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Bringing "Climate-Smart Forestry" Down to the Local Level—Identifying Barriers, Pathways and Indicators for Its Implementation in Practice

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Abstract: The theoretical concept of "climate-smart forestry" aims to integrate climate change mitigation and adaptation to maintain and enhance forests' contributions to people and global agendas. We carried out two local transdisciplinary collaboration processes with the aim of developing local articulations of climate-smart forestry and to identify barriers, pathways and indicators to applying it in practice. During workshops in northern and southern Sweden, local stakeholders described how they would like forests to be managed, considering their past experiences, future visions and climate change. As a result, the stakeholders framed climate-smart forestry as active and diverse management towards multiple goals. They identified several conditions that could act both as barriers and pathways for its implementation in practice, such as value chains for forest products and services, local knowledge and experiences of different management alternatives, and the management of ungulates. Based on the workshop material, a total of 39 indicators for climate-smart forestry were identified, of which six were novel indicators adding to the existing literature. Our results emphasize the importance of understanding the local perspectives to promote climate-smart forestry practices across Europe. We also suggest how the concept of climate-smart forestry can be further developed, through the interplay between theory and practice.

Keywords: sustainable forest management; climate change; mitigation; adaptation; nature's contributions to people; stakeholder participation; interdisciplinary research; transdisciplinary collaboration; forest policy

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1. Introduction

Forest management plays a key role in mitigating climate change and its potential negative impacts [1]. As a result of climate change, increasing forest disturbance can be expected, particularly in boreal and coniferous forests [2]. These disturbances can have both positive and negative impacts on forests' potential to mitigate climate change [3]. Hence, several papers have reviewed how forest management can be better adapted to the changing climate [4–9]. While climate change adaptation and mitigation can be seen as two sides of the same coin, they have usually been treated separately in science and policy [5,10,11]. However, several authors are now arguing for their integration to achieve "climate-smart forestry" [12–15].

Climate-smart forestry is a new forest management concept that has emerged in recent years in Europe. It aims to integrate both climate change adaptation and mitigation to protect and enhance nature's multiple contributions to people and increase forests' contributions to global agendas [12–15]. The concept builds on "sustainable forest management" criteria and indicators but is more focused on climate change action [12,14,15]. Bowditch et al. [12] and Verkerk et al. [15] proposed universal definitions and principles for climate-smart forestry, while stressing the need to adapt them to the local conditions and contexts in which forests are used and managed. Previous research has emphasized that involving local stakeholders in these kinds of processes is essential to developing locally adapted, relevant and preferred strategies, as it tailors them to the local conditions and contexts [5,16–19]. Bowditch et al. [12] identified this as the next step in the launch of the climate-smart forestry concept across Europe.

In terms of forest management, northern Europe stands out in the world as particularly production-oriented, with a long history of extensive forest management [20]. With still relatively many people employed in the forest sector and connected industries, one could assume that people in northern Europe would be especially concerned with the consequences of climate change. However, previous studies have shown the opposite. Forest owners in northern Europe are the least concerned about climate change among forest owners in Europe and have to a smaller degree changed their management to mitigate the effects [21,22]. Why is that? Is the management of forests already adapted to the changing climate? Are forest owners simply unaware of its effects? Or which other explanations could there be? Given this conundrum, we identified Sweden as an interesting case for studying what climate-smart forestry could translate to locally. To achieve some spatial and contextual variation, we identified one area in southern and one in northern Sweden as our study areas. While the tree species distribution are quite similar between the two, the local climate, forest productivity and forest ownership differ substantially [23,24]. Hence, they should provide two interesting cases of local articulations of climate-smart forestry that can help guide similar processes in other parts of Europe.

The aim of our study is to translate the theoretical concept of climate-smart forestry into something that is locally applicable, by bringing it down to the local level. Our assumption is that by engaging local stakeholders in two local collaboration processes in Sweden, we can better understand the local perspectives on climate-smart forestry, including barriers, pathways and indicators for its implementation in practice. At the end, we discuss our results in relation to the existing literature and expand on how the climate-smart forestry concept can be further developed in Europe.

2. Materials and Methods

To study local articulations of climate-smart forestry in Sweden, we used the ideas and principles of "reflexive forestry" [19] as our point of departure. In reflexive forestry, a shared understanding of forest management is fostered through collaborative processes including multiple stakeholders representing different ways of thinking, knowing about and working practices in the forest [19]. Reflexive forestry also emphasizes that we need both past experiences and future visions to scrutinize and deal with the challenges of today, that is, transtemporal thinking [19]. Prior to this study, the engaged stakeholders had been part of two workshops focusing on learning from the past and establishing visions [25] and pathways for the future [26], within the research project "Bring down the sky to earth", with the overarching aim of developing local pathways for forest land-use in support of climate action and local development [27], see Figure 1.

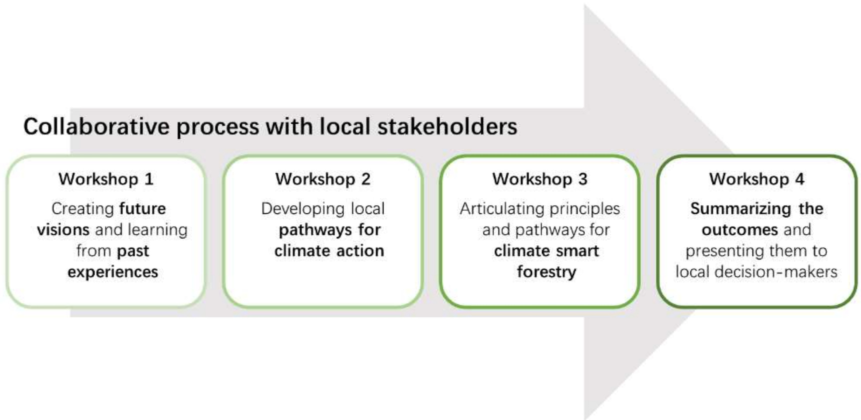

Figure 1. The set-up of the transdisciplinary collaborative process in the "Bring down the sky to earth" project, of which this study reports output from Workshop 3.

2.1. The Study Areas and Local Stakeholders

Our study areas were Vindeln and Umeå Municipalities, in Västerbotten County in northern Sweden, and Växjö and Lessebo Municipalities, in Kronoberg County in southern Sweden (Figure 2). They cover 495,000 ha and 208,000 ha of land, respectively, and are dominated by forests (forests cover 82% and 83% of the land area) [28]. A large proportion of the forest land in the northern study area is considered unproductive forests (30% of the forest land, compared to 12% in the southern area) [28], where the Swedish Forestry Act prohibits harvesting of wood. The productive forests in both the northern and southern study areas are dominated by Scots Pine (*Pinus sylvestris* L.), Norway spruce (*Picea abies* H. Karst) and Birch (a mix of *Betula pendula* Roth and *Betula pubescens* Ehrh.) [23]. There is a gradient across Sweden, with Scots pine being the most common species in the north (ranging from 48 to 30%) and Norway spruce in the south (29% to 51%) [23]. Birch is distributed evenly across the country, but in lower densities (about 10%–15%) [23]. The browsing of ungulates, namely moose (*Alces alces* L.), roe deer (*Capreolus* L.), red deer (*Cervus elaphus* L.) and fallow deer (*Dama dama* L.) are believed to be the main driver of the "sprucification" of southern Sweden, as a result of failing regenerations with Scots pine and broadleaved tree species [29–31].

Figure 2. The location of the study areas in northern and southern Sweden. Satellite image from Wikimedia Commons, created by Koyos with NASA WorldWind; and geographical distribution of our study areas visualized with data from Lantmäteriet.

Most productive forests in Kronoberg County are owned by family forest owners (78%), while the forests in Västerbotten County have a mixed ownership structure (40% is owned by family forest owners, 31% by the state and 23% by private forest companies) [23]. Of the family forest owners, about 80% in the southern study area are resident and own on average 30 hectares; while 72% of the forest owners in the northern area are resident and own on average 47 hectares [32]. Generally the state and private forest companies own forest properties larger than 1000 hectares [23,32]. The forests in our study areas are predominantly managed trough even-aged management with natural regeneration or planting. The average clear-cut size is about five hectares in the northern parts of the country, and two and a half hectares in the southern areas [32]. Shelterwood systems are also used, but to a low degree, and selective felling is uncommon. Some forests are left unmanaged (all unproductive forests, see numbers above; and 11% of the productive forests in Västerbotten County and 8% in Kronoberg County) to maintain and promote biodiversity [33].

In many ways, forests are a part of the way of life in both of our study areas, with the Swedish right to public access as an example of that. It allows the public to roam, camp and forage berries and mushrooms in any forest, without needing the forest owners' permission. Many Swedes enjoy an outdoor lifestyle, with forest walks and foraging as the most common activities [34,35]. Commercial berry-picking also occurs, mainly with foreign labor [36]. Another common interest is hunting, which over time has gone from being a way to supply the family with meat to being mainly an recreational activity [37]. In both areas, nature-based tourism is also a part of the forest use, although most nature-based tourism in Sweden is concentrated towards coasts and mountains [38]. In the northern study area, the land is also used by the Indigenous Sami to herd reindeer (*Rangifer tarandus* L.), which is a domestic deer that grazes freely in the area during wintertime. In addition, there are many forest industries in Sweden, which also owns large proportions of the forests, especially in the northern areas [23].

For the local collaborative processes, we engaged local stakeholders resident in our two study areas. The stakeholders were recruited to represent different interests related to forests, such as forest owners, forest industry representatives, people engaged in ENGOs, hunters, educators, local development representatives, tourism entrepreneurs and Sámi reindeer herders (Table 1). When recruiting stakeholders, we first identified forest-related organizations in our study areas, and then identified potential participants within these. Generally, the persons invited to participate were the chairperson of the organization or of the local unit of the organization (when approaching national or regional organizations). On some occasions, the invited persons redirected us to another person within their organization. In total, there were more than 30 stakeholders involved in the project, and while they were recruited from certain organizations, we asked them to act as members of the local community in the workshops. Twenty-three local stakeholders participated in workshop 3 (Table 1): fourteen stakeholders in northern Sweden and nine in southern Sweden. Both groups included a mix of men and women. Informed consent was obtained from all the stakeholders included in the study. In addition to the local stakeholders, eight researchers (one historian, two historians of science and ideas, two political scientists, and three forest scientists) were involved in planning and carrying out the workshops. To enable constructive dialogues, the process was guided by a professional facilitator [39].

Table 1. The stakeholders participating in workshop 3.

Interests	Southern Sweden			Northern Sweden		
	Men	Women	Total	Men	Women	Total
Education	0	0	0	1	1	2
Environmental organization	1	1	2	2	0	2
Forest industry	0	1	1	2	0	2
Family forest owner	3	1	4	3	1	4
Hunting	0	0	0	1	0	1
Local development	1	0	1	0	1	1
Reindeer herding	0	0	0	0	1	1
Tourism and recreation	1	0	1	0	1	1
Total	6	3	9	9	5	14

2.2. The Design of Workshop 3

The workshop was arranged as a visit in a forest, aiming to provide the stakeholders common references while also allowing the environment to catalyze and open up the discussions as inspired by the "forest walks" method developed by Laakkonen, et al. [40]. In contrast to the individual interviews carried out in Laakkonen, et al. [40], our study mainly used focus group discussions out in the forest (complemented with written individual reflections). Focus groups have been commonly used in, for example, sociology, psychology, marketing and, more recently, nature conservation research, mainly as they allow for debate and discussions between stakeholders [41]. In focus groups, the stakeholders' thoughts and views are challenged by the other participants. This allows for more, and often more nuanced and reflexive, aspects to be discussed than in individual interviews [42]. However, there is always a risk that some participants end up dominating the discussions, while others do not feel safe enough to express their opinions [42]. To address this risk, researchers served as moderators for all discussions. We also chose to complement the discussions with individual written reflections.

The workshops were held in the Vindeln and Asa experimental forests in northern and southern Sweden, respectively. They are both centers for experimental forest research in Sweden [43]. The purpose of situating the workshops within the research infrastructures was to allow the local stakeholders to experience different forest management systems, some of which are quite unconventional in the Swedish forest landscape. The aim was to broaden and challenge the participants' perceptions of how forests can be managed, and thus allow the environment to stimulate reflexive discussions, as reflexivity involves both 'self-confrontation' and 'reflection' to enable the 'rethinking' of current practices [19,44,45]. The workshops included visits to five different forests, managed in five different ways: one left unmanaged, one managed with continuous cover forestry, one with even-aged forestry, one with even-aged forestry including intensive fertilization and one with even-aged forestry including exotic tree species.

The workshops lasted one full day. They started with an introduction by the facilitator, consisting of a presentation of the workshop aim and program, a short summary of previous workshops, and establishment of rules for the day. At each of the five forest sites, the stakeholders were introduced to the site and management system by a forest scientist. This introduction included descriptions of the management system in general and descriptions of how it was applied at the specific sites. The stakeholders then had a couple of minutes to briefly experience and reflect on the site and management in groups of two to three people, before joining a larger group of four to five stakeholders and two researchers. In the group, they discussed risks and opportunities with each kind of management from their local perspective and when considering climate change. The groups were put together to include a mix of interests, ages and genders. The researchers mainly moderated, audio recorded and took notes on the discussions, while also answering the occasional science-based question posed to them. During this time, the facilitator kept track of the time and aided the moderating of the researchers when needed. Afterwards, all groups gathered, and the researchers repeated the main points of the discussions to the entire group, in the same language used by the stakeholders, to allow an exchange of ideas between the groups. After each presentation, the stakeholders could comment on each other's discussions, and this part was moderated by the facilitator. This four-step process, consisting of (i) the introduction by the forest scientist, (ii) pairwise reflections, (iii) small group discussions, and (iv) full group discussions, was repeated at each of the sites throughout the day.

At the end of the workshop, the stakeholders were taken indoors to conclude the discussions they had had during the day and relate these to the discussions they had had during previous workshops [25,26]. To relate to the previous discussions, the leaders of these workshops provided a short presentation of the main features and talking points of the workshops, which included the stakeholders' past experiences and future visions for their local society, as well as potential pathways to achieving those visons. This was followed by a short discussion with the entire group on which kind of forest management they would like to see, considering their past experiences, future visions and climate change. This discussion was moderated by the facilitator. Finally, the stakeholders wrote anonymous individual reflections on the same topic. The workshops in northern and southern Sweden were carried out during the autumn of 2019.

2.3. Analyzing the Material

The questions asked by the researchers to the stakeholders during the workshops were broad and open, hence, the material reflected a diversity of perspectives. To process the raw material into the summary provided in the results section, the recorded group discussions and the individual reflections were transcribed and analyzed by the main author. The analysis was based on "grounded theory" and "the constant comparative method", which is a common method for analyzing qualitative data [46,47] and material from focus group discussions [41] that involves coding, categorizing and thematizing the material. After the transcription of the material, the individual statements were extracted and grouped in different themes. For each theme, categories were identified and described. The categories and themes were later tested against the recorded and transcribed material and validated by the co-authors, and then rearranged until the categories and themes were judged to provide a reflection of the material, but in a condensed form. In this process, we considered it important to maintain the width of the material, to not exclude any of the stakeholders in the condensing process. A trade-off of this choice might be a loss of depth of the material, as some of the reasoning/arguments behind statements could not be included. Overall, the analysis involved an extensive iterative process, in line with Hjerm et al. [47] and Fejes and Thornberg [46]. In the end, the material was clustered into the following themes: (i) descriptions of current forestry practices and their consequences, (ii) articulations of climate-smart forestry practices and their potential benefits, and (iii) the barriers and pathways for implementing climate-smart forestry at a local level. These themes, in turn, included several categories and codes, presented in Table 2. The individual reflections mainly reflected the latter themes (theme ii. and iii. above), while the focus group discussions revolved around all themes identified in the material.

Whilst the first analysis of the material was inductive, or data-driven, the latter part was deductive, or theory-driven. In the latter part, the material gathered during the workshop on climate-smart forestry and how to achieve it was analyzed through the lens of sustainable forest management [48] and climate-smart forestry [12,14], focusing on criteria and indicators. In this process, we screened the material for criteria and indicators and identified several from previous frameworks and literature, but also some that were novel and specific for the case studies we investigated.

Table 2. The final themes, categories and codes derived from the material.

Themes	Categories	Codes	Derived from:
Current practices	Strengths and weaknesses with :Even-aged management; and Unmanaged forests	Climate change mitigation; climate change adaptation; biodiversity; local uses	Focus group discussions
What climate-smart-forestry would entail locally	General ideas that should guide the management: active management and multiple use; diverse management; landscape perspective.	Forest management principles, such as: Tree species; management systems; management aim; management scale.	Focus group discussions and individual reflections
Barriers and pathways for climate-smart forestry	Perceived barriers and pathways related to: socio-economic context, cultural context environmental conditions	Markets and value chains for wood products; use and promotion of non-wood products and services; forest ownership and taxation policies; forest policies; knowledge and experience; management of ungulates; collaboration and networks	Focus group discussions and individual reflections

3. Results

During our workshops, local stakeholders identified the strengths and weaknesses of the current forestry practices in our study areas (Section 3.1), articulated how they would frame climate-smart forestry locally (Section 3.2) and barriers and pathways for its implementation in practice (Section 3.3). Based on the workshop material, we have also identified indicators for climate-smart forestry (Section 3.4).

As the presented statements came from group discussions and anonymous individual reflections, we present the results without disclosing the identity of the individual stakeholders. This choice safeguards the anonymity of participating stakeholders. The material included both statements that the stakeholders agreed and disagreed on, which is why the results in some instances can be perceived as ambiguous. However, this ambiguity reflects the local multi-stakeholder settings in which the forests in our study areas are used and managed, which is why we have chosen to present both the general and diverging perspectives.

3.1. Current Forestry Practices and Their Consequences

Both the northern and the southern stakeholder groups stated that the local forests in their respective area were mainly managed through either even-aged forestry with native spruce (*Picea abies* H. Karst) or pine (*Pinus sylvestris* L.) or leaving forests unmanaged.

The main benefit identified for the practice of even-aged forestry was that it produced timber and pulpwood effectively. This was perceived by several stakeholders to be the main source of income for forest-related practices, whereas the income from non-wood products and services, for example, tourism and berry-picking, were considered less profitable. Some stakeholders also argued that due to the Swedish right to public access, which allows people to roam and forage freely in any forests, non-wood benefits from forests provided no income for the forest owners.

From a climate change mitigation perspective, all participating stakeholders agreed that forestry promoting timber and pulpwood production is important to the replacement of fossil-based materials and fuels with renewable ones. However, most of the stakeholders were concerned that societal demands would exceed the potential supply from the forest. This generated a discussion on the importance of reducing overall consumption. Moreover, some were concerned with the quality of the wood currently produced, as they identified high quality wood to be essential for producing long-lasting construction materials, which they thought were central to the sustainable use of these resources.

From a climate change adaptation perspective, multiple problems with even-aged forestry were mentioned, such as risks of large-scale infestations of pests and diseases, extensive wind throws, drought-stressed trees and lack of species diversity. This was particularly prominent in southern Sweden, where the stakeholders were currently experiencing such issues. They identified the causes of the problems to be the favoring of spruce in regeneration over the past decades, due to the species having a more rapid growth, in conjunction with major problems of browsing damage to pine from a growing ungulate population. Some stakeholders suggested that this, through a chain of events, had led to the current large-scale outbreaks of spruce bark beetles (*Ips typographus* L.). In northern Sweden, the trend has rather been to regenerate with pine; hence, the northern stakeholders were more concerned about browsing damage and pathogens on pine, while they were also concerned about the bark beetle situation in southern Sweden. Overall, many of the stakeholders from both northern and southern Sweden wanted to increase the proportion of deciduous trees and mixed species forests to spread risks and increase resilience, from both environmental and financial perspectives. In northern Sweden, some also wanted to use deciduous trees as fire barriers around their residential areas, as they identified them as more fire resistant.

The major problem of even-aged forestry highlighted by the stakeholders was its impact on biodiversity, where monocultures and short rotation periods were particularly perceived as having the most negative effects. In relation to forests' social values, the stakeholders identified the even-aged management system as advantageous for berry-picking, walks and outings, skiing, moose safari and hunting (specifically in northern Sweden). However, they emphasized that most of these opportunities were only present during a part of the rotation period, or during a certain season, and that the preferences differ greatly between different people. While some enjoy the openness of a clear-cut, others think it looks awful. However, most stakeholders agreed that they did not like very large clear-cuts (>10 ha), which were mainly considered a problem in northern Sweden by both stakeholder groups.

The main benefit of leaving forests unmanaged agreed upon by most of the stakeholders was that it contributed to biodiversity, recreation, tourism, and feed and habitat for wildlife. However, some of the stakeholders also identified problems with leaving forests totally unmanaged, mainly due to the ingrowth of spruce, which was considered a major concern by stakeholders in both northern and southern Sweden. From their perspective, ingrowth of spruce is a threat to other tree species, and therefore to biodiversity as such, but also to recreational values, as it creates a darker and less amicable forest. These stakeholders therefore concluded that many forests left unmanaged should benefit from some management, that is, at least work to remove some of the spruce. They also stressed the value of unmanaged forests for educational and cultural purposes.

The climate benefits of unmanaged forests were intensively debated. While some asserted that such forests hold large carbon stocks in both their soil and trees, others argued that the longevity of these stocks was uncertain, as spruce bark beetles and forest fires could release the carbon back to the atmosphere. A couple of the stakeholders held that some selective cutting should be allowed, as the timber produced in these forests would probably be of a very high quality, and thus be very long-lasting in constructions, such as has happened in century-old timber houses. At the same time, other stakeholders emphasized that deadwood remaining in the forest has a high value for biodiversity and that any harvest may decrease its availability. It was concluded that these forests offered multiple values and that any management intervention involved trade-offs.

In conclusion, the benefits of the current practices identified by the stakeholders as dominant in both the north and the south were mainly that even-aged forestry produced timber and pulpwood effectively, while leaving forests unmanaged preserved biodiversity. The main drawbacks were that these two practices were not appropriate everywhere, and that they may impact forests' other contributions to people negatively. Both stakeholder groups also described the management as mainly focused on the forest stand-level, while the forest landscape perspective was mostly neglected. Suggestions on how to achieve a landscape perspective in forest management included considering how the area is used by the local people, how the surrounding forests are managed and potential problems with pests and pathogens. One example often brought up was the risk of pest dispersal, specifically spruce bark beetles, from unmanaged forests to the surrounding areas, and the potential financial damage that might bring for the affected forest owners.

3.2. Local Articulations of Climate-Smart Forestry Practices

There are three major principles in the stakeholders' articulation of climate-smart forestry, that is, forestry that is adapted to their past experiences, future visions and climate change. These are:

- Active management to achieve various goals in different places;
- Diversified and site-specific management, mainly using a broader palette of methods and tree species adapted to the specific location and site conditions;
- Consideration of the landscape perspective.

3.2.1. Active Management to Achieve Various Goals in Different Places

Many of the local stakeholders portray climate-smart forestry as the application of diverse management measures where forests are actively managed to optimize forests' various contributions to people, including biodiversity. Active management refers to the process of actively tending to the forests to achieve a certain goal, in contrast to passive management, which allows the forests to develop in any direction. For example, when aiming to produce timber, there is an active and conscious effort to thin and manage the stand to produce high quality timber; instead of letting the stand to develop in its own direction. When aiming to preserve biodiversity, management should, in some cases, be applied to increase biodiversity in that area, that is, to remove ingrowth of spruce or promote regeneration of pioneer species. When aiming to increase recreational values, the forests, as well as the trails, signage, and camp sites should be managed to promote utility and accessibility. For the most part, the stakeholders thought that passive management leads to low goal fulfilment, while active management leads to the opposite. However, in the case of biodiversity conservation, they identified several trade-offs with active management (see previous section). In addition, while the stakeholders did agree that the forests should be managed to promote multiple values, they did not agree to what extent the different values should be favored—for example, the distribution between forests managed for biodiversity and forests managed for timber production or recreation.

3.2.2. Diversified and Site-Specific Management

From most of the stakeholders' perspectives, it was important to use a diverse set of methods and tree species in the forest landscape. When using a broader palette or toolbox, they thought that the most appropriate method and tree species for each specific site and location could be used, supporting forest health and utility. In line with this, they wanted to increase the proportion of broadleaves in the landscape overall, while also increasing the proportion of mixed species forests. By diversifying, they thought that they could spread both financial and environmental risks, so that "all eggs aren't put in the one basket". They also understood that other tree species have different properties to those used currently: for example, using birch as fire barriers around residential areas or using larch for its specific wood properties. More tree species and methods also mean higher biodiversity, which they thought was important for long-term sustainability.

While the stakeholders overall were in favor of the diversification of methods and species, there were different opinions of which methods and tree species to include and to what extent they should be used. For example, some of the stakeholders identified a potential in using exotic species, especially fast-growing species or using them in conditions where the native species would struggle. Others were completely opposed to exotic species overall, as they thought that they pose a threat to the native species and ecosystem. A similar division was apparent in relation to fertilization. Some stakeholders identified a potential in fertilizing more forests, especially at the end of the rotation period, to increase yield and carbon capture. Others argued strongly against fertilization because of its environmental impact. The stakeholders were also divided when it came to continuous cover forestry (described as forestry without clear-cuts). Some thought it could be better for biodiversity and forests' recreational values. Others were concerned that it would mainly favor spruce (because of its shade tolerance), that it would not be financially sustainable or that it would not capture the same amount of carbon as even-aged managed forests.

3.2.3. Consideration of the Landscape Perspective

The stakeholders also stressed that more consideration should be given to the landscape perspective, for example by creating corridors for wildlife and endangered species, creating fire barriers of deciduous trees around residential areas and removing sick trees to limit the dispersal of pests and pathogens. Most of them also thought that forests close to lakes, wetlands or urban areas should be given particular consideration. While the majority of stakeholders argued that the landscape perspective is important, they did not discuss further how, or on which scale, this should be implemented.

3.3. Barriers and Pathways for Implementing Climate-Smart Forestry Locally

The stakeholders identified several conditions and factors, environmental, socio-economic and cultural, that they thought enable current forestry practices and act as barriers to the climate-smart forestry practices. They also identified several pathways, mainly socio-economic and cultural, for overcoming these barriers and implementing climate-smart forestry locally. These are described alternately below as they often overlap, meaning that one condition or factor that currently acts as a barrier could also be managed differently and thereby become a pathway for climate-smart forestry.

3.3.1. Markets and Value Chains for Wood-Based Products

Several of the local stakeholders described the current markets for wood-based products as limited, due to low prices and few wood assortments. They thought that this steers the management towards either using large-scale machines with high productivity or doing nothing, as the potential revenue from the alternatives will not make a profit or break even. They also related this to the size of the clear-cuts. Several stakeholders thought that the high costs and low revenues steer the management towards harvesting larger areas at a time, while they would prefer a more specialized management with smaller machines. They also thought that the narrow markets leave little room for using other tree species in forestry. Hence, they identified a need to create local and more diverse value chains.

The benefits of local value chains were, from several of the stakeholders' perspectives, that they can generate local employment and investment, and a more diverse forest management. From their perspective, with local value chains, the jobs, taxes and investment remain in the local economy, which creates more opportunities for local development and positive feedback loops. They also thought that promotion of local processing industries focusing on wood assortments other than the common ones or even non-timber forest products, would create incentives for forest owners to undertake types of management other than business-as-usual. Consequently, they thought that this would create more diverse forest management, which would be better from a risk perspective in a changing climate and probably also create more opportunities for other uses of the forest.

3.3.2. Forests' Many Contributions to People

A large proportion of the stakeholders identified a potential in using more of the products and services produced in the forests, such as mushrooms, berries, and recreational experiences. By foraging and processing more of the mushrooms and berries produced in the local forests, less food would have to be imported to Sweden and more jobs could be created locally. However, it was also discussed whether this would be financially viable, as there are probably valid reasons for why this is not being done already.

Another aspect discussed was the many health-related advantages of being out in the forests, and that more people should take greater advantage of them. In this respect, they thought that more forests should be managed to promote their aesthetic and recreational values, while also maintaining trails, signs and camps to improve accessibility. To do this, they emphasized that there must be a way for the forest owner to receive compensation for doing this, especially as many forest owners have borrowed money to purchase the forest. This was also discussed in relation to carbon capture and storage, which were believed to be of value to the wider public. By compensating forest owners, forests' many contributions to people could be promoted and forest management diversified. However, it was not clear if the forests owners were to be compensated through market solutions or by the authorities. Moreover, several stakeholders emphasized that, regardless of how it was funded, it should be on a voluntary basis for the forest owner.

3.3.3. Forest Ownership and Taxation Policies

Some of the stakeholders in northern Sweden described how much of the profits, and employment that are created in the wood-based value chain do not stay locally, which hinders local development. They attributed the problem to the forest ownership structures and taxation policies, as a large proportion of the forests are owned by non-resident owners or large forest companies, which pay their taxes in a taxation area different to the one where the forest is located. Hence, in addition to creating local value chains, they also argued for more local ownership of forests.

Several of the northern stakeholders also believed that locally owned forests would lead to more responsible and diverse management of forests, as they thought that local owners would care for them more sustainably than non-resident owners. They argued that local forest owners show greater consideration to the local people and environment, as they also have a better understanding of the local context in which the forest is situated. They also thought increased local ownership would enable collaboration among landowners, which could help keep costs down while allowing for better management.

While local ownership was considered one option to return more of the taxes to the area from which they originated, local taxation of natural resources was another. Referencing the Norwegian system, some of the stakeholders in northern Sweden stressed that the tax revenue from natural resources should be returned to the area from which the natural resources were extracted. From the stakeholders' perspective, this would limit the problem of the resources leaving the rural areas, as at least some of the financial resources would return, benefitting local development and promoting a "living countryside" ("levande landsbygd" in Swedish).

3.3.4. Nature Conservation and Forests' Multiple Use

Several of the stakeholders described the governmental conservation of forests as too focused on leaving forests unmanaged. From their perspective, most protected areas were set aside and then not managed. The stakeholders considered this to be a problem, as many areas—especially areas with large ingrowth of spruce—would benefit from some management, both for biodiversity and for recreation. Some of the stakeholders also believed that more of the conserved forests have the potential to be used for other purposes, for example recreation and human health, grazing and browsing of livestock, and selective cutting of high-quality timber. They felt that by opening up for other uses, except for large-scale forestry, both ecological and cultural values could be maintained and developed jointly. At the same time, multiple stakeholders argued for the need to leave large areas entirely unmanaged, for biodiversity, but also to act as a reference for current and future generations. The desirable proportion between the managed and unmanaged areas was, however, not elaborated on.

3.3.5. Local Knowledge and Experiences

Regarding the knowledge of different management practices, the stakeholders thought that there was a lack of knowledge relating to practices other than even-aged forestry practices—specifically, what works when and where and how different methods can be used to achieve different goals. For example, they discussed how continuous cover forestry could probably be used more in recreational areas, on moist soils, and in areas with a high risk of spring frost. However, for this to be the case, there needs to be more local examples of when this has been done successfully. The same is true for the use of native (and exotic) tree species other than pine and spruce. To provide these local examples, several of the stakeholders in northern Sweden identified large-scale forest owners as potential frontrunners, as they have the resources to test different management options.

When discussing the potential of using exotic species, the large-scale planting of the north American lodgepole pine (*Pinus contorta* Dougl.) in northern Sweden was brought up as a discouraging example by several of the stakeholders in both northern and southern Sweden. They were especially concerned by the rapid and large-scale introduction of the species in the native landscape, which they perceived to have been done without sufficient knowledge about its properties. One example described was that lodgepole pine can regenerate without forest fires, which was not known during the introduction of the species in the past. Today, 50 years after its introduction, multiple problems have been identified with lodgepole pine relating to biodiversity, recreation, reindeer husbandry and wood quality. Several of the stakeholders therefore highlighted the need for long-term field experiments with exotic species before considering planting them in the native landscape, while others were completely opposed to the use of exotic species.

Another perspective that was mentioned was the loss of traditional knowledge, for example, of when and how to cut a tree to obtain the best timber, or how to saw a log to maintain the quality. Relating to this, several of the stakeholders referred to historical practices, such as selective and seasonal cutting. However, they did not specify how traditional knowledge could be “brought back”, but instead reflected on problems with it “being lost”.

3.3.6. Management of Ungulate Populations

Several stakeholders considered the high browsing pressure from ungulates, mainly moose, roe deer, red deer and fallow deer, to be a major barrier for diversifying the tree species use in forestry. This is especially true in southern Sweden, as several of the species that potentially could be used in forestry are targeted by the browsers. Fencing off regenerated areas and young stands to keep the animals away from the trees was not considered an option, as the stakeholders thought it was both costly and time-consuming to set up and manage. Instead, they wanted an improved management of the ungulate populations. However, they did not specify how the management could be improved.

3.3.7. Local Collaborations and Networks

Several of the stakeholders thought that more local collaborations and networks could lead to a greater understanding of other people’s interests and perspectives, and could promote knowledge exchange, cost-cutting, and diversification of forest management and utilization. They perceived the debate about how forests should be managed to be very polarized, partly due to people having little understanding of interests and perspectives other than their own. Through more collaboration, understanding of other interests could increase and the level of conflict decrease, which some of the stakeholders had also experienced from our project. They believed that new ways of utilizing and managing forests could emerge from collaboration and knowledge exchange. They also identified multiple opportunities for collaborations between both forest owners and other stakeholders, to keep costs down and create new projects. If collaboration could lead to new businesses or potential income from the forest, then they also thought that it could help diversify management.

3.4. Local Indicators for Climate-Smart Forestry

We have used Forest Europe's set of criteria and indicators for sustainable forest management [48] and the climate-smart forestry indicators from Bowditch et al. [12] to identify indicators present in the local stakeholders' articulations of climate-smart forestry. The results from the northern and southern study areas are here presented jointly (Table 3) and later compared to indicators for climate-smart forestry identified by Bowditch et al. [12] and Santopuoli et al. [14].

Table 3. Indicators for Climate-smart Forestry identified in our study, adapted from Forest Europe's Criteria and Indicators for Sustainable Forest Management (SFM) [48] with additions from Bowditch et al. [12] and our study.

Criteria	Indicator	Type	Present in Our Study	Comments
Sustainable Forest Management indicators by Forest Europe	1 National Forest Programs or equivalent	Qualitative		
	2 Institutional frameworks	Qualitative	X	
	3 Legal/regulatory framework: National (and/or sub-national) and International commitments	Qualitative	X	
	4 Financial and economic instruments	Qualitative	X	
	5 Information and communication	Qualitative	X	
	C.1 Policies, institutions and instruments to maintain and appropriately enhance forest resources and their contribution to global carbon cycles	Qualitative	X	
	1.1 Forest area	Quantitative		
	1.2 Growing Stock	Quantitative	X	
	1.3 Age structure and/or diameter distribution	Quantitative	X	
	1.4 Forest carbon	Quantitative	X	
	C.2 Policies, institutions and instruments to maintain forest ecosystem health and vitality	Qualitative	X	
	2.1 Deposition and concentration of air pollutants	Quantitative		
	2.2 Soil condition	Quantitative		
	2.3 Defoliation	Quantitative		
	2.4 Forest damage	Quantitative	X	
	2.5 Forest land degradation	Quantitative		
	C.3 Policies, institutions and instruments to maintain and encourage the productive functions of forests	Qualitative	X	
	3.1 Increment and fellings	Quantitative	X	
	3.2 Roundwood	Quantitative	X	Quality aspects should also be included
	3.3 Non-wood goods	Quantitative	X	
	3.4 Services	Quantitative	X	
	3.5 Forests under management plans	Quantitative	X	

Table 3. *Cont.*

Criteria	Indicator	Type	Present in Our Study	Comments
	C.4 Policies, institutions and instruments to maintain, conserve and appropriately enhance the biological diversity in forest ecosystems	Qualitative	X	
	4.1 Diversity of tree species	Quantitative	X	
	4.10 Common forest bird species	Quantitative		
	4.2 Regeneration	Quantitative	X	Size of individual clear-cuts should also be included; also related to C6
	4.3 Naturalness	Quantitative	X	
	4.4 Introduced tree species	Quantitative	X	
	4.5 Deadwood	Quantitative	X	
	4.6 Genetic resources	Quantitative		
	4.7 Forest fragmentation	Quantitative	X	
	4.8 Threatened forest species	Quantitative		
	4.9 Protected forests	Quantitative	X	
	C.5 Policies, institutions and instruments to maintain and appropriately enhance of the protective functions in forest management	Qualitative		
	5.1 Protective forests—soil, water and other ecosystem functions—infrastructure and managed natural resources	Quantitative		
	C.6 Policies, institutions and instruments to maintain other socio-economic functions and conditions	Qualitative	X	
	6.1 Forest holdings	Quantitative	X	Should also include the proportion of resident/non-resident forest owners
	6.10 Recreation in forests	Quantitative	X	
	6.2 Contribution of forest sector to GDP	Quantitative		
	6.3 Net revenue	Quantitative	X	
	6.4 Investments in forests and forestry	Quantitative	X	
	6.5 Forest sector workforce	Quantitative	X	Should include forest sector in a broad sense, such as people employed in forest-related businesses other than the timber and pulp industry.
	6.6 Occupational safety and health	Quantitative		

Table 3. *Cont.*

Criteria	Indicator	Type	Present in Our Study	Comments
	6.7 Wood consumption	Quantitative	X	Should include the longevity of the products consumed.
	6.8 Trade in wood	Quantitative		
	6.9 Wood energy	Quantitative	X	
Indicators added by Bowditch et al. (2020)	Forestry	Quantitative	X	
	Slenderness	Quantitative		
	Vertical crowns	Quantitative		
	Horizontal crowns	Quantitative		
Indicators added by our study	Active forest management	Qualitative/Quantitative	X	Active management practices to optimize the use of the forests.
	Collaborations and networks	Qualitative	X	Collaborations and networks to promote forests' multiple use.
	Knowledge and experiences	Qualitative	X	Local knowledge and experiences of different management alternatives.
	Local value chains	Qualitative	X	Local value chains for forest products and services.
	Management of ungulates	Qualitative/Quantitative	X	Management of ungulates to promote tree species diversity.
	Taxation policies	Qualitative	X	Taxation policies that feed back to the local area from which the wood was harvested.

The indicators for climate-smart forestry identified in our material cover a broad range of aspects, including descriptions of forest characteristics, forestry practices, forest use and forest ownership, of which most are related to how the local stakeholders articulated climate-smart forestry (Section 3.2) and pathways for implementation (Section 3.3). In total, we identified 39 indicators, of which 32 were from Forest Europe's set of indicators for sustainable forest management [48], one from Bowditch et al.'s added indicators for climate-smart forestry, and six novel indicators. For some of the indicators, we have added a comment on how the current definition of the indicator can be broadened to better capture the aspects that were important to the local stakeholders in our study areas. For example, related to the *forest sector workforce*, the stakeholders were also concerned with the employments created outside of the forest industry, such as people employed in nature-based tourism or the berry-picking industry. Related to *round wood* and *wood consumption*, they also found the quality of the wood produced and consumed to be important, in addition to the quantity. The novel indicators we identified (see descriptions in Table 3), mainly focused on the social context surrounding forest management in our study areas, such as *active forest management*, *local value chains* and *collaborations and networks*.

Compared to Bowditch et al. [12], who used a similar approach together with multinational forest experts from mountain regions of Europe, it is clear that the contexts and perspectives differ. In general, the indicators identified in Bowditch et al. [12] relate to environmental aspects and forest characteristics that in some cases were not pronounced in our study areas, such as indicators related to soils, deposition of air pollutants, defoliation and the shape of tree crowns (Table 3). Instead, the stakeholders in our study areas focused on social aspects of forests, such as forest uses and employments, which in turn were not present in Bowditch et al. [12]. When comparing both of these studies to Santopuoli et al. [14], who based their indicators for climate-smart forestry of a literature review, there are several similarities and differences to both of the studies. The comparison thus becomes more ambiguous. The most distinctive way in which our study differ is that our study also included qualitative indicators, while both Bowditch et al. and Santopuoli et al. focus exclusively on quantitative indicators for climate-smart forestry.

4. Discussion and Conclusions

Many studies have discussed how forest management in Europe can become climate-smart from a theoretical perspective [12–15,49,50]. However, our study provides novel insight to how this can be brought down to the local level, for it to be understandable and applicable in practice. We have together with local stakeholders developed local articulations of climate-smart forestry for two areas in Sweden, and identified potential barriers, pathways and indicators for its implementation in practice. The results reflected many similarities between our two areas and stakeholder groups, related to the shared national context, but also an exchange of knowledge and experiences between the two regional locations. While our local articulations and indicators will be specific to these locations, we do think they can provide valuable feedback to the previous definitions and indicators of climate-smart forestry, for example, [12,15], which we discuss in this chapter.

Conceptually, a scientific meta-level discussion aimed to define climate-smart forestry feeds into local articulations that in turn feeds back to the meta-level (Figure 3). In this feed-back loop, exchange between science and practice as well as between local level, national level and European level is promoted. This process could be supported by applying the ideas and principles of reflexive forestry, which promotes the inclusion of multiple stakeholders, with different views and knowledge of forests [19]. This allows multiple perspectives and favors the development of shared understandings of climate-smart forestry. As in our study, were both stakeholder groups framed climate smart forestry similarly, namely, active and diverse management towards multiple goals. While these local articulations could fit within the previously suggested definitions, mainly to integrate climate change adaptation and mitigation into forest management to enhance nature's contributions to people and global agendas [12,15], they do also provide a more practice-centered, perspective. Even though this distinction could be considered trivial, it might have great importance for the concept's implementation in practice, as it is then defined in a way that is easily understandable and relatable for the stakeholders. As argued by Klein and Juhola [16], "to many stakeholders adaptation concepts developed and applied by academics appear overly theoretical and irrelevant to their day-to-day reality". The same could be said about climate-smart forestry, which is why we need these local articulations of the concept for it to hold meaning, and make sense, on the local level, to thereafter feed back to the meta-level scientific discussion (Figure 3).

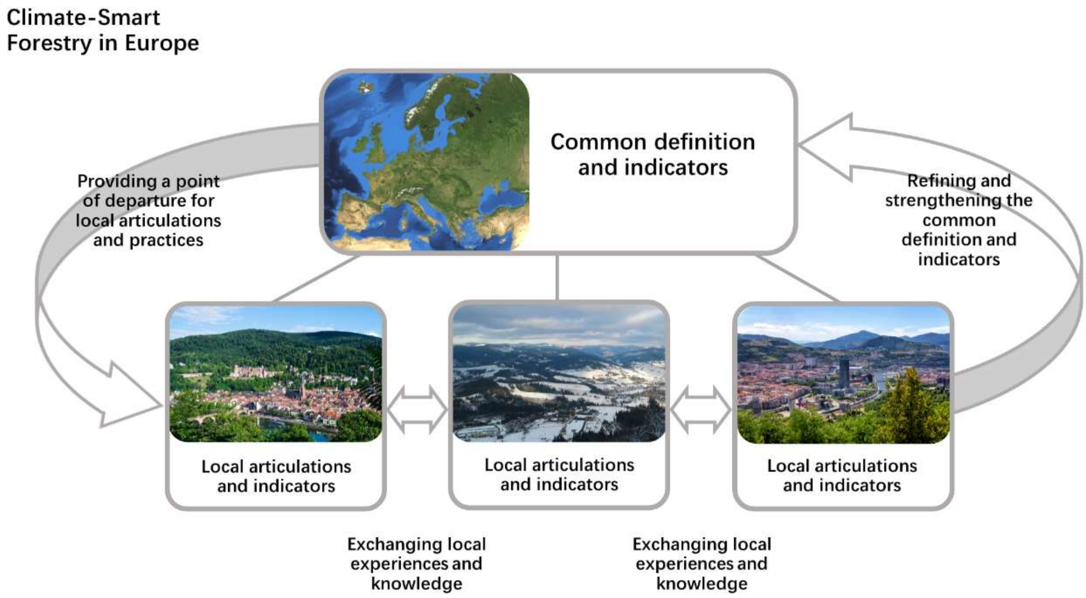

Figure 3. A conceptual figure for how the concept of climate-smart forestry could be used and developed in Europe. The message convened is that a meta-level scientific discussion on common indicators and definitions for climate-smart forestry needs to connect to local articulations and indicators to become applicable in practice and in turn can feed back to the meta-level. Top satellite image from Wikimedia Commons: created by Koyos with NASA WorldWind. Bottom photos from Unsplash (from left to right): by Matteo Krossler, Tetiana Shyshkina, and Yves Alarie.

When bringing climate-smart forestry down to the local level, our results reveal a variety of preferences among the local stakeholders, even though we had quite few participants. Especially when going beyond general principles. For example, while they often agreed on the overarching principles, such as diversifying the use of tree species in forestry, they disagreed about the details, for example, if this diversification should include exotic species or not. Even though the details of this discussion have been condensed in the results section, it very much resembles the scientific discussion on the same topic [51,52]. The same is true for several other issues, meaning that they did not achieve consensus on some of the how's. Here, we also identified a few differences between the northern and southern stakeholders, mainly relating to the different contexts and conditions. For example, some of the northern stakeholders identified the ownership structure to be a problem, while this was not mentioned by those from southern Sweden, relating to the fact that more forests in northern Sweden are owned by the state and forest industries [23]. This heterogeneity of preferences or opinions could be regarded as a problem in terms of policy making and steering, as it lacks clear direction. However, it could also be viewed as an opportunity in terms of forest management. With diverse preferences on how to manage forests, forest management could also be diverse [53].

An important aspect of climate-smart forestry is *climate change adaptation* [12,14,15]. In this regard, the local perspective in northern and southern Sweden differs from the perspective of previous authors. While Bowditch et al. [12] stated that climate change adaptation measures aim to "maintain or improve [forests'] ability to grow under current and projected climatic conditions and increase their resistance and resilience", the perspective of the local stakeholders were, rather, to actively tackle ongoing issues that risk becoming more severe in the future. Instead of *climate change adaptation* per se, this reflects an *adaptive forest management approach* [54]. This is similar to the results of Andersson and Keskitalo [55], and the main difference is if the management decision or issue tackled is perceived to be related to climate change or not. For example, are the outbreaks of spruce bark beetles in southern Sweden perceived to be a consequence of climate change, of forest management or of something else entirely? The actions aiming to limit the outbreaks would only be classified as climate change adaptation if it was perceived to be directly linked to climate change, while it could be regarded as adaptive management regardless of the perceived cause. Hence, the focus on climate change adaptation in the literature, could exclude important forest management considerations. This could perhaps also offer some explanation as to why forest owners in northern Europe do not seem to be adapting their forest management to climate change [21,22]—simply because they do not consider their management actions to be directly or solely related to climate change. When further developing the climate-smart forestry concept, it should be considered if climate change adaptation should be promoted together with or be replaced by adaptive forest management, to better fit local understandings and practices. This is something that local articulations of climate-smart forestry can contribute with to refine and strengthen a common definition of the concept (Figure 3).

Climate change mitigation is another key part of the climate-smart forestry concept. Previous authors have emphasized the need to increase carbon capture and storage, in both forests and products, and to achieve a climate-smart forestry by replacing fossil-based fuels and materials [12–15,49]. However, the stakeholders in our study presented a different perspective. While they agreed with the literature, most of them did not identify a significant potential in *increasing* the carbon sink or the amount of harvested wood in their local forests, in relation to what is already produced. Instead, they identified ways to improve the quality of the materials produced, to increase the longevity of the products, while also emphasizing the need to use resources sustainably, similarly to Jandl et al. [13]. Hence, when the stakeholders were presented with options to increase carbon capture and the supply of renewable materials, such as using exotic species and intensive fertilizing, they were not really interested. Especially as they thought that it would create even more risks, and thereby linking it to adaptation, while they also perceived it to be negative for forests' multiple contributions to people. This is in line with some of the previous research into stakeholder attitudes [56–58]. Looking at the history of Swedish forestry, the current practices have already increased the carbon stocks in forests (using standing wood volumes as a proxy) and forest products substantially over the last 60 years [59,60], with the consequence that other values have been set aside [61]. When climate change reopens the question of how and why we manage forests, the local stakeholders seem to want something different. This reflects the trade-offs between the different aspects of climate-smart forestry, which will be negotiated in relation to the stakeholders' future visions; their past experiences and practices; and climate change. Which is why transtemporal perspectives on forest management [19] are essential also for climate-smart forestry.

How, then, to achieve climate-smart forestry? While the stakeholders appear to have a positive attitude towards the idea of climate-smart forestry, they also emphasized that intent or attitude is not enough to implement it in practice. There are several external factors and conditions that influence the management as well, ranging from taxes and markets to knowledge and environmental conditions, see also [62–64]. While they, in some sense, were optimistic that these might be overcome, they also provided insight into why this haven't been done already, thereby reflecting both an optimism and a realism (or pessimism) when it comes to their implementation. While this realism may seem conservative, it does reflect the on-the-ground realities in which forests are currently being managed. It does not mean that this cannot change, or that the circumstances are the same everywhere. Given this line of argument, the potential for the implementation of climate-smart forestry practices can vary according to time and place. Moreover, it emphasizes the need to understand the barriers and pathways for climate-smart forestry from a wider perspective, as it goes beyond the mere natural scientific aspects of forest management. This is also reflected in the indicators for climate-smart forestry, where our local indicators included even more social aspects of forests than previous indicators [12,14,48]. Which is why also the indicators for climate-smart forestry could be informed by indicators developed locally (Figure 3).

There is also a need for exchange of knowledge and experiences between different places (Figure 3). In our study, we used two study areas to be able to compare local articulations of climate-smart forestry in two different settings. However, when analyzing the results, we found that there were more similarities than differences between the two groups of local stakeholders. One of the reasons for this, apart from the areas being located within the same country, is that they were clearly influenced by the settings and difficulties in the other study area. For example, the stakeholders in southern Sweden were worried about the use of exotic tree species, because they had heard about existing problems with exotic tree species in northern Sweden. The northern group was worried about the large pest outbreaks in southern Sweden, which they wanted to avoid. This reflects the interplay between different local areas, where there is a mutual exchange of knowledge and experiences, that we argue benefits the local articulations, and implementation, of climate-smart forestry in practice [17,65,66]. Hence, supporting and promoting these local exchanges should also be an integral part of developing climate-smart forestry across Europe Figure 3).

In conclusion, our results suggest that there is much to learn by bringing climate-smart forestry down to the local level. It reduces the gap between theory and practice, as the conceptual idea of climate-smart forestry becomes translated into something that is both apprehensible and applicable on the local level. At the same time, the local articulations and understandings of climate-smart forestry helps improve the concept and its indicators, while highlighting the potential barriers and pathways for its implementation in practice. This could also inform and be informed by similar articulations in other places, trough the exchange of local experiences and knowledge. Thus, based on our results and the following discussion, we believe that the concept of climate-smart forestry can be further developed through the interplay between theory and practice; and an exchange of knowledge and experiences between people in different places and contexts.

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References

1. IPCC. *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*; IPCC: Geneva, Switzerland, 2019.
2. Seidl, R.; Thom, D.; Kautz, M.; Martin-Benito, D.; Peltoniemi, M.; Vacchiano, G.; Wild, J.; Ascoli, D.; Petr, M.; Honkaniemi, J. Forest disturbances under climate change. *Nat. Clim. Chang.* **2017**, *7*, 395–402. [CrossRef]
3. Reyer, C.P.; Bathgate, S.; Blennow, K.; Borges, J.G.; Bugmann, H.; Delzon, S.; Faias, S.P.; Garcia-Gonzalo, J.; Gardiner, B.; Gonzalez-Olabarria, J.R. Are forest disturbances amplifying or canceling out climate change-induced productivity changes in European forests? *Environ. Res. Lett.* **2017**, *12*, 034027. [CrossRef]

4. Bolte, A.; Ammer, C.; Löf, M.; Madsen, P.; Nabuurs, G.-J.; Schall, P.; Spathelf, P.; Rock, J. Adaptive forest management in central Europe: Climate change impacts, strategies and integrative concept. *Scand. J. For. Res.* **2009**, *24*, 473–482. [CrossRef]
5. Keenan, R.J. Climate change impacts and adaptation in forest management: A review. *Ann. For. Sci.* **2015**, *72*, 145–167. [CrossRef]
6. Keskitalo, E.C.H.; Bergh, J.; Felton, A.; Björkman, C.; Berlin, M.; Axelsson, P.; Ring, E.; Ågren, A.; Roberge, J.-M.; Klapwijk, M.J. Adaptation to climate change in Swedish forestry. *Forests* **2016**, *7*, 28. [CrossRef]
7. Lindner, M.; Fitzgerald, J.B.; Zimmermann, N.E.; Reyer, C.; Delzon, S.; van der Maaten, E.; Schelhaas, M.-J.; Lasch, P.; Eggers, J.; van der Maaten-Theunissen, M. Climate change and European forests: What do we know, what are the uncertainties, and what are the implications for forest management? *J. Environ. Manag.* **2014**, *146*, 69–83. [CrossRef]
8. Vilà-Cabrera, A.; Coll, L.; Martínez-Vilalta, J.; Retana, J. Forest management for adaptation to climate change in the Mediterranean basin: A synthesis of evidence. *For. Ecol. Manag.* **2018**, *407*, 16–22. [CrossRef]
9. Hagerman, S.M.; Pelai, R. Responding to climate change in forest management: Two decades of recommendations. *Front. Ecol. Environ.* **2018**, *16*, 579–587. [CrossRef]
10. Kongsager, R. Linking climate change adaptation and mitigation: A review with evidence from the land-use sectors. *Land* **2018**, *7*, 158. [CrossRef]
11. Locatelli, B.; Evans, V.; Wardell, A.; Andrade, A.; Vignola, R. Forests and climate change in Latin America: Linking adaptation and mitigation. *Forests* **2011**, *2*, 431–450. [CrossRef]
12. Bowditch, E.; Santopuoli, G.; Binder, F.; del Río, M.; La Porta, N.; Kluvankova, T.; Lesinski, J.; Motta, R.; Pach, M.; Panzacchi, P. What is Climate-Smart Forestry? A definition from a multinational collaborative process focused on mountain regions of Europe. *Ecosyst. Serv.* **2020**, *43*, 101113. [CrossRef]
13. Jandl, R.; Ledermann, T.; Kindermann, G.; Freudenschuss, A.; Gschwantner, T.; Weiss, P. Strategies for climate-smart forest management in Austria. *Forests* **2018**, *9*, 592. [CrossRef]
14. Santopuoli, G.; Temperli, C.; Alberdi, I.; Barbeito, I.; Bosela, M.; Bottero, A.; Klopčič, M.; Lesinski, J.; Panzacchi, P.; Tognetti, R. Pan-European sustainable forest management indicators for assessing Climate-Smart Forestry in Europe. *Can. J. For. Res.* **2021**, *51*, 1–10. [CrossRef]
15. Verkerk, P.; Costanza, R.; Hetemäki, L.; Kubiszewski, I.; Leskinen, P.; Nabuurs, G.; Potočnik, J.; Palahí, M. Climate-Smart Forestry: The missing link. *For. Policy Econ.* **2020**, *115*, 102164. [CrossRef]
16. Klein, R.J.; Juhola, S. A framework for Nordic actor-oriented climate adaptation research. *Environ. Sci. Policy* **2014**, *40*, 101–115. [CrossRef]
17. Lawrence, A. Adapting through practice: Silviculture, innovation and forest governance for the age of extreme uncertainty. *For. Policy Econ.* **2017**, *79*, 50–60. [CrossRef]
18. Ogden, A.E.; Innes, J.L. Application of structured decision making to an assessment of climate change vulnerabilities and adaptation options for sustainable forest management. *Ecol. Soc.* **2009**, *14*, 11. [CrossRef]
19. Mårald, E.; Sandström, C.; Nordin, A. *Forest Governance and Management Across Time: Developing a New Forest Social Contract*; Routledge: New York, NY, USA, 2017.
20. McDermott, C.; Cashore, B.W.; Kanowski, P. *Global Environmental Forest Policies: An International Comparison*; Earthscan: London, UK, 2010.
21. Blennow, K.; Persson, J.; Gonçalves, L.M.S.; Borys, A.; Dutcă, I.; Hynynen, J.; Janeczko, E.; Lyubenova, M.; Merganič, J.; Merganičová, K. The role of beliefs, expectations and values in decision-making favoring climate change adaptation—Implications for communications with European forest professionals. *Environ. Res. Lett.* **2020**, *15*, 114061. [CrossRef]
22. Blennow, K.; Persson, J.; Tome, M.; Hanewinkel, M. Climate change: Believing and seeing implies adapting. *PLoS ONE* **2012**, *7*, e50182. [CrossRef]
23. Swedish University of Agricultural Sciences. *Forest Statistics 2019*; Swedish University of Agricultural Sciences: Umeå, Sweden, 2019.
24. Swedish Meteorological and Hydrological Institute. Normal Mean Annual Temperature. Available online: https://www.smhi.se/data/meteorologi/temperatur/normal-arsmedeltemperatur-1.3973 (accessed on 12 August 2021).
25. Priebe, J.; Reimerson, E.; Hallberg-Sramek, I.; Sténs, A.; Sandström, C.; Mårald, E. Transformative Change in Context—Stakeholders' Understandings of Leverage at the Forest-Climate Nexus. *Sustain. Sci. Forthcom* **2022**. Accepted for Publication.
26. Reimerson, E.; Priebe, J.; de Boon, A.; Hallberg-Sramek, I.; Sandstrom, C. *Local Articulations of Climate Change Action in Sweden (Preliminary Title)*; Department of Political Science, Umeå University: Umeå, Sweden, 2022; to be submitted.
27. Mårald, E. Bring down the Sky to the Earth: How to Use Forests to Open up for Constructive Climate Change Pathways in Local Contexts. Available online: https://www.umu.se/en/research/projects/bring-down-the-sky-to-the-earth/ (accessed on 20 August 2021).
28. Statistics Sweden. Markanvändningen i Sverige Efter Kommun Och Markanvändningsklass. Vart 5:e år 2010–2015. Available online: http://www.statistikdatabasen.scb.se/sq/118313 (accessed on 7 December 2021).
29. Pfeffer, S. Impacts of Multi-Species Deer Communities on Boreal Forests across Ecological and Management Scales. Doctoral Thesis, Swedish University of Agricultural Sciences, Umeå, Sweden, 2021.
30. Felton, A.; Petersson, L.; Nilsson, O.; Witzell, J.; Cleary, M.; Felton, A.M.; Björkman, C.; Sang, Å.O.; Jonsell, M.; Holmström, E. The tree species matters: Biodiversity and ecosystem service implications of replacing Scots pine production stands with Norway spruce. *Ambio* **2020**, *49*, 1035–1049. [CrossRef]

31. Ara, M.; Barbeito, I.; Kalén, C.; Nilsson, U. Regeneration failure of Scots pine changes the species composition of young forests. *Scand. J. For. Res.* **2021**, 1–9. [CrossRef]
32. The Swedish Forest Agency (SFA). The Statistical Database. 2020. Available online: http://pxweb.skogsstyrelsen.se/pxweb/sv/Skogsstyrelsens%20statistikdatabas/?rxid=03eb67a3-87d7-486d-acce-92fc8082735d (accessed on 10 January 2022).
33. Statistics Sweden. Formellt Skyddad Skogsmark, Frivilliga Avsättningar, Hänsynsytor Samt Improduktiv Skogsmark. År 2018–2020. Available online: http://www.statistikdatabasen.scb.se/sq/118317 (accessed on 7 December 2021).
34. Fredman, P.; Romild, U.; Yuan, M.; Wolf-Watz, D. Latent demand and time contextual constraints to outdoor recreation in Sweden. *Forests* **2012**, *3*, 1–21. [CrossRef]
35. Hörnsten, L. Outdoor Recreation in Swedish Forests—Implications for Society and Forestry. Doctoral Thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden, 2000.
36. Sténs, A.; Sandström, C. Divergent interests and ideas around property rights: The case of berry harvesting in Sweden. *For. Policy Econ.* **2013**, *33*, 56–62. [CrossRef]
37. Lindqvist, S.; Camilla, S.; Bjärstig, T.; Kvastegård, E. The changing role of hunting in Sweden: From subsistence to ecosystem stewardship? *Alces* **2014**, *50*, 35–51.
38. Lundmark, L.; Müller, D.K. The supply of nature-based tourism activities in Sweden. *Tour. Int. Interdiscip. J.* **2010**, *58*, 379–393.
39. Reed, M.S. Stakeholder participation for environmental management: A literature review. *Biol. Conserv.* **2008**, *141*, 2417–2431. [CrossRef]
40. Laakkonen, A.; Zimmerer, R.; Kähkönen, T.; Hujala, T.; Takala, T.; Tikkanen, J. Forest owners' attitudes toward pro-climate and climate-responsive forest management. *For. Policy Econ.* **2018**, *87*, 1–10. [CrossRef]
41. Nyumba, T.; Wilson, K.; Derrick, C.; Mukherjee, N. The use of focus group discussion methodology: Insights from two decades of application in conservation. *Methods Ecol. Evol.* **2018**, *9*, 20–32. [CrossRef]
42. Bryman, A. *Social Research Methods*; Oxford University Press: Oxford, UK, 2016.
43. Swedish University of Agricultural Sciences. Experimental Forests and Research Stations. Available online: https://www.slu.se/en/departments/field-based-forest-research/experimental-forests/ (accessed on 2 March 2021).
44. Boström, M.; Lidskog, R.; Uggla, Y. A reflexive look at reflexivity in environmental sociology. *Environ. Sociol.* **2017**, *3*, 6–16. [CrossRef]
45. Pickering, J. Ecological reflexivity: Characterising an elusive virtue for governance in the Anthropocene. *Environ. Politics* **2019**, *28*, 1145–1166. [CrossRef]
46. Fejes, A.; Thornberg, R. *Handbok i Kvalitativ Analys*, 3rd ed.; Liber: Stockholm, Sweden, 2019.
47. Hjerm, M.; Lindgren, S.; Nilsson, M. *Introduktion Till Samhällsvetenskaplig Analys*; Gleerups Utbildning AB: Malmö, Sweden, 2014.
48. Forest Europe. SFM Criteria & Indicators. Available online: https://foresteurope.org/sfm-criteria-indicators/ (accessed on 14 June 2021).
49. Nabuurs, G.-J.; Delacote, P.; Ellison, D.; Hanewinkel, M.; Hetemäki, L.; Lindner, M. By 2050 the mitigation effects of EU forests could nearly double through climate smart forestry. *Forests* **2017**, *8*, 484. [CrossRef]
50. Yousefpour, R.; Augustynczik, A.L.D.; Reyer, C.P.; Lasch-Born, P.; Suckow, F.; Hanewinkel, M. Realizing mitigation efficiency of European commercial forests by climate smart forestry. *Sci. Rep.* **2018**, *8*, 1–11. [CrossRef]
51. Aubin, I.; Garbe, C.; Colombo, S.; Drever, C.; McKenney, D.; Messier, C.; Pedlar, J.; Saner, M.; Venier, L.; Wellstead, A. Why we disagree about assisted migration: Ethical implications of a key debate regarding the future of Canada's forests. *For. Chron.* **2011**, *87*, 755–765. [CrossRef]
52. Hewitt, N.; Klenk, N.; Smith, A.L.; Bazely, D.R.; Yan, N.; Wood, S.; MacLellan, J.I.; Lipsig-Mumme, C.; Henriques, I. Taking stock of the assisted migration debate. *Biol. Conserv.* **2011**, *144*, 2560–2572. [CrossRef]
53. Nordlund, A.; Westin, K. Forest values and forest management attitudes among private forest owners in Sweden. *Forests* **2011**, *2*, 30–50. [CrossRef]
54. Innes, J.; Joyce, L.A.; Kellomäki, S.; Louman, B.; Ogden, A.; Parrotta, J.; Thompson, I.; Ayres, M.; Ong, C.; Santoso, H.; et al. Management for adaptation. In *Adaptation of Forests and People to Climate Change: A Global Assessment Report*; Seppälä, R., Buck, A., Katila, P., Eds.; IUFRO: Helsinki, Finland, 2009; pp. 135–186.
55. Andersson, E.; Keskitalo, E.C.H. Adaptation to climate change? Why business-as-usual remains the logical choice in Swedish forestry. *Glob. Environ. Chang.* **2018**, *48*, 76–85. [CrossRef]
56. Hemström, K.; Mahapatra, K.; Gustavsson, L. Public perceptions and acceptance of intensive forestry in Sweden. *Ambio* **2014**, *43*, 196–206. [CrossRef] [PubMed]
57. Lindkvist, A.; Mineur, E.; Nordlund, A.; Nordlund, C.; Olsson, O.; Sandström, C.; Westin, K.; Keskitalo, E. Attitudes on intensive forestry. An investigation into perceptions of increased production requirements in Swedish forestry. *Scand. J. For. Res.* **2012**, *27*, 438–448. [CrossRef]
58. St-Laurent, G.P.; Hagerman, S.; Kozak, R. What risks matter? Public views about assisted migration and other climate-adaptive reforestation strategies. *Clim. Chang.* **2018**, *151*, 573–587. [CrossRef]
59. Iordan, C.-M.; Hu, X.; Arvesen, A.; Kauppi, P.; Cherubini, F. Contribution of forest wood products to negative emissions: Historical comparative analysis from 1960 to 2015 in Norway, Sweden and Finland. *Carbon Balance Manag.* **2018**, *13*, 1–16. [CrossRef] [PubMed]

60. Swedish University of Agricultural Sciences. *Figure 1.7-Total Standing Volume by Year (Five Year Average), Table Contents and Protected Areas*; Swedish University of Agricultural Sciences: Umea, Sweden, 2021.
61. Beland Lindahl, K.; Sténs, A.; Sandström, C.; Johansson, J.; Lidskog, R.; Ranius, T.; Roberge, J.-M. The Swedish forestry model: More of everything? *For. Policy Econ.* **2017**, *77*, 44–55. [CrossRef]
62. Lidskog, R.; Sjödin, D. Why do forest owners fail to heed warnings? Conflicting risk evaluations made by the Swedish forest agency and forest owners. *Scand. J. For. Res.* **2014**, *29*, 275–282. [CrossRef]
63. Lidskog, R.; Sjödin, D. Risk governance through professional expertise. Forestry consultants' handling of uncertainties after a storm disaster. *J. Risk Res.* **2016**, *19*, 1275–1290. [CrossRef]
64. Lodin, I.; Brukas, V.; Wallin, I. Spruce or not? Contextual and attitudinal drivers behind the choice of tree species in southern Sweden. *For. Policy Econ.* **2017**, *83*, 191–198. [CrossRef]
65. Hamunen, K.; Virkkula, O.; Hujala, T.; Hiedanpää, J.; Kurttila, M. Enhancing informal interaction and knowledge co-construction among forest owners. *Silva Fenn.* **2015**, *49*, 1214. [CrossRef]
66. Kueper, A.M.; Sagor, E.S.; Becker, D.R. Learning from landowners: Examining the role of peer exchange in private landowner outreach through landowner networks. *Soc. Nat. Resour.* **2013**, *26*, 912–930. [CrossRef]