

Healthy forests, healthy society, healthy sector

Recommendations by leading research organizations in the boreal forest zone to support resilience and well-being grounded on the boreal forests

Boreal forests are important locally, nationally, and globally through the multiple benefits they provide to societies.

The leading research organizations in the boreal forest zone suggest essential research themes focusing on the forests and their management, renewal of our forest sector as well as ambitious development of new products and services that benefit climate and societies towards circular bioeconomy (Figure 1).

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The following themes need to be addressed in solution-oriented research for the future:

1. For healthy forests, **we need long-sighted, multifunctional forest management**
2. For healthy society, **we need in-depth knowledge on forests' role in sustainability transition**
3. For healthy sector, **we need a vision for a renewed forest sector**

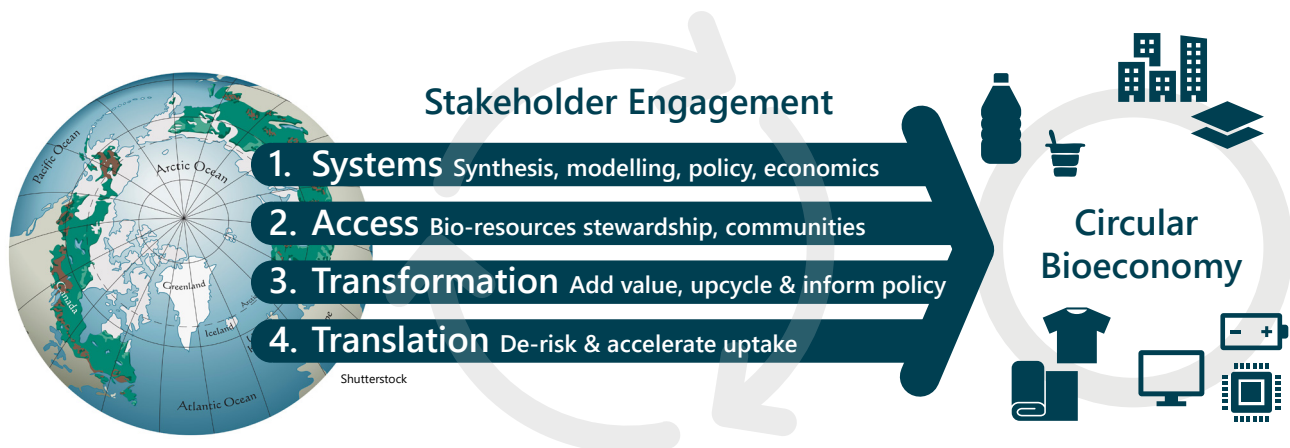


Figure 1 In innovating new forest management practices, products and services, careful consideration of several aspects with extensive stakeholder engagement is required. Attention must be paid, for example, to the impact of new solutions on forests' production possibilities, biodiversity and resilience, as well as to societal issues.

Why boreal forests matter?

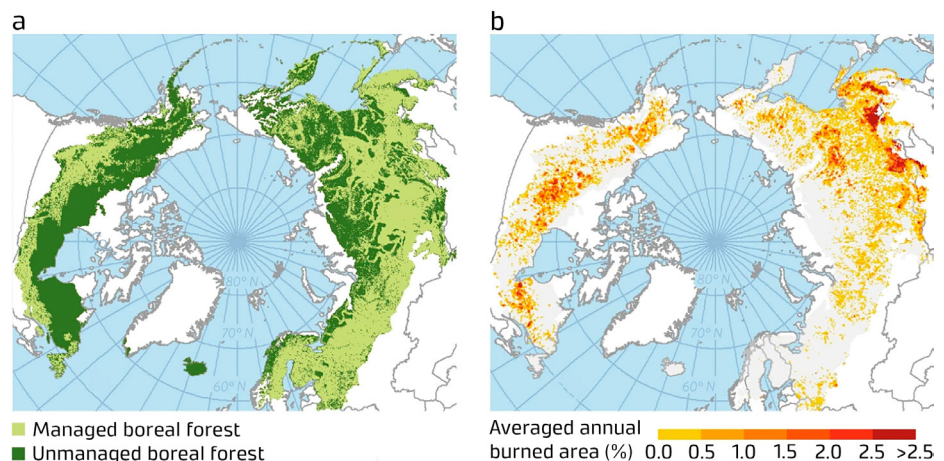
Boreal forests are the world's second largest biome, and they differ in multiple ways from forests growing in tropical areas. Major differences compared to tropical forests are, e.g., the lower number of tree species and cold winter periods that result in lower growth rates. As a result, the challenges and solutions for their sustainable management often differ from those of tropical forests. However, due to their diverse and unique biological communities, boreal forests are globally important ecosystems. Furthermore, it has been estimated that carbon storage of boreal forests may be greater than the carbon storage of tropical forests (Corey et al. 2015).

Changing environmental conditions and societal demands challenge the vitality of the boreal forests (Figure 2). They provide a wide range of ecosystem services at multiple spatial scales. The planetary triple crisis, surprisingly rapidly changing environmental conditions and geopolitical crisis have already impacted

the provision of various products and services from these forests. The future development of the boreal forest sector will largely depend on how well research and innovation actions succeed in developing, upscaling, implementing and commercializing new innovative sustainable solutions related to products and services provided by the boreal forest ecosystems.

The management of boreal forests varies between regions and countries. However, the tree species, growing conditions and use of the products that are harvested from these forests are not so different. Thus, the transferability of scientific results, commercial solutions and best practices can be excellent. This transferability is further strengthened through the well-developed innovation systems that have evolved in many of the countries where boreal forests are located. **Thus, cooperation between countries where forest resources are important could and should be strengthened. This position paper aims to identify joint research themes.**

Figure 2 | Location of boreal forests. Managed boreal forests cover 12.2 Mkm² and unmanaged 11.6 Mkm² (Fig 2a). The managed boreal forests are most often found in the southern and more populated areas. The unmanaged boreal forests are found in northern and less populated areas. In recent decades, forest fires have become more severe and frequent (Fig 2b).



1. Healthy forests – more long-term, multifunctional forest management is needed

During past decades, we have witnessed increase in the growing stock volumes of boreal forests in various countries. However, in recent years, biotic and abiotic damages have increased sharply, and growth rates have started to decline. Positive development has also been observed in some biodiversity related variables. Deadwood volumes in boreal forests have increased indicating that the activities to better integrate biodiversity into forest management are working in practice.

To be able to respond to changing environmental conditions and increasing demands on boreal forests, new solutions for diversified and adaptive forest management are urgently needed. Through new solutions, we can promote healthy, biodiverse, and resilient forests that provide a wide range of key-ecosystem services. These services include mitigation and adaptation to climate change and the sustainable sourcing of forest-based materials to develop competitive industries.

Research themes we propose:

- 1. Creating predictive models and early warning systems** using big data analytics and remote sensing to proactively evaluate the sensitivity of forest stands and landscapes to abiotic and biotic disturbances such as climate change impacts, pest outbreaks, and wildfires.
- 2. Developing and supporting application of multifunctional management frameworks** that balance ecological, economic, cultural, and social values, optimizing forest management for region-, community and owner-specified values and feasible management operations.
- 3. The creation of resilient next-generation forest structures** that are in line with future environmental conditions and the even more diverse forest use needs. These include adaptive forest management, utilization of genetic variation of already existing species in tree breeding and evaluation of the potential of assisted migration.



Figure 3 | The Donnie Creek wildfire in British Columbia, Canada, burned more than 6000 km² of forest in 2023. In Scandinavia, large forest fires have so far been rare. (Photo: © Province of British Columbia)

What we offer:

- Knowledge and skills to improve and increase the use of high-quality breeding material in tree-breeding.
- Long track records in forest monitoring. The history goes back over 100 years in the Nordic countries.
- Extensive expertise in forest modelling and active use of models in planning tools to support decision making. Modelling can support evidence-based decision making, e.g. through multifunctional forest management scenarios that illustrate future forest developments.
- Capability to put forest-related decisions into practice over large forest areas. We research and develop cutting-edge forest technologies and practices for sourcing wood and managing the risks of large-scale forest disturbances by e.g. reducing fuel load in the forest landscape.

2. Healthy society – better knowledge of the role of forests in sustainability transition is needed

The importance of the boreal forests in supporting both rural and urban communities cannot be overstated. By providing bio-based products and services, the boreal forests support the search for solutions to the challenges caused by climate change, biodiversity loss, population growth, and urbanization.

Products and services gained from boreal forests through different value-chains support, e.g., the socio-economic well-being of communities with employment and economic opportunities. In connection with sustainability goals, they contribute to healthy societies through economic, environmental, social, and cultural systems. For thousands of years, boreal forests have been a home to indigenous people in rural regions, providing food, shelter, and income. In urbanized areas, boreal forests provide, e.g., renewable construction materials to replace energy-intensive materials like concrete and steel. Together with nature-based solutions, boreal forests support technological improvements and life-cycle sustainability changes in processes, products and services that contribute to human well-being in buildings and living environments.



Figure 4 | Plywood panels used in the furniture industry.

Our research explores how boreal forests can drive societal change for healthier communities and sustainable resource use. In order to comprehensively examine the economic, environmental, and socio-cultural benefits, risks and acceptability of forest-based products and services over time, the roles and power dynamics of various actors (e.g., citizens, authorities, NGOs, companies) in decisions on sustainable forest use will be addressed. Furthermore, we will collaborate with indigenous communities in boreal forests to co-create research questions and sustainability solutions.

Research themes we propose:

- 1. Adding knowledge of nature-based solutions in the built environments as innovations for cooling, water & air purification and biodiversity enhancement**, when it is possible to substitute conventional technological solutions with nature-based ones.
- 2. Enhancing understanding of forest relationships and knowledge about forests and forest-based solutions as innovations for behavioral change**, that supports individuals and organizations in making informed decisions as societal actors to drive the sustainability transition.
- 3. Information on forests as means and platforms to develop community-based innovations** that meaningfully and sustainably support the well-being, livelihoods, and quality of life for forest-dependent and indigenous communities.
- 4. Rethinking of regional and national forest strategies and policies** to acknowledge the changing environmental conditions, operating environments, and societal needs in different local contexts.



Figure 5 | Multi-storey apartment building with wood in load-bearing structures and wooden bridge for walkers and cyclists in Joensuu, Finland. (Photo: Timo Roschler)

"The importance of the boreal forests in supporting both rural and urban communities cannot be overstated."

What we offer:

- Ample theoretical and empirical knowledge on interdisciplinary approaches to support comprehensive understanding on complex phenomena at the interface of producing information on boreal forest ecosystems, value networks, and power structures of different actors as decision-makers.
- Advanced social science methodological skills based on both qualitative and quantitative approaches, combined with an understanding of requirements for valid, reliable, and ethical research processes. These are needed to address the grand challenges at the intersection of boreal forests and society.
- Strong international networks of professionals in science and practice for capability building in renewal of research processes, societal impact, and co-creation of acceptable solutions for healthier societies.

3. Healthy sector – a vision for a renewed forest sector

The boreal forest sector has long traditions. Since the early 1900s, different forest industry branches have produced large volumes of products such as timber, pulp, paper, and board for export. Its impact on national economies has been and still is significant. Forest sector has changed alongside the changes that have taken place in the global consumption patterns.

Today, times and attitudes towards the use of boreal forests are changing, and so are the needs of customers and society as a whole. The forest sector should be able to address the changes in the operating environment which implies producing more from less. The sector needs to be a part of the circular bioeconomy transition by providing new solutions. In various European and global strategies, ambitious goals and restrictions have been set for the use of forest biomass. For example, countries have committed to the UN agreement to protect 30% of the Earth's land and water areas, and in the EU the recently accepted Nature Restoration Law will impact the management of the EU's boreal forests. Furthermore, the Finnish bioeconomy strategy (The Finnish Bioeconomy Strategy 2022) aims at to double the value-added of bioeconomy by 2035.

Circular, bio-based and resource-efficient products and services are key elements for the sustainability

transition. To achieve the strategic sustainability goals set, the forest sector cannot rely on its current product portfolios. In practice innovations in new products with higher value-added and climate benefits such as textile fibers or lignin-based products are needed (Figure 6). Moreover, new functional products to replace fossil-based materials can be envisioned, e.g. in biobased electronics or optics.

Products based on the sustainable use of the boreal forest resources can be drivers for sustainability change with the largest potential in replacing fossil-based materials or fossil energy. In a hydrogen economy, however, sustainable carbon will be an essential building block. The biobased CO₂ produced by the forest sector facilities could be first captured and then either utilized to produce new products or even stored permanently providing a technological carbon sink. Capturing CO₂ is currently costly, and the permanent storage of CO₂ is still being developed. Many open questions and uncertainties regarding CO₂ requiring research inputs still exist.

It is vital, that the forest sector takes a thought leadership role by creating an inspiring vision for a renewed forest industry, linking it to other sectors as well.

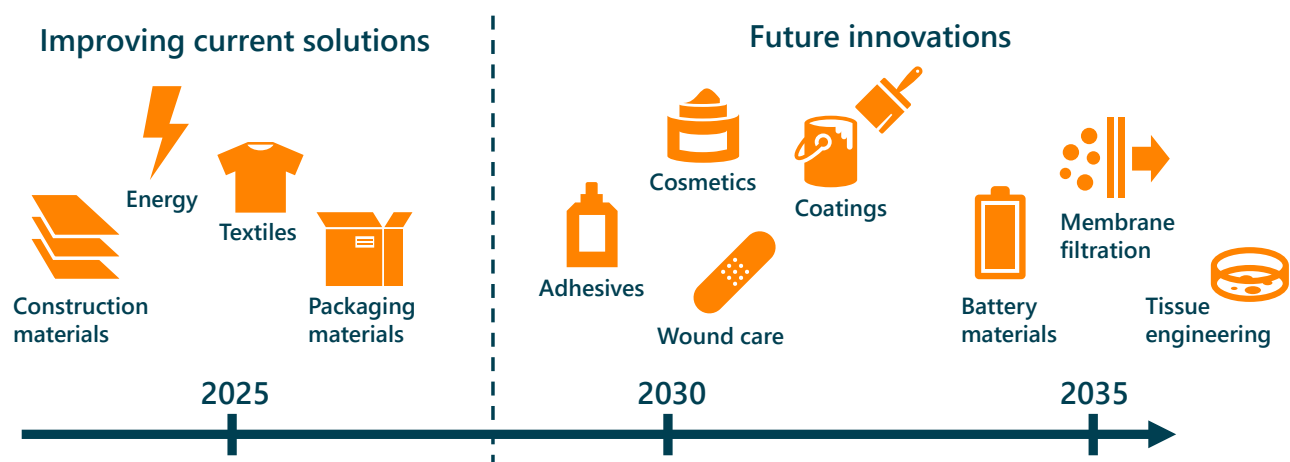


Figure 6 | Examples of current biobased products and future innovations (Österberg et al. 2024).

Research themes we propose:

- 1. Boosting forest sector growth with simultaneous inclusion of considerations of technological aspects, biodiversity issues and recreational use of boreal forests** by knowledge on how different needs of the society can be combined and fulfilled.
- 2. Increasing value-added within the forest-based value chains** by focusing on provision of information on high-value-added offerings based on innovations in products, processes and the use of raw materials acquired from boreal forests.
- 3. Enhancing knowledge of forest-based materials and fibers as innovations for new building solutions and technologies supporting sustainable building** to enable the supply of more affordable and better quality housing, and to reduce dependence on fossil fuels.
- 4. Assessing CO₂ economy potential of forest industries in the boreal region** to evaluate the potential of the forest industries to support the climate policy goals through the development and use of technologies for carbon capture for permanent storage (CCS) and utilization of captured carbon (CCU).

What we offer:

- Capability and means to implement the above-mentioned interdisciplinary research as our expertise and research partners cover the entire value chain. In particular, we are leading scientific organizations in studying the silviculture of boreal forests, enabling us to estimate the future availability of forest-based raw materials.
- Foresight expertise and scenario tools to show how different demands towards forests can be sustainably met.
- Active work and involvement in the fields where new and innovative forest-based products are being developed, and our expertise in assessing the impacts on national economies using sectoral and national economic models.

"The forest sector must take a thought leadership role by creating an inspiring vision for a renewed forest industry."

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More info

We represent the countries where boreal forests are actively managed with different management strategies.

The participating research organizations are:

Natural Resources Institute Finland (Luke),

Forestry Research Institute of Sweden (Skogforsk),

**Norwegian Institute of Bioeconomy Research (NIBIO) and
University of British Columbia, Canada (UBC)**

These organizations are united in their commitment to developing science-based solutions to enhance the sustainability of the forest sector.

The aim of this position paper is to highlight the importance of jointly identified research themes to various organizations and networks that support and fund related research. These participating organizations possess extensive expertise, knowledge and long history regarding the research related to boreal forests. Concurrently, we advocate for the inclusion of the identified research themes in the strategies and programmes of the relevant funding organizations. The proposed solutions are designed to facilitate evidence-based decision making thereby enhancing the sustainability and competitiveness of the forest sector operating in the boreal forest zone.

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We build sustainable future and well-being
from renewable natural resources.



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