a watershed restoration program in Finland and argue that it would be more supported by the general public if the benefits of species and biodiversity conservation generated by the program would be publicly communicated. Peters et al. (2015) demonstrate that respondents value climate, soil, and water regulation as important regulating ecosystem services. Further, there are discrepancies on how future use of wood for bioenergy forests would affect carbon sequestration and thus climate regulation.

3.3.4. Policy preferences and implications

Tromborg et al. (2007) find that bioenergy in Norway makes up a lower share of total energy production compared to Finland or Sweden as a result of low energy prices, which was influenced by the absence of energy tax policies, as well as few central heating facilities. They therefore emphasize the relevance of incentives, excess biowaste, and available water-born heating systems to further increase the share of bioenergy. However, there are also more physical explanations that enable or hinder bioenergy, such as chimneys or access to district heating. Supplementary to this, Bryngemark (2020) find that implementing biodiversity policies in Sweden can mitigate the prices of bioenergy, while it might increase prices for other wood sectors. As bioenergy from wood pellets and chips is considered a byproduct of biomass production, the authors argue that bioenergy prices might not be as affected by the competing demand for wood by the paper and roundwood industry. Based on semi-structured interviews with Finnish forestry stakeholders, Peters et al. (2015) also conclude that an increased demand for biomass provisioning does not necessarily conflict with conservation interests. Nonetheless, some research identifies low acceptance rates of increased biomass extraction at the cost of biodiversity (Getzner et al., 2018). As reported by Getzner et al. (2018), Austrian citizens were not willing to increase the commercial (read: production) function of the forest without enhancing conservation efforts. Furthermore, participants would only accept increased biomass extraction from the forest if additional conservation policies were implemented.

While these findings indicate some synergies between conservation efforts and provisioning services, the findings on low acceptance of deadwood and “untidy” forest presented in the section on the demand of for cultural ecosystem services in countries of the sustained yield paradigm might indicate a trade-off between biodiversity and forest recreation. However, whether demands for these services impede each other in the future might depend on the management approach chosen. Nielsen et al. (2018) argue that closer-to-nature management facilitates the synergy between biodiversity conservation and recreational services by promoting desirable field layers. Other research suggests sustainable ecosystem management to mitigate potential trade-offs, for example, by opting for small size or fresh deadwood in managed forests instead of large rotten wood (Gundersen and Frivold, 2011). Additionally, these findings highlight the importance of management approaches for the demand of cultural ecosystem services. Juutinen et al. (2017) report that the preferences of forest management alternatives vary mostly between individuals, but not between regions.

Environmental friendliness is a less important driver of wood demand than prices. This seemingly limits the importance of sustainability labels in wood products. However, labels capturing environmental friendliness might matter for consumers with increased environmental awareness. Albrecht (2018) reports that preferences of industry consumers of paper products are influenced based on how they are embedded in knowledge and cooperation networks. This was found for preferences regarding what the certification of paper products should cover, e.g. the share of recycled paper, forestry, or forest-certification in general.

To summarize, the demand for provisioning services is likely to increase in countries falling under the sustained yield paradigm. As the corpus reviewed in the synthesis yielded no information on provisioning services such as berry or mushroom picking, we find that the increase in demand is mostly driven by additional demand for roundwood and biomass. However, to satisfy increasing demands in the future, a

well-organized integration of forest landowners within national forest strategies is necessary to ensure supply. For biomass, the increased demand is mostly driven by (higher) energy prices. The overall availability of biomass and the installment of energy tax policies are important variables behind the price development. The increased demand for biomass for bioenergy might furthermore increase competition between wood processing industries. This might impact the demand for other wood products such as wooden furniture as price remains the most important variable in explaining purchasing behavior. Both increases in energy efficiency, as well as integrating biomass in supply chains more extensively by including byproduct streams, are suggested to satisfy these demands.

The demand for recreational services is mostly influenced by the forest management approach as well as socio-demographic factors of visitors. Age and education stand out as important factors as they have both been found to influence the frequency of recreational activities as well as the valuation and acceptance of deadwood. Furthermore, there is a willingness to pay for mixed stands and more complex development of forest conservation programs. This is especially relevant as the field layer significantly influences visual preference. Generally, there appears to be a preference for diverse forests with high levels of naturalness consisting of a mix of broadleaf and coniferous forests. Some research suggests a trade-off for forest management approaches that favor provisioning services with biodiversity and conservational values.

Finally, the precise setting and goal of the forest management approach is frequently described to be crucial to determining synergies and conflicts between different forest ecosystem services. In that sense, the reviewed literature suggests that the way certain services are emphasized by different management alternatives might matter more than the choice of which ES should be promoted itself. This is mostly described for conservational values regarding provisioning of timber and recreational preferences.

3.4. Multipurpose forestry

In total 60 articles were categorized in the multipurpose forestry paradigm. The cultural ESs were covered in 24 articles. Regulating and maintaining services were covered in 22 articles, with an additional 13 articles looking at provisioning services. Under the demand for wood-based products bioenergy was the most covered topic (5), followed by construction (four articles) and furniture (three articles). Pulpwood was studied in two articles.

In multipurpose forestry we observe that provisioning services are viewed as a tool for climate change mitigation, by extracting wood for products that would store carbon in the long term. However, the supply of provisioning services, namely wood extraction, and its demand is mismatched. For recreation services, we find a tendency to prefer mixed coniferous stands over coniferous forests, with sociodemographic characteristics of visitors such as income or education playing an important role in aesthetic preferences.

3.4.1. Provisioning Services

Research in Swiss forestry networks finds that forestry actors preferred increased wood extraction as climate mitigation measure compared to increased carbon sequestration in the forest (Creutzburg and Lieberherr, 2021). However, this presumes that the demand for wood biomass matches its supply. To address a mismatch between demand that exceeds supply of forest provisioning services in Ireland,

Duesberg and Dhubhain (2019) find that intensification of forest management might be accepted by environmental and recreational actors. This was also found for approaches that address this mismatch by lowering consumption. Duesberg and Dhubhain (2019) explain this ambiguity by pointing out that disputes might revolve more around the precise setting of intensified forest management (e.g., if more sensitive conservation areas would be left un-afforested). On the other hand, demand that does not exhaust supply might also limit the feasibility of forest management approaches. Binder et al. (2004) find that underutilization of wood biomass due to low harvest rates in Switzerland impede on sustainable forest management as it skews the age structure of forest stands.

Binder et al. (2004) find that household demand for wood products in Appenzell, Switzerland equals 27'400m³/year, of which only 34% is covered by regional resources, and that only 13% of wood residues produced in sawmills is used regionally as firewood. Comic et al. (2021) assessed fuelwood consumption in Bosnia Herzegovina at household level and identified a mismatch between the reported official data and the real data, which the former being almost five times higher. This is a relevant issue for formulating and implementing environmental policies aimed at sustainable forest management and consumption. In fact, provisioning services often have an interplay with other ESs, undermining the environmental sustainability of forest ecosystems. To reduce environmental impacts of bioenergy, Mehr et al. (2018) emphasize the importance of material use with subsequent incineration instead of direct energy generation. Furthermore, the authors conclude that the national electricity mix is substantive for whether incineration should aim at generating heat only or co-generate heat and power.

Peters et al. (2015) investigated the synergies and tradeoffs between multiple ESs. According to German stakeholders (namely practitioners and conservationists), there is a strong competition between the production of solid roundwood and bioenergy production. In fact, the latter would undermine the quality of wood. However, in terms of marketability, increased production of bioenergy wood would make the whole chain more profitable. Higgins et al. (2020) found that habitants of Northern Ireland are willing to pay for an ecolabel scheme for wooden products, especially those with more environmentally friendly attitudes and higher levels of education. In addition, they prefer to have more vague claims rather than too much information on the label.

Non-timber forest products also constitute a provisioning service. Kilchling et al. (2009) found that in Switzerland there is relatively high demand for non-timber forest products, namely food. This extraction of non-timber forest products generates a window of opportunity for the forest sector economy. In Germany, 3.5% of the total wood demand can be attributed to construction sector (Jochem et al., 2016). 36% of this share can be attributed to new construction whereby the largest share (29%) is for residential construction and 7% non-residential construction. In turn, 64% of wood used in construction is used in modernization, whereby 51% is used for residential construction and 13% for non-residential construction.

Potkany et al. (2021) investigated preferences for wooden houses in Slovakia and found that respondents have a low awareness of wood used for construction. The authors identified family groups with at least one child, aged between 26 and 50 years old, with a university degree and a net household income between 1,200 € to 2,000 € per month as consumers with highest interest in wood construction.

While an increase of wood products in construction might seem desirable, a life cycle analysis of wood products provides a more nuanced view. Mehr et al. (2018) illustrate that choosing wood as only material for housing significantly increased the environmental impacts of wood. This is mostly due to the missing product cascading, meaning that certain wood products such as beams, boards, and particle boards are permanently bound in the construction product, and thus, cannot go through multiple uses (Binder et al., 2004).

We find that furniture makes up large shares of processed wood. A study in Switzerland suggests that 37% of all wood processed is used for "¾ products" and furniture (Binder et al., 2004). The literature indicates that in order to minimize environmental impacts of wooden furniture, particle boards are preferably produced from post-consumer wood. If that is not possible, it should be produced from residual wood (Mehr et al., 2018). Some research finds willingness to pay for labelled wood furniture to be 16% higher compared to the existing unlabeled alternative (Veisten, 2007).

This willingness to pay was also found to be higher for women. Guzel (2020) have assessed preferences for wood and furniture in Turkey, where consumers were found to appreciate wood for its organic character and naturalness. While consumers mostly use wood for furniture purposes, they prefer wooden composites, as they are cheaper than entire wooden furniture products. Manuel et al. (2015) investigated the importance of visual aspects in furniture in Germany and found that visual appearance of the furniture is highly important, irrespective of the technical features. This means that the aesthetic character of wooden furniture plays a significant role in consumer preferences.

3.4.2. Cultural services

Similar to the sustained yield paradigm, recreational preferences under the multipurpose forestry paradigm were influenced by socio-demographic and socio-economic characteristics of visitors such as age, income, and employment status (Abildtrup et al., 2013), as well as the phase of development of the forest stand (Edwards et al., 2012). While tree species itself appears to have no significant effect on forests' recreational value, a preference for broadleaf and mixed stands over coniferous stands was identified (Abildtrup et al., 2013; Edwards et al., 2012). Additionally, we find evidence that the perspective respondents are asked to take (e.g., "social" vs. "private") does not influence the willingness to pay for site attributes (van Rensburg et al., 2002). However, knowledge of forest or landscape management was found to influence recreational preferences (Petucco et al., 2013; van Rensburg et al., 2002). According to Doli et al. (2021), in Kosovo, visitors are willing to pay extra taxes for a sustainable management plan for a National Park around Germia. Namely, 56% of them would pay around 1-2% extra in taxes if that would mean increasing recreation services in the park and having sustainable development management policies. Cultural services can enter in synergy with provisioning services in Germany, where Peters et al. (2015) found that visitors may prefer some degree of logging as it leaves the forest tidier. In addition, collection of firewood can serve as both provisioning and recreational service, with visitors collecting firewood pieces in the forest. For Karahalil et al. (2015), respondents in a National Park in Turkey value rafting as the most important recreation activity, followed by general recreation. Other park-related benefits they value are, water quality and lastly biodiversity conservation. activities. Howley et al. (2011) report that respondents in Ireland positively value forests for recreation purposes and consider carbon sequestration and soil regulation as more important services than timber production. Nonetheless, there is high heterogeneity in their preferences.

In terms of visual preferences, some research suggests preference for thinned forests over unthinned ones as the vision is not blocked and light manages to pass through (Duesberg and Dhubhain, 2019). In a study of Lupp et al. (2022) in Germany respondents show a strong preference for natural looking forests, consisting of mixed and uneven aged stands. This is also consistent with Edwards et al. (2012), where respondents prefer a mixed forest over a forest with only coniferous. Another aspect to be considered is the presence of deadwood and the perceived tidiness of the forest. Deadwood is often not appreciated by the general public, and this can be linked to a poor understanding of underlying ecological processes (van Rensburg et al., 2002). This is in line with Edwards et al. (2012) who find that forest stands that are "tidied up" (e.g., removal of deadwood and undergrowth) are preferred to stands without any intervention. Though, in Germany, the role of deadwood is somewhat better recognized (Lupp et al., 2022). Providing information on the ecological role of deadwood may increase appreciation rates (Gundersen et al., 2016; Lupp et al., 2022) and might as such be important to move to management approaches that are more widely accepted and beneficial from an ecological point of view.

3.4.3. Regulation and Maintenance

A core aspect in managing different ecosystem services in multifunctional management is how the different ecosystem services interact and interplay with each other. Nielsen et al. (2018) report that closer-to-nature forest management is well-suited to foster synergies between biodiversity and ecosystem functioning and recreational services as this management approach would promote desirable (i.e. visually preferred) field layers. Varying visual preferences may cause difficulties in finding the optimal management for different ecosystem services. To solve issues related to divergent aesthetic preferences of forest visitors and forest managers, van Rensburg et al. (2002) argue that additional information may improve valuation of these characteristics (namely elements perceived as "untidy" or representing death and decay). However, forest managers' duty to ensure regulating services and visual preferences of forest visitors might be directly conflicting.

Soil health and nutrient availability enter in synergy with provisioning services, and according to Peters et al. (2015), German stakeholders see excessive wood extraction, driven by an increasing demand for timber and biomass, as a threat for the aforementioned services. Tolunay and Bassullu (2015) assessed willingness to pay for carbon sequestration in Turkey. Respondents would be available to pay extra for planting a new forest via a donation, with a total willingness to pay of $23.52/year per household.

3.4.4. Policy preferences and implications

Assessing the French forest sector, Lecocq et al. (2011) find that a modeled substitution policy aiming at publicly subsidizing wood consumption has positive effects on demand compared to the business-as-usual. The authors furthermore conclude that substitution policies outperform stock policies aiming at payments for forest owners as they further increase carbon sequestration.

Edwards et al. (2012) suggests that forest recreation might be directly impeded by wood production. In all assessed regions , the forest management alternative "wood biomass production" scored as lowest for recreational value. Instead, they find a clear preference for forest nature reserves and close-to-nature forestry in Great Britain and Central Europe.

Amongst many climate change mitigation options, increased carbon storage in the forest might not be preferred by forestry actors. Creutzburg and Lieberherr (2021) assessed Swiss forest network preferences and found most actors opposed this climate mitigation measure as compared to increased wood extraction. Interestingly, actors that preferred increased carbon storage in the forest were found to share less information on cantonal forest policy than actors opposing it. Stock policies aim at increasing carbon stock in the forest by compensating forest owners for foregone benefits. Such stock policies have poor effects compared to substitution policies (Lecocq et al., 2011). As such, it might be difficult to increase forest carbon stocks by policy interventions. Substitution policies would result in higher timber and lead to a mismatch with supply. By addressing future timber demands in Ireland, Duesberg and Dhubhain (2019) find that imports are considered as very unacceptable by organizations that are having an environmental or recreational interest in Irish forests management. Instead, more than half of the respondents found it acceptable to afforest abandoned agricultural land for this reason. Furthermore, mixed stands with a maximum of 50-70% conifers were considered acceptable. That is also confirmed by Upton et al. (2012) who illustrated that respondents in Ireland positively value afforestation programs and forest management, especially when it involves recreation aspects.

Other research highlights the relevance of sawmills and wood processing industries in re-aligning demand and supply of wood products on a regional level (Binder et al., 2004). By ensuring quality to customers, providing a market based on formal contracts for foresters, and fostering wood exports, these industries would pose an important leverage point.

Concerning the construction sector, Jochem et al. (2016) find the demand for wood in buildings to be almost elastic, these authors associate an increase in wood prices directly with an increase in the demand for steel and reinforced concrete. In residential construction, the choice of building material was found to be little impacted by price, but rather by personal preference. Therefore, low wood prices might mainly impact wood shares in non-residential construction. Regarding the paper industry, Albrecht (2018) reports that paper industry actors preferred the presence of sustainable wood labels over the specific details of certification.

Regarding forest management, Sheremet et al. (2017) investigated preferences for disease control policies in the United Kingdom, finding out that respondents are willing to pay extra for disease control, but only when they concern charity or state-owned forests and only when it does not involve tree felling and biocide use.

In summary, provisioning services, especially biomass provision, are highly valued. However, it is unlikely that an increasing demand will be able to match the supply. There is demand for recreation facilities and preferences for mixed, broadleaf and uneven aged forests. Nonetheless, the role of deadwood is not fully understood. Concerning regulation services, while they are in demand, they interplay and may enter into conflict with other services, namely production.

3.5. Ecosystem Management

The following section entails the results of the articles falling under the ecosystem management paradigm. This paradigm encompasses 37 articles and 18 of these articles studied cultural ESs. Regulating and maintaining services were covered in 15 articles. A further 11 articles considered provisioning services. In general demand for wood-based products was not studied frequently under this paradigm, only two articles looked at bioenergy and one paper looked at construction.

While timber provision is an important provisioning services, there is also a demand for non-timber forest products and biobased textiles. In addition, provisioning of non-timber forest products interplays with recreation services. There is a preference for mixed stands rather than monocultures and in general “natural looking” forests.

3.5.1. Provisioning Services

For Italy, research in mountainous areas in the north demonstrates that timber provisioning is considered to be the most important forest ES (Grilli et al., 2015). The low valuation of fuel wood and game activities would be a consequence of socioeconomic change such as abandonment of mountainous areas which historically served as integrator for common property rights (Grilli et al., 2015; Paletto et al., 2014). In addition to timber, another provisioning service concerns non-timber forest products. These entail production or picking of berries, mushrooms, herbs, honey and other products. As investigated by Di Cori et al. (2021) there is a demand for non-timber forest products, and they provide two types of forest ESs, namely provisioning and recreational. This finding is also supported by Garcia-Nieto et al. (2013) who found a significant relationship between tourism and mushroom harvesting. Also de Frutos et al. (2016) found that in Spain the average willingness to pay in the form of a permit for mushroom harvesting was roughly 22 euros per year.

The ESs valuation varies among stakeholder groups and with geographical area. For example, Paletto et al. (2014) found that forest managers and owners prioritize provisioning and timber production, whereas the tourist sector values cultural services more strongly.

Another provisioning service offered by forest is raw materials for textiles. By assessing the willingness to pay for biotextiles in Italy, Notaro and Paletto (2021) found values of 6.83€, 28€ and 65.67€, for socks, T-shirts, and shirts made from European Beech (*Fagus Sylvatica*) fiber. However, the purchasing decision is mostly influenced by concerns surrounding negative impacts of the product on human health. Notaro and Paletto (2021) found that consumers with higher environmental awareness are willing to pay extra for bio-textile products in Italy. The price increase would range between 64% and 128%. Interestingly, sustainable packaging of the product plays a significant role, whereas the environmental impact of the whole value chain processes does not have a significant influence.

3.5.2. Cultural Services

For alpine landscapes, forests were found to be the second most preferred feature in alpine landscapes, after water bodies such as lakes and rivers (Pastorella et al., 2017). Furthermore, wildlife observation and hiking are identified as the most valued recreational activities. Also preferences for recreational services

are mostly influenced by socio-demographic factors. This aligns with previous findings that attest recreational values to increase with age and decrease with management intensity of forest stand (Edwards et al., 2012). Opposed to this, Simoes et al. (2013) identify travel cost and substitute prices as significant factors for forest recreation in Portugal, demographic variables have little impact. However, the authors find low price elasticity of demand, which was argued to demonstrate that travel cost alone has a limited effect on visitation levels. Oliveira et al. (2017) found that visitors of the Park of Leira can be divided into five segments based on their willingness to pay for recreational benefits. There are three segments with WTP higher than average. These segments also show higher levels of environmental awareness and willingness to volunteer. Another segment has a lower willingness to pay, and the last segment has also a higher willingness to pay, but scores low on environmental awareness. They observe a correlation between the frequency respondents visit forests and their requirements to the forest. According to Aasetre et al. (2016), Dutch visitors prefer to recreate in more natural looking forests.

According to Pelyhukh et al. (2019), respondents from Italy prefer mixes between broadleaf and coniferous stand and an open canopy. This was also found to be true for visual preferences within central Europe (Edwards et al., 2012). Mixed stands found to be preferred by forest visitors as monocultures generally scored low (Edwards et al., 2012). Further, the phase of development was found to be influential, as opposed to tree species, which had the least effect on visual preferences. As a recurring aspect in the other paradigms, deadwood plays a role. Respondents from Italy do not show appreciation for deadwood and wooden debris, and they prefer forests landscapes without deadwood presence (Paletto et al., 2022).

3.5.3. Regulation and Maintenance

The importance of ESs might depend on the respondent's relationship to the forest. Grilli et al. (2015) find that protection from natural hazards was perceived as most important forest ES for inhabitants of a mountainous region in Italy. According to Maroto et al. (2013), stakeholders in Spain value regulating services (water regulation, carbon sequestration, biodiversity conservation) more than social aspects (namely recreation and educational activities, employment creation and landscape) of the forests and provisioning services (wood production). According to Garcia-Nieto et al. (2013), in Spain, erosion control is the second demanded ES and gains particular importance at non-local level, while it is supplied at local level.

3.5.4. Policy preferences and implications

The demand for non-timber forest products is increasing. Nevertheless, Gorriz-Mifsud et al. (2015) find that forest owners do not want to receive money as compensation for mushroom picking to match supply of and demand for non-timber forest products. Instead, forest owners prefer investments in current forest infrastructure. The authors argue that this is due to the perception of mushrooms as a public good as opposed to timber as a private good. This perception would be reinforced by the extensive legal framework for timber use and the absence thereof for mushroom picking.

Varela et al. (2017) identify, in Mediterranean forests, two different scenarios that are reflecting social demand: one fire prevention management alternative, one biodiversity-oriented management alternative and a combination of both. That implies fire risk must be involved in management development.

To wrap up, while there is a strong demand for timber extraction, there is also a demand for extraction non-timber forest products. Cultural services play an important role, and the public tends to prefer mixed, uneven-aged forests. They do not have extensive knowledge on the ecological role of deadwood. Erosion control stands out as demanded regulation and control service.

4. Conclusion

Following a systematic literature review approach, we assessed current and future demands for forest ecosystem services (ESs) within Europe. Using a search string based on keywords contained within five key publications on the demand for forest ESs we identified 155 journal articles for this literature review. By applying a coding scheme, findings on the demand for three forest ESs (provisioning, cultural, and regulation and maintenance), as well as several wood products (bioenergy, construction, and furniture) were extracted and categorized. By expanding Winkel et al. (2011) forestry paradigms, we categorized the data by grouping country-specific findings based on three possible orientations of sustainable forest management. While “Sustained Yield” emphasizes sustainability of timber production in terms of the maximum (quantity and quality) of possible timber production within the preservation of forest ecosystem health, “Multipurpose Forestry” emphasizes the maximum yield of timber alongside other forest services, thus emphasizing the maintenance of certain other forest services such as recreation. “Ecosystem Management” emphasizes ecological sustainability which mostly focuses on the maximum ecological quality of forest ESs, and therefore, the maintenance of a minimum amount of timber.

4.1. Demand for ecosystem services in Europe

Overall, the assessed literature suggests that the EU demand for roundwood and biomass is likely to increase, especially for coniferous wood. This development is described as mostly driven by additional demand for bioenergy that is supplied by forest biomass. Such a general trend is also confirmed for countries of the sustained yield paradigm whereby the assessed research is concerned about the maintenance of maximum future supply. As energy prices have been presented as decisive for the demand for bioenergy, the installment and shaping of energy tax policies is likely a key intervention that determines future demand. However, if the increased demand for bioenergy is supplied using fuelwood, wood prices might rise due to the competition with other wood processing industries. Some literature suggests that this could be detrimental to the demand for wooden furniture as purchase decisions have been described as mostly influenced by price. To alleviate the additional pressure, increases in energy efficiency as well as integration of biomass into existing supply chains have been suggested.

For the countries interpreting sustainable forest management in line with the multipurpose forestry paradigm, we found a considerable demand for provisioning services. However, wood products extraction is also seen as a preferable way to mitigate climate change. Furthermore, the literature considered reports on negative consequences caused by the underutilization of wood due to low demand. Finally, in countries that emphasize aspects of sustainable forest management according to the ecosystem management paradigm, non-timber forest products such as berries and mushrooms are also highly demanded, next to wood products. Regarding the demand for cultural ESs, there is a clear preference for mixed forest stands over monocultures when it comes to recreational activities. This finding is confirmed across all forestry paradigms. Additionally, visual preference is described to be mostly influenced by socio-demographic factors whereby the respondent's age is repeatedly found to be highly relevant. Besides this, most research identifies a low acceptance of dead wood that is often explained by a poor understanding of the underlying ecological processes and their relevance to the ecosystem.

Finally, there is a willingness to pay for regulating and maintenance services across the board. Carbon sequestration is mostly discussed in research assessing the EU level or countries following the sustained yield paradigm. It is also discussed for countries assigned to the multipurpose forestry paradigm because there might be trade-offs between different forest ESs. Carbon sequestration is less extensively discussed for countries belonging to the ecosystem management paradigm, but erosion control as well as protection from natural hazards were assessed more frequently instead.

4.2. Demand and forestry paradigms

If the forestry paradigms are understood as a continuum that represents the relevance of forestry to a country from high (sustained yield paradigm) to low (ecosystem management paradigm), there appears to be a comprehensible pattern regarding the number of publications that address individual forest ESs within each paradigm. We identified the most information for the sustained yield paradigm on the demand for provisioning services as well as bioenergy (see Table 5 at the beginning of the analysis section). With Finland, Sweden, and Norway alone 55 publications were assigned to this paradigm, constituting one-third of the overall assessed corpus. However, with 28 publications addressing the demand for cultural services, this paradigm also fostered the highest number of articles considering recreational and visual preferences. For one, this could represent the continuum of different understandings of sustainable forest management behind the categorical concept of a forestry paradigm. On the other hand, this could also represent a partial departure within the national sectoral logic to integrate other forest ESs into consideration.

Conversely, within the ecosystem management paradigm, we found the least number of publications assessing provisioning services. Furthermore, these publications would more frequently address the demands of non-timber forest products such as berries and mushrooms. While most studies in countries assigned to this paradigm also assessed cultural ESs, the relative share of paper assessing regulating and maintenance is higher compared to the sustained yield paradigm (25% vs. 34%). This observation is coherent under the frame of the introduced forestry paradigms as the relevance of forest ecosystems within countries following the paradigm is mostly posed by the provisioning of “side products” such as mushrooms and berries as well as the protection from natural hazards while wood production itself might be less relevant. Finally, we find the relative shares of articles considering one of the three ESs assessed (that is, provisioning, cultural, and regulation and maintenance) within the multipurpose forestry paradigm to be more harmonized as compared to the other two paradigms.

The literature review yielded relatively little information on the qualities and challenges of specific tree species as most research would consider some mix of coniferous and/or deciduous trees instead. Additionally, demand for wood products mostly comprised assessments of bioenergy, and to a much lesser extent, demand for construction or furniture. While there might be structural factors contributing to this, such as the source of information considered (journal articles only, no grey literature) or the inherent challenges posed by these areas of research (such as rather heterogenous construction sectors across Europe with differing regulations), this poses a potential knowledge gap that needs to be addressed. However, it is important to acknowledge that this finding applies to the assessed (arguably extensive) subset of literature addressing demand for forest ESs and there has been no evaluation of this gap in other literature outside of the scope of this report.

Generally speaking, within the literature assessed in this report, the societal demands for ESs identified are rather heterogeneous. While trade-offs are described for management approaches that foster high production with biodiversity, as well as carbon sequestration, less intensive management alternatives often lack the increased provisioning of wood or biomass. This heterogeneity is also reflected by the different stakeholders' views have on forest management. On one hand, the general public (comprising not only recreationists but also citizens, and communities living close to forests) prioritizes recreation services and values the role of biodiversity and conservation within forests. On the other hand, forest managers and owners prioritize provisioning services, consisting mostly of wood production. On top of that, conservation groups and public authorities also add to the heterogeneity of services offered by forests. An additional factor that adds complexity, which is reflected by the different paradigms, is the geographical (and hence also economic) diversity of forests and their services. This is also confirmed by stakeholder 2 (a recreation stakeholder), who has noted that what people want for recreational purposes is not necessarily what is ideal from a management perspective (e.g. the role of deadwood, the presence of clearcuts). However, they have also stated that people are willing to learn about forests, hence there is a window of opportunity to align this mismatch. This suggests that there is no one-size-fits-all solution in terms of management alternatives but that a set of management alternatives might be needed to meet future demands (Sing et al., 2018). In addition, while the general public positively values conservation and biodiversity, the demand for provisioning services, especially bioenergy, is expected to grow and the current stock of forest production, especially considering sustainable management goals, is potentially not sufficient. An underlying key aspect of this conflict between management alternatives and stakeholders is the lack of knowledge. For example, while the general public values biodiversity and carbon sequestration, it neglects the role of deadwood and prefers "tidy" forests. Explaining the role of forest ecosystems and forest management may improve the conflict situation between the general public and forest managers and facilitate the implementation of policies that fully recognize the ecological aspects and the role of biodiversity in forests. This is confirmed also by stakeholder 3 (a forest manager), highlighting the need for more transfer of information between forest officers and managers (the "suppliers" of ecosystem services) and the general public. In fact, a lack of awareness of the role of forest management can lead to potential conflicts.

4.3. Limitations

There are some limitations to the literature review that need to be addressed. Firstly, as presented in the analysis section, the representation of Northern and Western European countries was substantially larger than other parts of Europe. While a majority of 97 publications considered forest ESs demand in Finland, Sweden, Italy, Norway, Spain, and Germany, Eastern European countries like Ukraine, Romania, Serbia, and Croatia only occurred in one paper each. However, for the sustained yield paradigm as well as the multipurpose forestry paradigm, 70 articles addressed countries within each of these paradigms and the skewedness of our sample mostly resulted in a numerical underrepresentation in the ecosystem management paradigm with 37 mentions. It remains unclear whether this stems from the chosen exclusion criteria, but we argue it might represent the actual amount of research performed within this field instead, as the assessed corpus was rather comprehensive.

Second, noticeably, most articles within our search string that considered the demand for forest ESs assessed cultural ESs. While this might indicate that there is a high interest in addressing and satisfying

demands for this service, this finding might also stem from the way the search string was tailored. In line with the project proposal, this report assumes that ESs can be divided into a demand as well as a supply side. However, while we find this to be especially true for market products such as fuel wood, the methods available to assess demand for ESs might favor the assessment for certain services over others. This might be the case for cultural ESs as contingent valuations and survey designs are highly suited to assess demand for this service while comparable methods are unavailable or inadequate for other forest ESs. Instead, the self-conception of studies that assess the quantity and quality of provisioning or regulation and maintenance might align more with a supply view or might not be easily categorizable at all. Furthermore, we find that many articles assessed different ESs based on forest management alternatives instead. This supports the argument presented in the framework section that forest management inherently links the supply and demand of forest ESs by mitigating different societal needs and the physical realities in the forest ecosystems that shall be managed. While we acknowledge the importance of the supply and demand dynamic at the product level, we suggest future research to extend this logic by integrating forest management approaches.

Third, the role of imports and exports of wood pose an additional aspect that has to be considered. We have decided to limit the search string only to geographical Europe without including supply of wood coming from countries not belonging to this geographical scope. Nonetheless, we recognize the role of these countries in the supply of wood, also considering the challenges posed by an increasing demand that is expected to be difficult to meet.

4.4. Outlook

Together with the environmental assessment in T3.2 and the choice modelling in T3.3 of the Climb-Forest project, these findings feed into the assessment with the WP 5 stakeholders on new ways of using wood products during the second workshop at around year 2 of the project. Together with WP 5, we contribute to identifying the forest management alternatives that are more likely to meet the desired wood properties for current and future use. This allows us to identify both the quantity of long-lived and short-lived wood products delivered under different management alternatives and whether there might be a mismatch between supply and demand. This potential shortfall will feed into a WP7 workshop with policy maker stakeholders as a basis for discussion of alternative policy instruments that could be put into place for supply to meet demand. The findings presented in this report furthermore provide a basis to improve modelling assumptions made in WP 4 and thus to the development of sustainable, feasible and community-supported forestry pathways.

References

Aasetre, J., Gundersen, V., Vistad, O.I., Holtrop, E.J., 2016. Recreational preferences along a naturalness-development continuum: Results from surveys in two unequal urban forests in Europe. J. Outdoor Recreat. Tour. 16, 58–68. https://doi.org/10.1016/j.jort.2016.09.006

Abildtrup, J., Garcia, S., Olsen, S.B., Stenger, A., 2013. Spatial preference heterogeneity in forest recreation. Ecol. Econ. 92, 67–77. https://doi.org/10.1016/j.ecolecon.2013.01.001

Albrecht, M., 2018. Environmental customer demands and (forest) governance: evaluating market relations, knowledge networks and positionalities. Geogr. Ann. Ser. B Hum. Geogr. 100, 42–60. https://doi.org/10.1080/04353684.2017.1379032

Alliance Environnement, Directorate-General for Agriculture and Rural Development (European Commission), 2017. Evaluation study of the forestry measures under rural development: final report annexes. Publications Office of the European Union, LU.

Arnberger, A., Ebenberger, M., Schneider, I.E., Cottrell, S., Schlueter, A.C., von Ruschkowski, E., Venette, R.C., Snyder, S.A., Gobster, P.H., 2018. Visitor Preferences for Visual Changes in Bark Beetle-Impacted Forest Recreation Settings in the United States and Germany. Environ. Manage. 61, 209–223. https://doi.org/10.1007/s00267-017-0975-4

Bartczak, A., Englin, J., Pang, A., 2012. When are Forest Visits Valued the Most? An Analysis of the Seasonal Demand for Forest Recreation in Poland. Environ. Resour. Econ. 52, 249–264. https://doi.org/10.1007/s10640-011-9527-1

Binder, C., Hofer, C., Wiek, A., Scholz, R., 2004. Transition towards improved regional wood flows by integrating material flux analysis and agent analysis: the case of Appenzell Ausserrhoden, Switzerland. Ecol. Econ. 49, 1–17. https://doi.org/10.1016/j.ecolecon.2003.10.021

Boncina, A., 2011. History, current status and future prospects of uneven-aged forest management in the Dinaric region: an overview. Forestry 84, 467–478. https://doi.org/10.1093/forestry/cpr023

Börjesson, P., Hansson, J., Berndes, G., 2017. Future demand for forest-based biomass for energy purposes in Sweden. For. Ecol. Manag. 383, 17–26. https://doi.org/10.1016/j.foreco.2016.09.018

Brukas, V., Weber, N., 2009. Forest management after the economic transition—at the crossroads between German and Scandinavian traditions. For. Policy Econ. 11, 586–592. https://doi.org/10.1016/j.forpol.2009.08.009

Bryngemark, E., 2020. Bioenergy versus forest conservation: a partial equilibrium analysis of the Swedish forest raw materials market. Scand. J. For. Res. 35, 367–382. https://doi.org/10.1080/02827581.2020.1808696

CICES, 2018. V5.1 Revision Highlights [WWW Document]. URL https://cices.eu/revision-highlights/ (accessed 12.18.23).

Ciesielski, M., Sterenczak, K., 2018. What do we expect from forests? The European view of public demands. J. Environ. Manage. 209, 139–151. https://doi.org/10.1016/j.jenvman.2017.12.032

Comic, D.R., Glavonjic, B.D., Anikic, N.D., Avdibegovic, M.H., 2021. Comparative Analysis of Wood Fuels Consumption in Households in the Federation of Bosnia and Herzegovina. SEEFOR-SOUTH-EAST Eur. For. 12, 43–56. https://doi.org/10.15177/seefor.21-08

Creutzburg, L., Lieberherr, E., 2021. To log or not to log? Actor preferences and networks in Swiss forest policy. For. POLICY Econ. 125. https://doi.org/10.1016/j.forpol.2021.102395

Crivellaro, M., Maurizio, C., Giacomo, C., Marco, B., Alessandro, P., 2020. A social assessment of forest resource based on stakeholders' perception: an application in three Balkans rural areas. J. For. Res. 25, 308–314. https://doi.org/10.1080/13416979.2020.1782554

Czajkowski, M., Bartczak, A., Giergiczny, M., Navrud, S., Zylicz, T., 2014. Providing preference-based support for forest ecosystem service management. For. POLICY Econ. 39, 1–12. https://doi.org/10.1016/j.forpol.2013.11.002

Daily, G.C., 1997. Nature's services: Societal dependence on natural ecosystems. Island, Washingtom DC. https://doi.org/10.1071/pc000274

de Frutos, P., Martinez-Pena, F., Aldea, J., Campos, P., 2016. A Model to Estimate Willingness to Pay for Harvest Permits for Wild Edible Mushrooms: Application to Andalusian Forests. FORESTS 7. https://doi.org/10.3390/f7120292

Di Cori, V., Franceschinis, C., Robert, N., Pettenella, D.M., Thiene, M., 2021. Moral Foundations and Willingness to Pay for Non-timber forest products: A Study in Three European Countries. SUSTAINABILITY 13. https://doi.org/10.3390/su132313445
Doli, A., Bamwesigye, D., Hlavackova, P., Fialova, J., Kupec, P., Asamoah, O., 2021. Forest Park Visitors Opinions and Willingness to Pay for Sustainable Development of the Germia Forest and Recreational Park. SUSTAINABILITY 13. https://doi.org/10.3390/su13063160
Duesberg, S., Dhubhain, A.N., 2019. Forest intensification in Ireland: Developing an approximation of social acceptability. LAND USE POLICY 85, 368–386. https://doi.org/10.1016/j.landusepol.2019.03.028
Duncker, P.S., Barreiro, S.M., Hengeveld, G.M., Lind, T., Mason, W.L., Ambrozy, S., Spiecker, H., 2012. Classification of Forest Management Approaches: A New Conceptual Framework and Its Applicability to European Forestry. Ecol. Soc. 17, art51. https://doi.org/10.5751/ES-05262-170451
Ebenberger, M., Arnberger, A., 2019. Exploring visual preferences for structural attributes of urban forest stands for restoration and heat relief. Urban For. Urban Green. 41, 272–282. https://doi.org/10.1016/j.ufug.2019.04.011
Edwards, D., Jay, M., Jensen, F.S., Lucas, B., Marzano, M., Montagne, C., Peace, A., Weiss, G., 2012. Public preferences for structural attributes of forests: Towards a pan-European perspective. For. POLICY Econ. 19, 12–19. https://doi.org/10.1016/j.forpol.2011.07.006
European Commission, 2023. New EU forest strategy for 2030 [WWW Document]. URL https://environment.ec.europa.eu/strategy/forest-strategy_en
Forest Europe, 2020. State of Europe's Forests 2020.
Frampton, G.K., Livoreil, B., Petrokofsky, G., 2017. Eligibility screening in evidence synthesis of environmental management topics. Environ. Evid. 6, 27. https://doi.org/10.1186/s13750-017-0102-2
Galik, C.S., Abt, R.C., 2016. Sustainability guidelines and forest market response: an assessment of European Union pellet demand in the southeastern United States. GCB Bioenergy 8, 658–669. https://doi.org/10.1111/gcbb.12273
Garcia-Nieto, A.P., Garcia-Llorente, M., Iniesta-Arandia, I., Martin-Lopez, B., 2013. Mapping forest ecosystem services: From providing units to beneficiaries. Ecosyst. Serv. 4, 126–138. https://doi.org/10.1016/j.ecoser.2013.03.003
Gatto, P., Vidale, E., Secco, L., Pettenella, D., 2013. Exploring the willingness to pay for forest ecosystem services by residents of the Veneto Region. Bio-Based Appl. Econ. 21-43 Pages. https://doi.org/10.13128/BAE-11151
Getzner, M., Meyerhoff, J., Schlaepfer, F., 2018. Willingness to Pay for Nature Conservation Policies in State-Owned Forests: An Austrian Case Study. FORESTS 9. https://doi.org/10.3390/f9090537
Gorriz-Mifsud, E., Dominguez-Torres, G., Prokofieva, I., 2015. Understanding forest owners' preferences for policy interventions addressing mushroom picking in Catalonia (north-east Spain). Eur. J. For. Res. 134, 585–598. https://doi.org/10.1007/s10342-015-0874-2
Grilli, G., Nikodinoska, N., Paletto, A., De Meo, I., 2015. Stakeholders' Preferences and Economic Value of Forest Ecosystem Services: an Example in the Italian Alps. Balt. For. 21, 298–307.
Gundersen, V., Clarke, N., Dramstad, W., Fjellstad, W., 2016. Effects of bioenergy extraction on visual preferences in boreal forests: a review of surveys from Finland, Sweden and Norway. Scand. J. For. Res. 31, 323–334. https://doi.org/10.1080/02827581.2015.1099725
Gundersen, V., Frivold, L.H., 2011. Naturally dead and downed wood in Norwegian boreal forests: public preferences and the effect of information. Scand. J. For. Res. 26, 110–119. https://doi.org/10.1080/02827581.2010.536567
Guo, J., Gong, P., 2019. Assessing the impacts of rising fuelwood demand on Swedish forest sector: An intertemporal optimization approach. For. POLICY Econ. 105, 91–98. https://doi.org/10.1016/j.forpol.2019.05.020
Guzel, T.A., 2020. Consumer Attitudes toward Preference and Use of Wood, Woodenware, and Furniture: A Sample from Kayseri, Turkey. BIORESOURCES 15, 28–37. https://doi.org/10.15376/biores.15.1.28-37

Hanewinkel, M., Cullmann, D.A., Schelhaas, M.-J., Nabuurs, G.-J., Zimmermann, N.E., 2013. Climate change may cause severe loss in the economic value of European forest land. Nat. Clim. Change 3, 203–207. https://doi.org/10.1038/nclimate1687

Hanninen, R., Hurmekoski, E., Mutanen, A., Viitanen, J., 2018. Complexity of Assessing Future Forest Bioenergy Markets-Review of Bioenergy Potential Estimates in the European Union. Curr. For. Rep. 4, 13–22. https://doi.org/10.1007/s40725-018-0070-y

Hansson, K., Kuelvik, M., Bell, S., Maikov, K., 2012. A Preliminary Assessment of Preferences for Estonian Natural Forests. Balt. For. 18, 299–315.

Heinonen, T., Pukkala, T., Asikainen, A., 2020. Variation in forest landowners' management preferences reduces timber supply from Finnish forests. Ann. For. Sci. 77. https://doi.org/10.1007/s13595-020-00939-z

Higgins, K., Hutchinson, W.G., Longo, A., 2020. Willingness-to-Pay for Eco-Labelled Forest Products in Northern Ireland: An Experimental Auction Approach. J. Behav. Exp. Econ. 87. https://doi.org/10.1016/j.socec.2020.101572

Hoibo, O., Hansen, E., Nybakk, E., 2015. Building material preferences with a focus on wood in urban housing: durability and environmental impacts. Can. J. For. Res. 45, 1617–1627. https://doi.org/10.1139/cjfr-2015-0123

Howley, P., Ryan, M., Donoghue, C.O., 2011. Forestry in Ireland: An examination of individuals' preferences and attitudes towards the non-market benefits of forests. Ir. Geogr. 44, 291–302. https://doi.org/10.1080/00750778.2011.643392

IPBES, 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Jochem, D., Janzen, N., Weimar, H., 2016. Estimation of own and cross price elasticities of demand for wood-based products and associated substitutes in the German construction sector. J. Clean. Prod. 137, 1216–1227. https://doi.org/10.1016/j.jclepro.2016.07.165

Jonsson, R., Blujdea, V.N.B., Fiorese, G., Pilli, R., Rinaldi, F., Baranzelli, C., Camia, A., 2018. Outlook of the European forest-based sector: forest growth, harvest demand, wood-product markets, and forest carbon dynamics implications. IForest - Biogeosciences For. 11, 315. https://doi.org/10.3832/ifor2636-011

Juutinen, A., Kosenius, A.-K., Ovaskainen, V., Tolvanen, A., Tyrvainen, L., 2017. Heterogeneous preferences for recreation-oriented management in commercial forests: the role of citizens' socioeconomic characteristics and recreational profiles. J. Environ. Plan. Manag. 60, 399–418. https://doi.org/10.1080/09640568.2016.1159546

Karahalil, U., Baskent, E.Z., Kose, S., 2015. Integrating visitor characteristics and preferences into forest management plans in protected areas: A case study in Koprulu Canyon National Park. ECO MONT-J. Prot. Mt. AREAS Res. 7, 5–17. https://doi.org/10.1553/eco.mont-7-2s5

Kikulski, J., 2021. Social preferences regarding leisure and recreation time in forests in Poland. SYLWAN 165, 639–653. https://doi.org/10.26202/sylwan.2021089

Kilchling, P., Hansmann, R., Seeland, K., 2009. Demand for non-timber forest products: Surveys of urban consumers and sellers in Switzerland. For. POLICY Econ. 11, 294–300. https://doi.org/10.1016/j.forpol.2009.05.003

Lecocq, F., Caurla, S., Delacote, P., Barkaoui, A., Sauquet, A., 2011. Paying for forest carbon or stimulating fuelwood demand? Insights from the French Forest Sector Model. J. For. Econ. 17, 157–168. https://doi.org/10.1016/j.jfe.2011.02.011

Lehtoranta, V., Sarvilinna, A., Vaisanen, S., Aroviita, J., Muotka, T., 2017. Public values and preference certainty for stream restoration in forested watersheds in Finland. WATER Resour. Econ. 17, 56–66. https://doi.org/10.1016/j.wre.2017.02.004

Lupp, G., Kantelberg, V., Faeth, J., Hirschbeck, T., Kasbauer, C., Ritter, A., Schisslbauer, J., Pauleit, S., 2022. Through the Eyes of Forest Visitors-Perception and Scenic Preferences of Munich's Urban Proximate Woodlands. FORESTS 13. https://doi.org/10.3390/f13101584

Maes, J., Crossman, N., Burkhard, B., 2016. Mapping Ecosystem Services, in: Routledge Handbook of Ecosystem Services. Routledge, London.

Makkonen, M., Huttunen, S., Primmer, E., Repo, A., Hilden, M., 2015. Policy coherence in climate change mitigation: An ecosystem service approach to forests as carbon sinks and bioenergy sources. For. POLICY Econ. 50, 153–162. https://doi.org/10.1016/j.forpol.2014.09.003
Mandziuk, A., Fornal-Pieniak, B., Stangierska, D., Parzych, S., Widera, K., 2021. Social Preferences of Young Adults Regarding Urban Forest Recreation Management in Warsaw, Poland. FORESTS 12. https://doi.org/10.3390/f12111524
Manuel, A., Leonhart, R., Broman, O., Becker, G., 2015. Consumers' perceptions and preference profiles for wood surfaces tested with pairwise comparison in Germany. Ann. For. Sci. 72, 741–751. https://doi.org/10.1007/s13595-014-0452-7
Maroto, C., Segura, M., Ginestar, C., Uriol, J., Segura, B., 2013. Sustainable Forest Management in a Mediterranean region: social preferences. For. Syst. 22, 546–558. https://doi.org/10.5424/fs/2013223-04135
Mehr, J., Vadenbo, C., Steubing, B., Hellweg, S., 2018. Environmentally optimal wood use in Switzerland-Investigating the relevance of material cascades. Resour. Conserv. Recycl. 131, 181–191. https://doi.org/10.1016/j.resconrec.2017.12.026
Nielsen, A.B., Gundersen, V.S., Jensen, F.S., 2018. The impact of field layer characteristics on forest preference in Southern Scandinavia. Landsc. URBAN Plan. 170, 221–230. https://doi.org/10.1016/j.landurbplan.2017.10.005
Nordén, A., Coria, J., Jönsson, A.M., Lagergren, F., Lehsten, V., 2017. Divergence in stakeholders' preferences: Evidence from a choice experiment on forest landscapes preferences in Sweden. Ecol. Econ. 132, 179–195. https://doi.org/10.1016/j.ecolecon.2016.09.032
Notaro, S., Paletto, A., 2021. Consumers' preferences, attitudes and willingness to pay for bio-textile in wood fibers. J. Retail. Consum. Serv. 58. https://doi.org/10.1016/j.jretconser.2020.102304
Oliveira, F., Pintassilgo, P., Pinto, P., Mendes, I., Silva, J.A., 2017. Segmenting visitors based on willingness to pay for recreational benefits: The case of Leiria National Forest. Tour. Econ. 23, 680–691. https://doi.org/10.5367/te.2015.0526
Ouzzani, M., Hammady, H., Fedorowicz, Z., Elmagarmid, A., 2016. Rayyan—a web and mobile app for systematic reviews. Syst. Rev. 5, 210. https://doi.org/10.1186/s13643-016-0384-4
Paletto, A., Becagli, C., De Meo, I., 2022. Aesthetic preferences for deadwood in forest landscape: A case study in Italy. J. Environ. Manage. 311. https://doi.org/10.1016/j.jenvman.2022.114829
Paletto, A., De Meo, I., Cantiani, M.G., Cocciardi, D., 2014. Balancing wood market demand and common property rights: a case study of a community in the Italian Alps. J. For. Res. 19, 417–426. https://doi.org/10.1007/s10310-013-0427-9
Pastorella, F., Giacovelli, G., De Meo, I., Paletto, A., 2017. People's preferences for Alpine forest landscapes: results of an internet-based survey. J. For. Res. 22, 36–43. https://doi.org/10.1080/13416979.2017.1279708
Pelyhukh, O., Paletto, A., Zahvoyska, L., 2019. Comparison between people's perceptions and preferences towards forest stand characteristics in Italy and Ukraine. Ann. Silvic. Res. 43. https://doi.org/10.12899/asr-1786
Peters, D.M., Wirth, K., Boehr, B., Ferranti, F., Gorriz-Mifsud, E., Karkkainen, L., Krc, J., Kurttila, M., Leban, V., Lindstad, B.H., Malovrh, S.P., Pistorius, T., Rhodius, R., Solberg, B., Stirn, L.Z., 2015. Energy wood from forests-stakeholder perceptions in five European countries. ENERGY Sustain. Soc. 5. https://doi.org/10.1186/s13705-015-0045-9
Petucco, C., Skovsgaard, J.P., Jensen, F.S., 2013. Recreational preferences depending on thinning practice in young even-aged stands of pedunculate oak (Quercus robur L.): comparing the opinions of forest and landscape experts and the general population of Denmark. Scand. J. For. Res. 28, 668–676. https://doi.org/10.1080/02827581.2013.825006
Potkany, M., Skultetyova, M., Schmidtova, J., Hajduchova, I., 2021. Customer Preferences for Wood-based Houses in Slovakia. BIORESOURCES 16, 7798–7815. https://doi.org/10.15376/biores.16.4.7799-7816
Potschin-Young, M., Haines-Young, R., Görg, C., Heink, U., Jax, K., Schleyer, C., 2018. Understanding the role of conceptual frameworks: Reading the ecosystem service cascade. Ecosyst. Serv. 29, 428–440. https://doi.org/10.1016/j.ecoser.2017.05.015

Ranta, T., Lahtinen, P., Elo, J., Laitila, J., 2007. The effect Of CO2 emission trade on the wood fuel market in Finland. BIOMASS BIOENERGY 31, 535–542. https://doi.org/10.1016/j.biombioe.2007.01.006
Rosa, F., Di Fulvio, F., Lauri, P., Felton, A., Forsell, N., Pfister, S., Hellweg, S., 2023. Can Forest Management Practices Counteract Species Loss Arising from Increasing European Demand for Forest Biomass under Climate Mitigation Scenarios? Environ. Sci. Technol. 57, 2149–2161. https://doi.org/10.1021/acs.est.2c07867
Rougieux, P., Damette, O., 2018. Reassessing forest products demand functions in Europe using a panel cointegration approach. Appl. Econ. 50, 3247–3270. https://doi.org/10.1080/00036846.2017.1420887
Schulz, T., Lieberherr, E., Zabel, A., 2022. How national bioeconomy strategies address governance challenges arising from forest-related trade-offs. J. Environ. Policy Plan. 24, 123–136. https://doi.org/10.1080/1523908X.2021.1967731
Senf, C., Buras, A., Zang, C.S., Rammig, A., Seidl, R., 2020. Excess forest mortality is consistently linked to drought across Europe. Nat. Commun. 11, 6200. https://doi.org/10.1038/s41467-020-19924-1
Sheremet, O., Healey, J.R., Quine, C.P., Hanley, N., 2017. Public Preferences and Willingness to Pay for Forest Disease Control in the UK. J. Agric. Econ. 68, 781–800. https://doi.org/10.1111/1477-9552.12210
Sikkema, R., Steiner, M., Junginger, M., Hiegl, W., Hansen, M.T., Faaij, A., 2011. The European wood pellet markets: current status and prospects for 2020. BIOFUELS Bioprod. BIOREFINING-BIOFPR 5, 250–278. https://doi.org/10.1002/bbb.277
Simoes, P., Barata, E., Cruz, L., 2013. Using Count Data and Ordered Models in National Forest Recreation Demand Analysis. Environ. Manage. 52, 1249–1261. https://doi.org/10.1007/s00267-013-0119-4
Sing, L., Metzger, M.J., Paterson, J.S., Ray, D., 2018. A review of the effects of forest management intensity on ecosystem services for northern European temperate forests with a focus on the UK. For. Int. J. For. Res. 91, 151–164. https://doi.org/10.1093/forestry/cpx042
Suvanto, S., Esquivel Muelbert, A., Schelhaas, M.-J., Astigarraga, J., Astrup, R., Cienciala, E., Fridman, J., Henttonen, H., Kunstler, G., Kändler, G., König, L., Ruiz-Benito, P., Senf, C., Stadelmann, G., Starcevic, A., Talarczyk, A., Zavala, M., Pugh, T., 2023. Understanding Europe's forest harvesting regimes (preprint). Environmental Sciences. https://doi.org/10.31223/X5910J
Tolunay, A., Bassullu, C., 2015. Willingness to Pay for Carbon Sequestration and Co-Benefits of Forests in Turkey. SUSTAINABILITY 7, 3311–3337. https://doi.org/10.3390/su7033311
Tromborg, E., Bolkesjo, T.F., Solberg, B., 2007. Impacts of policy means for increased use of forest-based bioenergy in Norway - A spatial partial equilibrium analysis. ENERGY POLICY 35, 5980–5990. https://doi.org/10.1016/j.enpol.2007.08.004
Upton, V., Dhubhain, A.N., Bullock, C., 2012. Preferences and values for afforestation: The effects of location and respondent understanding on forest attributes in a labelled choice experiment. For. POLICY Econ. 23, 17–27. https://doi.org/10.1016/j.forpol.2012.06.006
van Rensburg, T., Mill, G., Common, M., Lovett, J., 2002. Preferences and multiple use forest management. Ecol. Econ. 43, 231–244. https://doi.org/10.1016/S0921-8009(02)00214-8
Van Zanten, B.T., Verburg, P.H., Espinosa, M., Gomez-y-Paloma, S., Galimberti, G., Kantelhardt, J., Kapfer, M., Lefebvre, M., Manrique, R., Piorr, A., Raggi, M., Schaller, L., Targetti, S., Zasada, I., Viaggi, D., 2014. European agricultural landscapes, common agricultural policy and ecosystem services: a review. Agron. Sustain. Dev. 34, 309–325. https://doi.org/10.1007/s13593-013-0183-4
Varela, E., Jacobsen, J.B., Mavsar, R., 2017. Social demand for multiple benefits provided by Aleppo pine forest management in Catalonia, Spain. Reg. Environ. CHANGE 17, 539–550. https://doi.org/10.1007/s10113-016-1038-8
Veisten, K., 2007. Willingness to pay for eco-labelled wood furniture: Choice-based conjoint analysis versus open-ended contingent valuation. J. For. Econ. 13, 29–48. https://doi.org/10.1016/j.jfe.2006.10.002
Winkel, G., Gleißner, J., Pistorius, T., Sotirov, M., Storch, S., 2011. The sustainably managed forest heats up: discursive struggles over forest management and climate change in Germany. Crit. Policy Stud. 5, 361–390. https://doi.org/10.1080/19460171.2011.628002

Zengin, H., Yeşil, A., Asan, Ü., Bettinger, P., Cieszewski, C., Siry, J.P., 2013. Evolution of Modern Forest Management Planning in the Republic of Turkey. J. For. 111, 239–248. https://doi.org/10.5849/jof.11-103

Annex A: Demand Code Book

To extract the information contained in the literature, codes are applied to paragraphs of text (herein also referred to as segments) to categorize and structure the information. There are no harsh cut-off criteria for where a segment starts or stops as rather the context is regarded. The codes are applied to the entire segment instead of specific sentences as this will help with the analysis later on. If the argumentative context spans across multiple pages, the codes are only applied to the section on the first page and a note is written that the argument spans across several pages. However, only relevant information (that is, the information itself, e.g. trends, numbers, distributions etc. rather than descriptions of how it was gathered) should be properly tagged with multiple codes. Additionally, only applicable codes are used, so there is no "NA" category in either code.

1. **Source**

Subcodes of this code are applied for the distinctive allocation of information obtained to articles assessed later on. The subcodes are created in vivo and follow the general citation code, using "et al." followed by the year of publication. This code always labels primary sources except if a publication synthesizes existing literature into new scientific insights (i.e., literature reviews).

2. **Research Question**

This tag is only applied once per document to capture the research question of the paper that is being assessed

3. **Future Research / Recommendations**

This code is applied to capture the need and design of future research as delineated in the conclusions of a paper.

4. **Authors affiliation**

   First author only, at country level.

5. **Focus of the paper** –

Put this code on the title, just once **per document**. If all or multiple are assessed, put multiple tags. Careful: As opposed to Code-Nr. 8 "Topical Scope", this code is applied to categorize the paper the with regard to its research question

   a. Policy
      Anything dealing with management / laws / strategies
   b. Demand
      Anything from the consumer's side – focus on consumption
   c. Supply
      Anything from the foresters/owner's view – focus on delivery

6. **Reference Year**

This code, if applicable, is also not applied directly but rather comprises several subcodes for the year the study uses as a baseline for demand. If nothing is specified, the publication year of the journal article can be used.

7. **Geographical scope**

This code defines the geographical scope the information contained in the coded segment refers to. This could be regions (e.g. the alps, countries, but also aggregates (e.g. Scandinavia, Balkans etc.) or Europe

8. **Topical scope**

This code is used to characterize the **information** and is applied to identify what part of the wood production chain is assessed by the publication. Its subcodes can be further expanded by adding whatever category might be applicable and appear suitable.

a. Supply
b. Demand
c. Forest Management / Governance

9. **Context**

This code is used to characterize the **information** and is applied to identify under what context the wood production chain is assessed. Its subcodes can be further expanded by adding whatever category might be applicable and appear suitable.

a. Climate Change
b. Land-use/Land-use change
c. Bioeconomy
d. Secondary information (Add subcategory specifying source)

10. **Methods**

With this code, the methods applied by the authors is roughly captured. This code focuses on rough descriptions and key words, so no precise methodological description is required. If it is not clear what the method is, a new subcategory is implemented or the paper is labelled as “other”.

a. Choice experiment
b. (Semi-)structured interviews
c. Modelling
d. Surveys
e. Other (specify which using sub-codes)

11. **Sample Size**

This code, if applicable, captures the sample size of the study (e.g. X participants, Y datapoints etc). Additionally, the name of the database (e.g., “Globiom”) is recorded as subcategory as well.

12. **Population**

The following subcodes are applied to categorize information contained in the articles assessed regarding wood and non-wood based products, or Policy/Management

a. Wood based products

i. Construction
    1. Hardwood
    2. Softwood
ii. Furniture
    1. Hardwood
    2. Softwood
iii. Bioenergy
    1. Hardwood
    2. Softwood
iv. Other (e.g. Pulpwood)
    1. Hardwood
    2. Softwood

b. Non-wood based products
c. Policy / Management preferences

13. Ecosystem Service

These subcategories assess what forest ecosystem services are targeted. If a segment assesses several forest ecosystem services or their interaction, multiple codes are applicable

a. Provisioning
    i. Wood
    ii. Non wood products
b. Cultural
    i. Recreational
    ii. Aesthetical / visual preference
c. Regulation and maintenance
    i. Carbon sequestration
    ii. Natural hazards protection
    iii. Water regulation and maintenance

14. Outcome - demand

The following subcodes are applied to further characterize the information. For one, the shaping of current and future demand/Supply in terms of monetary flows (e.g. sales statistics, market growth), preferences (e.g. willingness to pay), physical amounts (e.g. 200t of timber) or qualitative assessments (e.g. “will increase drastically”). On the other side, “Development” can be used to tag information on the barriers and drivers of current and future demand/supply.

a. Unit
    i. Monetary
    ii. Quantitative preferences (choice experiments)
    iii. Physical
    iv. Qualitative

b. Development
    i. Barrier/Challenge
    ii. Driver/Opportunity

15. Outcome – supply
    a. Development

i. Barrier/challenge
ii. Driver/Opportunity

Potential research question: **What do different approaches of the articles assessed fail to grasp?**

What do current overviews / Publications call for? Does this align with what they fail to grasp?

Justify selection of core articles that we discover by looking at the research question they seek to answer.

Annex B: overview of articles

Author	Year	Title	DOI	IF Quantile
Lehtoranta et al.	2017	Public values and preference certainty for stream restoration in forested watersheds in Finland	10.1016/j.wre.2017.02.004	2
Marta et al.	2020	A social assessment of forest resource based on stakeholders' perception: an application in three Balkans rural areas	10.1080/13416979.2020.1782554	1
Paletto et al.	2022	Aesthetic preferences for deadwood in forest landscape: A case study in Italy	10.1016/j.jenvman.2022.114829	1
Roces-Diaz et al.	2018	Assessing the distribution of forest ecosystem services in a highly populated Mediterranean region	10.1016/j.ecolind.2018.05.076	1
Notaro et al.	2022	Attitude and willingness to pay of young generations toward bio-textile produced using wood fibers	10.12899/asr-2318	2
Bryngemark	2020	Bioenergy versus forest conservation: a partial equilibrium analysis of the Swedish forest raw materials market	10.1080/02827581.2020.1808696	3
Rosa et al.	2023	Can Forest Management Practices Counteract Species Loss Arising from Increasing European Demand for Forest Biomass under Climate Mitigation Scenarios?	10.1021/acs.est.2c07867	1
Pelyukh et al.	2019	Comparison between people's perceptions and preferences towards forest stand characteristics in Italy and Ukraine	10.12899/asr-1786	2
Guzel	2020	Consumer attitudes toward preference and use of wood, woodenware, and furniture: A sample from Kayseri, Turkey	-	2
Potkany et al.	2021	Customer Preferences for Wood-based Houses in Slovakia	10.15376/biores.16.4.7799-7816	2
Geijer et al.	2011	Damned if you do, damned if you do not-Reduced Climate Impact vs. Sustainable Forests in Sweden	10.1016/j.reseneeco.2010.01.004	2
Nordén et al.	2017	Divergence in stakeholders' preferences: Evidence from a choice experiment on forest landscapes preferences in Sweden	10.1016/j.ecolecon.2016.09.032	1

Author	Year	Title	DOI	IF Quantile
Torralba et al.	2020	Examining the relevance of cultural ecosystem services in forest management in Europe	10.5751/ES-11587-250302	2
Gatto et al.	2014	Exploring the willingness to pay for forest ecosystem services by residents of the Veneto region	10.22004/ag.econ.172413	NA
Ebenberger et al.	2019	Exploring visual preferences for structural attributes of urban forest stands for restoration and heat relief	10.1016/j.ufug.2019.04.011	1
Vedel et al.	2015	Forest owners' willingness to accept contracts for ecosystem service provision is sensitive to additionality	10.1016/j.ecolecon.2015.02.014	1
Doli et al.	2021	Forest park visitors opinions and willingness to pay for sustainable development of the germia forest and recreational park	10.3390/su13063160	2
Juutinen et al.	2016	Heterogeneous preferences for recreation-oriented management in commercial forests: the role of citizens' socioeconomic characteristics and recreational profiles	10.1080/09640568.2016.1159546	2
Mäntymaa et al.	2017	Integrating nature-based tourism and forestry in private lands under heterogeneous visitor preferences for forest attributes	10.1080/09640568.2017.1333408	2
Carvalho-Ribiero et al.	2011	Is an attractive forest also considered well managed? Public preferences for forest cover and stand structure across a rural/urban gradient in northern Portugal	10.1016/j.forpol.2010.09.003	1
Di Cori et al.	2021	Moral Foundations and Willingness to Pay for Non-timber forest products: A Study in Three European Countries	10.3390/su132313445	2
Oliveira et al.	2015	Segmenting visitors based on willingness to pay for recreational benefits: The case of Leiria National Forest	10.5367/te.2015.0526	1
Doctorman et al.	2016	Perceived health state and willingness to pay for outdoor recreation: an analysis of forest recreationists and hunters	10.1080/02827581.2016.1143024	3
Veisten	2002	Potential demand for certified wood products in the United Kingdom and Norway	10.1093/forestscience/48.4.767	3

Author	Year	Title	DOI	IF Quantile
Schroder et al.	2013	Preferences for familiar and unfamiliar ecosystem insurance services in forests [WertschÃ¤tzung bekannter und unbekannter Versicherungs-Dienstleistungen in WaldÃ¶kosystemen]	-	NA
Janeczko	2016	Preferences of people with disabilities on wheelchairs in relation to forest trails for recreational in selected European countries	10.1515/ffp-2016-0013	4
Varela et al.	2018	Promoting biodiversity values of small forest patches in agricultural landscapes: Ecological drivers and social demand	10.1016/j.scitotenv.2017.11.190	1
Czajkowski et al.	2014	Providing preference-based support for forest ecosystem service management	10.1016/j.forpol.2013.11.002	1
Sheremet et al.	2017	Public Preferences and Willingness to Pay for Forest Disease Control in the UK	10.1111/1477-9552.12210	2
Rekola et al.	2005	Public preferences for uncertain regeneration cuttings: a contingent valuation experiment involving Finnish private forests	10.1016/j.forpol.2003.12.003	1
Gundersen et al.	2017	Public visual preferences for dead wood in natural boreal forests: The effects of added information	10.1016/j.landurbplan.2016.09.020	1
Rougieux et al.	2018	Reassessing forest products demand functions in Europe using a panel cointegration approach	10.1080/00036846.2017.1420887	2
Lorek et al.	2021	Social Assessment of the Value of Forests and Protected Areas on the Example of the Silesian Voivodeship	10.3390/su13063088	2
Mandzuik et al.	2021	Social preferences of young adults regarding urban forest recreation management in Warsaw, Poland	10.3390/f12111524	1
Paletto et al.	2014	Stakeholders' preferences and the assessment of forest ecosystem services: A comparative analysis in Italy	10.17221/85/2014-JFS	3
Grilli et al.	2015	Stakeholders' Preferences and Economic Value of Forest Ecosystem Services: an Example in the Italian Alps	-	4
De Meo et al.	2015	The attractiveness of forests: Preferences and perceptions in a mountain community in Italy	10.15287/afr.2015.308	2

Author	Year	Title	DOI	IF Quantile
Müller et al.	2020	The valuation of forest ecosystem services as a tool for management planning - A choice experiment	10.1016/j.jenvman.2020.111008	1
Lupp et al.	2022	Through the Eyes of Forest Visitors-Perception and Scenic Preferences of Munich's Urban Proximate Woodlands	10.3390/f13101584	1
Japelj et al.	2017	Using a latent class model to segment citizens of Ljubljana (Slovenia) according to their preferences over the recreation setting in the Golovec urban forest	-	4
Arnberger et al.	2017	Visitor Preferences for Visual Changes in Bark Beetle-Impacted Forest Recreation Settings in the United States and Germany	10.1007/s00267-017-0975-4	2
Tolunay et al.	2015	Willingness to Pay for Carbon Sequestration and Co-Benefits of Forests in Turkey	10.3390/su7033311	2
Getzner et al.	2018	Willingness to Pay for Nature Conservation Policies in State-Owned Forests: An Austrian Case Study	10.3390/f9090537	1
Higgins et al.	2020	Willingness-to-Pay for Eco-Labelled Forest Products in Northern Ireland: An Experimental Auction Approach	10.1016/j.socec.2020.101572	3
Solino et al.	2009	Social demand for electricity from forest biomass in Spain: Does payment periodicity affect the willingness to pay?	10.1016/j.enpol.2008.10.002	1
Manuel et al.	2015	Consumers' perceptions and preference profiles for wood surfaces tested with pairwise comparison in Germany	10.1007/s13595-014-0452-7	1
Hegetschweiler et al.	2007	Fire place preferences of forest visitors in northwestern Switzerland: Implications for the management of picnic sites	10.1016/j.ufug.2007.03.001	1
Tromborg et al.	2011	Projecting demand and supply of forest biomass for heating in Norway	10.1016/j.enpol.2011.08.009	1
Konijnendijk	2000	Adapting forestry to urban demands - Role of communication in urban forestry in europe	-	1
Scholz et al.	2007	Measuring the impact of wood species on consumer preferences for wooden furniture by means of the Analytic Hierarchy Process	-	3

Author	Year	Title	DOI	IF Quantile
Paredes-Sánchez	2018	Modelling hybrid thermal systems for district heating: A pilot project in wood transformation industry	**10.1016/j.jclepro.2018.05.170**	1
Agimass et al.	2018	The choice of forest site for recreation: A revealed preference analysis using spatial data	**10.1016/j.ecoser.2017.11.016**	1
Upton et al.	2012	Preferences and values for afforestation: The effects of location and respondent understanding on forest attributes in a labelled choice experiment	**10.1016/j.forpol.2012.06.006**	1
Winkel et al.	2022	Governing Europe's forests for multiple ecosystem services: Opportunities, challenges, and policy options	**10.1016/j.forpol.2022.102849**	1
Gundersen et al.	2008	Public preferences for forest structures: A review of quantitative surveys from Finland, Norway and Sweden	**10.1016/j.ufug.2008.05.001**	1
Bernath et al.	2008	Recreational benefits of urban forests: Explaining visitors' willingness to pay in the context of the theory of planned behavior	**10.1016/j.jenvman.2007.01.059**	1
Sandstrom et al.	2011	Governing competing demands for forest resources in sweden	**10.3390/f2010218**	1
Ciesielski et al.	2018	What do we expect from forests? The European view of public demands	**10.1016/j.jenvman.2017.12.032**	1
Karahalil et al.	2015	Integrating visitor characteristics and preferences into forest management plans in protected areas: A case study in Koprulu Canyon National Park	**10.1553/eco.mont-7-2s5**	4
Pastorella et al.	2017	People's preferences for Alpine forest landscapes: results of an internet-based survey	**10.1080/13416979.2017.1279708**	1
Broman	2001	Aesthetic properties in knotty wood surfaces and their connection with people's preferences	**10.1007/BF01171221**	1
Scarpa et al.	2000	Importance of forest attributes in the willingness to pay for recreation: A contingent valuation study of Irish forests	**10.1016/S1389-9341(00)00026-5**	1
Nabuurs et al.	2014	European perspective on the development of planted forests, including projections to 2065	**10.1186/1179-5395-44-S1-S8**	3
Lundmark	2009	Factor demand and price sensitivity of Forest-Based biomass in the european energy and forest sectors	**10.1080/19390450902910129**	NA

Author	Year	Title	DOI	IF Quantile
Howley et al.	2011	Forestry in Ireland: An examination of individuals' preferences and attitudes towards the non-market benefits of forests	**10.1080/00750778.2011.643392**	NA
Erol	2012	Differences between urban and rural population with respect to demand on forestry aspects, in a case study of the Turkish province of balÄ±kesir	**10.1590/S0103-84782012000300009**	NA
Valasuik et al.	2017	Are bilateral conservation policies for the Bialowieza forest unattainable? Analysis of stated preferences of Polish and Belarusian public	**10.1016/j.jfe.2017.03.001**	3
Börjesson et al.	2017	Future demand for forest-based biomass for energy purposes in Sweden	**10.1016/j.foreco.2016.09.018**	1
Peters et al.	2015	Energy wood from forests-stakeholder perceptions in five European countries	**10.1186/s13705-015-0045-9**	2
Anttila et al.	2018	Regional balance of forest chip supply and demand in Finland in 2030	**10.14214/sf.9902**	2
Notaro & Paletto	2021	Consumersâ€™ preferences, attitudes and willingness to pay for bio-textile in wood fibers	**10.1016/j.jretconser.2020.102304**	1
Edwards et al.	2012	Public preferences for structural attributes of forests: Towards a pan-European perspective	**10.1016/j.forpol.2011.07.006**	1
De Frutos et	2016	A Model to Estimate Willingness to Pay for Harvest Permits for Wild Edible Mushrooms: Application to Andalusian Forests	**10.3390/f7120292**	1
Guo et al.	2019	Assessing the impacts of rising fuelwood demand on Swedish forest sector: An intertemporal optimization approach	**10.1016/j.forpol.2019.05.020**	1
Crespo et al.	2015	Perceptions and realities: public opinion on forests and forestry in Finland, 1993-2012	**10.14214/sf.1140**	2
Eriksson et al.	2013	How is setting preference related to intention to engage in forest recreation activities?	**10.1016/j.ufug.2013.07.004**	1
Termansen et al.	2013	Modelling and mapping spatial heterogeneity in forest recreation services	**10.1016/j.ecolecon.2013.05.001**	1

Author	Year	Title	DOI	IF Quantile
Jonsson	2013	How to cope with changing demand conditions - The Swedish forest sector as a case study: an analysis of major drivers of change in the use of wood resources	**10.1139/cjfr-2012-0139**	2
Comic et al.	2021	Comparative Analysis of Wood Fuels Consumption in Households in the Federation of Bosnia and Herzegovina	**10.15177/SEEFOR.21-08**	4
Aasetre et al.	2016	Recreational preferences along a naturalness-development continuum: Results from surveys in two unequal urban forests in Europe	**10.1016/j.jort.2016.09.006**	2
Manuel et al.	2015	Consumers' perceptions and preference profiles for wood surfaces tested with pairwise comparison in Germany	**10.1007/s13595-014-0452-7**	1
Toppinen et al.	2010	Forest sector modelling in Europe-the state of the art and future research directions	**10.1016/j.forpol.2009.09.017**	1
Vergerachea et al.	2023	Future wood demands and ecosystem services trade-offs: A policy analysis in Norway	**10.1016/j.forpol.2022.102899**	1
Morri et al.	2014	A forest ecosystem services evaluation at the river basin scale: Supply and demand between coastal areas and upstream lands (Italy)	**10.1016/j.ecolind.2013.08.016**	1
Wilnhammer et al.	2015	Effects of increased wood energy consumption on global warming potential, primary energy demand and particulate matter emissions on regional level based on the case study area Bavaria (Southeast Germany)	**10.1016/j.biombioe.2015.06.025**	1
Karahalil et al.	2015	Integrating visitor characteristics and preferences into forest management plans in protected areas: A case study in KÃ¶prÃ¼lÃ¼ Canyon National Park	**10.1553/eco.mont-7-2s5**	4
Potkany et al.	2019	Research into customer preferences of potential buyers of simple wood-based houses for the purpose of using the target costing	**10.1515/eng-2019-0048**	2
Tyrvainen et al.	2014	Demand for enhanced forest amenities in private lands: The case of the Ruka-Kuusamo tourism area, Finland	**10.1016/j.forpol.2013.05.007**	1
Paletto & Notaro	2018	Secondary wood manufactures' willingness-to-pay for certified wood products in Italy	**10.1016/j.forpol.2018.04.002**	1
Greenslade et al.	2020	Seeing the Wood for the Trees: Factors Limiting Woodland Management and Sustainable Local Wood Product Use in the South East of England	**10.3390/su122310071**	2

Author	Year	Title	DOI	IF Quantile
Hoibo et al.	2015	Building material preferences with a focus on wood in urban housing: durability and environmental impacts	**10.1139/cjfr-2015-0123**	2
Gorriz-Mifsud et al.	2016	Demand and supply of ecosystem services in a Mediterranean forest: Computing payment boundaries	**10.1016/j.ecoser.2015.11.006**	2
Sedliacikova et al.	2021	MAPPING THE WOOD COLOUR PREFERENCES AMONG POTENTIAL CUSTOMERS	**10.17423/afx.2021.63.2.14**	NA
Hanninen & Kallio	2007	Economic impacts on the forest sector of increasing forest biodiversity conservation in Finland	**10.14214/sf.286**	2
Varela et al.	2017	Social demand for multiple benefits provided by Aleppo pine forest management in Catalonia, Spain	**10.1007/s10113-016-1038-8**	2
Chreptun et al.	2023	Optimizing forest landscape composition for multiple ecosystem services based on uncertain stakeholder preferences	**10.1016/j.scitotenv.2022.159393**	1
Alonso Chavez et	2018	Variability in commercial demand for tree saplings affects the probability of introducing exotic forest diseases	**10.1111/1365-2664.13242**	1
Eriksson et al.	2012	Recreation in Different Forest Settings: A Scene Preference Study	**10.3390/f3040923**	1
Sikkema et al.	2011	The European wood pellet markets: current status and prospects for 2020	**10.1002/bbb.277**	2
Arnberger et al.	2010	How many people should be in the urban forest? A comparison of trail preferences of Vienna and Sapporo forest visitor segments	**10.1016/j.ufug.2010.01.002**	1
Babi Almenar et	2023	Modelling the net environmental and economic impacts of urban nature-based solutions by combining ecosystem services, system dynamics and life cycle thinking: An application to urban forests	**10.1016/j.ecoser.2022.101506**	1
Kilchling et al.	2009	Demand for non-timber forest products: Surveys of urban consumers and sellers in Switzerland	**10.1016/j.forpol.2009.05.003**	1

Author	Year	Title	DOI	IF Quantile
Baumeister et al.	2020	Exploring cultural ecosystem service hotspots: Linking multiple urban forest features with public participation mapping data	**10.1016/j.ufug.2019.126561**	1
Deniz	2023	The Effect of Forest Certification on Log Sale Prices: A Case Study in Northwestern Turkey	**10.3390/f14030596**	1
Karner et al.	2017	Environmental trade-offs between residential oil-fired and wood pellet heating systems: Forecast scenarios for Austria until 2030	**10.1016/j.rser.2017.05.242**	1
Maroto et al.	2013	Sustainable Forest Management in a Mediterranean region: social preferences	**10.5424/fs/2013223-04135**	4
Lindhjem	2006	20 years of stated preference valuation of non-timber benefits from Fennoscandian forests: A meta-analysis	**10.1016/J.JFE.2006.09.003**	3
Johansson	2012	Why do forest companies change their CSR strategies? Responses to market demands and public regulation through dual-certification	**10.1080/09640568.2012.743882**	2
Garcia-Nieto et al.	2013	Mapping forest ecosystem services: From providing units to beneficiaries	**10.1016/j.ecoser.2013.03.003**	1
Thrippleton et al.	2021	A Multi-Criteria Decision Support System for Strategic Planning at the Swiss Forest Enterprise Level: Coping With Climate Change and Shifting Demands in Ecosystem Service Provisioning	**10.3389/ffgc.2021.693020**	2
Creutzburg et al.	2021	To log or not to log? Actor preferences and networks in Swiss forest policy	**10.1016/j.forpol.2021.102395**	1
Beljan et al.	2021	Insight into Market Supply and Demand of Private Forests in Croatia	**10.15177/seefor.21-16**	4
Heinonen et al.	2020	Variation in forest landowners' management preferences reduces timber supply from Finnish forests	**10.1007/s13595-020-00939-z**	1
Bostedt et al.	2019	Planning on a wider scale â€“ Swedish forest owners' preferences for landscape policy attributes	**10.1016/j.forpol.2019.04.013**	NA
Blanco et al.	2017	The effect of forest owner decision-making, climatic change and societal demands on land-use change and ecosystem service provision in Sweden	**10.1016/j.ecoser.2016.12.003**	1

Author	Year	Title	DOI	IF Quantile
Makkonen et al.	2015	Policy coherence in climate change mitigation: An ecosystem service approach to forests as carbon sinks and bioenergy sources	**10.1016/j.forpol.2014.09.003**	1
Duesberg et al.	2019	Forest intensification in Ireland: Developing an approximation of social acceptability	**10.1016/j.landusepol.2019.03.028**	1
Juutinen et al.	2021	Forest owners' preferences for contract-based management to enhance environmental values versus timber production	**10.1016/j.forpol.2021.102587**	1
Tyrväinen et al.	2021	Private landowners' preferences for trading forest landscape and recreational values: A choice experiment application in Kuusamo, Finland	**10.1016/j.landusepol.2020.104478**	1
Nielsen et al.	2018	The impact of field layer characteristics on forest preference in Southern Scandinavia	**10.1016/j.landurbplan.2017.10.005**	1
Juutinen et al.	2022	Common preferences of European small-scale forest owners towards contract-based management	**10.1016/j.forpol.2022.102839**	1
Perez-Rodriguez et al.	2020	Evaluation of Forest Industry Scenarios to Increase Sustainable Forest Mobilization in Regions of Low Biomass Demand	**https://doi.org/10.3390/app10186297**	3
Sandra et al.	2021	Consumers' preferences, attitudes and willingness to pay for bio-textile in wood fibers	**10.1016/j.jretconser.2020.102304**	1
Veisten	2006	Willingness to pay for eco-labelled wood furniture: Choice-based conjoint analysis versus open-ended contingent valuation	**10.1016/j.jfe.2006.10.002**	3
Binder et al.	2004	Transition towards improved regional wood flows by integrating material flux analysis and agent analysis: the case of Appenzell Ausserrhoden, Switzerland	**10.1016/j.ecolecon.2003.10.021**	1
Mehr et al.	2018	Environmentally optimal wood use in Switzerland-Investigating the relevance of material cascades	**10.1016/j.resconrec.2017.12.026**	1
Ranta et al.	2007	The effect Of CO2 emission trade on the wood fuel market in Finland	**10.1016/j.biombioe.2007.01.006**	1
Jonsson et al.	2018	Outlook of the European forest-based sector: forest growth, harvest demand, wood-product markets, and forest carbon dynamics implications	**10.3832/ifor2636-011**	3

Author	Year	Title	DOI	IF Quantile
Jochem et al.	2016	Estimation of own and cross price elasticities of demand for wood-based products and associated substitutes in the German construction sector	**10.1016/j.jclepro.2016.07.165**	1
Dimic-Misic et al.	2018	Identifying the challenges of implementing a European bioeconomy based on forest resources: Reality demands circularity	**10.5937/fmet190160D**	3
Albrecht	2017	Environmental customer demands and (forest) governance: evaluating market relations, knowledge networks and positionalities	**10.1080/04353684.2017.1379032**	1
Petuco et al.	2018	Visitor preferences of thinning practice in young even-aged stands of pedunculate oak (Quercus robur L.): comparing the opinion of forestry professionals in six European countries	**10.1080/02827581.2017.1329455**	2
Karakaya et al.	2017	Socioeconomic structure and analysis of the demand for wood raw materials in the poplar wood-processing companies of the Sakarya and Kocaeli provinces in Turkey	**10.1080/10549811.2017.1333912**	3
Juutinen et al.	2016	Heterogeneous preferences for recreation-oriented management in commercial forests: the role of citizens' socioeconomic characteristics and recreational profiles	**10.1080/09640568.2016.1159546**	2
Pastorella et a.	2017	People's preferences for Alpine forest landscapes: Results of an internet-based survey	**10.1080/13416979.2017.1279708**	1
Galik et al.	2016	Sustainability guidelines and forest market response: An assessment of European Union pellet demand in the southeastern United States	**10.1111/gcbb.12273**	1
Gundersen et al.	2015	Effects of bioenergy extraction on visual preferences in boreal forests: a review of surveys from Finland, Sweden and Norway	**10.1080/02827581.2015.1099725**	3
Tromborg et al.	2007	Impacts of policy means for increased use of forest-based bioenergy in Norway - A spatial partial equilibrium analysis	**10.1016/j.enpol.2007.08.004**	1
Gundersen et al.	2011	Naturally dead and downed wood in Norwegian boreal forests: public preferences and the effect of information	**10.1080/02827581.2010.536567**	3
Sanchez-García et al.	2017	A GIS methodology for optimal location of a wood-fired power plant: Quantification of available woodfuel, supply chain costs and GHG emissions	**10.1016/j.jclepro.2017.04.058**	1

Author	Year	Title	DOI	IF Quantile
van Rensburg et al.	2002	**Preferences and multiple use forest management**	**10.1016/S0921-8009(02)00214-8**	1
Kikulski	2021	Social preferences regarding leisure and recreation time in forests in Poland	**10.26202/sylwan.2021089**	4
Abildtrup et al.	2013	Spatial preference heterogeneity in forest recreation	**10.1016/j.ecolecon.2013.01.001**	1
Edwards et al.	2012	Public Preferences Across Europe for Different Forest Stand Types as Sites for Recreation	**10.5751/ES-04520-170127**	2
Mifsud et al.	2015	Understanding forest owners' preferences for policy interventions addressing mushroom picking in Catalonia (north-east Spain)	**10.1007/s10342-015-0874-2**	2
Grilli et al.	2015	Stakeholders' preferences and economic value of forest ecosystem services: An example in the Italian alps	**-**	4
Paletto et al.	2014	Balancing wood market demand and common property rights: a case study of a community in the Italian Alps	**10.1007/s10310-013-0427-9**	3
Simões et al	2013	Using count data and ordered models in national forest recreation demand analysis	**10.1007/s00267-013-0119-4**	2
Petucco et al.	2013	Recreational preferences depending on thinning practice in young even-aged stands of pedunculate oak (Quercus robur L.): comparing the opinions of forest and landscape experts and the general population of Denmark	**10.1080/02827581.2013.825006**	3
Hansson et al.	2012	A preliminary assessment of preferences for Estonian natural forests	**-**	4
Bartczak et al.	2011	When are Forest Visits Valued the Most? An Analysis of the Seasonal Demand for Forest Recreation in Poland	**10.1007/s10640-011-9527-1**	1
Hänninen et al.	2018	Complexity of Assessing Future Forest Bioenergy Markets-Review of Bioenergy Potential Estimates in the European Union	**10.1007/s40725-018-0070-y**	1

Author	Year	Title	DOI	IF Quantile
Lecoq et al.	2011	Paying for forest carbon or stimulating fuelwood demand? Insights from the French Forest Sector Model	**10.1016/j.jfe.2011.02.011**	3
Eggers et al.	2008	Impact of changing wood demand, climate and land use on European forest resources and carbon stocks during the 21st century	**10.1111/j.1365-2486.2008.01653.x**	1
Ozturk et al.	2006	Determining demand priorities of various stakeholders regarding forest goods and services in the context of sustainable forestry: A case study from Turkey	**-**	NA

Annex C: overview of excluded articles

Authors	Year	Title	DOI	Exclusion criteria
Rutschmann B., Kohl P.L., Steffan-Dewenter I.	2023	Foraging distances, habitat preferences and seasonal colony performance of honeybees in Central European forest landscapes	10.1111/1365-2664.14389	wrong outcome
Denic M., Kuehneweg M., Schmidt T.	2023	Hydromorphological preferences of freshwater pearl mussel (Margaritifera margaritifera) in upland streams of the Bavarian Forest: A case study	10.1016/j.limno.2022.126034	wrong outcome , wrong population
Na M., Hicks L.C., Zhang Y., Shahbaz M., Sun H., Rousk J.	2022	Semi-continuous C supply reveals that priming due to N-mining is driven by microbial growth demands in temperate forest plantations	10.1016/j.soilbio.2022.108802	wrong outcome
Christiansen D.M., Iversen L.L., EhrlÃ©n J., Hylander K.	2022	Changes in forest structure drive temperature preferences of boreal understorey plant communities	10.1111/1365-2745.13825	wrong outcome , wrong population
SoliÃ±o M., AlÃa R., AgÃºndez D.	2020	Citizens' preferences for research programs on forest genetic resources: A case applied to Pinus pinaster Ait. in Spain	10.1016/j.forpol.2020.102255	

Authors	Year	Title	DOI	Exclusion criteria
Kittler B., Stupak I., Smith C.T.	2020	Assessing the wood sourcing practices of the U.S. industrial wood pellet industry supplying European energy demand	10.1186/s13705-020-00255-4	wrong geographic scope
Bostedt G., Zabel A., Ekvall H.	2019	Planning on a wider scale â€“ Swedish forest owners' preferences for landscape policy attributes	10.1016/j.forpol.2019.04.013	wrong outcome
van den Oever M., Molenveld K.	2019	Creep deflection of Wood Polymer Composite profiles at demanding conditions	10.1016/j.cscm.2019.e00224	wrong outcome
Di Cristofaro, Marco and Sallustio, Lorenzo and Sitzia, Tommaso and Marchetti, Marco and Lasserre, Bruno	2020	Landscape Preference for Trees Outside Forests along an Urban-Rural-Natural Gradient	10.3390/f11070728	wrong population
Bonsu, Nana O. and Dhubhain, Aine Ni and O'Connor, Deirdre	2017	Evaluating the use of an integrated forest land-use planning approach in addressing forest ecosystem services conflicting demands: Expereince within an Irish forest landscape	10.1016/j.futures.2016.08.004	wrong population
Vedel, Suzanne Elizabeth and Jacobsen, Jette Bredahl and Thorsen, Bo Jellesmark	2015	Forest owners' willingness to accept contracts for ecosystem service provision is sensitive to additionality	10.1016/j.ecolecon.2015.02.014	wrong outcome
Sedmak, Robert and Tucek, Jan and Levicka, Martina and Sedmakova, Denisa and Bahyl, Jan and Jusko, Vladimir and Kaspar, Jan and Marusak, Robert and Bushenkov, Vladimir A.	2020	Optimizing the Tending of Forest Stands with Interactive Decision Maps to Balance the Financial Incomes and Ecological Risks according to Owner Demands: Case Study in Rakovnik, the Czech Republic	10.3390/f11070730	wrong population

Authors	Year	Title	DOI	Exclusion criteria
Bottalico, Francesca and Pesola, Lucia and Vizzarri, Matteo and Antonello, Leonardo and Barbati, Anna and Chirici, Gherardo and Corona, Piermaria and Cullotta, Sebastiano and Garfi, Vittorio and Giannico, Vincenzo and Lafortezza, Raffaele and Lombardi, Fabio and Marchetti, Marco and Nocentini, Susanna and Riccioli, Francesco and Travaglini, Davide and Sallustio, Lorenzo	2016	Modeling the influence of alternative forest management scenarios on wood production and carbon storage: A case study in the Mediterranean region	10.1016/j.envres.2015.10.025	wrong outcome
Almenar, Javier Babi and Petucco, Claudio and Sonnemann, Guido and Geneletti, Davide and Elliot, Thomas and Rugani, Benedetto	2023	Modelling the net environmental and economic impacts of urban nature-based solutions by combining ecosystem services, system dynamics and life cycle thinking: An application to urban forests	10.1016/j.ecoser.2022.101506	wrong outcome
Marques, Marlene and Oliveira, Manuela and Borges, Jose G.	2020	An approach to assess actors' preferences and social learning to enhance participatory forest management planning		
Moss, Joseph L. and Doick, Kieron J. and Smith, Stefan and Shahrestani, Mehdi	2019	Influence of evaporative cooling by urban forests on cooling demand in cities		wrong population

Authors	Year	Title	DOI	Exclusion criteria
Oviedo, Jose L. and Campos, Pablo and Caparros, Alej and ro	2022	Contingent valuation of landowner demand for forest amenities: application in Andalusia, Spain	10.1093/erae/jbab022	wrong outcome
Juutinen, Artti and Kurttila, Mikko and Pohjanmies, Tahti and Tolvanen, Anne and Kuhlmey, Katharina and Skudnik, Mitja and Triplat, Matevz and Westin, Kerstin and Makipaa, Raisa	2021	Forest owners' preferences for contract-based management to enhance environmental values versus timber production	10.1016/j.forpol.2021.102587	wrong outcome
Kang, Moon Jeong and Siry, Jacek P. and Colson, Gregory and Ferreira, Susana	2019	Do forest property characteristics reveal landowners' willingness to accept payments for ecosystem services contracts in southeast Georgia, US?	10.1016/j.ecolecon.2019.02.016	wrong geographic scope
Tyrvainen, Liisa and Mantymaa, Erkki and Juutinen, Artti and Kurttila, Mikko and Ovaskainen, Ville	2021	Private landowners' preferences for trading forest landscape and recreational values: A choice experiment application in Kuusamo, Finland	10.1016/j.landusepol.2020.104478	wrong outcome
Bartolome, Jordi and Miro, Jordi and Panades, Xavier and Jose Broncano, Maria and Plaixats, Josefina and Rigau, Teresa and Jose Milan, Maria and Baraza, Elena	2020	Preference by Donkeys and Goats among Five Mediterranean Forest Species: Implications for Reducing Fire Hazard	10.3390/ani10081302	wrong outcome , wrong population
Roces-Diaz, Jose V. and Vayreda, Jordi and Banque-	2018	The spatial level of analysis affects the patterns of forest ecosystem services supply and their relationships	10.1016/j.scitotenv.2018.01.150	wrong outcome

Authors	Year	Title	DOI	Exclusion criteria
Casanovas, Mireia and Diaz-Varela, Emilio and Bonet, Jose A. and Brotons, Lluis and de-Miguel, Sergio and Herr and o, Sergi and Martinez-Vilalta, Jordi				
Chreptun, Claudia and Ficko, Andrej and Gosling, Elizabeth and Knoke, Thomas	2023	Optimizing forest landscape composition for multiple ecosystem services based on uncertain stakeholder preferences	10.1016/j.scitotenv.2022.159393	wrong outcome
Juutinen, Artti and Haeler, Elena and J and l, Robert and Kuhlmey, Katharina and Kurttila, Mikko and Makipaa, Raisa and Pohjanmies, Tahti and Rosenkranz, Lydia and Skudnik, Mitja and Triplat, Matevz and Tolvanen, Anne and Vilhar, Ursa and Westin, Kerstin and Schueler, Silvio	2022	Common preferences of European small-scale forest owners towards contract-based management	10.1016/j.forpol.2022.102839	wrong outcome
Wang, Sen	2019	Managing forests for the greater good: The role of the social license to operate	10.1016/j.forpol.2019.05.006	wrong outcome
Unterberger, Christian and Olschewski, Rol	2020	Stated preference data on the insurance value of forests in Switzerland	10.1016/j.dib.2020.106466	supply
Stark, M and Lett, B and Antal, N	2001	Human factors influencing the competitiveness of forestry and wood industry - WAYS FOR IMPROVING		

Authors	Year	Title	DOI	Exclusion criteria
		WOODWORKING INDUSTRY FOR TRANSITIONAL ECONOMICS, PROCEEDINGS		
Sikkema, Richard and Fiorese, Giulia	2014	USE OF FOREST BASED BIOMASS FOR BIOENERGY IN EU-28 - RESEARCH FOR RURAL DEVELOPMENT 2014, VOL 2		
North, Benjamin W. and Pienaar, Elizabeth F.	2021	Continued obstacles to wood-based biomass production in the southeastern United States		wrong population, wrong geographic scope
Kuokkanen, Matti and Kuokkanen, Toivo and Stoor, Tuomas and Niinimaki, Jouko and Pohjonen, Veli	2009	Chemical methods in the development of eco-efficient wood-based pellet production and technology	10.1177/0734242X08100654	wrong study design , wrong outcome - demand
Rosenberger, R and all S. and Needham, Mark D. and Morzillo, Anita T. and Moehrke, Caitlin	2012	Attitudes, willingness to pay, and stated values for recreation use fees at an urban proximate forest	10.1016/j.jfe.2012.06.003	wrong geographic scope
Karttunen, Kalle and Ranta, Tapio and Ahtikoski, Anssi and Huuskonen, Saija and Hynynen, Jari and Kojola, Soili and Lehtonen, Mika and Salminen, Hannu and Hakala, Outi and Kujala, Susanna and Torma, Hannu and Kinnunen, Jouko	2017	IMPACT OF ALTERNATIVE FOREST BIOMASS DEMAND AND SUPPLY SCENARIOS ON REGIONAL ECONOMY IN FINLAND - ARTICLES OF THE 25TH EUROPEAN BIOMASS CONFERENCE		
Bolkesjo, TF and Tromborg, E and Solberg, B	2005	Increasing forest conservation in Norway: Consequences for timber and forest products markets	10.1007/s10640-004-8248-0	wrong outcome - demand

Authors	Year	Title	DOI	Exclusion criteria
Pal and er, Teijo	2015	Applying dynamic multiple-objective optimization in inter-enterprise collaboration to improve the efficiency of energy wood transportation and storage	10.1080/02827581.2014.1001780	wrong outcome - demand
Scarascia-Mugnozza, Giuseppe and Pisanelli, Andrea	2008	Multifunctional forestry, global change and the impact on mobilizing wood resources - EUROPEAN WOOD PROCESSING STRATEGY: FUTURE RESOURCES MATCHING PRODUCTS AND INNOVATIONS		
Heinonen, Tero and Pukkala, Timo and Asikainen, Antti	2020	Variation in forest landowners' management preferences reduces timber supply from Finnish forests	10.1007/s13595-020-00939-z	supply
Verkerk, Pieter Johannes and Zanchi, Giuliana and Lindner, Marcus	2014	Trade-Offs Between Forest Protection and Wood Supply in Europe	10.1007/s00267-014-0265-3	supply
McGrath, M. J. and Luyssaert, S. and Meyfroidt, P. and Kaplan, J. O. and Buergi, M. and Chen, Y. and Erb, K. and Gimmi, U. and McInerney, D. and Naudts, K. and Otto, J. and Pasztor, F. and Ryder, J. and Schelhaas, M. -J. and Valade, A.	2015	Reconstructing European forest management from 1600 to 2010		wrong outcome - demand
Sakagami, Masaji and Sakaguchi, Daishi	2018	Estimating Preferences for Wood Products with Environmental Attributes		wrong geographic scope
Garcia, Wagner de Oliveira and Amann, Thorben and Hartmann, Jens	2018	Increasing biomass demand enlarges negative forest nutrient budget areas in wood export regions	10.1038/s41598-018-22728-5	wrong geographic scope

Authors	Year	Title	DOI	Exclusion criteria
Hetemaki, L and Hanninen, R and Toppinen, A	2004	Short-term forecasting models for the Finnish forest sector: Lumber exports and sawlog demand		wrong temporal scope
Moiseyev, AN	2003	Future scenarios for wood supply and demand in Russia - ECONOMIC ACCESSIBILITY OF FOREST RESOURCES IN NORTH-WEST RUSSIA		wrong publication type
Gerasimov, Yuri and Karjalainen, Timo	2013	Energy wood resources availability and delivery cost in Northwest Russia	10.1080/02827581.2013.828098	wrong outcome - demand
Barua, S. K. and Lehtonen, P. and Pahkasalo, T.	2014	Plantation vision: potentials, challenges and policy options for global industrial forest plantation development	10.1505/146554814811724801	
KirstovÃ¡ M., Pyszko P., KoÄ Ã¡rek P.	2019	Factors influencing microhabitat selection and food preference of tree-dwelling earwigs (Dermaptera) in a temperate floodplain forest	10.1017/S0007485318000147	wrong population , wrong outcome - demand
SoliÃ±o M., Oviedo J.L., CaparrÃ³s A.	2018	Are forest landowners ready for woody energy crops? Preferences for afforestation programs in Southern Spain	10.1016/j.eneco.2018.05.026	wrong outcome - products
Sauter P.A., MuÃŸhoff O.	2018	What is your discount rate? Experimental evidence of foresters' risk and time preferences	10.1007/s13595-017-0683-5	
Shrestha S., Dwivedi P.	2017	Projecting land use changes by integrating site suitability analysis with historic land use change dynamics in the context of increasing demand for wood pellets in the southern United States	10.3390/f8100381	wrong geographic scope
NordÃ©n A., Coria J., JÃ¶nsson A.M., Lagergren F., Lehsten V.	2017	Divergence in stakeholders' preferences: Evidence from a choice experiment on forest landscapes preferences in Sweden	10.1016/j.ecolecon.2016.09.032	wrong outcome - products
Barreneche, C. and Vecstaudza, J. and Bajare, D. and Fern and ez, A. I.	2017	PCM/wood composite to store thermal energy in passive building envelopes - 3RD INTERNATIONAL	10.1088/1757-899X/251/1/012111	

Authors	Year	Title	DOI	Exclusion criteria
		CONFERENCE ON INNOVATIVE MATERIALS, STRUCTURES AND TECHNOLOGIES (IMST 2017)		
Kostov, G. and Mihailova, J.	2008	Forest Industry Demand and Forest Resources Supply - Challenges and Outlooks in Bulgaria - EUROPEAN WOOD PROCESSING STRATEGY: FUTURE RESOURCES MATCHING PRODUCTS AND INNOVATIONS		wrong publication type
Andersson, Gert and Flisberg, Patrik and Nordstrom, Maria and Ronnqvist, Mikael and Wilhelmsson, Lars	2016	A model approach to include wood properties in log sorting and transportation planning	10.1080/03155986.2016.1198070	wrong outcome
Sydor, Tim and Mendell, Brooks and Siry, Jacek and De La Torre, Rafael and Harris, Tom and Izlar, Bob and Hamsley, Am and a	2009	A Framework for Tracking the State of the Forest Industry: Case Study of Georgia	10.1093/sjaf/33.4.157	wrong geographic scope
Hitka, Milos and Lipoldova, Martina and Schmidtova, Jarmila	2020	EMPLOYEES' MOTIVATION PREFERENCES IN FOREST AND WOOD-PROCESSING ENTERPRISES	10.17423/afx.2020.62.1.13	wrong outcome , wrong outcome - demand
Teresa Honorato, Maria and Altamirano, Tomas A. and Tomas Ibarra, Jose and De la Maza, Mariano and Bonacic, Cristian and Martin, Kathy	2016	Composition and preferences regarding nest materials by cavity-nesting vertebrates in the Andean temperate forest of Chile	10.4067/S0717-92002016000300005	wrong population , wrong outcome - products
Bergeron, Francis C.	2014	EVALUATION OF THE COHERENCE OF THE WASTE WOOD MANAGEMENT IN SWITZERLAND BY		

Authors	Year	Title	DOI	Exclusion criteria
		QUALITATIVE AND QUANTITATIVE APPROACH - ARTICLES OF THE 22ND EUROPEAN BIOMASS CONFERENCE: SETTING THE COURSE FOR A BIOBASED ECONOMY		
Sedliacikova, Mariana and Alac, Patrik and Moresova, Maria and Sedliacik, Ivan	2021	MAPPING THE WOOD COLOUR PREFERENCES AMONG POTENTIAL CUSTOMERS	10.17423/afx.2021.63.2.14	wrong outcome
Sanchez-Garcia, S. and Athanassiadis, D. and Martinez-Alonso, C. and Tolosana, E. and Majada, J. and Canga, E.	2017	A GIS methodology for optimal location of a wood-fired power plant: Quantification of available woodfuel, supply chain costs and GHG emissions	10.1016/j.jclepro.2017.04.058	wrong outcome
Olsiakova, Miriam and Kaputa, Vlasislav and Drilickova, Eva and Krssak, Milos	2018	FACTORS INFLUENCING CONSUMERS' PREFERENCES FOR WOOD FRAMED HOUSES - INCREASING THE USE OF WOOD IN THE GLOBAL BIO-ECONOMY		
Sosa, Am and a and Acuna, Mauricio and McDonnell, Kevin and Devlin, Ger	2015	Managing the moisture content of wood biomass for the optimisation of Ireland's transport supply strategy to bioenergy markets and competing industries	10.1016/j.energy.2015.04.032	wrong outcome , wrong outcome - demand
Nicholls, David L. and Roos, Joseph	2006	Lumber attributes, characteristics, and species preferences as indicated by secondary wood products firms in the continental United States	10.1007/s00107-005-0071-y	wrong geographic scope
Stahl, Magnus and Berghel, Jonas	2011	Energy efficient pilot-scale production of wood fuel pellets made from a raw material mix including sawdust and rapeseed cake	10.1016/j.biombioe.2011.10.003	

Authors	Year	Title	DOI	Exclusion criteria
Hajduchova, Iveta and Viszlai, Igor	2015	THE EFFECT OF TAXATION ON AVAILABLE RESOURCES OF FOREST ENTERPRISES - ECOLOGY, ECONOMICS, EDUCATION AND LEGISLATION, VOL III		
Kaputa, Vladislav and Olsiakova, Miriam and Mat'ova, Hana and Drlickova, Eva	2019	DO PREFERENCES FOR WOOD-FRAMED HOUSES' ATTRIBUTES CHANGE OVER TIME? - DIGITALISATION AND CIRCULAR ECONOMY: FORESTRY AND FORESTRY BASED INDUSTRY IMPLICATIONS		
Melichar, Jan and Kaprova, Katerina and Urban, Jan	2013	WELFARE ANALYSIS WITH DISCRETE CHOICE MODELS - INVESTIGATING PUBLIC PREFERENCES FOR FOREST RECREATION ATTRIBUTES - 7TH INTERNATIONAL DAYS OF STATISTICS AND ECONOMICS		
Rajapaksha N.S.S., Butt K.R., Vanguelova E.I., Moffat A.J.	2013	Earthworm selection of Short Rotation Forestry leaf litter assessed through preference testing and direct observation	10.1016/j.soilbio.2013.08.006	wrong population , wrong outcome - demand
Ellison D., Futter M.N., Bishop K.	2012	On the forest cover-water yield debate: From demand- to supply-side thinking	10.1111/j.1365-2486.2011.02589.x	wrong outcome - demand
Wilson M.W., O'Donoghue B., O'mahony B., Cullen C., O'Donoghue T., Oliver G., Ryan B., Troake P., Irwin S., Kelly T.C., Rotella J.J., O'Halloran J.	2012	Mismatches between breeding success and habitat preferences in Hen Harriers Circus cyaneus breeding in forested landscapes	10.1111/j.1474-919X.2012.01236.x	wrong population , wrong outcome - demand
Lindhjem H., Mitani Y.	2012	Forest owners' willingness to accept compensation for voluntary conservation: A contingent valuation approach	10.1016/j.jfe.2012.06.004	wrong outcome - demand

Authors	Year	Title	DOI	Exclusion criteria
Rodionov, Andrei and Bauke, Sara L. and von Sperber, Christian and Hoeschen, Carmen and K and eler, Ellen and Kruse, Jens and Lew and owski, Hans and Marhan, Sven and Mueller, Carsten W. and Simon, Margaux and Tamburini, Federica and Uhlig, David and von Blanckenburg, Friedhelm and Lang, Friederike and Amelung, Wulf	2020	Biogeochemical cycling of phosphorus in subsoils of temperate forest ecosystems	10.1007/s10533-020-00700-8	wrong outcome
Cannon, PF and Simmons, CM	2002	Diversity and host preference of leaf endophytic fungi in the Iwokrama Forest Reserve, Guyana	10.2307/3761797	wrong geographic scope , wrong outcome
Kittler, Brian and Stupak, Inge and Smith, C. Tattersall	2020	Assessing the wood sourcing practices of the US industrial wood pellet industry supplying European energy demand	10.1186/s13705-020-00255-4	wrong geographic scope , wrong population
Ribeiro Nunes, Leonel Jorge and Goncalves Barata, Eduardo Jorge	2019	ENERGETIC VALORIZATION OF RESIDUAL BIOMASS: RURAL DEVELOPMENT MODEL BASED ON NATIVE FOREST EXPLOITATION - PROCEEDINGS OF THE 4TH INTERNATIONAL CONFERENCE ON ENERGY \& ENVIRONMENT (ICEE 2019): BRINGING TOGETHER ENGINEERING AND ECONOMICS		

Authors	Year	Title	DOI	Exclusion criteria
Dezzotti, Alej and ro and Mortoro, Ariel and Medina, Andrea and Sbrancia, Renato and Beltran, Hernan Attis	2019	PLANT RICHNESS AND LIFE FORM DIVERSITY ALONG VEGETATION AND FOREST USE GRADIENTS IN NORTHWESTERN PATAGONIA OF ARGENTINA	10.1590/01047760201925032645	wrong geographic scope
Scholz, B. and Urselmans, S. and Kjaer, J. B. and Schrader, L.	2010	Food, wood, or plastic as substrates for dustbathing and foraging in laying hens: A preference test	10.3382/ps.2009-00598	wrong population
Horvat, Sanja and Domljan, Danijela and Grbac, Ivica	2008	SOLID WOOD FURNITURE IN CROATIAN HOUSEHOLDS - USERS' REAL NEEDS, DEMANDS AND EXPECTATIONS - WOOD IS GOOD - PROPERTIES, TECHNOLOGY, VALORISATION, APPLICATION, 19TH INTERNATIONAL SCIENTIFIC CONFERENCE, 2008		
Bostedt, Goran and Zabel, Astrid and Ekvall, Hans	2019	Planning on a wider scale - Swedish forest owners' preferences for landscape policy attributes	10.1016/j.forpol.2019.04.013	wrong outcome , supply
Bisaglia, C. and Romano, E. and Cutini, M. and Nucci, F.	2011	Conversion of a High-Demanding Thermal-Energy Level Greenhouse from Conventional Oil Heating System to Wood-Based Renewable Sources Heating System for Tropical Plants Production in Mediterranean Conditions - INTERNATIONAL SYMPOSIUM ON HIGH TECHNOLOGY FOR GREENHOUSE SYSTEMS: GREENSYS2009		wrong publication type
Lindhagen, A and Hornsten, L	2000	Forest recreation in 1977 and 1997 in Sweden: changes in public preferences and behaviour	10.1093/forestry/73.2.143	USER-NOTES: {"Oli"=>["technically, the publication year would just fit under our scope

Authors	Year	Title	DOI	Exclusion criteria
				but its using very, very old data so I excluded it"]}
Kohsaka, R and Flitner, M	2004	Exploring forest aesthetics using forestry photo contests: case studies examining Japanese and German public preferences	10.1016/j.forpol.2004.03.016	wrong outcome
Botwinska, Katarzyna and Mruk, Remigiusz and Tucki, Karol and Wata, Mateusz	2017	Simulation of fuel demand for wood-gas in combustion engine - INTERNATIONAL CONFERENCE ENERGY, ENVIRONMENT AND MATERIAL SYSTEMS (EEMS 2017)	10.1051/e3sconf/20171901018	
Correa Simioni, Sintia Carla and Mercado Tovar, Diego and Rodrigues, Jessica Ferreira and de Souza, Vanessa Rios and Nunes, Cleiton Antonio and Vietoris, Vladimir and Marques Pinheiro, Ana Carla	2018	Temporal dominance of sensations and preferences of Brazilians and Slovakians: A cross-cultural study of cachacas stored with woods from the Amazon rainforest	10.1002/jsfa.8922	wrong outcome , wrong population
Goli, Giacomo and Negro, Federico and Emmerich, Lukas and Militz, Holger	2023	Thermal and chemical modification of wood - a combined approach for exclusive, high-demanding performance products	10.1080/17480272.2022.2143281	wrong outcome
Urban J., Suchomel J., DvoÅ™Ã¡k J.	2008	Contribution to the knowledge of woods preferences of EUropean beaver (Castor fiber L. 1758) in bank vegetation on non-forest land in the forest district Soutok (Czech Republic)	10.11118/actaun200856040289	wrong outcome , wrong population

Authors	Year	Title	DOI	Exclusion criteria
Roos J., Nicholls D.L.	2006	Domestic market opportunities for Alaska lumber-species preferences by secondary wood products manufacturers in the continental United States		wrong geographic scope
Fenton R.T.	2001	Forecasts of forest products demand in Japan		wrong geographic scope
Regina I.S., Tarazona T.	2001	Organic matter and nitrogen dynamics in a mature forest of common beech in the Sierra de la Demanda, Spain	10.1051/forest:2001128	wrong outcome
[No author name available]	2000	Wood Mackenzie predicts slow demand growth but improved margins for Europe's refiners		wrong outcome , wrong publication type
Benson J.F., Willis K.G.	1993	Implications of Recreation Demand for Forest Expansion in Great Britain	10.1080/00343409312331347345	wrong temporal scope
Baudin A., Solberg B.	1989	Substitution in demand between sawnwood and other wood products in Norway		wrong temporal scope

Project Partners

CLIMB-FOREST

Working closely with the forestry sector and policy makers, CLIMB-FOREST aims to ensure Europe's forests are resilient to the changing climate and support people and nature.

www.climbforest.eu
@ClimbForest

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101059888