Futures & Foresight Science

WILEY

ORIGINAL ARTICLE OPEN ACCESS

Avoiding Nightmare Forests: Insights From a Co-Creative Workshop

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Received: 12 September 2024 | **Revised:** 4 April 2025 | **Accepted:** 16 April 2025

Funding: The authors received no specific funding for this work.

Keywords: backcasting | bioeconomy | futures and foresight | interdisciplinary co-creation | Nordic forests and sustainability | risk-mitigation

ABSTRACT

Since the 1987 UN report "Our Common Future", aimed at bridging divides among various stakeholders by advocating for "sustainable development", renewed demands for environmentally adjusted measures have emerged, calling for a future that consolidates socially just, ecologically sound, and economically viable outcomes through sustainable forest management. For Nordic forests, this means policy measures focused on enhancing the forest-based bioeconomy, transitioning to a fossil-free society, adapting to climate change and combatting rapid biodiversity loss while securing continuous timber supply and valuable livelihoods. With expectations for Nordic forests to meet these demands, an impending challenge is how to bring about a desirable future while minimizing uncertainties. Given this urgency, we present a backcasting method applied to a co-creative workshop among research scholars to examine prospective scenarios for Nordic forests, ranging from nightmarish futures to risk-mitigation strategies. The workshop builds on an interdisciplinary research project to provide policy support for sustainable governance. We found that despite fears expressed about an adverse intensive forestry scenario, most participants identified multifunctionality and delivering multiple ecosystem services as critical to the future sustainability of Nordic forests. In addition, participants highlighted the coming need to incorporate hybrid forest management approaches for high-value biodiversity and to consider precautionary measures in forestry decisions. We conclude that approaching the future through a backcasting workshop promises to bring together a broad range of participants to create a common vision.

1 | Introduction

Forests are valuable, biodiversity-rich ecosystems with a considerable ability to absorb carbon. They provide manifold ecosystem services like habitats for many common and endangered species, both fauna and flora, and are a great source of recreational value (Lindgaard et al. 2022; Lier et al. 2020). However, forests are increasingly threatened by various factors, the greatest being global warming and habitat loss caused by intensive land use practices (Bastrup-Birk et al. 2016; Järvinen 2024). Forests are also impacted by interconnected environmental challenges that transcend geographical borders,

from climate change to biodiversity loss, manifested in disrupted ecosystems (Ayodeji Abatan et al. 2024; Hite and Seitz 2021; Muys et al. 2022). Society and forest managers are thus confronted with complex environmental issues that demand future-oriented measures for sustainability planning (Meena 2024; Prins et al. 2023). Over the last three decades, conservation, sustainable development, and the prospective growth of forests have been increasingly prioritized in international and European forest policy-related agendas. For instance, the United Nations' "Our Common Future" report (Brundtland Report), published in 1987, defined "sustainable development" as meeting the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development 1987).

It particularly laid the groundwork for convening the 1992 Earth Summit and the adoption of Agenda 21, the Rio Declaration on Environment and Development, and the Statement of Principles for the Sustainable Management of Forests adopted by more than 178 governments at the United Nations Conference on Environment and Development (UNCED) in 1992 (United Nations 1992). The 2030 Agenda for Sustainable Development, adopted in 2015 by United Nations members, focuses on 17 globally relevant Sustainable Development Goals (SDGs) aiming among other things to tackle climate change and preserve the forests. SDG 7 (Affordable and Clean Energy), SDG 13 (Climate Action) and SDG 15 (Life on Land) particularly are expected to benefit forests in a multitude of ways (Katila et al. 2019). However, realizing these expectations depends heavily on the regional context, including the country's national development status and forest conditions. It is therefore important to understand the legalities countries are adopting in managing their forests more sustainably, upcoming demands, regional challenges and threats and their implications.

1.1 | Study Objectives

This paper addresses this need through the lens of Nordic forests to foresee the future sustainability based on a co-creative workshop of scientists from various institutions interested in forest-related issues, organized at the "5th International Forest Policy Meeting—A Political Forest" (IFPM5), 10-12 April 2024, hosted by the University of Helsinki. We applied a backcasting approach inspired by the framework of John Robinson (Robinson 2003)—which involves developing normative scenarios to explore the feasibility and implications of attaining desired endpoints. Using a co-creative social learning process through interactive group discussions, we explored two objectives: (a) imagining nightmarish futures, that is, undesirable scenarios (for humanity and forest biodiversity) in Nordic forests; (b) developing a risk-mitigation strategy that includes measures and tools to counteract these undesirable future scenarios. The alternative futures being explored are then put into the context of the current common policy direction toward a sustainable forest-based bioeconomy. Earlier studies on the path dependency of a transition (Luhas et al. 2021) have highlighted the need to create cross-sectoral cooperation, generate new knowledge, and illustrate heterogenous pathways to meet future uncertainties (Purkus et al. 2017; Vallejos et al. 2025). The workshop method used in this study contributes to insights on how these aims could be met. The scenario framework will be further explored in Section 2.2. However, in the following section, we'll clarify what we mean by Nordic forests, and why we see it as an illuminating case for exploring alternative futures.

1.2 | The Case of Nordic Forests

The efforts of Nordic countries to meet international commitments to the sustainable forest management involve a mix of national forest policies, EU forest policies and international regulations that incorporate multiple strategies for forest management and restoration (Nebasifu et al. 2024). Forests are particularly crucial in producing and preserving social, economic, and environmental values (Köhl et al. 2020). Nordic forests are also renowned for their cultural importance to indigenous Sámi communities through traditional forest use, such as reindeer herding and handicrafts (Fridén et al. 2024). With the challenges of climate change and biodiversity loss (Määttänen et al. 2023; Virkkala et al. 2023), the governance of Nordic forests is increasingly shaped by EU legislation and hopes that forests will meet multiple societal needs while upholding the benefits of sustainability and principles of shared responsibility between EU institutions and member states (Winkel et al. 2022).

For instance, the New EU Forest Strategy for 2030, a flagship element of the European Green Deal and the EU Biodiversity Strategy for 2030, aims to improve the quantity and quality of EU forests, reversing negative trends, and strengthening their resilience against uncertainties brought by climate change (Pecurul-Botines et al. 2023). The LULUCF (Land Use, Land-Use Change and Forestry) regulation sets an EU-level net removal target of 310Mt CO_2e by 2030 by requiring EU Member States to decrease greenhouse gas emissions and increase removals in the LULUCF sector (Nainggolan et al. 2021; Nabuurs et al. 2018). Complementing these policy targets, the Nordic Council of Ministers through Nordic Co-operation have established Vision 2030, stating an agenda for the Nordic Region as the most sustainable and integrated region in the world by 2030 under three strategic priorities including a competitive Nordic Region, a green Nordic Region, and a socially sustainable Nordic Region (Nordic Cooperation 2025).

This trend necessitates capturing new insights into how today's decisions may shape the future sustainability of Nordic forests. Understanding the uncertainties (and fears) facing this future is crucial for forest planning and improving decision-making processes (de Pellegrin Llorente et al. 2023). Nordic forests can be defined as those forests embedded in the Nordic region and its countries, which includes the forests in Finland, Sweden, Denmark, Norway, Iceland, the Faroe Islands, Greenland, and Åland (Nordic Cooperation 2024). Nordic forests differ in their ecosystem characteristics; for instance, the ecological zones range from Temperate Oceanic in Denmark, Temperate continental and Boreal coniferous in Sweden and Finland, to Boreal mountainous in Norway (Fridén et al. 2024). However, the Nordic countries share common trends in their forest policy development, characterized by an increasing demand for

"multifunctionality"—an increasingly important element of the sustainable use and management of forests in the Nordic countries (Fridén et al. 2024). Multifunctionality is a rather complex concept to define, quantify, or realise, but some scholars refer to associating sustainable forest management with supplying timber while providing additional ecosystem services as non-timber forest products and secondary objectives (Caicoya et al. 2023). Within the Nordic region, the provision of multifunctional forests based on multi-use (e.g., active forest management and nature conservation, simultaneously generating wood and nonwood forest products and services, along with potential value creation), multi-strategy (climate change mitigation, sustainable wood production, and ecological restoration), and multi-species (mixed forests with rich tree diversity) in the face of transitioning to the forest-based bioeconomy is increasingly essential to improve the quality and resilience of forests in view of future and unknown demands for products and services (Högbom et al. 2023; Lindgaard et al. 2022).

On a national level, we also find distinct elements of decisions favoring sustainable forest management in their development of forest-related policy over the last three decades (Linser and Wolfslehner 2022; Nebasifu et al. 2024). Sustainable forest management in Nordic forests is conceptualized as a multifunctional model balancing increased biomass production with conservation goals, maintaining forest renewal, preventing forest loss, while maintaining the services it provides (Högbom et al. 2021; Lindahl et al. 2017). In Finland, an important development was the Finnish Bioeconomy Strategy 2022–2035, which highlights Finland's visions and aspirations to be a forerunner in the global forest-based bioeconomy leading towards a sustainable society. Amid these developments, studies also show that forest policy has historically been strongly oriented towards increasing timber supply for the forest industry; for instance, through forestry subsidies that predominantly support increasing timber production (Viitala et al. 2022; Siiskonen 2013). In Denmark, the Danish National Forest Programme adopted in 2002 targeted the sustainable management of Danish forests through balancing between economic, social, and environmental goals. Sweden, following the Swedish Environmental Objectives 2000, emphasized maintaining high timber production standards while achieving environmental goals (Nebasifu et al. 2025). While these developments show growing recognition of the role of forests in providing valuable ecosystem services, pressure has increased for forest stakeholders to balance their production ambitions while delivering a diverse array of ecosystem services (Fridén et al. 2024).

To explore valuable insights into the future sustainability of Nordic forests, we need to understand potential challenges, threats and needs conveyed in scholarly contributions on Nordic forests in the future. For instance, energy transition and climate mitigation are thus said to probably become more prominent (Lindahl and Westholm 2011; Wahlberg 2024). However, this faces the looming challenge of how to frame sustainability pathways reflected in forest-related strategies to minimize impending forest conflicts (Westholm 2015). While others call for forest restoration, biodiversity conservation and enhancement, green transformations and diversification of ecosystem services for future value creation (Häyrinen et al. 2016; Luhas et al. 2021; Muys et al. 2022; Nebasifu et al. 2024), we should emphasize the value of knowledge co-production in developing and evaluating coming forest scenarios (Hallberg-Sramek et al. 2023). We intend to address this need by foreseeing future scenarios, seeking to understand what they could tell us about strategies to effectively accommodate multiple stakeholder interests in the sustainable management and use of Nordic forests.

2 | Materials and Methods

The futures workshop is a method often used within futures and foresight science designed to enable a group to jointly approach a complex problem (Jungk and Müllert. 1987; Eickhoff and Geffer 2009). Futures are explored in the plural, to underline the many possible scenarios (Sardar 2010; Bengston 2017). Since there is no experience with these futures, knowledge of them is based on cognition and expectations (Gabriel 2014; Heino 2021). Instead of predicting the future, it is a powerful tool for wiser decisions and actions today, which in turn determine how the future will turn out (Glenn 1994; Bell 2009). This means that a futures workshop can be used as a practical tool to explore both uncertainty and perceptions from various stakeholders (Heino 2021). Methods of approaching uncertainties are an urgent necessity in forest governance. Futures workshops aim at both gathering existing knowledge and creating new knowledge which grows from the interaction between participants (Dufva and Ahlqvist 2015). Regardless of the types of workshop, for example, foresight, scenario, or backcasting workshops, the group discussion and interaction is key (Dufva and Ahlqvist 2015; Nygrén 2019; Borch et al. 2013). Approaches from futures studies in relation to forest management have for example, been used to guide public participation in Sustainable Forest Management in Ireland (Bonsu et al. 2017), facilitate the adaptiveness of forest managers through scenario analysis (Wollenberg et al. 2000), understand the learning processes of policy actors in relation to forest futures processes in Germany (Sotirov et al. 2017), and explore policy goals with stakeholders in Sweden through backcasting (Sandström et al. 2020). A recent review of qualitative foresight research in the forest sector reveals backcasting as a popular method, with a focus on achieving desirable futures (Heiskanen et al. 2022). Avoiding undesirable futures, although suggested to be a relevant application for backcasting (Quist and Vergragt 2006; Robinson 1990), is conspicuously absent.

Backcasting stems from the view that, in complex human systems, our ability to predict the likelihood of alternative outcomes over periods extending decades into the future can be compromised by several factors, such as the absence of knowledge about the dynamics of systems conditions, the deliberate nature of human decision-making, and prospects for innovation and surprise (Robinson 2003, 841). Backcasting is a method of first determining either a vision or dystopia. Even if it is typically used to create preferable futures pathways or scenarios, the method can also be used to analyze futures to be avoided (Vergragt and Quist 2011), as in this study. Attention to desirable futures rather than undesirable ones may stem from an urge to seek solutions to contemporary sustainability issues. However, theorizing about how to avoid undesirable "nightmare" futures is more likely to engage thinking in alternative

ways than does a focus on desirable ones. This necessitates developing alternative scenarios that are self-consistent but often with incommensurate outcomes in addressing complex societal problems like sustainability. Within this scope of predictability, considering that the most likely future may not be the most desirable, it is important to explore the desirability and feasibility of alternative futures. Exploring alternative scenarios enables decisive actions and knowledge to address an uncertain future (Robinson 2003, 842). Thus, our intention is to theorize about possible undesirable futures and strategies that could help avoid them as a "policy choice". Accordingly, the normative nature of backcasting implies that we consider the choice of futures to study and how to evaluate the resulting scenarios. Whose desires are to be expressed in the backcasting scenario (Robinson 2003, 844)? It is therefore vital to give some thought to how alternative preferences and values are incorporated into the backcasting process.

2.1 | Data Collection

During the year 2023, an initial call for papers and panels was opened for the IFPM5 conference highlighting six thematic areas of interest for submissions: Forestry and forest policy in the EU and the challenge of policy integration; Knowledge, data, and evidence in a political forest; Deforestation, trade & investment, and the governance of supply chains over time; (Forest) land use, forest owners, and land conflicts; Inequality, intersectionality & gender in forest policy and practice; and an Open category:

Choosing from the "Open category: Forest People, Policy, Instruments, Impacts", our project team proposed an interactive session (co-creative workshop) submitted as an abstract to the IFPM5 conference organizers in September 2023, which was accepted in mid-December 2023. The content of the abstract was developed in line with the research project objectives to support decisions for sustainable Nordic forest management and use. In collaboration with the IFPM5 organizers, we initiated a call for participants in March 2024 through the conference emailing list. An email was then sent to notify persons who responded to the call, indicating the purpose, schedule, and location of the workshop in Helsinki, Finland. Overall, from 16 participants that signed up for the workshop, 10 individuals from different institutions and disciplines finally participated, with a male-to-female ratio of 6:4. The workshop was arranged as part of a series of other co-creative events planned within our project between 2022 and 2025, all aimed at co-producing and exchanging knowledge to support decisions for the sustainable use and management of Nordic forest. Thus, it was equally relevant to pursue the workshop with the lesser participant number which then adds to the overall series of events arranged within our project. Thinking qualitatively, the workshop participants hold a range of diverse and rich backgrounds, including forest management and sustainability science disciplines that testify to their sufficiency in context specific problem resolution capability, which was considered valuable in addressing the themes and tasks designed within the workshop programme.

2.1.1 | Developing a Workshop Programme

In interdisciplinary workshops, the use of programmes for directing dialogue, divergent and convergent conversations, as well as outcome-based decisions often form an important part of strategizing for change (Greenly and Carnall 2001). Weeks before the workshop, members of the project team organized two online meetings of 1–2 h each to design the workshop's programme in conformity with the specified timeframe (90 min) arranged for parallel sessions at the IFPM5 Conference. This process included applying a critical appraisal of the target theme to situate the backcasting in the context of Nordic forests by brainstorming on current structural problems affecting the sustainable use and management of Nordic forests, discussing the main problems, establishing exemplary points on challenges impacting Nordic forests, and reflecting on the most important points to consider towards developing the workshop programme.

According to Troxler and Kuhnt (2007), critical appraisal helps participants to vent their criticisms on the topic being targeted and feeding them into circumstances of change. Through the online meetings, we were able to reflect on the pressing issues impacting today's Nordic forests which then inspired the organization of activities and relevant points for planning the workshop. The task and questions for the workshop were further refined based on feedback from seven project members during the meetings. This also enabled us to connect the objectives of our project with the "open category" theme and rethink aspects related to forest and people, policy instruments, and impacts in the case of Nordic forests more broadly. Table 1 shows the programme developed for the workshop.

2.1.2 | Assigning a Pre-Task

A day before the workshop, participants were contacted via email with the pre-task of imagining one to three keywords that reflect their thoughts about the future sustainability of Nordic forests, and to bring along their smart phones with the aim of gathering their responses during the workshop session using a QR scan for the mentimeter tool—interactive presentation software that allows real time user engagement.

Three of the authors and members of the initiating project team moderated and facilitated the workshop itself. We familiarized participants with the workshop's content by introducing them to backcasting as an approach to sustainability challenges. Participants were then allowed to randomly place themselves into two groups, A and B (Table 2).

After introducing the workshop's aim, activities, and a QR code we designed for the mentimeter, we began focusing on the participants' understanding of sustainable forest management while gathering the keywords they proposed linked to the workshop's pre-task. Using keywords can help enhance interaction among participants with different expertise while allowing them to easily grasp topical issues through the mentimeter within a limited timeframe. First, all participants were asked to individually suggest one to three keywords each related to "the future sustainability of Nordic forests" and to enter their keywords on their phones by scanning the QR code connecting

TABLE 1 | Workshop programme.

Activity	Description
Backcasting, sustainability, and the policy choice	Introduction to backcasting ▪ Presentation: solving sustainability problems through backcasting ▪ Mentimeter task conducted
Group tasks	Co-creating undesirable futures (20 min) ▪ In your group, imagine the most undesirable scenarios in the future of Nordic forests. ▪ Discuss in your group some examples of the undesirable future. Risk-mitigating strategy (30 min) ▪ Imagine what you would do against an undesirable future. ▪ Discuss in your group the measures you would consider to counter undesirable future scenarios. ▪ What kinds of risks or uncertainties do you anticipate and foresee? ▪ What kinds of measures would you consider as mitigating the risks? Cross-group comparisons (20 min) ▪ Comparing undesirable futures and counter measures across the groups ▪ Identifying emerging data
Conclusion	Concluding remarks (10 min)

TABLE 2 | Attributes of participants by country and work disciplines.

Study group	Participant by numbering	Country	Work discipline
A	1	Finland	Forest and environmental economics
	2	Austria	Forest, environmental and natural resource policy
	3	Germany	Forest and climate policy
	4	Finland	Environment, climate, and energy issues
	5	Sweden	Forest management
B	6	Finland	Sustainable use of renewable natural resources
	7	Poland	Environmental sociology and politics
	8	Finland	Forest ecology
	9	Finland	Environmental and natural resource economics
	10	Sweden	Sustainability transitions and forest resource governance

them to the mentimeter. The responses were then randomly recorded on a single mentimeter platform displayed using a projector screen. Overall, we gathered 25 keywords including sustainable bioeconomy, biodiversity protection, well-being, equity, multi-use, market, versatile, timber supply, adaptation, climate change, resilience, name, multifunctionality, biodiversity, close-to-nature forestry, my, value, beautiful, fair transition, pests, justice, synergies and trade-offs, tree species adaptation, climate resilience and old growth forests.

To make use of backcasting in the co-creative workshop, we adopted three group tasks (Figure 1) from Table 1, within which each group was asked:

a. To choose one to three keywords from the "25 keywords" list based on their perceived importance to planning the future sustainability of Nordic forests.

b. To use the chosen keywords in answering the questions listed under tasks 1–3.

c. We also investigated whether there were any keywords similarly chosen by both group A and B. This enabled us to identify similarities between the groups. Both groups listed the terms multifunctionality and forest ecosystem services (see phase 3 in Table 3).

The questions for each group task (Table 1) included:

Task 1. Co-creating nightmarish (undesirable) futures:

- In your group, imagine the most undesirable scenarios (for humanity and biodiversity) in the future of Nordic forests.
- Discuss some examples of this undesirable future in your group.

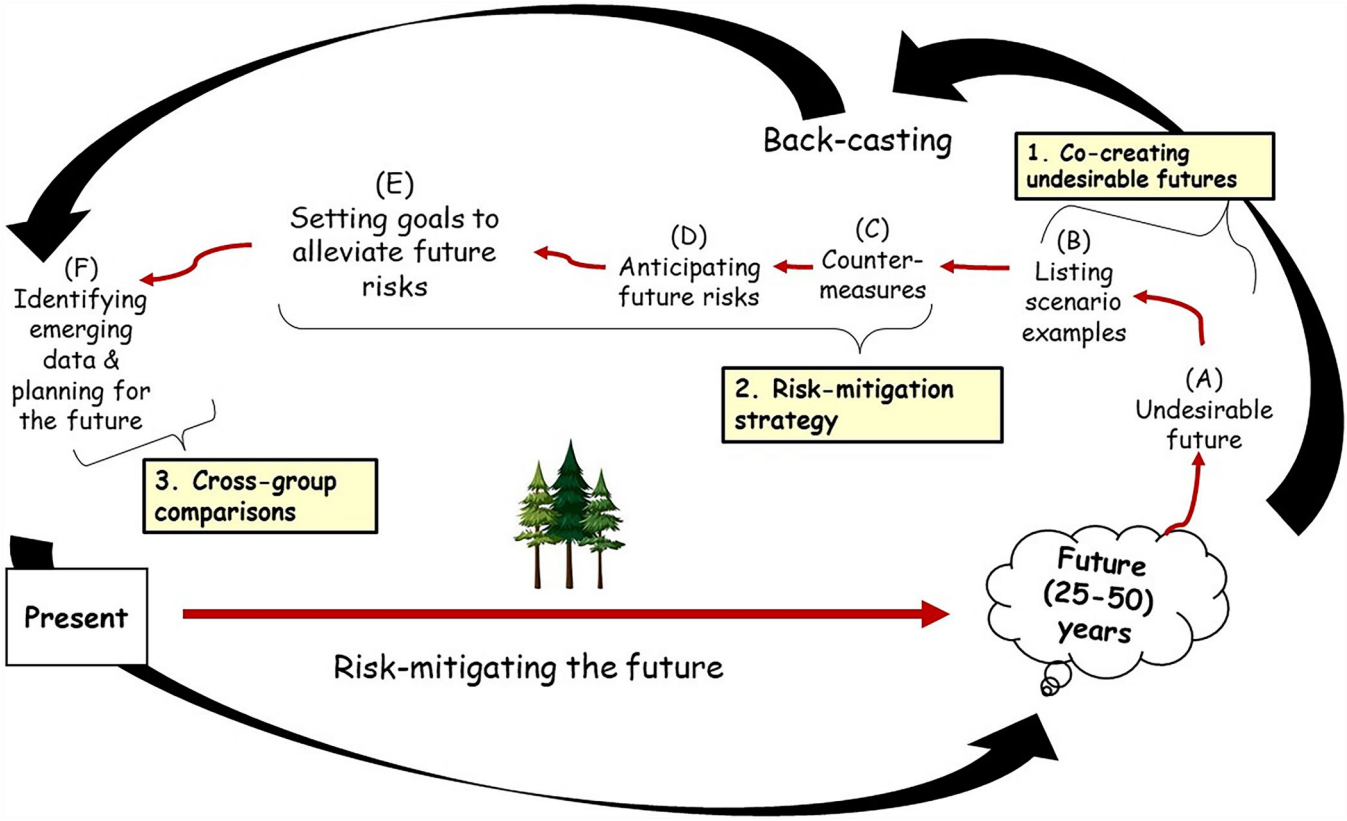

FIGURE 1 | Phases adopted in the backcasting process (Lead author's illustration, 2025).

Task 2. Risk-mitigating strategy:

- Discuss the measures you would consider for counteracting undesirable future scenarios in your group.
- What kinds of risk or uncertainty do you anticipate and what mitigation measures would you consider?

Task 3. Cross-group comparisons:

- Comparing undesirable futures and their risk mitigation between the groups
- Identifying emerging data

Instead of starting from the desirable future scenario, we opted to begin with the "undesirable" future which allowed the groups to reflect on fears and possible uncertainties and how to circumvent them. Starting from the undesirable future is particularly useful for building resilience, which necessitates imagining from scenarios with a collapse-type state of shocks to scenarios that can withstand or avoid such shocks in a system (Kishita et al. 2017). The workshop was structured overall as a social learning process using group discussions that enabled participants to exchange ideas through three underlying tasks (Table 1 and Figure 1).

2.2 | Analytical Framework and Data Analysis

For us to better understand the context of backcasting from the undesirable future to risk mitigation, we need to situate the nightmarish outcomes within future scenario frameworks and pathways for Nordic forests. A relevant example concerns the framework on path dependency emerging from economies of scale, learning effects and network effects in which actors in the forestry sector are increasingly focused on transitioning towards a more sustainability forest-based bioeconomy (Luhas et al. 2021). This bioeconomy transition pathway highlights greater recognition for cross-sectoral collaboration, novel and top value bioproducts and generating new knowledge, while illustrating heterogeneous pathways and the uncertainties about sustainability (Purkus et al. 2017; Vallejos et al. 2025).

In the Nordic region, the forest-based bioeconomy transition pathway has a complex relationship with biodiversity and climate which are valuable for forests. For instance, the forest-based bioeconomy and its associated policy targets may impact climate change through the storage of biomass carbon, forest carbon sequestration, and the production of bioproducts that replace fossil-based energy and materials (Hurmekoski et al. 2019). An impeding challenge however concerns the dominant approaches to bioeconomy that focus on mitigating climate change, but not considering biodiversity sufficiently (De Queiroz-Stein and Siegel 2023).

Thus, the above framework investigates and situates the nightmarish futures alongside the bioeconomy transition pathways through backcasting. This scenario framing enables us to better grasp respondents' knowledge of the uncertain future, potential risks, and how to mitigate them. In doing so, we used cross-tabulation analysis to compare the variable categories identified in the responses between study groups A and B (Table 3). This allowed us to determine whether participants in both groups anticipate the prospective sustainability of

TABLE 3 | Cross comparisons of variable categories between the study groups.

Study group	Chosen keywords	Phase 1/Nightmarish futures	Phase 2/Risk-mitigation strategy	Phase 3/Cross group comparisons
A	Resilience	• No resilient forests • Damaged forests and landscapes • Towns unsheltered by protective forests • Invasive species and diseases • War, nuclear contamination • Monocultures • Changes in natural vegetation	• Prohibition of monocultures, clearcutting, and peat mining • Diversifying site-adapted species and mixed species • Obligatory management of protective forests • Precautionary measures • Implementation of EUDR, LULUCF, Water framework directive, EU Forest and Biodiversity Strategies	• Both groups view multifunctionality and forest ecosystem services as relevant to the future sustainability of Nordic forests. • Multifunctionality: On the nightmarish scenario, both groups observed the over-protection of forests disconnecting from humans. Meanwhile, both groups observed promoting multi-species as a risk mitigation. • Forest ecosystem services: Both groups observed biodiversity loss and its eventual extinction as a nightmare, while forest diversification was an important mitigation measure.
	Multifunctionality	• No timber supply • No income from forests • Biodiversity destroyed • No more forest industry • Increased pressure from environmentalists putting all forests under protection • No carbon storage • Not enough oxygen anymore	• Multifunctional forest management • Sensibilization of forest managers, administrators, and politicians • Tree species adaptation • Assisted migration • GMOs tree breeding to capture more carbon and improve their resilience against diseases • Restoring biodiversity with positive correlations with carbon storage	
	Forest ecosystem services	• No clean air/water • Less rich biodiversity • No recreation function • No protective function • Disconnection between nature and society	• Education • Sensibilization and information campaigns • Public funding • Promoting circular economy, bioeconomy, and technical innovations	
B	Justice	• Centralized authority and capitalism • Polarization, unaccountability, and no trust	• Active engagement in governance—deliberative governance • Participatory decision-making processes • Regulate and finance inclusivity and cultural diversity in forestry	

(Continues)

TABLE 3 | (Continued)

Study group	Chosen keywords	Phase 1/Nightmarish futures	Phase 2/Risk-mitigation strategy	Phase 3/Cross group comparisons
	Multifunctionality	• Extremely restricted forest areas—no man's land • Violence connected to forest access • Development on forestland—for example, settlements, solar power fields • All wetlands converted into forests/plantations.	• Work toward heterogeneity in the forestry system • Mixing forest management methods	
	Forest ecosystem services	• Collapse—cascading destruction • Population increase • Monoculture, mass extinction, and nonnative plants	• Diverse tree species composition • Continuous cover forest management	

Nordic forests in the same way or whether they differ. According to Momeni et al. (2018), cross-tabulation analysis enables the identification of variable categories, their association, and their correlation. Table 3 shows the distinct and common categories and their variables across the study groups.

3 | Results

In illustrating the results, we focus on (i) the nightmarish future associated with undesirable scenarios and (ii) the risk-mitigation strategy that addresses how to circumvent the undesirable scenarios (Table 2). Based on a demographic analysis of the respondents, we observed that all the participants' background disciplines had some connection to sustainability both in the Nordic and the broader European context (Table 2). This was likely due to the framing of the IFPM5 conference themes that attracted several experts with previous knowledge of forest policy and sustainability issues within and beyond the Nordic region. A shared understanding among participants in conceptualizing "sustainability" was the concept's focus on ways to meet human needs for timber and other ecosystem services without jeopardizing forest health for future generations. As mentioned earlier, each group was then tasked to choose 1–3 keywords from the "25 keywords" list created earlier. The keywords should correspond to the concepts that the group perceived as most important for the planning future Nordic forest sustainability. Among the words chosen, we see both more general concepts (resilience, justice), and concepts specific to forest ecosystems (multifunctionality, forest ecosystem services). We believe the selection of keywords represents the variation in the participants' disciplinary backgrounds (Table 3).

3.1 | Nightmarish Futures

Analysis of the responses showed that group A aligned their answers to three keywords including multifunctionality, forest Ecosystem Services (ES), and resilience in connection with the future sustainability of Nordic forests (Table 3). Taking account of multifunctionality, participants anticipated an undesirable future with loss in biodiversity, no timber supply, no income from forests, no more forest industry, no carbon storage, loss of oxygen and increased pressure from environmentalists putting all forests under protection. Based on the forest ES keyword, participants noted no clean water and air, less rich biodiversity, no recreational function, no protective function, and a disconnection between nature and society. Considering "resilience", undesirable scenarios included damaged forests and landscapes, invasive species and diseases, war and nuclear contamination, natural vegetation change, towns unsheltered by protective forests and extreme heat that are life-threatening to human society, and extreme weather conditions such as floods which damage nature and infrastructure.

Meanwhile, group B picked up the words multifunctionality, justice, and forest ES in making sense of the future sustainability of Nordic forests. Here, participants imagined undesirable scenarios which included the homogenization of

landscape, lack of cultural services, no provision of ES, extremely restricted forests – no-go zones and even-aged monocultures. Regarding justice, the centralization of authority through hierarchical governance in top-down systems, increased polarization between urban/rural populations and decreased trust between citizens and government were identified as scenarios in an undesirable future. In the case of forest ES, the group imagined the replacement of native forests by exotic species such as eucalyptus, the conversion of wetlands into plantations, and the mass extinction of native species as undesirable scenarios.

3.2 | Risk-Mitigation Strategy

To counteract these nightmarish futures, each group proposed risk-mitigation strategies related to their chosen keywords. On multifunctionality, group A suggestions were to adopt multifunctional forest management approaches; sensitize forest managers, administrators, and politicians to best practices for forestry; use genetically modified (GM) trees to capture more carbon and increase resilience against diseases and restore biodiversity with positive correlations to carbon storage. It should be noted that the use of GM trees poses considerable risks of decreasing genetic diversity. However, some participants shared the view that its applicability as an option in scenarios of GM tree field-testing and for tree breeding incorporating new techniques to protect forests from disturbances of an uncertain future (e.g., neophytic diseases) could be considered with caution. For forest ES, aspects like education, information campaigns and sensitization, public funding, promoting circular bioeconomy, nature-based solutions in urban environments, technical innovations, protecting high value forest and old growth forest, restoring peat areas and resolving land use conflicts were identified as risk-mitigation measures. In the area of resilience, participants aligned their risk-mitigation measures with prohibiting monocultures, clear-cutting and peat mining, planting or seeding site-adapted tree species, making it obligatory for forest management to maintain the protective function of forests, adopting precautionary measures and implementing regulations (like the LULUCF, EU Forest and Biodiversity Strategies and the new EU Deforestation Regulation).

In group B, when asked about the risk-mitigation strategy, participants listed working towards heterogeneity and diverse tree species composition in the forest system as essential to counter undesirable scenarios related to the multifunctionality keyword. Meanwhile, in mitigating injustices, participants identified active engagement in governance through deliberative governance and participatory decision-making processes as important measures, supported by educational and rural-urban exchange programmes to encourage inclusion and cultural diversity in decisions about forests. For forest ES, there were calls for continuous cover forest management and mixed tree species forest management.

Comparing the responses for groups A and B, we found that both generally connected the future sustainability of Nordic forests with the variable categories of multifunctionality and the delivery of ecosystem services despite some diversity in individual views. In both groups and under the above categories, participants observed uncertainties as part of the undesirable scenario. They were particularly fearful of a future where more pressure is put on forests that may result in an extreme scenario in which remaining forests become highly restricted under circumstances of over-protection. Further, there were worries that there could be a mass extinction of forest-dependent species. As responses to these uncertainties and undesired aspects of forests and society, both groups discussed a need for hybrid approaches to forest management that allow preservation of high-value biodiversity in Nordic forests as well as incorporating precautionary measures in decision making processes.

4 | Discussion

The main contribution of this study employs the backcasting approach (Luhas et al. 2021; Vergragt and Quist 2011) to anticipate scenarios for the future sustainability of Nordic forests. Anticipating along the path dependency framework of transitioning to a more sustainable forest-based bioeconomy (Luhas et al. 2021; Purkus et al. 2017; Vallejos et al. 2025), we addressed two aspects: an undesirable future and a risk-mitigation strategy based on the viewpoints of research scholars and conducted within a workshop. The outcomes show how backcasting, which takes undesirable futures as a starting point, can be a promising approach to creating a shared vision among a pool of participants from different institutions but with a common interest in forest policy. Our study thus contributes to the futures and foresight discourse by responding to previous demands underlining the urgency of applying knowledge co-production in developing future forest scenarios (Hallberg-Sramek et al. 2023). By implication, backcasting through a co-creative workshop provided an opportunity to start developing a shared picture of the directions in which we do not want Nordic forests to go. From there, participants actively proposed concrete actions to avoid those undesired futures. The workshop did impact the development of insights that supplement our project's objective to generate evidence-based decision support for a sustainable use of Nordic forests while adding to a series of other co-creative events arranged within the project.

Making use of John Robinson's work enabled us to position sustainability as a policy choice that allowed participants to explore predictions of alternative future scenarios with incommensurate outcomes, through which we observed the views of scholars from different countries, institutions, and background disciplines, who share interests in the governance of Nordic forests. By engaging them through social learning, they learned about each other and co-produced meaningful knowledge of nightmarish futures and how to mitigate them. This approach enabled them to consider the implications of their planning of long-term sustainable forest management.

Anticipating the future sustainability of Nordic forests however presents many challenges; for instance, in the paradox of framing sustainability pathways wherein actors market their visions and strategies in terms of “sustainable development”, and yet envision biased futures of ecological modernization (see also, Leipold 2021) that differ from the principles promoted in

the Brundtland Report (Westholm 2015). The risks of using dominant approaches to bioeconomy that focus on mitigating climate change, whilst not giving enough attention to restoring biodiversity (De Queiroz-Stein and Siegel 2023) or to preserving traditional ecological knowledge that has been generated over long time through indigenous land use practices is another challenge. As the transition towards sustainability continues to receive heightened attention in the Nordic countries, policies seek ways to enhance the development of a sustainable forest-based bioeconomy. The EU Bioeconomy Strategy (adopted in 2022) plays an important role in envisioning pathways for national governments to accelerate their domestic development towards carbon neutrality and the deployment of a circular and sustainable bioeconomy (European Commission 2022; Luhas et al. 2021). While it stresses enhancing the resilience of ecosystems and ensuring their contribution to climate change mitigation and biodiversity protection, the responsibility for implementing targets however lies with national governments. Moreover, along with a need to support forest renewal and green transformations into the future (Nebasifu et al. 2024), diverse forest ecosystem services must become more significant in strengthening future value creation within the forestry sector (Häyrinen et al. 2016).

While the workshop partially attempted to address these issues, we also need to reflect on the limitations of our study. We do see that the workshop format gave an entry point that allowed participants to engage with the topic of forest futures from angles not usually taken. For the future, we see potential in expanding the method in the following ways. First, the workshop timeframe (90 min) implied using a rather compressed schedule that left little room for deeper debate about further aspects of forest sustainability, as well as the iterative refinement of ideas. For future use of the method, we see it benefitting from a longer timeframe and possibly being divided into several meetings, allowing for participants' ideas to evolve over time, and for details on pathways for policy implementation to be further developed. Although indigenous rights and local cultural practices play a vital role to advancing inclusion and fairness in forestry, these issues were not widely discussed in the workshop. Future workshops would strongly benefit from integrating local communities (e.g., Sámi reindeer herders) into the co-creative process. For feasibility, the current study was undertaken with 10 participants at a session of an academic conference. This worked well for exploring the method and the workshop format, but for co-creating reliable policy alternatives, the workshop would benefit from including a more diverse and larger group. Here we focused on qualitative methods and insights. The backcasting approach offers potential for mixed-methods, and a future continuation could integrate quantitative models to enhance the predictive reliability of the backcasting.

Further, given the predominant focus of responses on dystopian futures overshadowing "moderate" futures, there is potential for comparing alternative futures from a dystopian view alongside best-case scenarios. This best-case could include better tree growth and carbon sequestration in mixed woodlands; use of tree species choices that reap maximum benefits under dynamic environmental conditions; as well as optimizing for forest-related skills and expertise in modified climate smart conservation strategies to deliver on multiple values and ecosystem functioning against dystopias. Studies have shown that diverse trees offer multiple benefits such as providing clean water, fresh air, stable climate, food, and comfort to humanity whilst increasing the inputs of plant residues that provide additional nutrients for soil microorganisms, which fosters more active microbial community (Chen and Hu 2024). Given the increased risk of forest vulnerability to pests, diseases, and climate change, especially for large native species like oak and beech, the best-case future would also shift away from the present monocultures to polyculture-forests. This could increase carbon sequestration and boost resilience if managed by halo-pollarding (MacKenzie et al. 2024), although more strategies and breeding programmes must be developed to test the diversity potential for mixing native and nonnative species in forest stands.

Our study also indicates common mitigation scenarios to counteract the dystopias, including the attributes of multifunctionality and forest ecosystem services (ES). Of the risk-mitigation strategies proposed by the two groups, some are currently being implemented in various degrees in the different Nordic countries. Starting with the concept of multifunctional forest management, it refers to integrating diverse ecological and societal demands with timber production (Borrass et al. 2017). In some European countries, the concept and model for management has been widely adopted through policy programs like the LÖWE programme in Germany (Borrass et al. 2017). Despite there is an active debate on the multiple use of forests in Nordic countries (Beland-Lindahl et al. 2017; Pohjanmies et al. 2021), the current management regime leads to large trade-offs between timber and non-timber ecosystem services (Hohti et al. 2025).

When it comes to the potential of genetically modified forest reproductive material as a strategy for more resilient forests, research is being conducted focusing on the feasibility of such strategies in a Nordic context using field trials and simulations (Liziniewicz et al. 2022; Rönnberg-Wästljung et al. 2022). A study focusing on forest managers' willingness to pay for genetically improved material indicated an overall acceptance for such a strategy to be used in the future (Tikkinen et al. 2021). Another suggested risk mitigation strategy was to increase structural and tree species diversity, a theme that can be noticed in national forest policies across the Nordic region. When it comes to policy outcomes, research shows effects such as increased proportions of dead wood and deciduous trees in Sweden and Norway (Breidenbach et al. 2020; Kyaschenko et al. 2022), increase of total volume of deciduous trees in Finland (Korhonen et al. 2021). At the same time the region also sees trends of decline in old-growth forests, understory vegetation, and red-listed forest tree species (Kyaschenko et al. 2022; Økland et al. 2023; Breidenbach et al. 2020) which indicates that it is still of high relevance to continue increasing floral diversity. Studies evaluating climate mitigation scenarios for Swedish and Finnish forests have projected that adopting bioeconomy solutions will negatively impact ES supply more than adopting natural climate solutions (NCS) such as protecting semi-natural forests (Mazziotta et al. 2022). By limitation, increasing wood demand through bioeconomy solutions could decrease ES multifunctionality but also trigger increase in

CO_2 emissions which would negatively impact nonwood ES in production forests (Mazziotta et al. 2022).

Lastly, the suggestions for strategies that focused on political changes included for instance, support to deliberative governance processes and development of educational policy programs. One example of the deliberative governance model being used was in the policy development of the METSO Biodiversity Programme for Southern Finland (Borg and Paloniemi 2012). Other studies on the topic have highlighted few participatory decision-making arenas for forest policy in Norway (Veivåg Helseth et al. 2023), and that governance processes are ill-equipped in representing needs of local and indigenous communities (Hovik et al. 2010; Löf et al. 2022).

Nevertheless, what does these observations suggest for optimising risk-mitigation attributes for the future sustainability of Nordic forests? Based on the workshop outcomes, we ponder on three recommendations in planning for a best-case future.

4.1 | Recommendation 1: Diversification and the Integrated Management Choice

Forest ecosystems simultaneously provide multiple services and possess intrinsic multifunctionality values (Winkel et al. 2022). In sustainable forestry, forests should produce multiple ecosystem services for society, such as carbon sequestration, temperature regulation, timber, and biodiversity. The New EU Forest Strategy for 2030 stresses this need by attempting to improve the quantity and quality of EU multifunctional forests, reversing negative trends and increasing their resilience against the uncertainties of climate change (Pecurul-Botines et al. 2023). However, planning for the future demands caution about forest multifunctionality as a complex issue. In the Nordic countries, for instance, many forest management plans associate multifunctionality with timber supply as a primary objective, while providing nontimber products and recreation activities as secondary benefits (Caicoya et al. 2023). Given predictions of an increase in wood demand as central to achieving the EU's climate mitigation goals (Grassi et al. 2017), the risk of an increased wood harvest could intensify pressure on the provision of other ecosystem services (Caicoya et al. 2023).

Thus, in adopting multifunctional forest strategies, one must consider options for applying hybrid forms of management to a broad array of ecosystem services. In this management scenario, diversifying forest structures (age and tree species composition) and integrated management strategies (e.g., combining continuous cover forestry and any-aged forestry) may help adapt forests to climate change while still sustaining the supply of various goods and services (Díaz-Yáñez et al. 2020; Pukkala 2016). In this setting, the competence of integrated plans is crucial to creating multifunctional landscapes that connect people and allow animals to thrive. See, for instance, a recent study based on the NCP (Nature's Contribution to People) framework, which showed significant success in the use of integrated forest restoration plans targeting multiple goals, with outcomes that deliver on average 89.9% of biodiversity value NCP, 83.3% of climate change mitigation, and 93.9% of societal NCP (Gopalakrishna et al. 2024).

4.2 | Recommendation 2: Putting Private-Public Demands at the Forefront of Sustainability

In governing a sustainable forest future, multifunctional forestry must be capable of meeting diverse societal interests and supporting forestry practices acceptable to different social groups and the private and public sectors in conformity with principles of sustainable development. Sustainability in this regard starts from the present need to caution the use of forests in ways that make space for future options by recognizing what stakeholders see as worth saving and managing responsibly. In this respect, multifunctionality implies combining private forest owners' management goals with public policy objectives and balancing private and public interests. Thus, in planning for future Nordic forests that can capably deliver multiple ecosystem services to meet private and public demands, it is essential to consider diverse outputs from different ecosystems while balancing management responsibilities with benefits accruing to the private and public stakeholders. One must also shift from hierarchical regulatory systems to negotiations among stakeholders with conflicting or complementary societal needs to recognize joint forest management responsibilities between the private and public sectors (Schmithüsen 2007). In other regions of the world, joint forest management mechanisms did provide several benefits by involving the local population in supporting the long-term rehabilitation of degraded forests (Das 2024; Schuchmann et al. 2015).

4.3 | Recommendation 3: A Call for Novel Methods to Address Future Uncertainties

Climate change, natural disturbances, biodiversity loss and decarbonization present impending uncertainties that require new methods and data to promote a resilient and multifunctional forest and forestry in the Nordic countries. However, this faces an immediate challenge concerning the uncertainties about future climatic, environmental, and economic conditions and the diverse preferences of decision-makers (Díaz-Yáñez et al. 2021). Because forests offer many more ecosystem services than simply climate change mitigation, it is necessary to secure their healthy condition and vitality (Ferretti et al. 2020). There is a need for novel approaches and data that ensure continuity in delivering ecosystem services and in overcoming the impending fears and challenges facing Nordic forests. Perhaps engagement with undesirable futures is most often achieved implicitly and indirectly in that a transition towards a posited desirable future is also a transition away from a "business as usual", undesirable future. However, there remains the distinct possibility that complex change can develop in ways that have negative implications for social-ecological systems, resulting in nightmarish futures. Our study contributes to this underdeveloped approach to futures studies methodologies. Another example of novel approaches is Gregor et al. (2024) use of a multi-criteria optimization approach that was useful in developing strategies for multifunctional forestry across a broad range of climate scenarios, suggesting ways to ensure healthy forests, climate change mitigation and other ecosystem services. See also Gang et al. (2024) study, which uses the *Pareto frontiers*

to assess the value of tree species under competing objectives considering an uncertain future. Both studies represent examples of seeking new methods to minimize future fears against future forests.

5 | Conclusion

Nordic forests remain valuable sources of livelihoods, timber, carbon sinks, and hosts to valuable plant and animal species. However, climate change and other land uses continue to threaten their sustainability, which calls for innovative approaches to handle uncertainties. This study was an attempt to explore the Nordic case, seeking foresight about the future sustainability of its forests. Inspired by the work of John Robinson, we used the backcasting method in a co-creative workshop to explore undesirable scenarios potentially facing Nordic forests and how to counteract them. The workshop provided clues on anticipating future forests, understanding possible risks, and solving so-called "wicked" problems impacting sustainable forest management. Co-creation and collaboration can be challenging, as participants come with different perceptions, values and knowledge. However, based on the study group, the multifunctional use of forests and the ability of forests to deliver ecosystem services present viable scenarios for the future sustainability of Nordic forests. They observed a situation with too much pressure on forests that may trigger the extinction of forest-dependent species and lead to severe restrictions as an undesirable outcome. To mitigate this risk, the workshop participants saw a need to apply hybrid approaches to the management of forests so as to promote high-value biodiversity and to include precautionary measures in decision-making processes. Accommodating these demands in the eventual governing the sustainability of Nordic forests necessitates policies that promote diversification and integrated spatial planning of forests and adopting novel methods to minimize future uncertainties, while putting private and public demands at the forefront of designing conservation policies and ecosystem restoration activities.

Acknowledgments

We are grateful to the scholars and researchers who participated in the workshop. Special thanks to the organizers of the 5th International Forest Policy Meeting (IFPM5) who accepted our proposal for a co-creative session and for their assistance in facilitating the selection of participants. We acknowledge the support of our colleagues in the GreenPole project team and NordForsk and Nordic Forest Research (SNS) for funding this study. Finally, our gratitude to the editorial team and reviewers for their thoughts. This study was supported by funding from NordForsk through the GreenPole project "Green forests policies: A comparative assessment of outcomes and trade-offs across Fenno-Scandinavia" under project number 103443, and from SNS through ForPol "Transdisciplinary coproduction in forest policy research" project number 128. Open access publishing facilitated by Helsingin yliopisto, as part of the Wiley - FinELib agreement.

Ethics Statement

We declare that this manuscript adheres to the policies of Futures & Foresight Science as outlined in the Guide for Authors and the ethical guidelines.

Consent

Relevant informed consent was obtained from the participants in the workshop.

Data Availability Statement

The authors have nothing to report.

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