

Synergies between climate and bio- diversity objectives in laws, policies and management practices



Content

PREFACE	5
LIST OF ACRONYMS	6
1. INTRODUCTION	7
2. SCOPE AND RESEARCH QUESTIONS	9
3. METHODOLOGY	10
4. SYNERGIES BETWEEN BIODIVERSITY, CLIMATE AND POLLUTION IN NATURE BASED SOLUTIONS	12
4.1 The relevance of NbS for synergy measures	14
4.2 Factors influencing NbS potentials	17
5. POLICY MEASURES AND SYNERGIES	19
5.1 International agreements and protocols	19
5.2 Legislative measures	21
5.3 Voluntary agreements	22
5.4 Financial measures	23
5.5 National, regional and local planning	24
5.6 Management approaches	25
6. SCREENING FOR POTENTIAL SYNERGIES IN MEASURES	28
6.1 Existing tools	28
6.2 An applied framework	32
6.3 The potential for integrating NbS into existing EU policies, strategies and approaches	33
7. POLICY LANDSCAPE IN THE FIVE NORDIC COUNTRIES	35
7.1 Sweden	35
7.2 Iceland	37
7.3 Norway	38

7.4 Finland	40
7.5 Denmark	41
8. CASE EXAMPLES OF SYNERGIES IN POLICY MEASURES	44
Continuous Cover Forestry Provides Opportunities to Integrate Environmental Concerns in Production Forests in Sweden	44
Protecting Pristine Wetlands – Eyjabakkur Wetlands in Iceland	47
From National Pollinator Strategy to Local Pollinator Project in Norway	51
Subsidies for Lowland Soil Projects in Denmark	54
A Mix of Measures help Protect Shoreline Forests of Finland	58
Accelerating Peatland Restoration through National Wetland Restoration Action Plan in Norway	61
Pointing out Eelgrass Meadows as Protected Areas in Sweden	63
Afforestation done by Farmers - Payment for Ecosystem Services in Iceland	67
A government Resolution to Change the Path of Peatlands in Finland	72
Promoting Green Roofs in Local Plans in Denmark	75
Riparian Vegetation Protection Acts Safeguards Nature-based Solutions in Norway	79
Action plans for Threatened Species and Habitats in Sweden	83
Reclaiming Degraded Land to Mitigate Climate Change in Iceland	86
Promoting Synergy Projects – National Subsidy Program in Denmark	90
Preserving Biodiversity through Payment for Ecosystem Services: The Forest Biodiversity Programme METSO in Finland	94
9. FINDINGS AND CONCLUSIONS	97
Measures suitable for achieving synergies	97
Spatial awareness – considerations of suitability and the surrounding landscape	100
Proper funding and cost-effectiveness	101

Stakeholder involvement at multiple levels	102
Accumulating knowledge and sharing knowledge	103
Multiple and concise objectives from the beginning	103
Have the measures been evaluated?	103
Were further effects achieved? (Cultural, economic value etc.)	104
Can the identified successful measures or projects (ensuring synergies) be applied in other countries/different regulatory settings?	105
Beyond the scope of this project	106
10. SUCCESS STORIES – BUT NOT WITHOUT BARRIERS	107
Nature-based solutions – Do we get the benefits promised	108
Nature is complex and so is the political landscape	109
11. RECOMMENDATIONS FOR NORDIC COOPERATION	111
REFERENCES	115
About this publication	140

This publication is also available online in a web-accessible version at:
<https://pub.norden.org/temanord2023-510>



PREFACE

This report has been commissioned by the Nordic Working Group on Biodiversity with the objective to support knowledge exchange between the Nordic countries on policy and management tools for nature-based solutions that address climate and environmental issues. It compiles examples of laws, policies and management practices that synergise efforts to address biodiversity, climate change and pollution.

The project report is written by Amalie Engelbrecht Hansen, Elvira Borgman and Rikke Fischer-Bogason from Norion Consult; Doan Nainggolan from iClimate - [Aarhus University Interdisciplinary Centre for Climate Change](#); Sigrid Engen, Lajla Tunaal White, Magni Olsen Kyrkjeeide and Megan Sarah Nowell from NINA - Norwegian Institute for Nature Research; Stephen Woroniecki and Katharina Heimes from Environmental Change Centre for Climate Science and Policy Research at Linköping University; and Prof. emer. Pekka Kaupi from Department of Forest Sciences, Helsinki University.

LIST OF ACRONYMS

CAFF	Conservation of Arctic Flora and Fauna
CAP	Common Agricultural Policy
COP	Conference of Parties
CBD	Convention on Biological Diversity
EIA	Environmental Impact Assessment
IFS	Iceland Forest Service
IPBES	The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	The Intergovernmental Panel on Climate Change
IUCN	The International Union for Conservation of Nature
LULUCF	Land Use, Land Use Change and Forestry
NbS	Nature-based Solutions
OECD	Organisation for Economic Co-operation and Development
PES	Payment for Ecosystem Services
SCSI	Soil Conservation Services of Iceland
UNFCCC	UN Framework Convention on Climate Change
WFD	Water Framework Directive



1. INTRODUCTION

We are in the midst of a triple crisis, our environment and societies are under threat and face severe pressure from the combined crises of climate change, biodiversity loss and pollution. These crises are closely interlinked and reinforce each other. It is therefore vital to address them together and not individually. Nature-based solutions (NbS) can, if done properly, help tackle these crises together. Climate change represents a systemic and transboundary risk that affects or will affect landscapes, habitats, biodiversity and ecosystem services. Causing vast changes in nature and environment and with a clear link to loss of species, ecosystems and ecosystem services, it is evident that climate change mitigation, risks and climate change effects must be addressed by all levels of governing and in all sectors.

A close interlink between climate, biodiversity and NbS fosters a relevance of addressing these areas and their synergies in relevant laws, policies and management practices. As a result, national policy makers are striving to uncover and ensure synergies between measures to address climate change (both mitigation and adaptation), pollution, and biodiversity. Examples of this are – on an international level – the EU Climate Adaption Strategy, including promotion of NbS – and – on a national and local level - providing and implementing very specific strategies, plans and management schemes. The latter can for example take the form of forest protection, afforestation and peatland restoration; all examples of protection or restoration of ecosystems that can provide reductions in climate change drivers, mitigate the impact, and enhance biodiversity.

“Nature-based Solutions are actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits.”(Cohen-Shacham et al. 2016)

A recent study of synergies in conservation of biodiversity and climate change mitigation in Nordic peatlands and forests^[1] shows examples of several synergies in nature management that benefit both biodiversity and climate. These examples are not rare, and they are in use in all the Nordic countries. Still, it is important to further ensure mainstreaming and integration of climate considerations and biodiversity plans and actions, if the Nordic countries are to increase carbon uptake in ecosystems and mitigate climate change effects. Existing initiatives are not sufficient, and there are still a number of conflicting interests, lack of financing, sectoral fragmentation, and other challenges that pose barriers to the efforts.

In order to address this important area, communicate the good examples, and disseminate the need for further coordination and actions, the Nordic Council of Ministers has initiated this study that compiles Nordic examples of laws, policies and administrative practices that synergise efforts to address biodiversity loss, climate change and pollution. The main objective of the study is to support the exchange of knowledge and experience to further develop effective policy and management tools for NbS for the climate and the environment. The project also proposes further joint Nordic initiatives for increased co-operation and facilitate policy development in this field.

The main target groups are policy makers and civil servants in the Nordic countries at all levels (i.e., national, regional and local/municipal), as well as internationally.

1. Dinesen et al. (2021)



2. SCOPE AND RESEARCH QUESTIONS

This study aims to highlight good examples of laws, policies and management practices, collectively identified as “measures”, that promote synergies between safeguarding biodiversity, decreasing pollution and adapting to and mitigating climate change. It aims to answer the following questions:

- Which measures relevant for the Nordic countries have promoted both climate and biodiversity effects in laws, policies and management practices?
- Which barriers are seen in the Nordic countries for the implementation of integrated policy solutions addressing both climate and biodiversity effects?
- Which measures relevant for the Nordic region have successfully promoted synergies between climate and biodiversity?

The geographical scope of the study is the five Nordic countries Denmark, Finland, Iceland, Norway and Sweden.

In terms of measures, the focus is mainly on physical planning, voluntary agreements, financial regulation, economic incentives, legislation, and management practices. As an overall umbrella to the national approaches, the links to international agreements are addressed when relevant.



3. METHODOLOGY

The study consists of a desk study of existing literature, identification of relevant cases, and development of recommendations for screening methods of laws, policies and management practices.

An analytical framework has been developed to ensure that all relevant thematic questions are answered through the study, and to provide the methodological approach to identification and analyses of relevant examples of laws, policies and management practices. The logic of the part of the analytical framework concerning the development of research and operational questions and their link to the analytical stages is visualized below.

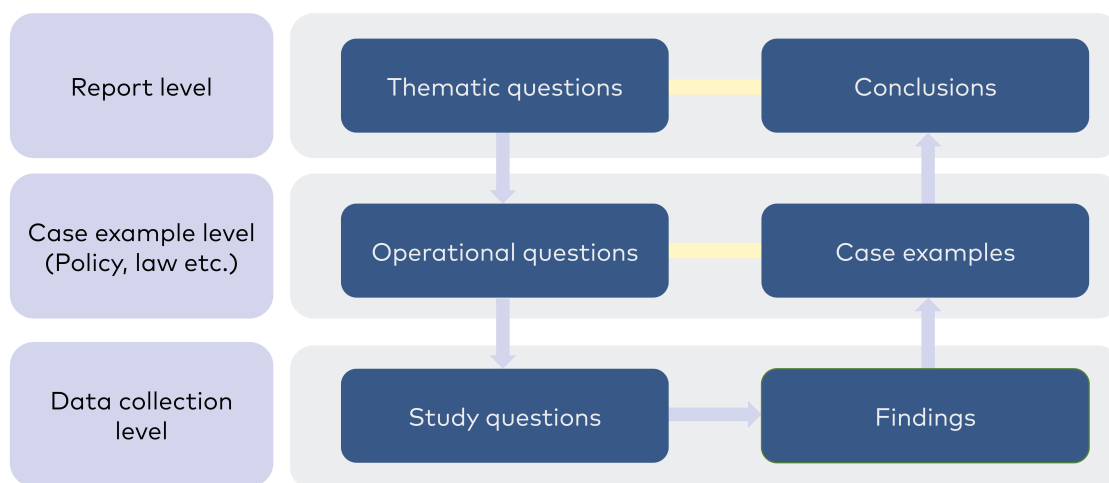


Figure 1. Analytical framework

A desk study of relevant literature has been carried out to map the current scientific landscape around synergies between safeguarding biodiversity, decreasing pollution and adapting to and mitigating climate change. The literature review has had specific focus on NbS and incorporated scientific articles as well as official reports and grey literature to address the thematic questions posed in the study.

For the case studies, a long list of 50 potential, relevant case examples of policies and management practices promoting synergies in the Nordic countries has been identified through desk research/web searches and through the vast Nordic network of the authors of this report. Cases were selected based on a set of criteria to safeguard the diversity and quality of the final case studies.

Criteria for case selection have been:

- Country (five Nordic countries represented)
- Scale (National, regional or municipal)
- Variation in measures between management practices, laws and policy instruments
- Representation of the different environmental objectives as well as the indirect benefits
- Type of nature affected
- Synergies promoted

Applying the aforementioned criteria to the long list led to the final selection of 15 cases. Once selected, cases were analysed through desk research, following the analytical framework (Figure 1), by experts in each country. Cross-cutting case analyses were then performed to reveal trends and findings on a Nordic level.

Finally, screening tools of laws, policies and management practices that can help identifying untapped synergies between climate change, pollution and biodiversity measures has been identified in the literature study.



4. SYNERGIES BETWEEN BIODIVERSITY, CLIMATE AND POLLUTION IN NATURE BASED SOLUTIONS

Responses to the climate and nature crises have long been dominated by a silo approach, addressing them separately and without considering the links and interdependencies. However, since the crises are interconnected and are reinforcing each other, the responses need to be cross-sectoral, enabling synergies and minimizing trade-offs. As stated in a joint report by IPBES and IPCC, "a new conservation paradigm would address the simultaneous objectives of a habitable climate, self-sustaining biodiversity, and a good quality of life for all". A new paradigm thereby takes a holistic viewpoint of the challenges that the global societies are facing related to the natural world, and places emphasis on the need for solutions that address several objectives at once. In this new paradigm, nature-based solutions (NbS) can play a significant part in mitigating issues related to climate change, biodiversity loss and pollution.

NbS are, as defined by IUCN, "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits".^[2] A more elaborate definition has been adopted by the United Nations Environment Assembly, which states that NbS are "actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits."^[3] NbS is an umbrella

2. Pörtner et al. (2021)
3. Nature-based Solutions Initiative (2022A)

term for ecosystem-based methods used to address societal threats and challenges, including climate change, biodiversity loss, and pollution.



Figure 2. Conceptual figure of NbS as defined by IUCN.^[4]

The ecosystem-based approaches under the NbS umbrella are:^[5]

- Ecosystem restoration approaches
- Issue-specific ecosystem-related approaches
- Infrastructure-related approaches
- Ecosystem-based management approaches
- Ecosystem protection approaches

4. Cohen-Shacham et al. (2016)
5. Cohen-Shacham et al. (2016)

These approaches can reinforce synergy measures when integrated into policy and management practices. The next section as well as Chapter 6 “Policy Measures and Synergies” discuss this further.

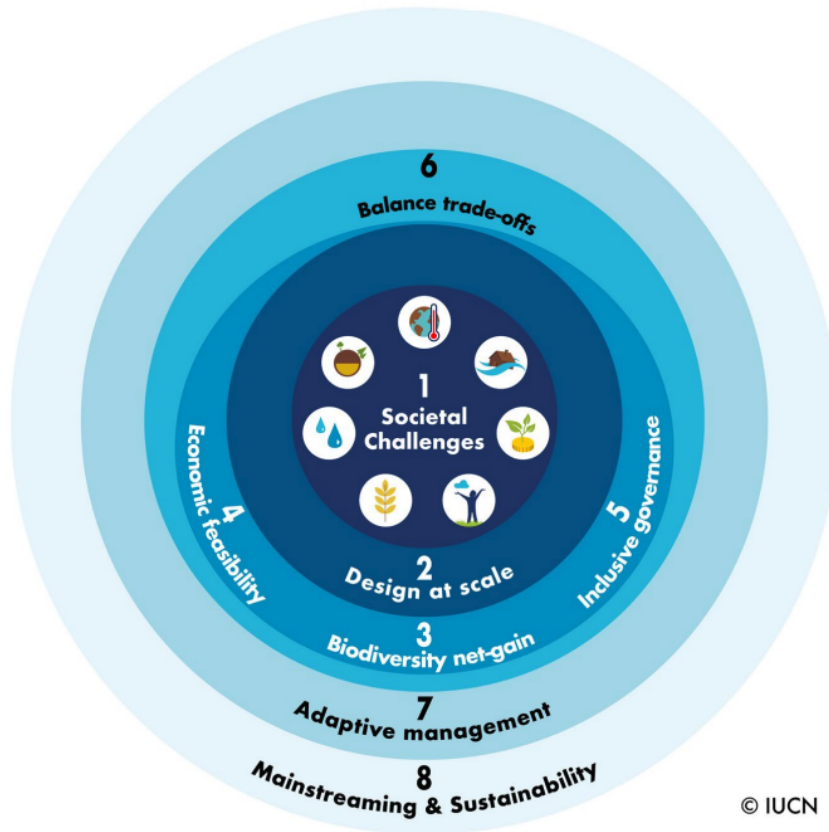
4.1 The relevance of NbS for synergy measures

Due to their overarching goals and designs (Figure 2), NbS methods are suitable when addressing the common challenges of climate change, biodiversity and pollution.^[6] There is also evidence of the synergistic capacities of NbS. A systematic review of NbS has found that on average there is seen a 67% increase in local species richness, when NbS is implemented in order to address climate change.^[7]

Meanwhile, it should be noted that NbS are context-specific, and that the potential for synergistic outcomes from measures varies between biomes and ecosystem uses. In some ecosystems it may be possible to achieve significant synergies, while measures may work antagonistic in other areas.^[8] In a report by the Nature-based Solutions Initiative, trade-offs were mainly found in measures related to forest management or creation of novel ecosystems; for example establishment of afforestation plantations using species non-native to the area.^[9] This evidence suggests that although such afforestation measures are often branded NbS, they do not supply the desired benefits, but can rather have negative effects on climate and biodiversity. Further research is in demand on NbS in different land uses and areas, especially since a considerable amount of research that has been done on NbS is mainly in an urban context. There is a need for further studies exploring the potentials for NbS in rural areas.^[10]

When seeking for NbS interventions that can have co-benefits related to climate change mitigation or adaptation and biodiversity preservation, it is highly relevant to target ecosystems that are carbon- and species-rich.^[11] Protecting these areas against degradation is especially important since it brings benefits both for climate and biodiversity. Ecosystem types that are relevant to consider for their richness of both carbon stocks and biodiversity are for example forests, wetlands, grasslands, coastal ecosystems and kelp forests. While protecting ecosystem integrity is first priority, there are also effective opportunities for synergistic measures through restoring nature in already degraded ecosystems.^[12]

6. Cohen-Shacham et al. (2016)
7. Key et al. (2021)
8. Pörtner et al. (2021)
9. Key et al. (2021)
10. Solheim et al. (2021)
11. Pörtner et al. (2021)
12. Cook-Patton et al. (2021)



© IUCN

Figure 3. The relationship between eight criteria in the IUCN global standard for NbS.^[13]

NbS can be integrated into production practices in the agricultural or forestry sector where they can contribute to increased adaptive capacity to climate change as well as mitigation potential through for example reduced fertilizer input. Furthermore, NbS can be implemented through alternative production approaches such as agroforestry, agroecology and crop diversification. These types of measures can support biodiversity in a productive landscape, while also contributing to carbon sequestration and increased resilience to stressors induced by climate change.^[14]

13. IUCN (2020)

14. Seddon et al. (2020)

IUCN Global Standard for Nature-based Solutions

1. NbS effectively address societal challenges
2. Design of NbS is informed by scale
3. NbS result in a net gain to biodiversity and ecosystem integrity
4. NbS are economically viable
5. NbS are based on inclusive, transparent and empowering governance process
6. NbS equitably balance trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits
7. NbS are managed adaptively, based on evidence
8. NbS are sustainable and mainstreamed within an appropriate jurisdictional context

While NbS provide a solid framework and actual solutions that can be implemented into policy and practice, it demands a holistic approach to simultaneously address the socio-ecological crises we are facing. In 2020, the IUCN published the first version of a standard for Nature-based Solutions. The standard contains 8 criteria and 28 indicators (Figure 3). The aim of the standard is to provide clarity on what is covered by the concept of NbS, prevent misconceptions and provide guidance on how to deploy it successfully. The standard can be used across all regions of the world, in a natural, cultural or urban landscape and the standard is suitable for both small and large-scale interventions. The standard can be used by a wide range of stakeholders from national and local governments, the private sector, NGOs and various others.^[15]

Guidelines supporting successful NbS have also been developed by researchers and practitioners in the UK.^[16] As seen in the table below, the guidelines are stated as a set of recommendations that are crucial to adopt and implement in order to achieve the anticipated effects while avoiding or preventing burden shifting, which is always a risk when implementing measures to prevent or mitigate environmental degradation.

15. IUCN (2020)

16. Seddon et al. (2021)

Table 1. NbS guidelines developed by a large number of researchers and practitioners in the UK.^[17]

Guidelines
1. NbS are not a substitute for the rapid phase out of fossil fuels and must not delay urgent action to decarbonize our economies
2. NbS involve the protection and/or restoration of a wide range of naturally occurring ecosystems on land and in the sea
3. NbS are implemented with the full engagement and consent of Indigenous Peoples and local communities, including women and disadvantaged groups, and should be designed to build human capacity to adapt to climate change
4. NbS sustain, support, or enhance biodiversity, that is, the diversity of life from the level of the gene to the level of the ecosystem

4.2 Factors influencing NbS potentials

The temporal scale between decisions and effects for climate-biodiversity-pollution related measures may vary. Applied NbS can have offset or delayed effects, and effects related to climate vs. biodiversity vs. pollution may be manifested at different times. Offsets are also relevant at a spatial scale, as measures can result in tele coupling effects that have impacts at other geographical places than where the intervention was implemented. This includes spill-over effects to other regions.

According to IPBES and IPCC, there is a need for rapid and sufficient synergistic actions.^[18] Accomplishing decision making and implementation processes sooner decreases the risk of irreversible adverse effects, increases the cost-efficiency of measures and creates added utility of the measures in a societal context. In a climate change context, NbS present many opportunities, although they can only be seen as part of the solution as their capacity for mitigation and adaptation is relatively small compared to quick phase-out of fossil fuels. It is also evident that NbS can be scaled up and have greater potential in a circular, green economy, where there is less pressure on natural areas from over-consumption of natural resources and modern, western diets.

NbS covers multiple cross-sectoral topics, this is one of the strengths, but it also possesses some management challenges. Municipal workers who often are responsible for the implementation of NbS, might lack awareness of NbS and its

17. Seddon et al. (2021)

18. Pörtner et al. (2021)

possibilities, or do not feel properly educated to practice it. To properly implement NbS there is a need for engaging multiple departments; cross-departmental coordination has also been identified as a challenge.^[19]

19. Haxwell et al. (2018)



5. POLICY MEASURES AND SYNERGIES

NbS are fundamental in the plan and design of policies and actions, and measures that promote synergies in addressing climate, biodiversity and pollution span across a range of scales. It is an ecosystem-based approach, but more explicitly aimed at integrating solutions into policy and planning. This study has a wide scope and thereby includes measures from national regulations, strategies, and policies as well as regional planning and governance. The functioning of the measures in the implementation stage will be highlighted through a selection of cases. In this section, we present measures that have potential to simultaneously address synergies between climate change, biodiversity loss, and pollution.

5.1 International agreements and protocols

Synergies can be promoted through “soft” collaboration mechanisms or “hard” policy coherence.^[20] At the international level, knowledge exchange between scientific bodies and councils can promote collaboration towards common goals. When promoting policy coherence, “hard” synergies, is a more complex political process through negotiations and governance agreements at national level. Both soft and hard international agreements can have downstream effects on national legislation, promoting synergies at the national level.

Policy responses that simultaneously address biodiversity, climate change and pollution are still limited on the international political stage, despite the growing amount of scientific literature that point at the interlinkages between the issues. International agreements have mainly been focused at addressing one major environmental issue, and they seldomly refer explicitly to each other.

20. Tsioumani (2022)

However, it can be seen that unintentional synergies emerge through several international agreements and cross-national cooperation forums. This is because more parameters than the theme in focus of the given effort benefit from the initiatives that are proposed and implemented.

International instruments relevant for the Nordic countries on biodiversity, climate change or pollution include:

- UN Framework Convention on Climate Change (UNFCCC)
- Convention on Biological Diversity (CBD)
- Paris Agreement
- UN's Sustainable Development Goals
- EU policies, strategies and directives including
 - EU Biodiversity Strategy
 - EU Green Deal
 - Habitats Directive
 - Birds' Directive
 - Water Framework Directive
 - CAP
 - EU Forestry Policy
 - EIA Directive
 - Ambient Air Quality Directive
 - Upcoming Nature Restoration Law

The listed agreements generally have converging overall objectives, as they aim towards a goal of addressing global change issues.

It should also be mentioned that there is an increasing focus on promoting mutually supportive outcomes, especially in the COPs for UNFCCC and CBD, where the UNFCCC increasingly focuses on the role of nature for climate change and the CBD increasingly focuses on the role of climate change for biodiversity conservation. Other opportunities for synergies at the international level include, among others, efforts under the Joint Liaison Group of the Rio Conventions, and work in the framework of the Sustainable Development

Goals.^[21] There are moreover guidelines by the United Nations Development program on how to integrate NbS into National Determined Contributions.^{[22] [23]}

5.2 Legislative measures

National regulations for biodiversity conservation, climate change mitigation and adaptation and pollution are in place in each of the Nordic countries. National environmental targets set the stage for political strategies and regulations, and extensive monitoring programs observe ecosystem health. Implementation of NbS actions becomes more achievable when targets, actions and monitoring efforts are specified, for example in national climate and biodiversity strategies.

Environmental laws are undeniably central for the promotion of synergies, as deficiencies in the legal framework can lead to undesirable environmental degradation, especially when adverse economic interests are involved.^[24] To ensure efficient legislation, it is important that environmental protection is not only outlined in environmental law, but that national legislation is streamlined on all departments, especially in terms of fiscal, infrastructure and foreign law.^[25]

Legislative measures are crucial for regulating relevant measures for promoting synergies, and thereby also serve the purpose of safeguarding rights of Indigenous peoples and local communities. Improper implementation of NbS pose a risk for local communities; for example, with regards to their access to land and natural resources and inclusion in decision-making processes.^[26] The legal framework must therefore be strong in its protection of the rights of indigenous people.

Types of legislative measures that are relevant for synergetic effects, include nature conservation acts, land distribution, and environmental protection laws. The specific national regulations relevant for promoting synergies are described further for each country and exemplified through the case collection.

21. Tsioumani (2022)
22. UNDP (2019)
23. WWF (2020)
24. Prakash (2021)
25. Coalition of Finance Ministers for Climate Action (2022)
26. DIIS (2022)

5.3 Voluntary agreements

Voluntary Agreement is a term that can be applied to agreements between affected stakeholders and a state level authority representing the government. The voluntary agreements can for example be relevant when aiming at altering land use, and where expropriation is not a preferable or relevant approach.

Within environmental regulation, a definition of voluntary agreements put forward by the OECD can be used to describe the measure, although the term 'firms' could be broadened and cover different types of stakeholders: "*Environmental voluntary agreements are arrangements between firms and regulators in which firms voluntarily commit to actions that improve the natural environment. The regulator encourages and/or supervises these actions.*"^[27]

Further, OECD defines three different types of VA:

- **Public Voluntary Programme**
Commitments devised by the environmental agency and in which individual stakeholders are invited to participate. Since participation in the voluntary programme is a choice left to individual stakeholders, they can be seen as "optional regulations".
- **Negotiated Agreements**
Involve commitments for environmental protection developed through bargaining between a public authority and industry/stakeholder. They are frequently signed at the national level between an affected sector and a public authority, although agreements with individual stakeholders are also possible. The negotiated agreements tend to be formal, but not necessarily legally binding.
- **Unilateral Commitments**
Unilateral commitments are set by the industry acting independently without any involvement of a public authority. The unilateral commitments are, strictly speaking, outside the overall definition (which included the participation of a regulator), but some unilateral commitments include a third party for monitoring or validation, hereby establishing the credibility created through participation of an authority.^[28]

27. OECD (2003)

28. Bauer & Fischer-Bogason (2011)

The Voluntary Agreements can further be subdivided into different setups

- Individual/collective
- Local/global
- Binding/nonbinding
- Open/closed access to third parties
- Target based or implementation based

The parameters illustrate that there is a vast variety within the use of this type of measure.^[29]

In an agri-environmental context, voluntary agreements with landowners are increasingly used to promote nature conservation for example by setting land aside or by changing land management practices. It provides a concrete opportunity for efforts that can have positive effects on climate mitigation and adaptation, pollution, and biodiversity. Voluntary programs already exist across the Nordic countries. Landowners are often rewarded with monetary or other benefits for their participation.

5.4 Financial measures

The use of economic instruments in environmental regulation can offer an alternative to the more traditional 'command-and-control' instruments, meaning the direct regulation that is traditionally used.^[30] Financial measures can be applied as incentives or regulatory tools in the strive for improving biodiversity and/or addressing climate change and/or pollution. Typical measures are funding programmes, investments, subsidies, soft loans, fees and taxes.

Public financing is the most important type for scaling up investments in synergy measures. Payment for Ecosystem Services (PES) is another type of financial measure to support protection of natural areas that supply ecosystem services - contributions from nature to society. PES schemes can be structured in many ways and should be adapted to local conditions to ensure maximum efficiency.

On an international level, funding for nature conservation is performed large scale through EU programmes such as LIFE and Horizon. There are several examples of

29. Bauer & Fischer-Bogason (2011)

30. Danish EPA (2017)

projects that aim directly at promoting synergistic measures through NbS and NbS was a part of the Horizon 2020 programme for research and innovation.^[31]

Public bodies, private organisations and communities all play a role in financing synergy measures. Blended finance can be used as a method to leverage financing. It is a term for spending public money on projects to make them attractive to investments from private money. This is a way to make a stronger investment case, promoting the currently underrepresented private financing in the NbS sector. While investments that promote synergy measures must increase dramatically, capital flows that negatively affect nature must, on the other hand be reduced. This is from the EU level sought by applying the taxonomy to public investments as part of the Green Deal scheme.

5.5 National, regional and local planning

NbS are very often related to land use; making national, regional and local planning important. The Nordic countries have quite similar governing and administrative structures when it comes to physical planning. This is especially the case for the municipal level, which is relevant for the promotion of NbS, as the success of NbS can depend largely on the extent to which it becomes integrated in mainstream planning and development processes.^[32]

Important steps for the planning of NbS at local level are identified as:^[33]

- The involvement of various stakeholders and actors in the review process.
- Achieving a good balance of regulations (command-and-control mechanisms) and incentives (market-based instruments).
- Reduction of bureaucracy through removal of redundant rules and regulations.
- Streamlining of national, regional, and local policies to better realise the overarching goals and targets.
- Institutionalising regular review activities to enable continuous improvement.

The authority of the regional levels does not have the same character in the Nordic countries, and this does to some level provide different planning process

31. [IUCN](#) (2022)

32. Haxwell et al. (2019)

33. Haxwell et al. (2019)

environments. As an example, Finland's legally binding regional plans are used to pinpoint the general structures of land use, whereas the Danish regions have no planning authority.

Moreover, it differs how detailed planning regulation is seen from government/state level. This is further complicated by the fact that there are significant differences between the countries in terms of the type of policy instruments that are used at the different levels, their legal status, and how they interplay (for example strategic, framework and regulatory instruments).

5.6 Management approaches

Tackling climate change, biodiversity loss and pollution through joint measures requires new approaches to environmental management. This involves administrative practices as well as on-the-ground actions. Synergistic measures need to be promoted throughout the management process and involve all affected stakeholders in order to be successful.

A management strategy that is increasingly used to address multiple global change issues is adaptive management. Adaptive management provides a dynamic approach, suitable for addressing multiple targets. It builds on a non-linear concept, where actions are continuously monitored and adapted to new knowledge, lessons learned and conditions.^[34]

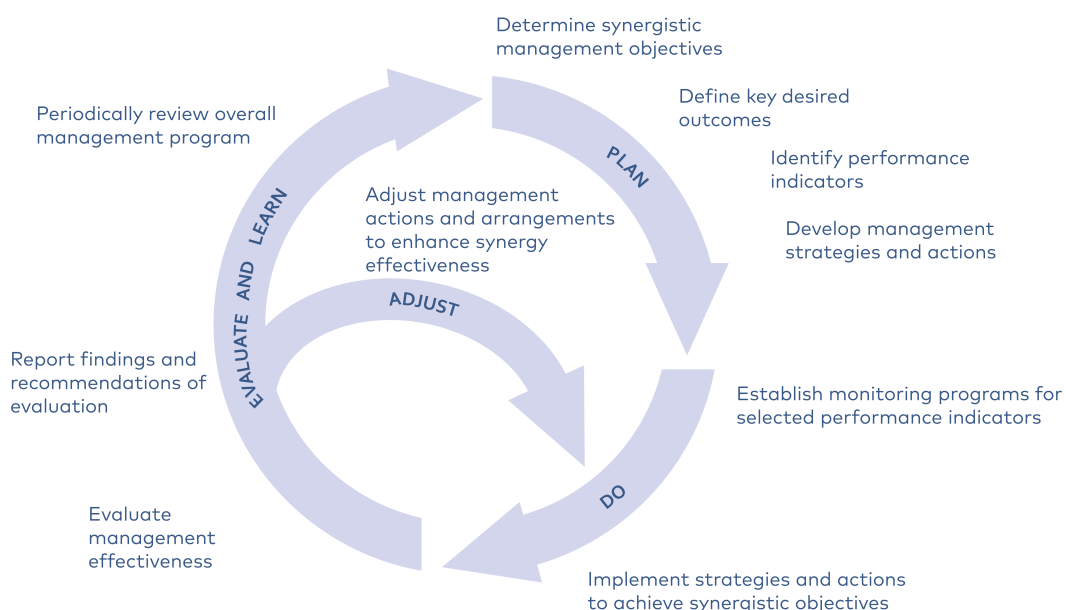


Figure 4. The adaptive management process. Adapted from Commonwealth

Adaptive management is guided by a process of several steps, as seen in Figure 4 above. The steps do not follow a universal model and should be adapted to the specific project. Additional to the steps outlined in the figure, an efficient adaptive management model for synergistic measures can include the following stages:^[35]

Plan

- Assessment of current conditions, including local challenges, risks and community needs
- Determination of goals and objectives that promote synergies
- Establish needed resources for successful implementation, long-term monitoring and planning
- Design of management plan based on the goals, stakeholder responses, and functionality requirements

Do

- Implementation strategies according to locally relevant criteria and pre-defined plan and design
- Ensure ongoing funding and resource provisions for management and monitoring
- Set milestones and targets

Evaluate and learn

- Monitor outcome, effects and impacts based on key desired outcomes and performance indicators
- Evaluate the results with wide inclusion of stakeholders
- Modify management plan based on monitoring and evaluation

Adjust

- Deliver aftercare management and adjust ongoing actions to promote effectiveness

Adaptive management is especially useful in the context of multiple problems and the application of NbS since it recognises uncertainty of global change and that management actions are needed despite uncertain outcomes. This further enforces the importance of documentation and monitoring to strengthen scientific learning and development of improved management practices. This is well suited for management with synergistic goals that may have higher complexity than single-goal management measures.^[36] Since objectives and impacts are regularly revised, there are opportunities to evaluate the interactions between them, and if taken actions are providing the sought synergy benefits, or if there is risk of trade-offs.

There is, however, a growing knowledgebase of successful management approaches to promote synergies between climate change adaptation and mitigation, biodiversity preservation and decreased pollution. The Nature-based solutions Initiative has a best practice case study platform where management practices from around the globe are presented.^[37] Conservation Evidence is another resource providing a catalogue of concrete measures for evidence-based conservation, with the opportunity to filter the actions by threat (pollution, climate change and severe weather, biological resource use etc.) in order to find measures that can serve as multi-functional solutions.^[38] These platforms can serve as resources in the development of management measures, to ensure an approach that is scientifically founded and proven to have effects. The case studies in this report can also serve as such a resource, providing concrete examples of management measures in the Nordic countries.

36. Cohen-Shacham et al. (2019)

37. Nature-based Solutions Initiative (2022)

38. Conservation Evidence (2022)



6. SCREENING FOR POTENTIAL SYNERGIES IN MEASURES

Policy measures that promote the potential synergies between biodiversity, climate change and pollution objectives can be difficult to identify early in the policy process. Nonetheless, it is relevant to detect the synergy potential in the planning phase through relevant screening processes as well as to identify and address potential risks, impacts and trade-offs. This is both in order to develop and implement such measures when relevant and to enable potential synergies, but also to be able to provide effective monitoring systems and alternative measures, making it possible to discover if the implementation does not provide the expected results.

The identification of potential synergies can be based on targeted frameworks and relevant environmental criteria. Several different initiatives within this field have been developed or are currently being developed working to enhance or identify such criteria and the related synergy potentials.

6.1 Existing tools

The IUCN Standard for NbS provides a framework for designing, adopting, managing and verifying outcomes of NbS, providing a step-by-step process from identifying societal challenges to applying adaptive management.^[39] Numerous tools exist that can contribute to better map and include biodiversity and climate objectives into policy measures and management practices. The tools support mapping and assessing e.g., high value ecosystems, areas prone to flood risk, or impacts of pollution. They can therefore contribute to a sound knowledge foundation for improving synergistic policies and management and support that decisions related to NbS are made on an informed basis. Examples are:

39. IUCN (2020)

The NbS Evidence Platform^[40]

- Explore evidence on how effective different nature-based interventions are for addressing climate change impacts
- Compare social, economic and ecological effects of different nature-based interventions
- Filter by region, country, ecosystem type, intervention type, or type of outcome
- Generate maps, graphs and download data
- Directly link from science to national policy
- <https://www.naturebasedsolutionsevidence.info/>
- <https://www.nbspolicyplatform.org/adaptation-planning/adaptation-action-types/nature-based-actions/>

The EU horizon funded project RECONNECT^[41]

- Aims at enhancing the European reference framework on Nature-Based Solutions for hydro-meteorological risk reduction by demonstrating, referencing, upscaling and exploiting large-scale NbS in both urban and non-urban areas
- <https://www.webscada.nl/reconnect/measures-new/#!/filters>

40. Nature-based Solutions initiative (2022B)

41. Reconnect (2022)

Toolkit for Ecosystem Service Site-based Assessment (TESSA) V. 2.0^[42]

- Primarily aimed at conservationists, but has the potential to be used by other practitioners within environmental management
- Provides guidance on conducting a preliminary scoping appraisal at a site(s) to understand the important services provided by a site and to whom
- Methods for measuring the ecosystem services
- The valuation of an 'alternative state' in order to compare a current and alternative state of the site and hence estimate the impact of potential or actual changes on the ecosystem services provided
- <http://tessa.tools/>

Nature Map Explorer

- Mapping terrestrial areas of significance for conservation and restoration of biodiversity, carbon storage, and other ecosystem services.
- <https://explorer.naturemap.earth/map>

United Nations Biodiversity Lab (UNBL)^[43]

- Access to global spatial data to generate insight and impact for conservation and sustainable development
- <https://unbiodiversitylab.org/maps-of-hope/>

42. [IPBES](#) (2019)

43. UN Biodiversity Lab (2022)

ReGreen, an EU project

- Nature based solutions in urban areas.
- The project aims to advance evidence and tools by systematically modelling ecosystem services and biodiversity and examining synergies and trade-offs between them.
- Review and assess evidence, experience, and good practices of NbS, including side effects both positive and negative.
- Assessment of the multiple benefits and values of ecosystem services that good NbS practice can provide.
- Co-creating together with city authorities the project develops scenarios of NbS interventions that can be used to assess the impacts of NbS in ecosystem models. The impacts include air pollution, urban heat islands, noise, flooding, water quality and biodiversity.
- City authorities are the main target group

Other potential tools and models that can help to identify synergies might be found here at International Institute for Applied Systems Analysis:

- <https://iiasa.ac.at/models-tools-data>

The listed tools can contribute to better integrate measures targeting multiple cross-agenda objectives and applying the most appropriate NbS. Focusing on applying NbS and achieving synergies can contribute greatly to reaching the 2030 targets for the Paris agreement, the SDGs and the EU biodiversity strategy.

6.2 An applied framework

A project that can serve as inspiration for how to screen for potential synergies and trade-offs between different objectives is a British project from 2013 conducted by the Department for Environment, Food & Rural affairs.^[44] The project aimed at ensuring integration of actions to achieve objectives across different EU- and national programmes. To gather the relevant information for the project, the authors used questionnaires, held focus meetings with both internal and external parties and facilitated a workshop. This led to identification of overlaps, interrelationships, synergies, and implications between the different programmes. A table showing the connection between different objectives was developed, outlining both synergies, links and potential conflicts.

Part of the table is shown here to illustrate the setup:

	Programme Objective	Synergy	Significant link	Potential link	Potential conflict
Bio-diversity 2020	B1a Better habitat quality	WFD1, WFD3, FCRM3	WFD2	WFD4, FCRM1, FCRM2, FCRM4	FCRM1, FCRM2, FCRM4
	B1b More, bigger, and less fragmented habitats	FCRM3	WFD1, WFD2, WFD3	WFD4, FCRM1, FCRM2, FCRM4	(...)
	B1c Integrated approach to ecosystem	(...)	(...)	(...)	(...)
	(...)	(...)	(...)	(...)	(...)
WFD*	WFD1 Better water quality	B1a, B1c, B3, FCRM3	B1b, B1d, B3	FCRM1, FCRM2	FCRM1, FCRM2
	(...)	(...)	(...)	(...)	(...)
FCRM**	(...)	(...)	(...)	(...)	(...)

44. Environment Agency & Natural England (2013)

The project applies an ecosystem-based management approach to ensure that objectives are managed and targeted in an integrated way that respects environmental limits and identifies synergies early in the process. Furthermore, it makes it possible to identify the various relevant and potentially overlapping regulations and framework directives with relevance to the project, so that these can be taken into account. An ecosystem-based approach contains three key elements:

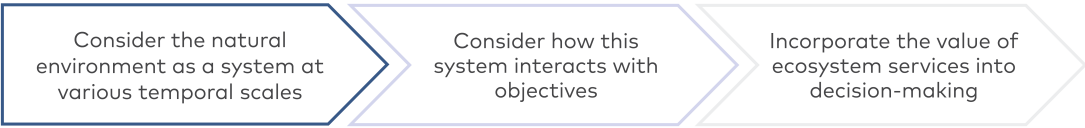


Figure 5. The three key elements of the ecosystem based approach.

6.3 The potential for integrating NbS into existing EU policies, strategies and approaches

The EU report ‘Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and disaster risk reduction’, focuses on how policy makers can implement NbS.

The report provides an overview of the possibilities for integrating NbS into key EU policies:

Table 4: [European Environment Agency (2021): Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and disaster risk reduction. Retrieved from: <https://www.eea.europa.eu/publications/nature-based-solutions-in-europe/>

EU policies, strategies & approaches	Level of NbS support	Type of integration
European Green Deal	Strong	Explicit
Biodiversity Strategy for 2030	Strong	Explicit
Bioeconomy strategy	Medium	Explicit
Forest Strategy	Medium	Implicit
Green Infrastructure Strategy	Strong	Explicit
LULUCF Regulation	Medium	Implicit

Action Plan on the Sendai Framework	Strong	Explicit
Adaptation Strategy	Strong	Explicit
Common Agricultural Policy	Medium	Implicit
Farm-to-Fork Strategy	Medium	Explicit
Water Framework Directive	Medium	Implicit
Floods Directive	Strong	Implicit
Urban Agenda	Medium	Explicit

Mapping key objectives from compatible or overlapping strategies against NbS can be a way to provide an overview and make potential synergistic and antagonistic overlaps between different policy agendas apparent. Thereby bridging silos and allowing for better horizontal management of the issues and ensuring that the right stakeholders are identified and get involved in the process.

In the summer of 2022, the European Commission adopted a proposal for an EU regulation on nature restoration. The proposal is one of EU's initiatives that aims to scale up nature restoration in this decade. The new law will contribute to meet objectives across various EU strategies and policies such as the EU Biodiversity Strategy, the European Climate Law, the Adaptation Strategy, the Farm to Fork Strategy, the Blue Economy Strategy, the Zero Pollution Action Plan, and the European Green Deal investment plan. If implemented it will be an important legal tool, the law can contribute to ensure restoration of terrestrial, coastal, and marine ecosystems.^[45]



7. POLICY LANDSCAPE IN THE FIVE NORDIC COUNTRIES

The presentations in chapter 6 of different policy measures to promoting NbS and relevant synergies show us that there are many different policy options for reducing biodiversity degradation, mitigating climate change, ensuring climate adaption, and reducing levels of pollution. Which policy measures will be most effective and applicable in terms of providing synergies, will depend on many factors, including the policy landscape of each country in relation to climate, biodiversity and pollution. Below, this landscape is briefly presented for each of the Nordic countries.

7.1 Sweden

Sweden has a population of 10.3 million people. The majority lives in and around Stockholm or in the southern parts of the country, whereas the population density in the northern part of Sweden is very low.^[46] Almost 70% of the Swedish land area is covered by forest^[47] and 10% of the land area consists of lakes and rivers.

Sweden is divided into 21 counties (län), and 290 municipalities.^[48] The municipalities are responsible for executing and providing environmental protection. The three main authorities for the environment are the Swedish Environmental Protection Agency (Naturvårdsverket), The Swedish Chemical Agency (Kemikalieinspektionen) and the Swedish Agency for Marine and Water Management (Havs och Vattenmyndigheten).^[49]

Sweden has an environmental code constituting a legal framework to promote sustainable development.^[50] The code was enacted in 1999, partly aiming at

46. Nordic Council of Ministers and Nordic Council (2022A)

47. Swedish Forest Industries (2022)

48. Swedish Nature Agency (2022)

49. Swedish Nature Agency (2022)

50. Swedish Environmental Protection Agency (2022)

reducing the number of applicable acts and do away with complex and fragmented legislation within the environmental field, and partly to address evolving environmental issues.^[51] The code covers provisions for management of land and water, water operation, biodiversity preservation, nature conservation and protection, chemical products, waste management and environmentally hazardous activities. The environmental code dictates assessment of environmental effects before conducting environmentally hazardous activity, thereby having a preventive effect. The environmental code of conduct also entails penalties and sanction charges for committing environmental crimes. As a supplement to the code, the Swedish parliament has adopted several environmental objectives divided in a generational goal, milestone targets and 16 environmental quality objectives.^[52] The environmental objectives serve as an important tool both at a national scale, as well as in the municipalities' efforts towards sustainability.^[53]

In 2017, Sweden adopted a climate policy framework together with a climate law that presents how Sweden can live up to the Paris agreement. Sweden has a goal of zero net emissions by 2045. The law states that every part government is obliged to pursue policies that are in line with climate goals adopted by the parliament.^[54]

A "Swedish strategy for biodiversity and ecosystem services" was adopted in 2014.^[55] The strategy contributes to achieving the environmental quality objectives, with seven of the objectives from 1999 focusing on biodiversity. The strategy designates the Swedish Environmental Protection Agency to provide other administrative authorities with sufficient guidance on how to successfully achieve the goals. The County Administrative Boards are as such guided in how to ensure that ecosystem services are considered when developing green infrastructure plans, and on how to manage natural and cultural values towards preservation.^[56]

Legislation concerning air quality is defined in the air quality regulation (2010:477),^[57] environmental air quality standards have been implemented in compliance with the EU.^[58] In 2013 the bill "towards a toxin-free environment – a platform for chemicals policy" (Govt Bill 2013/14:39) was accepted.^[59]

The Swedish Agency for Marine and Water Management are responsible for protecting, restoring, and monitoring freshwater and marine resources. Fishing pressures has led to reductions in many species both animals and plants. Eutrophication and acidification are high stressors for the marine environment, and of high concern in the entire Baltic Sea. Acidification is also a concern for Swedish rivers and lakes. Many of the Swedish rivers have been regulated for hydropower, which has damaged local populations of migrating fish species such as

51. Swedish Ministry of the Environment (2001)
52. Swedish Nature Agency (2022)
53. Swedish Environmental Protection Agency (2018)
54. Swedish Ministry of the Environment (2021)
55. Swedish Ministry of the Environment (2015)
56. Swedish Ministry of the Environment (2013)
57. The Swedish Parliament (2010)
58. Swedish Ministry of the Environment (2001)
59. The Swedish Government Office (2015)

salmon.^{[60],[61],[62]}

7.2 Iceland

In Icelandic, approximately 6% of the land is cultivated. The rest is either used for grazing or undeveloped. It is estimated that before human settlement, 65% percent of the land area had vegetation cover, up to 40% being woodland. During colonization, the vegetation was used as building materials, fuel and grazing, and natural revegetation was kept abate by extensive grazing, volcanic activity and a harsh climate. Today, only 25% of Iceland is vegetated. This has caused soil erosion, and much of the land has been severely degraded, also contributing to GHG emissions through loss of soil carbon. It is estimated that 39% of the land is subject to extensive soil erosion,^[63] 35% is desertified, and 45% of the ecosystems are in bad condition.^[64] The two state agencies Soil Conservation Service of Iceland (SCSI) and Iceland Forest Service (IFS) were both founded in 1907, and throughout the 20th century they made significant efforts to combat soil erosion, desertification and deforestation. The annual area for restoration projects is ca. 8.000 ha.^[65]

The Ministry of the Environment, Energy and Climate is responsible for most matters concerning environmental protection and nature conservation. Local authorities implement many of the climate-related policies, and the municipalities have done considerable work in developing sustainable development policies within the framework of Local Agenda 21.^[66]

The biggest risks from climate change, Iceland faces, are glacial retreat and sea level rise, changes to marine ecosystems including ocean acidification, increased risk of landslides and coastal flooding, and increased risk of vegetation fires.^[67]

The net emissions from the Icelandic LULUCF sector are greater than from all the other sectors. Grassland, wetlands and cropland are the main sources within the sector.^[68] Iceland is not a member of the EU but is a part of the European Economic Area agreement. As such, Iceland closely collaborates with the EU on the climate agenda and is a party to the Paris agreement. Iceland participates in emissions trading (EU-ETS)^[69] and has introduced the EU climate laws: Effort Sharing Regulation & Regulation on LULUCF.^[70]

60. Swedish Agency for Marine and Water Management (2016A)

61. Swedish Agency for Marine and Water Management (2016B)

62. Swedish Agency for Marine and Water Management (2016C)

63. Iceland's Ministry of Food, Agriculture and Fisheries (2022)

64. Iceland's Ministry of Food, Agriculture and Fisheries (2022)

65. Iceland's Ministry of Food, Agriculture and Fisheries (2022)

66. UNFCCC (2022)

67. Umhverfisstofnun (2021)

68. Iceland's Ministry for the Environment and Natural Resources (2021)

69. Iceland's Ministry of the Environment, Energy and Climate (2022)

70. European Commission (2019)

Iceland is committed to cutting emissions by 55%, aligned with the aspirations of the EU countries, and aspire to be climate neutral in 2040. Iceland's emission profile differs from many other wealthy countries: 75% of heating and electricity in Iceland is provided by renewables (mainly hydro and geothermal energy), and the electrical consumption is one of the highest per capita in the world.^[71] 79% of the generated electricity is used in heavy industry; predominantly by aluminium smelters.^[72] Iceland has great opportunities for climate mitigation by carbon sequestration done by afforestation, revegetation, and halting emissions from the soil by restoring previously drained wetlands.^[73]

The latest National Biodiversity Strategy was adopted by the government in 2008. In 2018, 56 vascular plants,^[74] 41 bird species,^[75] and 6 mammal species (terrestrial and marine)^[76] were on the IUCN Red List of Threatened Species.^[77] Iceland is a member of the biodiversity group of the Arctic council, CAFF.^[78] The main act for nature protection is the Act on Nature Conservation No44/1999.

The air quality in Iceland is good. The biggest concern is particulate matter from studded tires during the winter. In some parts of Iceland, H₂S has risen significantly, originating from geothermal powerplants. Parts of the Icelandic highlands have large sandy areas which, if there are strong winds, can cause particle pollution through sandstorms.^[79]

Iceland has ratified the EU Water Framework Directive, 2022–2027 is the second cycle under WFD obligations.^[80] Freshwater resources are abundant in Iceland and water is generally unpolluted. However, several are disturbed by hydro power construction; both reservoirs for water storage and disruption of water flows.^[81]

7.3 Norway

Forests and mountains cover a large part of Norway's terrestrial area. Only 3% of the land is suitable for agricultural practices. The Norwegian oceanic territories are six times bigger than the terrestrial land area.^[82]

There are three different levels of public administration in Norway. The national level, the regional level comprised of the county governor, the county council and the county municipality ("Fylkeskommune"), and lastly the local level made up by the municipalities. The county municipalities and the county governor have key

71. Iceland's Ministry for the Environment and Natural Resources (2018)

72. Iceland's Ministry for the Environment and Natural Resources (2018)

73. Iceland's Ministry of the Environment, Energy and Climate (2022)

74. Icelandic Institute of Natural History (2022A)

75. Icelandic Institute of Natural History (2022B)

76. Icelandic Institute of Natural History (2022C)

77. IUCN (2022)

78. Conservation of Arctic Flora and Fauna (2022)

79. European Environment Agency (2020)

80. European Commission (2022)

81. Iceland's Ministry for the Environment and Natural Resources (2018)

82. Norwegian Environment Agency (2022A)

responsibilities when it comes to environmental management. The municipalities have a main responsibility for land-use planning and also have certain responsibilities when it comes to pollution.

Norway is party to the Paris Agreement, and as an EEA member, Norway is working together with the rest of the EU to achieve their climate goal. Norway aims to reduce greenhouse gas emissions by 50–55% in 2030, and by 90–95% by 2050 compared to 1990 levels.^[83] This is in line with the EU ambitions and Norway has also implemented the EU climate law. In 2021, the Climate Action Plan 2021–2030 was published, outlining concrete policy actions to achieve the goal of 55% reduction in 2030. Some of the main policy measures are based on the polluters pay principle, especially within the oil sector.^[84] Even though 90% of Norwegian energy consumption is covered by hydropower from the country's 1600 hydropower plants, and wind power almost covers the last 10%, the biggest sources of income in Norway are oil and natural gas extraction and exportation.

The Norwegian Act on Biodiversity Management from 2009 is still in effect. The act is the legal foundation for better protection and appointment of new protected areas.^[85] Currently, 289 species are red listed as critically endangered in Norway, 959 are strongly endangered, and 1504 are estimated to be vulnerable.^[86] 30% of terrestrial nature types are assessed to be threatened.

Near 18% of Norwegian terrestrial territory is currently under protection^[87], this is mainly mountainous areas ("høyfjellsområder"). Only 3% of Norwegian marine territory is under protection. The main threats to terrestrial biodiversity in Norway are land use and land use changes; other threats are pollution, invasive species, oceanic acidification, and climate change which especially is a threat to the arctic areas of Norway. In the government's latest biodiversity strategy, the importance of the municipalities' role is emphasized due to their impact on land-use management.

In 2008, the EU Water Framework Directive went into force in Norway. The water quality in Norway is generally good, the biggest impacts are excess fertilization, environmental pollutions, invasive species, and physical changes to the water course such as channelization.^[88] 80% of the coastal waters have good or very good quality. Regional water plans are being reassessed every fifth year.^[89] Regulations for pollution are covered by the pollution law updated in 2020.^[90] The biggest air polluters in Norway are particulate matter (PM₁₀ and PM_{2,5}) and NO₂ mainly from roads and urban environments.^[91]

83. The Norwegian Government (2021A)

84. The Norwegian Government (2021B)

85. Norwegian Environment Agency (2022B)

86. Sabima (2022)

87. Norwegian Environment Agency (2022A)

88. Statsforvalteren.no (2022)

89. Norwegian Environment Agency (2022C)

90. Lovdata (2022)

91. Norwegian Environment Agency (2022D)

7.4 Finland

Almost two thirds of Finland's land area are covered in forest. Lakes and rivers cover 10%. 6% of the land area is used for agriculture. The Finnish population is approximately 5.5 mill people, and about 20% live in the capital of Helsinki.^[92]

Finland has 19 provinces and 310 municipalities, and the governance is divided in the national, regional, and municipal level. The regional councils have limited self-governing power. At the regional level, the duties are divided between six regional state administrative agencies and 15 centres for economic development, transport, and the environment. The latter are responsible for the regional implementation of environmental protection, nature protection, monitoring the environment and water resources. The municipalities are responsible for land use planning, maintenance of local infrastructure and the municipal environment water and wastewater management.^[93] The environmental protection act from 2014, is still in force and was amended in 2019.^[94]

Finland is committed to the Paris Agreement and aims to be climate neutral by 2035. A new act on climate change went into force in the summer of 2022, stating that GHG absorptions shall continue to increase beyond 2035, and by 2040 Finland shall absorb more CO₂ than they emit. The act also includes the land use sector,^[95] and the related measures focus on wasteland afforestation and rewetting agricultural soil on former peatlands suitable for rewetting. Both measures are expected to increase carbon sequestration. Adopting more sustainable agricultural practices that allows carbon to build up in the soil is another measure suggested.^[96] The Ministry of Agriculture and Forestry is currently working on the development of a climate plan for implementation.

The Finnish Ministry of the Environment is in the process of reforming the existing legislation for nature conservation as well as the nature conservation act; the current legislation is from 1996. One of nine Finnish species are threatened, and approximately half of the different habitat types are threatened as well. One of the biggest threats is deforestation; currently, 90% of the Finnish forests are available for wood production.^[97] Finland has several large programmes that targets biodiversity including the Helmi Habitats Programme and the METSO programme.^[98] Finland adopted a strategy for the conservation and sustainable use of biodiversity in Finland in 2012 for the period of 2012–2020 containing 105

92. Nordic Council of Ministers and Nordic Council (2022B)

93. European Committee of the Regions (2022)

94. Finlex (2019)

95. Finlex (2022)

96. Ministry of Agriculture and Forestry of Finland (2022)

97. Finlex (2019)

98. Ministry of Agriculture and Forestry of Finland (2022)

actions.^[99] A new strategy for the current decade is underway.

The biggest air pollutants in Finland are PAHs and ozone. A National Air Pollution Control Programme was adopted in 2019, including measures to implement EU's National Ceilings Directive.^[100] The latest data for the ecological status of surface waters are from 2019, 87% of lake- and 68% of river surfaces were estimated to be in good- or very good condition. The conditions are best in the northern and eastern parts of the country, and worst in the south that has the highest population density. The biggest threat to surface waters is eutrophication for lakes, especially smaller lakes, and siltation of rivers. Most of the coastal waters are classified as moderate or in poor condition, especially in the south.^[101] There are approximately 240 regulation projects in Finland where water ways have been somewhat altered for hydropower production, fish farming, flood protection, water supply etc., the Finnish restoration projects are affecting more than 300 lakes and reservoirs. A large part of the regulation projects was implemented in the second half of the 20th century; today several initiatives work on mitigating the harm done by some of the regulation projects.^[102] Marine waters are governed in alignment with the Act on Environmental Protection in Maritime transport and the act on the protection of the sea.

7.5 Denmark

Land use in Denmark is dominated by agriculture (60%), followed by forestry (15,5%). Urban areas, infrastructure and industry make up 14%, while 10% is nature areas.

The Danish environmental regulation and spatial planning is governed from three levels; state, regional and municipal – however, with no actual planning authority placed with the regions. The Ministry of Environment is overall responsible for environmental and nature concerns in spatial planning. This is implemented through different governing documents, including the Danish Strategy on Biodiversity. Other environmental legislations influencing land-use planning and protecting nature include Acts on nature protection, environmental protection, water environments, forestry and the ocean. Several laws make up the regulations related to biodiversity in Denmark. This includes the Environmental Protection Act, the Nature Protection Act, the Watercourse Act, the Forestry Act and the Planning Act.

The municipalities are responsible for the planning and operational tasks of nature management, including biodiversity protection, within the framework conditions defined by the national government. Spatial planning is prepared through municipal

99. Ministry of Agriculture and Forestry of Finland (2020)

100. Finnish Ministry of the Environment (2020)

101. Finnish Ministry of the Environment (2019)

102. Finnish Environment Institute (2019)

comprehensive plans that include descriptions of nature quality and protected areas. Lastly, for developing projects or construction, the municipalities develop local plans, which are more detailed than the municipality plans and cover smaller areas.

Municipalities are also obliged to make climate adaptation plans that map risk of flooding as part of or in addition to the comprehensive plan.^[103] More general municipal climate action plans are currently being developed in 96 out of 98 Danish municipalities through the voluntary program DK2020, where the municipalities are applying the international standard "The Climate Action Planning Framework", which is also being applied in the C40 cities.^[104] Denmark has a greenhouse gas emission reduction goal of 70% for 2030 as decided by the Danish Climate Act and, as a part of the Paris Agreement, a goal of net zero emissions in 2050.^{[105], [106]}

The Danish strategy for biodiversity "Nature plan Denmark" was published in 2014. It outlines the most urgent threats to biodiversity in Denmark, mainly land use for agriculture and forestry, increased nutrient loading and pollution. In the strategy, focus is also put on the connection between biodiversity loss and climate change, and on the need for solutions that promote both issues. It states that the government "has focus on synergies between measures on the climate arena and protection of biodiversity" (p. 51).^[107] Concretely, the government wishes to integrate nature protection and biodiversity into the climate effort, for example through taking lowland agricultural soils out of production and carrying through LIFE-climate projects, which are EU funded large-scale projects aiming to implement innovative climate responses.

The Nature and Biodiversity package was approved by the Danish Government and supporting parties in 2020.^[108] Through this agreement, the parties are aiming to revise the legal framework on nature and supply funding for projects that promote nature and biodiversity in Denmark. Focus lies on a strategy for protection of endangered species, appointing "untouched" protected forest areas and establishment of new national parks. The package also includes climate change as a focus theme.^[109] The preceding nature package which was implemented by the previous government in 2016 had climate and nature synergies as a focal point.^[110] One of the specific measures of this policy was a fund of 14.4 mil. DKK for projects that provided synergies between natural values and climate adaptation capacity.^[111] In 2019, 4.439 out of all 13.276 Danish species (animals, plants and fungi) were on the IUCN red list of threatened species.^[112]

103. Klimatilpasning (2022)

104. KL – Local Government Denmark (2022)

105. Governing parties in Denmark (2019)

106. Danish Ministry of Climate, Energy and Utilities (2022)

107. The Danish Government (2014)

108. Danish Ministry of Environment (2020A)

109. Danish Ministry of Environment (2020B)

110. Danish Ministry of Environment and Food (2016)

111. Klimatilpasning (2021)

112. Moeslund (2022)

The main air pollutants in Denmark are PM_{2,5}, PM₁₀, NO_x, and O₃. Road transport is the main source of NO_x-emissions. The main source for PM_{2,5} is non-industrial combustion, and for PM₁₀ it is non-industrial combustion and agriculture. The pollutants with the biggest environmental impacts are aerial depositions of N-compounds.^[113] Large parts of the Danish aquatic environment are eutrophicated, this is especially a problem in coastal waters where eutrophication has led to areas of oxygen depletion. Leaching of nutrients from agriculture and sewage are the main drivers of eutrophication. A lot of Danish streams have been physically altered up through the 20th century creating poor living conditions for the biota.^[114] Most of the legislation aimed to target nutrient pollution is defined through the implementation of the Nitrates Directive and the Water Framework Directive through national action plans.

113. DCE (2022)

114. DCE (2021)



8. CASE EXAMPLES OF SYNERGIES IN POLICY MEASURES

In order to shed light on how the Nordic countries have been successful in implementing measures to simultaneously address climate change, pollution and biodiversity objectives in laws, policies and administrative practices, three cases from each of the Nordic countries (Sweden, Norway, Denmark, Iceland and Finland) are presented. The cases address different policy solutions and different types of NbS.

Continuous Cover Forestry Provides Opportunities to Integrate Environmental Concerns in Production Forests in Sweden

Forests cover 70% of Sweden's land area. As the forests sequester carbon, they are crucial for mitigating climate change. At the same time, forests provide an important habitat for Sweden's native species. Since about 90% of the productive forest area in Sweden is managed for timber production,^[115] the type of management has a major impact on the availability and quality of forest habitats. The Swedish Forest Agency promotes an increase of Continuous Cover Forestry (CCF) on forest land, which provides high biological, cultural, recreational values or can be used for reindeer husbandry.

115. Felton (2016)

Close-to-nature forest management methods such as continuous cover forestry provide opportunities to integrate environmental concerns in production forests.^[116] To date, however, most forest management in Sweden has been carried out under rotational forestry, which involves clear-cutting with retention areas. The Swedish Forestry Agency has issued a guideline clarifying the definition of continuous cover forestry ("hyggesfritt skogsbruk") and enabling a common understanding of the concept among stakeholders.^[117] "Non-clearcut forestry on forest land intended for wood production implies that the forest is managed in such a way that the land always has a tree cover, without any larger clear-cut areas".^[118] As a soft regulatory measure, the Swedish Forest Agency recommends an increase in Continuous Cover Forestry (CCF) on forest land which provides high biological, cultural, recreational values or that is used for reindeer husbandry. Apart from this, the SFA advises CCF as a complement to rotation forestry. The final decision on the management method is in the hands of the landowner according to the principle of 'freedom with responsibility'.^[119]

Continuous cover forestry enables structural complexity

Many forest species depend on the continuity of the forest, which is interrupted when the forest is cleared. With continuous cover forestry, the forest is continuously covered with trees, maintaining microclimatic conditions, and benefiting species tied to this habitat type. An uneven-aged, heterogeneous forest structure is created which improves the overall structural complexity of the forest and mimics natural forests and natural disturbance regime.^[120] Therefore, these measures can have positive effects on many soil fungi (mycorrhiza), forest birds, mosses, mollusks, and lichens.^[121] Nevertheless, for sensitive species factors such as dead wood, old trees and moisture are crucial.^[122]

Types of continuous cover forestry

CCF includes several methods, depending on the forest species. For Norway, spruce-dominated forests 'Blädning' is a suitable method due to the low light requirement of the species. Through this method, an uneven-aged forest structure is created, and the felling takes place every 10–30 years focusing on the largest trees. 'Luckhuggning' (gap cutting) is a method that can be applied in spruce and beech forests, but attempts are also made in pine forests. It involves the creation of small gaps of a maximum size of 0.25 hectares. The size of the gaps depends on the type of forest and the amount of light that is to reach the ground. The larger the gaps, the greater the possibility of regenerating light-demanding tree species

116. Eyvindson et al. (2021); Nordlund & Westin (2011)

117. SFA (2021a)

118. SFA (2021a)

119. SFA (2010)

120. Felton et al. (2020)

121. SFA (2017)

122. SLU (2017)

such as pine and deciduous trees. In the gaps, small trees and plants can be left, together with individual storm-resistant trees. The rejuvenation of trees in the gaps creates an uneven forest stand. Rejuvenating a stand using 'luckhugging', takes about 3–4 cuts or 20–30 years. A variant of 'luckhugging' is 'Schackrutehugging'. This measure is still at the experimental level and includes the division of the forest into a grid pattern which is then felled in two or more stages. A method that can be used for tree species that need more light to grow such as Scots pine is called 'överhållen skärm'. Under the canopy of large trees, a stand of young trees is cultivated either through natural seeding or planting. Once the new stand has grown (at least 2.5 meters of height), the mature trees can be gradually felled. However, to be considered as CCF, at least 25 of the mature trees per hectare need to be left.^[123]

The Swedish Forest Agency's policy focusing on increased application of CCF is in line with the EU Forestry Strategy (COM (2021) 572 final), which also highlights the importance of management practices that support biodiversity and resilience. The policy can also be linked to the Swedish forestry Act giving environmental and production goals equal weight (SFS 1993:553) and the environmental quality objectives 'Living forests'.^[124]

Continuous cover forestry supports multifunctionality of forests

Forest management systems have been evaluated in 2017, but without a specific focus on synergies. Their evaluation shows that both ecological theories and empirical studies point towards higher benefits of late successional species from CCF than from rotation forestry. Regarding carbon balances, the evaluation is more uncertain, as climate benefits depend on the time scale, the interplay between forest management, carbon storage in forests and carbon storage in forest products, and the substitution effect of fossil fuels.^[125] Nevertheless, studies have shown that changes in soil carbon are lower in forest stands managed under CCF than under rotation forestry.^[126] This is due to the release of carbon by the stand after clear-cutting. Although net carbon emissions are similar under retention forestry and CCF, emissions are more widely dispersed under CCF and are associated with less soil enrichment.^[127]

In addition to that, studies have shown that CCF supports forest multifunctionality better than rotation forestry.^[128] Continuous cover forestry maintains cultural ecosystem services such as recreational values^[129] and promotes forest resilience.^[130] Climate adaptation is an important aspect in future forest management, especially since it is likely that the occurrence of storms in Sweden will

123. SFA (2021b)

124. SFA (2022)

125. SLU (2017)

126. Peura et al. (2018); SFA (2021b)

127. SFA (2021b)

128. Peura et al. (2018)

129. SLU (2017)

130. Pukkala et al. (2011); Pukkala et al. (2016)

increase.^[131] As an uneven-sized structure is created and open edge stands are avoided, the risk of wind damage is decreased.^[132]

Linköping Municipality: A pioneer in continuous cover forestry

Forest management in Sweden is regulated by soft laws. While rotation forestry is still the predominant forest management method,^[133] some municipalities and forest owners are applying CCF. The municipality of Linköping (2020) has highlighted the potential of CCF for climate adaptation and preserving biological diversity. As droughts, forest fires, storms, and periods of precipitation are expected to increase in Sweden as climate change progresses, avoiding monocultures and creating diverse forests are an integral part of the municipality's management plan. The decision for CCF is also due to recreational aspects. Due to the long planning horizon of forestry and the growth rate of the city, the municipality wants to maintain freedom of action. Therefore, the municipality considers its production forests as a resource that can be converted into recreational forests in the future.^[134]

Protecting Pristine Wetlands – Eyjabakkar Wetlands in Iceland

Wetland conservation and restoration are nature-based solutions for mitigating climate change. Wetlands sequester carbon, are rich in biodiversity, and when drained they emit large amounts of greenhouse gases. Most of the Icelandic wetlands have been destroyed or damaged up to this date. There are numerous efforts to restore degraded wetlands, and restoration of wetlands are an important part of Iceland's climate action plan. However, the conservation of the remaining wetlands is also of vital importance. Not only does it benefit other restoration projects, biodiversity and carbon sequestration are also generally higher in undisturbed wetlands compared to restored ones.

131. Öhrn et al. (2021); Vulturius et al. (2020)

132. Pukkala et al. (2016); Zubizarreta-Gerendiain et al. (2012)

133. SLU (2017)

134. Linköpings kommun (2020)

The importance of Icelandic wetlands

Wetlands are important ecosystems, providing a wide range of important ecosystem services such as carbon sequestration, water quality and biodiversity. In Iceland, wetlands are important bird habitats.

The Icelandic wetlands were mainly undisturbed until the mid-19th century, but in the 20th century, especially in the latter part, wetlands were drained for agricultural purposes at a grand scale.^[135] Wetland drainage was encouraged by the government up through the 20th century, and for most of the century, the government provided grants covering up to 70% of the drainage cost.^[136] Today, it is estimated that 40% of Icelandic peatlands have been completely drained and another 30% have been disturbed by draining.^[137] The extensive draining of wetlands has resulted in two-thirds of Iceland's greenhouse gas emissions arising from drained wetlands today.^[138] The United Nations Climate Change Council states that one hectare of drained land on average emits 19.5 tonnes of greenhouse gases annually.^[139]

It is estimated that 60,000 ha of drained wetlands currently are used for agriculture. But with increased will to bring back healthy wetland ecosystems, the Ministry of the Environment, Energy and Climate estimates that it is technically possible to restore 90,000 ha of previously drained wetland.^[140]

The first wetland restoration attempts were initiated by bird conservation enthusiasts in the late 1990s, and the first committee to address the possibility for wetland reclamation was formed in 1996 by the then agricultural and environmental minister.^[141] The Wetlands Fund was established in 2018 as a community project, raising funding for the restoration of damaged wetlands in Iceland.

Climate Change

Wetland restoration and conservation are effective measures to decrease greenhouse gas emissions, sequestering carbon and simultaneously providing other benefits such as improved water quality and biodiversity. In the Icelandic Climate Action Plan for 2018–2030, several of the mitigation measures within land use, land-use change, and forestry focuses on wetlands:^{[142],[143]}

135. [SCSI](#) (2022)

136. Institute of Economic Studies (2009)

137. Arnalds O., et al. (2016)

138. The Icelandic Wetland Fund (2022)

139. Government of Iceland (2021)

140. Ministry for the Environment and Natural Resources. (2018)

141. Ármannsdóttir, H. Þ. (2022)

142. Government of Iceland (2020)

143. IPCC Guidelines (2014)

- 20. Strengthened protection of wetlands: "Efforts will be made to ensure the protection of wetlands, as drained wetlands are a source of carbon dioxide emissions. Monitoring of wetland drainage will be improved, and regulations reviewed, inter alia to investigate setting requirements of wetland rehabilitation to compensate for draining activities."
- 21. Restoration of drained wetlands: "A plan for wetland restoration will be made and funded, in order to reduce emissions from drained wetlands, as well as restoring natural habitats"

In the period between 1990–2015, the LULUCF sector had the highest net emissions on Iceland. A large part of the absolute value of emissions from the sector was from cropland and grassland on drained organic soil. The emissions can be attributed to drainage of wetlands in the latter half of the 20th century, a practice that largely ceased by 1990. Emissions of CO₂ from drained wetlands continue for years after drainage.^{[144],[145]}

Wetlands Conservation

The Soil Conservation Service and Environment Agency of Iceland are responsible for putting new policies and measures forward. The types of instruments, the Icelandic Government announced to apply to achieve better wetland conservation, are fiscal, planning and regulatory policies and measures.^[146] The climate action plan concerning wetland conservation states that it is important that the current legislative provision on protection of wetlands is better adhered to. To achieve this, the collaboration between farmers, local authorities and governmental agencies needs to be improved further. However, wetlands protection can conflict with other measures for a green transition.

Restoration or conservation

Restoration is a complex undertaking. Evaluations of completed restoration projects often show less than desired results for a wide range of parameters such as native biodiversity, water quality and carbon sequestration even decades after completion.^{[147],[148]} It is important to acknowledge that the science of restoration is a relatively new field and is likely to improve with more research and a better understanding from trial and error. In later years, there has been a shift towards focusing more on ecological processes promoting restoration by re-establishing self-sustaining ecosystems. However, in the future, climate change might further

144. Ministry for the Environment and Natural Resources. (2018)

145. Ármannsdóttir, H. Þ. (2022)

146. Ministry of the Environment, Energy and Climate (2022)

147. Palmer & Stewart (2020)

148. Baumann et al. (2021)

diminish the possibilities for successful restoration back to the reference level, given changing environmental trends. The criteria for success are also highly site dependent. Restoration cannot be performed with a one size fits all approach.^[149]

The complexity of restoration emphasizes the importance of protecting and conserving unspoiled nature. When first degraded, it is difficult to re-establish a site to pre-degraded conditions. Climate mitigation benefits are generally higher in natural ecosystems, since disturbed ecosystems are more vulnerable and more readily release carbon.^[150] Also, research show that restoration projects often have more successful outcomes if undertaken in the proximity of high-quality ecosystems, since this enhances chances of species recovery and natural dispersal.^[151]

Eyjabakkar - the second-largest wetland in Iceland

Eyjabakkar is in the East highlands of Iceland. It has some of the most diverse vegetation in the Icelandic highlands, and the wetland is an important bird habitat with many different species.^[152] The area has been selected as a Ramsar Site due to the uniqueness of the area.^[153] At the beginning of the 21st century, there were plans to irrigate the entire area to create a power plant to provide hydropower for an aluminium smelter, but due to objections from civil society and NGOs, the plans were halted.^[154] Eyjabakkar is part of the Icelandic national park Vatnajökull that was established in 2008. The national park covers 14% of the Icelandic land area (more than 1,400,00 ha). The centre of the national park is the Vatnajökull ice cap and there are 10 volcanoes located in the park. The interactions between the ice cap and the volcanoes have created a dynamic landscape with large plains, river systems and canyons, and giving the national park the name: dynamic nature of fire and ice.^[155]

The Ramsar Convention

The convention on Wetlands, adopted in 1971, is an intergovernmental treaty providing a framework for the conservation and wise use of wetlands and their resources.

Iceland currently has six Ramsar Sites.

149. Meli et al. (2014)

150. Cook-Patton et al. (2021)

151. Mokany et al. (2020)

152. Baldursson et al. (2018)

153. Ministry for the Environment and Natural Resources & Ministry of Education, Science and Culture (2013)

154. Government of Iceland (2022)

155. IUCN (2022)

The risk of adding damage elsewhere

When the plans to irrigate Eyjabakkar were dismissed, the glacier river Jokulsa was dammed instead. This illustrates the complexities of accommodating multiple interests and policy goals simultaneously.^{[156],[157]} Furthermore, measures responding to one agenda can have detrimental effects on others. Hydro power provides 75% of Iceland's electrical energy.^[158] Hydropower plants can be very disruptive to local hydrology, impacting both downstream and upstream waterbodies, with potential negative consequences.^[159]

From National Pollinator Strategy to Local Pollinator Project in Norway

The creation of pollinator habitats benefits biodiversity, carbon sequestration,^[160] social health, urban resilience and well-being. The Norwegian Government published a national pollinator strategy in 2018, followed by information to Municipal Councils in a national expectation letter regarding their role in restoring habitats for pollinators and the importance of including this in their local planning.

Every four years, the Norwegian Government publishes national expectations regarding regional and municipal planning.^[161] The goal is to promote sustainable development throughout the entire country.^[162] The national expectations must be followed up and implemented by the county and municipal authorities, when developing strategies and plans.

In the 2019 governmental expectations it is stated that: "Preservation of habitats for wild pollinator insects is important for ecosystems and for pollination of agricultural crops. The government attaches great importance to safeguarding threatened nature, and that ecosystems are maintained in good condition. The municipalities have a particularly weighty responsibility to contribute to this in their planning, including by protecting selected types of habitats pursuant to the Nature Diversity Act."

156. Guide to Iceland (2022)

157. Environmental Justice Atlas (2022)

158. Government of Iceland (2022)

159. Voegeli & Finger (2021)

160. Kyrkjeeide et al. (2020)

161. Ministry of Local Government and Modernisation (2019)

162. Ministry of Local Government and regional development (2008) This follows from section 6-1 of the Norwegian Planning and Building Act

Linking the strategy to local activities

Porsgrunn Municipal Council (Porsgrunn Kommune) situated in the south of Norway is taking action for pollinators by planning and creating flower meadows and other pollinator habitats in municipal parks. Moreover, maps showing priority areas for pollinator actions in Porsgrunn's municipal plans were developed.^[163]

The Porsgrunn Pollinator Project shows how local and municipal actions can be integral to achieving the National Pollinator Strategy of 2018 by creating and restoring habitats for pollinators and improving green spaces in the city. The National Pollinator Strategy has three goals, i) increased knowledge, ii) establishing habitats and iii) communication), and the local project in Porsgrunn addresses all three. The project can be viewed as a response to the county climate action program (Klimahandlingsplan), which states that measures to protect pollinators must be taken.

Using data and spatial analyses to ensure maximum effect

The Porsgrunn Municipal County instigated the Porsgrunn Pollinator project in collaboration between local politicians, the municipality and the Norwegian Institute for Nature Research (NINA). The role of NINA was to create habitats in three locations that consisted of both floral resources and nesting sites for pollinators. The locations were chosen in order to increase the number of wild bees and other pollinators as well as to protect local species of wildflowers. Furthermore, NINA provided maps and advised on further targeted measures to prioritize in the surrounding areas.

The creation of maps showing priority areas for pollinator actions is a key aspect of integrating knowledge on biodiversity into Porsgrunn's municipal plans, thereby meeting the requirement for effective and informed local planning. Many types of pollinators require both floral resources and nesting sites within a certain radius and if the spatial location of pollinator interventions are not considered, then they are not useful. This project used spatial analysis in GIS to determine exactly what type of interventions were needed and where to create them to have the biggest impact.

Synergies between benefitting biodiversity and storing carbon

The creation of pollinator habitats is a significant effect of the national strategy. It will benefit biodiversity, but also has positive benefits for carbon sequestration,^[164] social health, urban resilience and well-being as other dimensions of nature-based solutions. Carbon is stored mainly in the soils of habitats such as meadows,

163. Pollinatoriltak Porsgrunn (2022)

164. Kyrkjeide et al. (2020)

especially where grasses dominate, with organic containing about 50% carbon. Meadows can in some cases have higher levels of carbon storage than forests and sequester more carbon in the soil (433 g C per m² in meadows vs 381 g C per m² per year in forests). Furthermore, by creating flower meadows in urban areas, which were previously grass, the need for mowing was reduced to only once per year, rather than every other week. This reduces the use of fuel and provides a stable habitat for wildlife. In the example of Porsgrunn Municipality, road islands were moreover replaced with pollinator-friendly vegetation, which contributes to reducing the urban heat island effect, increasing rainfall infiltration and capturing pollutants.

Implementation of national pollinator strategies through local planning and projects such as the Porsgrunn Pollinator Project addresses the need for more pollinator habitats by also promoting the management and restoration of critically endangered hay meadows. These traditional hay meadows have a very high diversity of both plants and wildlife; however, without a use or market for the hay, most have been abandoned. The Norwegian Institute for Nature Research has shown that hay from local hay meadows (referred to as donor meadows) can be used to establish new flower meadows, providing an incentive for better management. Over the following three years, seeds from the hay will germinate and grow into new flower meadows, which will be a very important resource for pollinators, whose populations are declining rapidly both in Norway and globally. Semi-natural meadow conservation and management is highly topical in Europe and the experience of the project will add to the growing body of research on developing protocols and guidelines.

A case of multi-level governance

When measures benefitting both biodiversity and climate mitigation can take form from a national pollinator strategy to local pollinator project, a true example of multi-level governance is seen. It is stated in the national strategy that "municipal authorities should give consideration to pollinator-friendly development and administration of municipal green infrastructure", and this is exactly what has been carried through in Porsgrunn Municipality. By bringing flower meadows into urban environments, new foraging resources for pollinators, habitats for birds and small mammals, and a renewable and sustainable source that conserves the local gene pool of flowering plants, has been established, while enhancing carbon sequestration. Meanwhile, hay meadow management has been supported and new markets for this species-rich hay has been created.



Photo: Megan Nowell

Subsidies for Lowland Soil Projects in Denmark

The Danish Government is offering subsidies to cease agricultural production on lowland soils with high organic content. The measure offers a joint solution for mitigating greenhouse gas emissions, nutrient pollution, and biodiversity loss. While experts agree that rewetting lowland soils is positive for climate and nature, it is difficult to foresee the specific climate and biodiversity effects, which will probably be highly dependent on the individual area characteristics.

Tackling eutrophication, greenhouse gas emissions and uniform landscapes

Eutrophication of coastal water and lakes is one of the great environmental problems in Denmark. The problem mainly stems from the country's intensive agricultural production, in which large amounts of fertilizer are applied to soils and then leach into water bodies. To address this issue, the Danish Government has been focusing on measures that contribute to reduced nutrient emissions to fjords and coastal waters, while combining this with reduced greenhouse gas emissions and increasing nature quality. Abandoning agricultural production on carbon rich lowland soils is one practice that can remedy all three challenges, and this has been

promoted by the Danish Government. The specific policy instruments used are subsidies for converting intensively cultivated agricultural soils to land for extensive production methods. Counting the subsidies and other measures with the purpose of rewetting agricultural land, the Government plans to take a total of 88.500 ha of lowland soils out of production.

Selected criteria to receive subsidies to establish lowland projects

- The project is located in a watershed area where a lowland project is expected to bring nitrogen reductions of minimum 30 kg nitrogen/ha/year.
- The project entails a shift to extensive agriculture contributing to a reduction of greenhouse gases corresponding to a minimum of 10 tons CO₂ equivalents/ha /year.
- The project supports natural hydrology in the area.
- The project is not expected to contribute to increase phosphorous emissions that have a negative effect on the environment.
- The project should be cost efficient.
- The project contributes to increasing nature quality and the creation of coherent, robust nature areas.

Funding is granted from the European Agricultural Fund for Rural Development and nationally from the Ministry of Food, Agriculture and Fisheries.^[165] Municipalities and local departments of the Nature Agency are eligible to apply for project funding from the fund, which is managed by the Agricultural Agency and open for applications twice per year.^[166] Both preliminary studies for lowland soil projects and actual establishment projects can receive funding.

In the period between 2014 and 2018, the Agricultural Agency examined 81 subsidy applications, out of which 13 projects were realised.^[167] The main reasons for funding rejections were that the proposed projects could bring increased risk for phosphorus emissions, and that they did not contribute with sufficient CO₂ reduction. Opposition from landowners was also one of the major hurdles.

165. Danish Agricultural Agency (2022)

166. Danish Agricultural Agency (2022)

167. SEGES (2019)

Climate opportunities of organic soils

In Denmark, it is estimated that 170.000 ha of carbon rich lowland soils are in use in intensive agricultural production, corresponding to 7% of the total agricultural land.^[168] Lowland soils are estimated to emit approximately half of the total greenhouse gases from Danish agricultural production.^[169] The reason for emissions to be particularly high in these areas is that lowland soils have been drained to ensure efficient crop yield. Draining supplies oxygen to the soils and stimulates the breakdown of organic matter by microorganisms, which results in emission of greenhouse gases to the atmosphere. Organic matter in the soils has slowly been built up during many years through uptake in plant material which is stored as peat. When the soils are drained, tilled, and cultivated, organic matter that has been accumulated over many years is quickly decomposed and emitted to the atmosphere as CO₂.

Lowland soils in Denmark have been drained at a large scale since the 19th century, and greenhouse gas emissions have as a consequence been ongoing for the past hundred to two hundred years.^[170] Rewetting this land is expected to halt the decomposition of organic materials, prevent greenhouse gas emissions and safeguard that remaining soil carbon is kept in the ground.^[171] Rewetting is done by blocking existing drain pipes, raising ditches, and eventually restoring natural water courses. The goal of this process is to recreate the natural hydrology of the area.

Uncertain climate results of rewetting

There are ongoing scientific discussions of the climate effect of rewetting agricultural soils. The assumption behind rewetting measures is that the lowland areas will stop emitting or, ideally, start sequestering CO₂. Researchers are however pointing to the fact that the restored wet areas are different to natural wetland areas in several ways.^[172] In restored areas there will be higher nutrient content from residual fertilizer, the hydrology is not completely natural and there has been changes in the microbial fauna. Rewetted peatlands have been demonstrated to emit methane, possibly as an effect of the existing plant and microbial community, for which it can take many years to return to natural conditions.^{[173],[174]} Methane is a highly potent greenhouse gas, and it is created when there are oxygen poor conditions in the soil, which is often the case after water has been reintroduced to the area. Methane emissions can create uncertainties regarding the actual capacity

168. The Danish Climate Council (2020)

169. The Danish Climate Council (2020)

170. REAS (2022)

171. Danish Environmental Agency (2022)

172. REAS (2022)

173. Emsens et al (2020)

174. Hemes et al. (2019)

of rewetted lowland soils to act as carbon stores or sinks in the short term, and there are several ongoing research projects that are aiming to quantify the expected climate effects.

In order to ensure that they act as a climate benefit it may be necessary to have more active management of the restored areas to support the natural flora and fauna, hydrology and microbial processes.

Rewetting for nutrient retention and biodiversity

Draining of agricultural soils and subsequent continuous adding of fertiliser have contributed to nutrient pollution of Danish lakes and coastal waters. Drainpipes provide a fast track where nutrients that are brought with the water quickly get transported to water bodies and the sea where they cause ecological issues through eutrophication and oxygen depletion. By blocking draining routes, the nutrient rich water is instead filtered through the soil where nutrients are held back. Stopping intensive agricultural production on the land will also mean a halt to fertilizer addition in these areas, decreasing the risk for airborne ammonia pollution which is known to have consequences such as eutrophication of soil and water bodies as well as increased acid deposition.^[175] 95% of ammonia pollution in Denmark is estimated to stem from agriculture.

Nutrient levels are also inevitably connected to the potential nature quality of rewetted areas, and researchers point to the fact that for efficient biodiversity outcomes, rewetted soils should be nutrient poor.^[176] On Danish land areas, biodiversity is generally high where nutrient levels are low, which means that many species, including threatened species, thrive in nutrient low conditions. In order to provide new habitats for a large diversity of species through rewetting, prioritising nutrient poor areas is the way forward. Other barriers that are relevant to address is that the rewetted area is very different from its natural state, making it difficult for wild populations to recolonise successfully.^[177] Moreover, the natural seed bank is likely to be diminished after years of soil disturbance through ploughing. Though no official evaluations have been found from the rewetting projects, it is expected that rewetting agricultural soils can have a positive effect on biodiversity, especially if combined with grazing animals that keep the areas open.

175. Danish Environmental Agency (2022b)

176. Bruun & Sand-Jensen (2022)

177. DCA (2021)

A Mix of Measures help Protect Shoreline Forests of Finland

The heterogenous private ownership of lands is a fundamental attribute in Finland, affecting opportunities and constraints of maintaining and restoring biological diversity. A majority of Finnish shoreline lands are privately owned, and throughout history, shoreline lands have been social and economic hot spots in Finland. Shoreline soils are fertile and have attracted farmers and settlements and are at the same time biodiversity hot spots in Finland. EU Natura 2000 designations, ecological compensation and a Sustainable Forestry Financing Act have provided important protective measures.

‘Shoreline Terrestrial Ecosystems’ are the stretch of land spanning 30 meters from the shoreline. Finland has approximately 300,000 km of shoreline, and shoreline terrestrial ecosystems cover roughly 900,000 hectares. The shorelines are related to both the coast and lakes. Recent surveys suggest that there are 180,888 lakes (larger than 500 m²) and 185,759 islands (larger than 100 m²) in Finland, making shoreline lands tremendously widespread.

Biodiversity hotspots and important ecosystems for climate change mitigation and adaption

Shoreline lands are diverse and ecologically important. More than half of the shoreline forests are forested with broad-leaved trees such as black alder (*Alnus glutinosa*) and the endangered water elm (*Ulmus laevis*).^[178] Many rare and endangered species of flora and fauna depend on the interface of terrestrial and littoral ecosystems; especially amphibians, but also numerous other terrestrial and aquatic organisms.^[179] In Finland, the amphibian crested newt, *Triturus cristatus*, is rare and endangered. Rare birds like white-backed woodpecker (*Dendrocopos leucotos*) and Eurasian golden oriole (*Oriolus oriolus*) dwell on shoreline forests. Beavers (*Castor fiber*) and otters (*Lutra lutra*) live by the shores. In addition to hosting biodiversity, shoreline vegetation modifies the leaching of elements such as carbon and nitrogen into aquatic ecosystems, affecting the chemistry of freshwater ecosystems.^[180]

Shoreline forests are similar to upland forests regarding climate change mitigation and adaptation. When carbon stock in vegetation and soils builds up, the forests act as both carbon pools and carbon sinks. Conservation is considered the best strategy for sink maintenance, contributing more effectively to carbon storage, while preserving the biodiversity associated with old-growth forests.

178. Spiecker et al. (2009)

179. The Ministry of the Environment (2019)

180. Lepistö et al. (2021)

Economic activity and climate change are pressuring the shoreline forests

In the past, the timber resources of forests were strongly exploited along the shores, as floating was readily available. At present, the harvest pressure of shoreline trees is strictly controlled,^[181] but climate change has put a strain on the world's forest resources. As the demand for wood products and renewable energy increases, Finland wishes to increase annual wood use from 65 mill m³ to 80 mill m³. An intensification in biomass removals can affect both forest biodiversity and ecosystem services, including carbon sequestration, in a negative way. It is crucial to identify the best management and utilization options that secure multiple forest values. Other threats prevail. This includes agricultural pollution, invasive species such as North American minks and racoon dogs, and high pressure from recreational activities. Climate change is also impacting species and ecosystem services, demanding that nature conservation is developed from the current static approach to more of a dynamic approach that takes changes in species distributions and faster evolving nature types into account.^[182]

Multiple measures provide aid

The EU Natura 2000 Programme was the first major attempt in Finland to specifically address protection and sustainable management of shoreline lands.^[183] Forested shoreline ecosystems are now half-way from turning from pastoral ecosystems to old-growth forests. Trees which gradually gained space in the 20th century on the abandoned grazing lands are approaching their maturity and death. Contemporary coastal forests consist of trees, which are typically 50–100 years old containing low, but gradually increasing frequencies of dead trees, snags, and logs.^[184]

In 2018, Finland launched the six-year project 'IBC-Carbon' that aims to provide knowledge on the effects of climate change through forest growth modelling, biodiversity modelling, as well as knowledge of carbon budgeting, and ecosystem services. To ensure better implementation of the project findings, one aim of the project is to provide suggestions for adaptations of the Finnish Forestry Framework and for a compensation scheme for forest owners. The scheme will give compensation for carbon storage/sequestration and biodiversity conservation.^[185]

The Sustainable Forestry Financing Act last amended in 2017, provide foresters possibilities to apply for subsidies for numerous types of works and projects.^[186] This includes environmental support for forestry to preserve habitats of special

181. The Island Committee (2007)

182. Kuusela et al. (2018)

183. SYKE (2018a)

184. The Ministry of the Environment (2022a)

185. SYKE (2018b)

186. Metsäkeskus Forest Centre (2022)

importance, and support for forest nature management projects in terms of restoration, habitat rehabilitation and management, and eradication of invasive species. It is moreover an aim to initiate projects of regional significance, emphasizing management of forest nature and the multifunctional use of forests, as well as landscape, cultural and recreational values.

Preserving coastal forest as ecological compensation

Local measures are equally important for shoreline forests. The City of Lahti is pilot testing ecological compensation in an urban environment, which is a novel approach in Finland.^[187] The municipality wishes to reduce biodiversity loss, but damaging local nature is inevitable when undertaking large construction projects. This loss of nature can, however, be compensated by conserving a natural area elsewhere. The city is constructing a new housing zone in one area of the municipality, damaging the nature in this area, and as compensation, the city will preserve the coastal forest in Alvojärvi. Alvojärvi has a high species diversity with many valuable old trees.

Ecological compensation

Ecological compensation means that local damage inflicted by humans on nature is offset by enhancing natural diversity elsewhere. Compensation can be done through restoring, managing, or protecting habitats. Compensation is a useful tool where harm cannot be avoided or alleviated on the spot (SYKE 2019).

The importance of a diverse approach

In summary, shoreline lands must not be managed as a uniform, monotonous system but rather as a diverse oasis of nature, wildlife, society, and economy. Due to multiple landowners, collaboration and compensation schemes are important to protect the Finnish shoreline forests.

Accelerating Peatland Restoration through National Wetland Restoration Action Plan in Norway

Restoring carbon dense wetland such as peatland is an important contribution to safeguard existing carbon stocks,^[188] and is one of the national actions taken to reduce greenhouse gas emissions in Norway. In order to support the efforts, Norway has adopted a national action plan on wetland restoration,^[189] which has accelerated peatland restoration in the country.

In 2016, Norway adopted the first generation of the national action plan on wetland restoration, covering a five-year period from 2016 – 2020. Currently, the second plan is in action, covering the period 2021–2025.^[190] The three main restoration goals in the Wetland Restoration Action Plan are to limit greenhouse gas emissions, ensure climate adaptation, and improve ecological conditions. Although the goals are stated as equally important, the emphasis of the three goals may differ among individual projects implemented under the program.

The Wetland Restoration Action Plan (WRAP) is a follow up of the Norwegian National Biodiversity Strategy and Action Plan,^[191] which states that restoration of wetlands is an important action to reach Aichi target 15 – restoring 15% of degraded ecosystems. 90% of the restoration efforts implemented through WRAP is peatland restoration.^[192] Restoration of peatlands in Norway started in 2016, and up to 2020, 80 mires have been restored. The restored sites have so far been within protected areas, but recently other state-owned properties are restored, and private landowners can voluntarily provide sites for restoration.

Restoring mires supports biodiversity and ensures carbon capture

The dominant wetland type in Norway is mires, covering 9% of the land area.^[193] Norway has a wide and unique range of mire types due to varied topography and climate. Mires hold large below ground carbon stocks, due to water-logged conditions that slow down decomposition and accumulate organic material as peat. Water-saturated areas have traditionally been considered waste land, and about 7000 km² of mires have been drained for agricultural and forestry purposes.^[194] Draining mires leads to decomposition of peat, and the total CO₂ emissions from drained wetlands were estimated to be equivalent to 10% of Norway's total emissions in 2013.^[195]

188. Günther et al. 2020

189. Norwegian Environment Agency 2016, 2020

190. Norwegian Environment Agency 2020

191. NBSAP; Norwegian Ministry of Climate and Environment 2015

192. Norwegian Environment Agency 2020

193. Bryn et al. 2018

194. Joosten et al. 2015

195. Joosten et al. 2015

Most of the degraded peatlands that have been restored under WRAP had one or several ditches draining the system. The drier conditions change the species composition and promote tree growth along the ditches. Measures used to restore the water table to ground level are removal of trees and blocking ditches. The ditches are filled with leftover wood, and plugs are made at a regular interval to stop the water flow. This hydrological restoration is called rewetting. The plugs are made of peat extracted on the site and placed at every 20 cm increase in elevation. When possible, the ditches are filled completely, and vegetation turfs placed back on top of the filled ditch. Excavators are used to perform the measures.

Restoring biodiversity and the ecological function of mire ecosystems is beneficial for carbon capture. Rewetting peatlands increases the water table level and stops the decomposition of organic matter in the peat layer. It does, however, also lead to anaerobic conditions, increasing the production of methane,^[196] a climate gas 28 times as potent as carbon dioxide in a 100-year time horizon.^[197] On short term, the rewetting of degraded mires will increase the release of carbon, but the long-term effect is that rewetting reduces climate warming.^[198] There is, moreover, growing evidence that a cover of peat mosses (*Sphagnum*) rapidly reduces these emissions,^[199] as peat mosses live in symbiotic relationships with methanotrophic organisms consuming methane. Thus, restoring biodiversity in mires, e.g., applying revegetation measures that re-establish the peat moss cover fast, seems to be highly important to limit methane emission from rewetted peatlands.

Monitoring is in place, but can be improved and must be continued

Long term monitoring is necessary to evaluate whether the three main goals of the Wetland Restoration Action Plan are met. Monitoring of the restoration outcome is established for two of the three restoration goals: i) Limit greenhouse gas emission and ii) improve ecological conditions. The effect for climate adaptation lacks monitoring. To evaluate if the goal to limit greenhouse is reached, fluxes of greenhouse gasses are monitored before and after restoration at one site in Trysil, Innlandet, using eddy covariance flux towers. In addition, the water table level is measured at the site. Vegetation is monitored at five sites to document the effect of restoration of vegetation^[200] in order to evaluate if the goal of improved ecological condition has been reached. Furthermore, a simplified monitoring set up, so called extensive monitoring, was implemented from 2017 to evaluate ecological condition in 60% of the restored sites.^[201] Analyses of vegetation data indicate that 5 years is too short a time span to detect effects from restoration, but also that intensive monitoring at the species level might be necessary to evaluate the success.^[202]

196. Günther et al. (2020)

197. IPCC AR5 (2014)

198. Günther et al. (2020)

199. Putkinen et al. (2018); Huth et al. (2021)

200. Hagen et al. (2015); Kyrkjeeide et al. (2018); Kyrkjeeide et al. (2021)

201. Lunde (2021)

202. Lunde (2021)

Peatmosses can provide further ecosystem services

The national action plans have accelerated peatland restoration in Norway, and peatland restoration has become one of the largest national restoration programs. Although the hydrological conditions seem to be restored at the sites, there is limited data on the success of the restoration on climate mitigation and ecological processes. Scaling up the monitoring of measures to evaluate the restoration success would aid in transferring the knowledge and competence, Norway has built up the last years, to neighbouring countries. The variation of mires found in Norway gives valuable experience in practical restoration work, as different mires may need individual approaches. The next step in Norwegian peatland restoration will be to include measures of ecological restoration, e.g., revegetation with peat mosses. This could further improve the ecosystems' function, and when successful, eventually restore a wider range of ecosystem services. We see raising awareness of implementing such measures in mitigation of nature loss in development projects. As peat are still extracted in such projects, reuse of peat as a nature-based solution could limit the greenhouse gas emission and biodiversity loss.

Pointing out Eelgrass Meadows as Protected Areas in Sweden

The City of Gothenburg decided in 2021 to protect the remaining eelgrass meadows in the Gothenburg archipelago. The plan is to establish marine biotope conservation areas to protect the threatened ecosystem.

Drastic decline of eelgrass meadows in Bohuslän

Eelgrass (*Zostera marina*) is the most common seaweed along the Swedish west coast. It grows in shallow waters in muddy and sandy bays with low to moderate wave exposure, where it forms dense meadows.^[203]

Eelgrass has experienced a drastic decline in the northern hemisphere. In Bohuslän, about 60% of the eelgrass has disappeared since the 1980s, which is equivalent to a loss of 12,500 ha. The main reasons for the decline are associated with coastal eutrophication, overfishing and increased coastal exploitation.^[204] Although overall water quality has improved in the last decades, natural seagrass recovery has not. The reasons for this are related to ongoing exploitation of Swedish coasts.^[205]

203.Göteborgs Stad (2021)

204.Havs- och Vattenmyndigheten (2017); Göteborgs Stad (2021)

205.Havs- och vattenmyndigheten (2017)

Eelgrass meadows provide key habitats for marine species

Eelgrass meadows are critical to biodiversity. They provide an important habitat for species tied to shallow coastal areas and serve as nursery habitat for fish including commercially important fish such as Atlantic cod, whiting, and eel.^[206] The loss of this habitat type and the ongoing fragmentation of habitats not only negatively impacts the genetic diversity of the meadows themselves, but also the genetic diversity of the species associated with them, possibly resulting in an extinction vortex.^[207]

Due to the continued decline in population size associated with range reduction, deterioration in habitat quality, and decreasing numbers of reproductive individuals, eelgrass has been classified as vulnerable in the 2020 Swedish Red List.^[208]

Eelgrass meadows act as carbon sink and help water regulation

Apart from providing habitats for marine species, eelgrass meadows provide a number of other ecosystem services. Not least, they are crucial for climate mitigation. Eelgrass meadows bind and store carbon in sediments,^[209] making them one of the most effective carbon sinks worldwide.^[210] This is related to three factors. First, eelgrass meadows tend to have high primary productivity. Secondly, seagrass meadows slow water movement, which promotes particle deposition and prevents sediment erosion. And finally, eelgrass has a low rate of decomposition.^[211]

Eelgrass helps stabilize the bottom which reduces sediment resuspension. It also cycles nutrients such as nitrogen and phosphorus which reduces eutrophication. Both these effects have positive implications on water quality.^[212]

Link to national and international policies

The decision by the city of Gothenburg to establish marine biotope areas contributes to the achievement of the national environmental objectives 'A rich diversity of plant and animal life' and 'a balanced marine environment, flourishing coastal areas and archipelagos'.^[213] On the international level, it can be linked to the UN Convention on Biological Diversity, the Oslo–Paris Convention (OSPAR) and Helsinki Commission (HELCOM).^[214] Eelgrass meadows are an area of concern in the action plan for endangered species and habitats by the Swedish Agency for Marine and Water Management where the necessity of both restoration of lost

206.Havs- och vattenmyndigheten (2017)

207.Jahnke et al. (2020)

208.SLU Artdatabanken (2020)

209.Havs- och vattenmyndigheten,(2017)

210.Moksnes et al. (2021)

211. Duarte et al. (2013); Fourqurean et al. (2012); Prentice et al. (2020)

212. Havs- och vattenmyndigheten (2017)

213. Naturvårdsverket (2018)

214. Göteborgs Stad (2021); Göteborgs stad (2019)

eelgrass meadows and the protection of intact meadows has been highlighted. The program states that the need to protect eelgrass meadows is particularly great in southern Bohuslän, and that work on establishing biotope protection for eelgrass meadows should be prioritized and intensified.^[215]

The effects are monitored

The suggestion to establish marine biotope areas in Bohuslän was accepted in 2021. The plan is to establish a marine biotope of an area of 20 ha. An evaluation of the distribution of eelgrass has been carried out by means of aerial photography, aerial photo interpretation by GIS and field verification. The evaluation showed a total area of 990 hectares of eelgrass meadows in the depth range of 0 to 6 meters within the sea area of the city of Gothenburg. The field verification pointed out that 35% of the number of eelgrass areas identified at the first aerial photo interpretation consisted of other vegetation or were vegetation-free at the time of verification.^[216]

Preserving eelgrass meadows is more cost-effective than restoring or losing it

The costs of creating a marine biotope of 20 ha are estimated to be about 40, 000 SEK. Added to this are the working time amounting to 47,000 SEK (80 hours) and the costs for follow-up of 50,000 SEK every three years.

The costs of establishing the protected area were weighted against the costs if the area is not protected and the ecosystem is lost. The evaluation has shown that preserving eelgrass meadows is more cost-effective than restoring or losing it.^[217] It is calculated that the costs for restoration amount to 1.2–2.5 million per hectare.^[218] In addition, the success of eelgrass restoration measures is uncertain, and it takes at least 5 to 10 years for the structure and function of the planted meadow to be fully established.^[219] Consequences of the loss of eelgrass meadows are the loss of important ecosystem services including carbon sequestration, water regulation, biodiversity, stabilization of sediments, nitrogen and phosphorus uptake and production of food. An economic quantification of losses is difficult.^[220] However, the loss of eelgrass meadows in Bohuslän was estimated at a minimum of 4 billion SEK up to 20 million SEK.^[221]

215. Havs- och vattenmyndigheten (2017)
216. Göteborgs stad (2021)
217. Göteborgs stad (2019)
218. Havs- och vattenmyndigheten (2017)
219. Göteborgs stad (2021)
220. Göteborgs Stad (2019)
221. Miljöpartiet (2021)

The costs for the assessment of the eelgrass meadows were partially funded with LONA grants provided by the Swedish Environmental Agency.^[222]

Stakeholder involvement

Within the city of Gothenburg Council, the main stakeholders involved are the building board and the Environment and Climate boards. Collaboration with neighbouring municipalities and the municipal network's nature conservation group run by Energikontoret Väst is planned. The county administrative board cannot currently prioritize the creation of marine biotopes in the Gothenburg archipelago but offered support.



Photo: Sebastian Sundberg

Afforestation done by Farmers - Payment for Ecosystem Services in Iceland

After settlement, woodlands in Iceland rapidly decreased from covering 25% of the terrestrial area to only covering 1% at the turn of the 20th century. Several afforestation projects have been initiated during the last century. Today, paying for ecosystem services (PES) schemes are the most used measure for afforestation projects. "Forestry on farms" is a popular afforestation scheme, where farmers are paid for afforesting their land. Afforestation is one of the measures in Iceland's Climate Action Plan, and to execute this, the Government is going to increase funding to the scheme. There are numerous benefits to afforestation; besides carbon sequestration, afforestation can increase biodiversity, water quality, and provide better shelter for Icelandic farmland. However, the benefits depend on the choice of tree species, the type of land afforested, and the location of the land chosen for afforestation, not all land is appropriate for forestry. Namely biodiversity can suffer from land use change, land use change often leads to a change in species composition.

A century of afforestation in Iceland

The planting on the presidential estate Thingvellir in 1899 is the first afforestation project undertaken in Iceland. Iceland adopted their first Forestry Act in 1907, which already contained afforestation aspirations. A new forestry law was adopted in 1955, and since the 1950s, the forested area in Iceland has more than doubled.^[223] This is both due to reforestation and natural extension of birch woodlands, but especially due to afforestation schemes.

One of the first attempts to afforest private land with state funding took place in 1970. From 1950 to 1990, The Icelandic Forestry Service (IFS) was responsible for most of the afforestation, but since the 90's, afforestation done by farmers has been the main source for new forests. In 1990, the Héraðsskógar Project was launched. This was the first regional afforestation project where farmers received government incentives for afforestation.^[224] The project received a lot of positive attention in Iceland, and other regional afforestation projects were established. In 2016, "Forestry on Farms" was created as a successor to regional afforestation projects.

223. Icelandic forestry service (2022a)

224. Brnkalakova et al. (2021)

The forested area in Iceland has increased annually with approx. 5% in the period 1990–2015. In 2016, the native birch forests covered 1,506 km and cultivated forests 400 km². Carbon sequestration in forests planted after 1990 is equivalent to 210,000 tonnes of CO₂.^[225] Thus, far most of the afforestation and reforestation have been dependent on state funding regardless of land ownership. The financial crisis in 2008 led to severe budgets cuts in the forest programmes, and the number of trees planted rapidly decreased in the following years. However, with the new forestry act and international obligations, there are once again aspirations to increase afforestation measures in Iceland.

A new national law for the forests

The new Forestry Law was passed in 2019, replacing the old legislation from 1955 and the Act on Regional Afforestation Programmes from 2006.^[226]

Article 1 describes the aim of the new legislation:

- a. To protect the country's natural forest and support its natural expansion**
- b. To protect and restore biodiversity**
- c. To continue afforestation for increase the Icelandic timber stocks for sustainable use**
- d. To use the forests sustainably, in a way that give the users of the forest the biggest economic, social, and environmental benefits to society**

The new legislation also prohibits clearcutting without permission.^[227]

Protecting and restoring biodiversity is one on the goals of the new Forestry Act. All planned forest plantations and afforestation efforts need to consider nature protection and landscape influence to prevent potential negative effects on biodiversity. Afforestation is considered one of the most effective measures to reclaim degraded land, re-establishing ecosystem processes, providing habitats, and preserve soil and water quality.^[228]

Reforestation and afforestation are often highlighted as nature-based solutions to mitigate climate change. Reforestation and afforestation are a key part of the Icelandic Climate Action Plan 2018–2030: "Reforestation and afforestation will be strengthened by a substantial increase in government funding to increase carbon uptake from the atmosphere, as well as for meeting other objectives. A special reforestation and afforestation plan will be made to allocate the increased resources".^[229] All the forestry measures presented in the climate action plans were reported implemented in the 2021 progress

225. Icelandic Forestry Service (2022b)

226. Act on Regional Afforestation Programs on Icelandic farms no 95/2006 (2006)

227. Alþingi (2019)

228. European Commission (2021)

229. Ministry for the Environment and Natural Resources (2020)

report.^[230]

In collaboration with the EU: Forest reference levels & the regulation on land use, land-use change and forestry

Iceland is part of EFTA. In 2020, Forest Reference Levels (FRLs) for Iceland was adopted. FRLs are used across the EU to account for greenhouse gas emissions and removals. They are a useful tool to track how managed forests contribute to the climate efforts of a country. Adoption of FRLs in Iceland is a result of a decision for the EFTA countries to extend the EU collaboration on climate actions, aligned under the regulation on land use, land-use change and forestry (LULUCF Regulation).^[231]

The Icelandic Ministry of the Environment and Natural Resources have published their planned LULUCF activities for the period of 2019–2022, where one of the activities is an increase in annual afforestation from 1,100 ha (2018) to 2,300 ha in 2022. The main measure to achieve this is by increasing grants for the farm afforestation scheme.^[232]

EU policies promote similar measures

The EU recognizes a need to reward farmers and landholders for the provision of forest ecosystem services, such as carbon sequestration. In 2021, the European Commission approved The New Forest Strategy for 2030. In the new strategy, Payment for Ecosystem Services (PES) schemes, such as the Icelandic afforestation scheme, is listed as a successful measure for rewarding farmers for their provisioning services.^[233] "Considering the increased climate and biodiversity ambition of the EU, the Member States are specifically encouraged, as relevant to their national circumstances, to set up a payment scheme for ecosystem services for forest owners and managers, in order to cover for costs and income foregone."

Payment for Ecosystem Services (PES)

are defined as a transfer of resources between social actors, which aim to create incentives to align individual and (or) collective land use decisions with the social interest in the management of natural resources to enhance or safeguard the provision of specific or bundled ES.

230.The Environment Agency of Iceland (2022)

231. ESA (2020)

232.Icelandic Forestry Service (2019)

233.European Commission (2021)

Other EU action plans also promote the use of PES schemes as an important policy tool for implementing European Green Deal^[234] and the Biodiversity Strategy to 2030.^[235]

The farm afforestation scheme Forestry on Farms since 2016

Researchers interviewed several farmers who have done afforestation projects on their lands with funding from the farm afforestation scheme. The study found that: "Overall, farmers have recognized the positive impact of afforestation on various regulating, cultural, and provisioning ES."^[236] A high amount of trust in the governmental institutions was identified as an enabling factor for the initial recruiting of farmers, the subsequent success of the program and the overall positive response from the farmers.

Observed benefits from Participation	Obstacles – room for improvement
● Improvement of in the microclimate leads to a reduction of climatic extremes ● Recreational value of forest mushrooms, berry picking etc. ● The opportunity to protect the landscape and to recreate the landscape of earlier times ● Tourism opportunities ● Contributing to sustaining sheep farming	● Inconsistent monitoring ● Lack of adequate professional advice for older forest stands ● Inconsistent governmental support has led to high fluctuations in the annual seedling production ● Underdeveloped timber industry in Iceland, makes it hard for farmers to hand off their timber

Successful afforestation^[237] was seen to be dependent on proper planning and site selection, the provision of education and advisory services to the farmers, and building and maintenance of fences to protect new forest stands from grazing sheep. Moreover, an app was developed to improve the tasks of monitoring and mapping for the farmers.

234. European Commission (2019)
 235. European Commission (2020)
 236. Brnkalakova et al. (2021)
 237. Brnkalakova et al. (2021)

Afforestation on Iceland: Choosing the right kind of tree

Large scale afforestation began by end 20th century with the regional afforestation programmes. One of the primary goals were initially to support rural development,^[238] but also land reclamation, timber production, recreation and providing shelter for crop cultivation and livestock are goals for afforestation. In later years, focus has partly shifted to environmental and social purposes, and especially afforestation as a mitigation tool for combating climate change is highlighted.^[239] Afforestation reduces atmospheric CO₂ by storing carbon in growing biomass, vegetation, and soil.^[240] Furthermore, continued emissions from degraded soils are halted.

Breeding and test programmes are on-going for several tree species. These include efforts to better adapt the trees to the current Icelandic climate and a future warmer climate with what it entails of pests and pathogens. Climate change is likely to impact what tree species that thrive in Iceland. There are for example indications that the native birch will suffer in a warming climate.^[241] This will greatly impact the forests of Iceland.

When a forest is established on previously unforested land or land deforested centuries ago, it affects ecosystems, landscapes, and rural development all together; especially when new tree species are introduced, which is sometimes the case in Iceland. It is not a foregone conclusion that an afforestation project will benefit biodiversity.^[242] Iceland only has a few native tree species, and birch is the only one that forms woodlands and forests. Many of the trees planted in afforestation schemes are therefore non-native.

Conflict of interests on limited land

There are continuing discussions in Iceland on how increasing afforestation schemes impact biodiversity, namely how it impacts migratory birds by altering their breeding grounds.^[243] When the land changes from being open to being forested, the species composition change as well. The type of trees used for afforestation can also impact species composition. Studies show that the abundance of species remains largely unchanged between native birch forest and forests with introduced tree species, but introduced tree species might change species composition.^[244] Some studies have found higher density of breeding birds and soil fauna in both native birch forests and in coniferous plantations compared to heathlands, but changes in species composition was observed as well, with the

238.Brnkalakova et al. (2021)

239.Government of Iceland (2020).

240.Nordic Council of Ministers (1996)

241. Icelandic Forest Service (2022a)

242.Nordic Council of Ministers (2008)

243.Nordic Council of Ministers (2008); Pálsdóttir et al. (2022)

244.Nordic Council of Ministers (2008); Pálsdóttir et al. (2022)

pre-existing biodiversity being negatively affected.^[245] Since Icelandic lowland areas are important breeding grounds for migratory birds there is a need to be precautionous.^[246]

A recent study shows that size and shape of the forest patches impact wildlife differently, and the pressures on migratory birds tend to be higher when afforestation occurs in small, dispersed blocks across the land, compared to when it is concentrated in on large block instead. It is therefore important to have an overall cohesive strategy for the afforestation schemes in Iceland that account for biodiversity conservation.^[247] The case of afforestation in Iceland illustrates how intertwined the climate and nature crises are, and what a balancing act it is to address one crisis without risking contributing to the other. Therefore, it is crucial to address the crises together.

A government Resolution to Change the Path of Peatlands in Finland

Efforts by the Finnish Government to protect and restore peatlands were accelerated in 2011 with a Peatland Strategy issued by the Ministry of the Agriculture and Forestry. The strategy was followed by a Government Resolution on the Sustainable Use and Protection of Peatland in 2012, and a proposal for a Conservation Programme in 2015.^[248] The government resolution is built on an ecosystem service approach suggested in the Peatland Strategy, including environmental, social and economic objectives. It outlines that - in general - natural mires will not be exploited. Instead, future harmful activities are directed towards already drained or altered sites.^[249]

Wetlands make up approximately a third of Finland's land area. Drainage of peatlands for forest production has been a large-scale land use change since the 1950s. Additionally, peatlands have been used for agriculture and peat extraction, providing resources for fuel and growth medium for plants. The drainage and extraction of peat has been most prevalent in the southern part of the country, while peatlands in the northern part of the country to a larger extent have been left untouched. The history of peatland exploitation is reflected in the current protection state of peatlands, as 66% of protected peatlands are located in northern Finland.^[250]

245. Icelandic Institute of Natural History (2022)

246. rsson et al. (2005)

247. Pálsdóttir et al. (2022)

248. The Finnish Government (2012)

249. The Finnish Government (2013)

250. GTK (2020)

Drainage and peat extraction lead to wide-scale greenhouse gas emission and ecological degradation

Peatland drainage has significant effects on greenhouse gas emissions, as it oxygenates organic material and allows for decomposition, which releases CO₂ and other greenhouse gases to the atmosphere. The greatest carbon losses in Finland are a result of peatlands drained for forestry, but drainage for agricultural land, peat extraction and other exploitation forms have also contributed to decreases in the peatland carbon pools. Moreover, drainage disturbs the nutrient cycle, contributing to nutrient leaching through runoff water as well as leaching of metals, dissolved organic carbon and particles.^[251] This affects the water quality of downstream water bodies, increasing the risk of organic pollution and eutrophication.

Finnish peatlands host unique ecosystems with species that commonly are poorly adapted to other habitats. Degradation of peatland habitat has as such led to decline in biodiversity in these areas. As an example, population sizes of peatland birds in Finland declined by 50% in 1981–2014.^[252]

The National Peatland Strategy in line with EU regulation

The Finnish Peatland Strategy was decided in 2011 and followed by a Government Resolution on the Sustainable Use and Protection of Peatland in 2012, which implemented the ecosystem approach of the 2011 strategy and environmental, social and economic objectives. Together with the Conservation Programme of 2015,^[253] it was ensured that natural mires will not be exploited, and that any future harmful activities will be directed to already drained or altered sites.^[254]

At EU level, the Habitats directive and the Natura 2000 network of protected areas draw up the legal framework for peatland protection. Peatlands are also a part of the EU Biodiversity Strategy, where peatlands are one of the target nature types for strict protection. In June 2022, the Commission of the European Union adopted a proposal on an EU Restoration Law which will include binding targets for peatland restoration.^[255]

Synergies between biodiversity decline and climate effects are clear and can be addressed as such

Plant communities have been found to guide the rate of CO₂ assimilation in mires, and loss of native communities lowers the rate, providing an example of the interlinkage between biodiversity decline and negative climate

251. Menberu et al. (2017)

252. Fraixedas, S. et al. (2017)

253. The Finnish Government (2012)

254. The Finnish Government (2013)

255. European Commission (2022)

effects.^[256] Climate change also has negative impacts on peatland biodiversity, for instance through disturbance of hydrology patterns and through reducing the natural resilience.

Meanwhile, there are synergistic measures which provide benefits for the climate and biodiversity. Several complementary political measures have followed the Government Resolution. Legal instruments were implemented through amendments in the Forest Act and the Environment Protection Act in 2014.^[257] In the Environmental Protection Act, the amendment implied that peat extraction permits could only be granted if there were no negative consequences to nature values of local or national interest. Other measures include the Finnish Biodiversity Action Plan connected to the Convention on Biological Diversity, which includes five actions to improve wetlands and mires. Moreover, there is the METSO programme (case XX) with a focus on forested mires, and the Helmi Habitats Programme launched in 2020, under which protection and restoration of mires is a focus.^[258]

Protection and restoration as on the ground measures

Around 14% of peatlands currently lie in protected areas. Peatland restoration has been done at a large scale in Finland, resulting in 25,000 ha of mires in protected areas restored between 1989 and 2018. The mainstream method for restoration projects has been according to a best practice handbook by Metsähallitus Natural Heritage Services and The Finnish Environmental Institute.^[259] Many peatland restoration projects have been carried out as a part of EU LIFE projects. Restoration has been done using an ecosystem-based approach, with the primary aim to increase biodiversity. Climate change mitigation is also one of the goals.

Biodiversity wins – but an array of measures is needed for cost-effective implementation

The Finnish Nature Panel is an independent board of scientists that are appointed to collect scientific evidence for the decision making in Finland. They have concluded that peatland restoration is an important tool for safeguarding biodiversity in Finland.^[260]

A study on data from almost 800 state-owned forestry-drained peatland stands in Northern Finland examined the effects of seven different land use and land management options for peatlands on biodiversity, climate impact and water emissions. The study aimed to find which combinations that could contribute jointly to biodiversity and ecosystem services such as climate mitigation and water protection in a cost-effective manner. It was concluded that trade-offs between biodiversity and previously mentioned ecosystem services, indicating that

256. Leppälä et al. (2011); Riutta et al. (2006)

257. Salomaa et al. (2018)

258. METSO (2022); Finland's Ministry of the Environment (2022)

259. Similä et al. (2014)

260. Finnish Nature Panel (2021)

compromises in land use and land management were necessary in order to cost-effectively provide biodiversity, climate change mitigation and water protection, since no management option alone can fulfil all objectives. In order to manage cost-effectively, a combination of management options is therefore needed.^[261]

Local people in favour of protection and restoration

When people in the northern Ostrobothnia region were surveyed on their opinions about peatland use, all respondent categories preferred increase of nature protection and continued restoration of peatlands. This indicated a wide consensus among the local population with the institutional goals of peatland restoration and protection. People whose livelihood depends on productive use of peatlands were more likely to also value continued or increased industrial activities in peatlands, highlighting that despite general agreement on protecting natural values, there are differing preferences on the use of peatlands. When planning local management, it is essential to assimilate these varying preferences while also using the opinions of the local population as an enabler of sustainable transition.^[262]

Promoting Green Roofs in Local Plans in Denmark

The City of Copenhagen promotes green roofs when new construction in the city is planned. It is a voluntary measure that has resulted in an increase in green roofs in the city. There are multiple benefits that can be gained from green roofs when it comes to climate adaptation, biodiversity and pollution. However, these vary greatly between different types of green roofs.

Cities are very vulnerable to climate change. Cities are characterized by large impermeable surfaces, increasing the risk of flooding and damage during heavy rain falls. Temperature dynamics are also different in cities; the grey infrastructure of buildings and roads store heat, and only release it very slowly, allowing the temperature in the city to increase. The dynamics of city heating are called the urban heat-island effect, and the phenomenon is expected to increase in the future due to climate-change, especially in the Nordics.^[263]

The expansion of cities and infrastructure disrupts the surrounding landscape and acts as barriers for species. In the last couple of decades, nature-based solutions in an urban setting have received a lot of attention for the ability to target multiple crises at once. One measure for nature-based solutions in the city is green roofs. Green roofs as green architecture can contribute to mitigating several threats

261. Juutinen et al. (2020)
262. Tolvanen et al. (2013)
263. Zandersen et al. (2014)

posed by climate change. Green roofs have the potential to provide several ecosystem services such as habitats services, regulating services, provisioning services and cultural services. Plants have a cooling effect due to increased evaporation.^[264] The average temperature in green areas is usually 1–2 degrees cooler than the surrounding city, green roofs can therefore mitigate the urban heat-island effect.^[265]

The thicker the better

Green roof is an urban nature-based adaptation measure. It is estimated that green roofs can take 50–80% of the yearly precipitation^[266] Green roofs do not have the capacity to mitigate downpours, but green roofs can reduce and delay rainwater on its way to the sewage system, thus, acting as a buffer capacity for the sewage system.^[267] A new type of roof is a blue-green roof, that has green elements with better water storage capacity. Studies have also indicated that green roofs have a positive impact on the performance of solar panels.^[268]

There are different types of green roofs, the type of greenery suitable for a given roof depends on the thickness of the substrate which again depends on the roof's carrying capacity.^{[269],[270]} Table 2 provides an overview of the different types of green roofs and their respective qualities

264. Zandersen et al. (2014)
265. Jensen & Møller (2013)
266. Københavns Kommune (2012)
267. Zandersen et al. (2014)
268. Irga et al. (2021)
269. Frederiksberg Kommune (2013)
270. Københavns Kommune (2012)

Table 2. Presentation of three different types of green roofs and their respective qualities, Adapted from: Frederiksberg Kommune (2013). Grønne tage og taghaver – kombineret med klimatilpasning i form af LAR og energibesparende tiltag & Københavns Kommune (2012). Grønne tage Det livgivende, klimatilpassede alternativ.

TYPES OF GREEN ROOFS	Extensive	Semi-intensive	Intensive
Short description	Environmental landscape	Environmental landscape & Gardens	Gardens & Parks
Access/stay	Very limited access	Access possible	Full accessibility
Type of vegetation	Mosses, sedum, herbs, & grasses	Grasses, herbs, & shrubs	Lawn, perennial plants, shrubs, & trees
Watering	None	Periodical	Regularly
Thickness of substrate	60–200	120–250 mm	150–400 mm
Weight	60–150 kg/m	120–200 kg/m	180–500 kg/m
Costs	Low	Medium	High

Green roofs have the potential to support biodiversity in the city. Urban green spaces can provide habitats for flora and fauna in the city, and studies show increased fauna species diversity on green roofs compared to conventional roofs.^[271] Numerous factors influence the benefits urban biodiversity can gain from green roofs. Plant species composition and whether the species are native or non-native plants all impact the effects greatly. When green infrastructure such as green roofs are compared to its counterparts in nature, then biodiversity is lower on the green roofs. Green infrastructure generally works best when connected to adjoining natural environments. Whether the roof type is extensive or intensive also matters greatly, and biodiversity is highest on intensive green roofs and lowest on extensive green roofs, which are usually dominated by uniform sedum vegetation.^[272] However even when a green roof is not suitable as a habitat, it can still work as a bio-corridor, creating connectivity in the urban landscape. A popular example of this is the green roofs in Oslo called 'highways for pollinator', allowing bees to cross the

271. Wooster et al. (2022); Filazzola (2019)
272. Zandersen et al. (2014)

city of Oslo.^[273]

The main air pollutants in Copenhagen that exceed threshold values are Nitrogen dioxide and air borne particulate matter (PM₁₀ and PM_{2.5}).^[274] Other urban air pollutants are ozone (O₃), Sulfur dioxide (SO₂) and other nitrogen oxides (NO_x).^[275] Particulate matter is caught on the plant's leaf surface, and can be absorbed and degraded by the plant, but in most cases the particulate matter stays on the leaf surface, until washed off by rain. The surface area of plants is generally larger than for other grey infrastructure and the potential for deposition is therefore higher. The deposition rate varies between different leaf surface types. Plants are capable of absorbing NO₂, O₃ and SO₂ through their stomata and convert them internally. The effects on air pollution are mostly local, and the effect is neglectable on a larger scale, but for the local area it can make a difference.^[276]

A successful voluntary measure

In 2009, the Municipality of Copenhagen published the draft for a climate plan for Copenhagen,^[277] stating an ambition for all new buildings with flat roofs to have green roofs from 2013, applying to both public and private construction projects.^[278] The municipality also set the goal of 325 000 m² green roof by 2015. Green roofs were presented as a measure for rainwater management and as a measure against the heat-island effect, and a tool to provide better and more cohesive green infrastructure in the city. When first announced, the plan was the globally most ambitious plan for green roofs and the plan received a lot of public attention.^[279] However, the ambitions were not fulfilled, as the demand for green roofs on all new buildings was changed to a "when possible" in the climate action plan from 2011,^[280] making it a voluntary measure.

In 2019 it was estimated that approximately 17% of new buildings are constructed with green roofs, which can be considered a successful outcome of a voluntary scheme. According to the Department for Engineering and Environmental Management, green roofs in Copenhagen amounted to 320 000 m² in 2019, almost reaching the 2015 goal. The majority of Copenhagen's green roofs are the extensive roof type with sedum shrubs. In local development plans, green roofs are mentioned as a suggestive measure, to be implemented when assessed to be suitable.^[281]

In the guidelines for environment in construction and facilities from 2016, green roofs are mentioned second in the hierarchy for local handling of rainwater.^[282] In

273. Hudekova (2020)
274. Jensen & Møller (2013)
275. Zakrisson (2019)
276. Jensen & Møller (2013)
277. Københavns Kommune (2009)
278. Teknik- og Miljøforvaltningen (2010)
279. COWI (2009)
280. Københavns kommune (2009)
281. Nielsen (2019A)
282. Nielsen (2019B)

the newest biodiversity strategy, green roofs are one of the measures to improve the grey city.^[283]

Today, there is a need for an actual strategy for green roofs in Copenhagen, to set the trajectory moving onwards. However, the example of Copenhagen illustrates that there can be a way forward when stricter regulation is not an option.

Expertise in our own Region

Even though green roofs are a relatively new measure as green infrastructure in city planning and urban construction, there is a long tradition across the Nordics to construct green roofs on traditional huts and houses. Norway, The Faroe Islands, and Iceland especially have a strong tradition of constructing turf roofs on their buildings.^[284] Modern green roofs originate from Germany, and the measure was developed in the 1960's.^[285] Today, Germany is a world leading expert on green roofs and has more than three mill m² green roofs, and more than 40 years' experience.^[286]

Riparian Vegetation Protection Acts Safeguards Nature-based Solutions in Norway

Protecting or restoring riparian vegetation can be a relatively easy implemented and affordable measure for ensuring nature-based solutions^[287]. Riparian vegetation can provide flood regulation, reduce erosion of riverbanks, reduce pollutants in watercourses, purify air and is important for life in and around watercourses^[288]. Human activity that negatively impacts riparian vegetation is extensively regulated in Norway^[289].

Riparian vegetation can be defined as the natural vegetation such as trees and bushes, growing along waterways from the water's edge to land areas that are not flooded.^[290] A waterway is defined by the Norwegian Water Resources Act § 2 (WRA) as any still or running surface water with year-round waterflow, including the bottom and banks.

Riparian vegetation provides numerous eco-system services

Precipitation has increased in Norway and is expected to increase further in both frequency and intensity in the period towards 2100 as a result of

283.Københavns Kommune (2015)

284.Jim (2017)

285.Jim (2017)

286.Jensen & Møller (2013)

287.Pulg et al. (2018); Skarbøvik et al. (2018)

288.Magnusen et al. (2019)

289.Staubo et al. (2019); Mürer (2019)

290.Pulg et al. (2018)

climate-change.^[291] Increased precipitation causes soils to saturate faster and run-off to lakes, and waterways to increase.^[292] Riparian vegetation can reduce pollution of waterways caused by precipitation, in farmed areas for instance, as sediments and nutrients are filtered through and absorbed by vegetation.^[293] It is also known to play a role in air purification^[294] by providing a reservoir for clean air to replace polluted air in adjacent urban areas or by filtering air and removing chemicals, soot and dust.^[295]

Climate-change will also increase the frequency and severity of flooding in Norway, especially as a result of heavy rain.^[296] Riverbeds and -banks are subject to erosion, especially during flooding, which can result in the loss of farmland and damage to buildings and infrastructure.^[297] Riparian vegetation protects riverbanks against erosion as roots keep the soil in place and reduce the velocity of the waterflow.^[298] Reduced velocity of waterflow also reduces flood damages.^[299] Protecting or restoring natural habitat may also mitigate climate-change as riparian vegetation contributes to CO₂ binding.^[300]

Riparian vegetation is important for biodiversity in and around waterways. It provides food and habitat for terrestrial and aquatic biodiversity such as fish, birds, and pollinating insects, as well as connectivity between habitat patches.^[301] It is, moreover, considered an important landscape element and is beneficial for aesthetics and recreation.^[302]

The effectiveness of regulations – some success stories and a way forward

Research on riparian vegetation in Norway seems to be relatively sector-based (e.g., related to farming, forestry). Below are some encouraging results from selected research projects carried out by the Norwegian Institute of Bioeconomy Research (NIBIO):

- Krzeminska et al., (2022) found a considerable effect of the existing riparian vegetation on soil and phosphorus retention in Vestfold, a region in southern Norway.

291. Norw. Environmental Agency (2021)

292. Magnussen et al. (2019)

293. Pulg et al. (2018); [Vannportalen.no](https://vannportalen.no)

294. Magnussen et al. (2019)

295. Jonassen (2009)

296. Norwegian Environmental Agency (2021)

297. [Vannportalen.no](https://vannportalen.no)

298. [Vannportalen.no](https://vannportalen.no)

299. NIBIO (2020)

300. Norw. Environmental Agency (2022)

301. [Vannportalen.no](https://vannportalen.no)

302. Staubo et al. (2019)

- Stokland (2021) found that forestry in riparian zones has been reduced in Norway the last 15 years. The study found that in 71–80 % of cases with logging in areas close to wetlands, rivers or lakes, a belt of riparian vegetation that was 5 meters or wider was left in 2017. For streams this percentage dropped to 29 % of streams.
- In 2001–2006, approximately 10 000 trees were planted along waterways in Våler municipality and approximately 34 % had survived in 2017 (Skarbøvik et al., 2018). Property owners were largely positive to these re-vegetation efforts (Ibid). A new effort to plant trees along streams has been initiated in four river basin sub-districts I South-Eastern Norway.

On a less positive note, there are also reports of riparian vegetation being exposed to illegal clearcutting and cultivation in Norway (Bjørkli and Wiseth 2018) and in some cases decision-making that allows human activity in these areas are made without enough knowledge about the consequences Aanderaa et al. 2020.

Maintaining riparian vegetation – an extensive set of regulations

Protection and revegetation of natural vegetation growing along waterways are considered relatively affordable measures.^[303] An extensive set of regulations limit actions that may negatively impact riparian vegetation in Norway.^[304] This includes laws regulating the use of water resources, agriculture, municipal planning, forestry, freshwater fisheries and nature diversity.^[305]

A central act is the Norwegian Water Resources Act (WRA). It states that along the banks of waterways with year-round waterflow, a natural belt of vegetation should be maintained to reduce runoff and provide habitat for plants and wildlife (WRA § 11). However, there are some challenges. For instance, no law governs revegetation of riparian zones that are presently without vegetation, and the Norwegian Soil Act states that areas of food production should be maintained and kept for food production.^[306]

Exemptions (permits) from the WRA can be made in certain cases and it is the ecological function of riparian vegetation that should be protected and not the vegetation as

303.Pulg et al. (2018)

304.Staubo et al. (2019)

305.Mürer (2019)

306.Blankenberg et al. (2017)

such.^[307] The way this is practiced is, for instance, that forestry (selection felling) or cultivation (e.g., grass production) can take place as long as the ecological functions of the riparian vegetation are maintained, while clearcutting violates these regulations.^[308] Nevertheless, a riparian zone with grass will have a different impact on biodiversity than one with trees or bushes. Authorities can also specify terms of the permit to minimize environmental impact such as leaving certain trees, gentle removal and transport of timber, no forestry during the breeding season, only allowing revegetation with native vegetation.^[309]

Property owners and the municipality should maintain riparian vegetation through their land management and land use planning, respectively. The municipality should also determine the width of the area that should be maintained when needed.^[310] If riparian vegetation has been removed, it can be restored by planting naturally occurring trees and bushes.^[311] The County Governor (i.e., the state's regional representative) can give exemptions from the requirement of maintaining riparian vegetation, while the Norwegian Water Resources and Energy Directorate (i.e., national agency under the Ministry of Petroleum and Energy) should follow up rule-violations and decide in cases when complaints have been made regarding the authorities' decision.^[312] Maintaining riverbanks is also mentioned specifically in the central government planning provisions for climate- and energy planning and climate adaptation. These planning provisions also specify that nature-based solutions should be considered in all plans following the Planning and Building Act.

No studies have assessed the state of riparian vegetation nationwide and its implication for outcomes such as climate adaptation, climate mitigation and biodiversity. Research has also yet to be synthesized across sectors. As a potential way forward, indicators of riparian vegetation state could be included (more comprehensively, in some cases) in environmental state assessments under the Water Framework Directive (2000) of waters in the EU and Norway.^[313] The Water Framework Directive has been adopted by Norway through the Water Regulation from 2007 ("Vannforskriften") under the European Economic Area (EEA) agreement.

307.WRA § 11; Staubo et al. (2019)

308.Larsen (2022); NIBIO (2020)

309.Staubo et al. (2019)

310.Staubo et al. (2019)

311. Pulg et al. (2018)

312. Pulg et al. (2018)

313. González del Tánago et al. (2021)



Photo: Anne-Grete Buseth Blankenberg

Action plans for Threatened Species and Habitats in Sweden

Existing measures, such as protected areas, and measures for sustainable land and water use are not sufficient for the conservation of several endangered species.^[314] In many cases, there is a complex co-dependence on other species and habitat requirements.^[315] Therefore, some species require special attention in order to maintain a viable population.^[316] The Swedish Action Plan for Threatened Species and Habitats facilitates the coordinated work of stakeholders, focuses on a compilation of knowledge, objectives and actions, as well as their financing. The goal of the programme is to create viable populations and functioning habitats for the most endangered species.

314. SLU (2022)
315. Naturvårdsverket, no date
316. SLU (2022)

Most action plans for threatened species and habitats in Sweden focus on the conservation of individual species, but some also focus on specific habitats associated with multiple endangered species. Several factors are considered when selecting species to be covered by the plans, including the species' threat status, international obligations, state of knowledge, and the possibility of improving population size through management or conservation measures.^[317] The action plans are in force for a certain period of time, which is usually 5 years. However, they can be extended in a renewed and updated version.^[318]

The Action Plans for Threatened Species and Habitats are linked to the Swedish environmental objective "A Rich Diversity of Plant and Animal Life"^[319] and the Bird and Habitat Directives from the EU and are as a policy instrument considered effective and complementary to protected areas. Each action plan has its own objectives, but there are also objectives set for the environmental quality objectives. However, objectives for the framework as a whole are missing, which makes an evaluation of the overall contribution difficult to assess.^[320]

One of the major obstacles identified in a recent evaluation was the lack of financial resources. Available financial resources were considered insufficient to meet identified needs and ensure long-term strategic planning.^[321]

Collaboration at landscape level

One of the biggest successes of these programmes is the collaboration at landscape level. Stakeholders involved are the Swedish Environmental Protection Agency, the Swedish Agency for Marine and Water Management, the county administrative boards, and other relevant actors such as landowners, municipalities and NGO's. The Swedish Environmental Protection Agency and the Swedish Agency for Marine and Water Management have the overall responsibility for the work and determine the action plans with help of SLU ArtDataBanken. Currently, SEPA is responsible for 132^[322] and the Swedish Agency for Marine and Water Management for 22 programmes.^[323]

The county administrative boards receive annual grants to undertake operations, either internally or by hiring contractors or landowners. Landowners can receive funding for carrying out conservation measures on their land. In addition, there is a collaboration between SLU Artdatabanken, the county administrative boards, the Center for Biological Diversity (CBM), and infrastructure agencies on a variety of management issues, including roadsides, embankments, and power lines.^[324] The collaboration at the landscape level between different stakeholders including SEPA,

317. SLU (2022)

318. Naturvårdsverket, no date

319. SLU (2022)

320. Naturvårdsverket (2022)

321. Naturvårdsverket (2022)

322. Naturvårdsverket, no date

323. SLU (2022)

324. SLU (2022)

SwAM, county administrative boards, SLU Swedish Species Information Centre has been regarded as a success. The success of the action plans however is depending on the cooperation of landowners in implementing the measures and is hampered by lack of financial resources.^[325]

Synergy biodiversity and climate

While the climate benefits of the action plans have not been evaluated, it is likely that some of the action plans have positive unintended climate effects. One example is the action plan on the conservation of rich fens (Åtgärdsprogram för bevarande av rikkärr). Rich fens have been negatively affected by drainage for agricultural and forestry purposes in Sweden. The action plans on rich fens focused, inter alia, on conducting inventories on rich fens and the restoration of this type of habitat by closing ditches, increasing mowing and site-specific management. The reason for this effort was biodiversity conservation as this habitat type is home to 160 red-listed species, of which 74 species are considered threatened.^[326] Mires, however, also have a major impact on the carbon balance. Mires act as a carbon sink, storing about 25 percent of the total organic carbon in the soil worldwide.^[327] Restoration of mires therefore leads to increased carbon sequestration, which has a long-term cooling effect. At the same time, however, increased methane emissions occur, the extent of which depends on groundwater levels and vegetation composition.^[328]

Another impact of peatland restoration is water regulation. Mires accumulate carbon organic matter and retain nutrients and other elements. This has positive effects on water quality and decreases freshwater eutrophication and acidification.^[329]

Examples of successful outcomes

Many action plans have been running for several years. One example where the action plan has proven successful was the action plan for the Swedish tree frog (*Hyla arborea*). It succeeded in building a viable population of a species that was previously threatened with extinction (NT).^[330]

325. Naturvårdsverket (2022)

326. Sundberg (2006)

327. SLU (2017)

328. Laine et al. (2019)

329. Bonn & Stoneman (2016)

330. Naturvårdsverket, no date

Reclaiming Degraded Land to Mitigate Climate Change in Iceland

One of the key mitigating measures in Iceland's Climate Action Plan is carbon sequestration by revegetation of degraded land. Due to centuries of land degradation caused both by anthropogenic and natural events, 40% of Iceland's terrestrial area is degraded today. Numerous land reclamation projects have been done over the years. The aims have evolved from focusing on halting sand drifting and ensuring land for agricultural purposes, to having more of an ecosystem-based approach, aiming to restore ecosystem services, biodiversity, carbon sequestration and disaster risk reduction.

Iceland launched their new climate strategy for being carbon neutral by 2040. 7 bn Icelandic kronor was allocated to climate mitigation measures in the LULUCF sector.^[331] By reclaiming and revegetating degraded land, it is possible to sequester carbon and thereby mitigate climate change.

Land degradation and soil erosion are of serious concern in Iceland. Iceland was settled in the late 9th century, and in the following centuries, large parts of Iceland was deforested. Other vegetation disappeared from large parts of the country, as extensive grazing hampered natural revegetation, leaving the soil degraded, prone to erosion, and increasingly desertified. The trajectory of soil erosion and desertification escalated further due to the Icelandic weather and ash depositions from volcanic eruptions.^[332] The first efforts on soil stabilization in Iceland can be traced back to the 18th century.

Up through the 19th century there were several efforts with re-vegetation using non-native plants to hinder drifting sand. In 1907, The Soil Conservation Service of Iceland (SCSI) was founded, and there were several reclamation efforts undertaken up through the 1900s.

In the beginning of the century, efforts were concentrated in the eastern parts of Iceland, focusing on combating drifting sands. From 1947 and onwards, more resources and labour forces were allocated to the field and the reclamation efforts expanded, gradually increasing towards the end of the 20th century. Sand drifting has posed major problems especially for Icelandic farmers by affecting the quality of grazing areas. Many of the reclamation efforts addressed this specifically. In recent decades, the focus has changed, and the objectives for land reclamation and restoration have become more diverse. Particularly climate change mitigation and biodiversity are of more concern^[333]. The latest law concerning land reclamation in

331. Government of Iceland (2018)

332. Arnalds (1987)

333. Arnalds et al (2001)

Iceland is from 2018 and states;

Article 1: The purpose of the law is to protect, restore and improve the nation's resources of soil and vegetation, and to ensure sustainable land use.^[334]

Climate Action Plan for Iceland

Iceland published their latest climate action plan in 2018, with an updated version published in 2020. Actions to reduce emissions and increase carbon sequestration through improved land use, land use change and forestry (LULUCF), are a significant part of the Icelandic Climate Action Plan.

When the 2018 Climate Action Plan was published, emphasis was put on the possibility to tackle multiple environmental crises, Iceland is facing: Improving biodiversity, increasing ecosystem resilience against extreme weather events, and combatting desertification when applying mitigation measures. The updated Climate Action Plan from 2020 continued to focus on carbon sequestration as a key mitigation measure. The 2021 progress report reported the measure I.2 Expanding revegetation (also called Enhanced action in land reclamation) to be implemented.^[335] The instruments applied to fulfil this measure are all fiscal. According to Iceland's report on policies, measures and projections from 2022, the annual scope for land reclamation is going to increase from 6,000 ha in 2018 to 12,200 in 2023 (not counting self-seeding). Collaboration projects between the Soil Conservation Service and the Icelandic Forest service is going to focus on land reclamation with native trees and shrub species.^[336]

The Icelandic Government has also published a Climate Change Mitigation Plan, specifically for the Land use, land-use change and forestry sector in 2019. The plan elaborates further on land restoration; especially in collaboration with farmers^[337] and other stakeholders. Revegetation measures have the possibility to enhance biodiversity, combat soil degradation, increase soil reclamation, and assist sustaining the livelihoods in rural areas in Iceland in addition to mitigating climate change.^[338]

In 2022, the Ministry of the Environment, Energy and Climate published: "Report on Policies, Measures, and Projections: Projections of Greenhouse Gas Emissions in Iceland until 2040", the report is based on the Climate Action plan from 2020. The report projects different trajectories depending on what measures are implemented. Figure 5 below shows two scenarios for carbon sequestration from soil reclamation. The orange trajectory is soil reclamation Business as Usual (BAU),

334. Althingi (2018)

335. The environment Agency of Iceland (2022)

336. The environment Agency of Iceland (2022)

337. The environment Agency of Iceland (2022)

338. Government of Iceland (2020)

based on historical trends; the blue is soil reclamation With Existing Measures (WEM), existing measures assume implementation of the 2020 Climate Action Plan measure for expanding revegetation. The projections show increased emission impact for soil reclamation WEM compared to BAU.

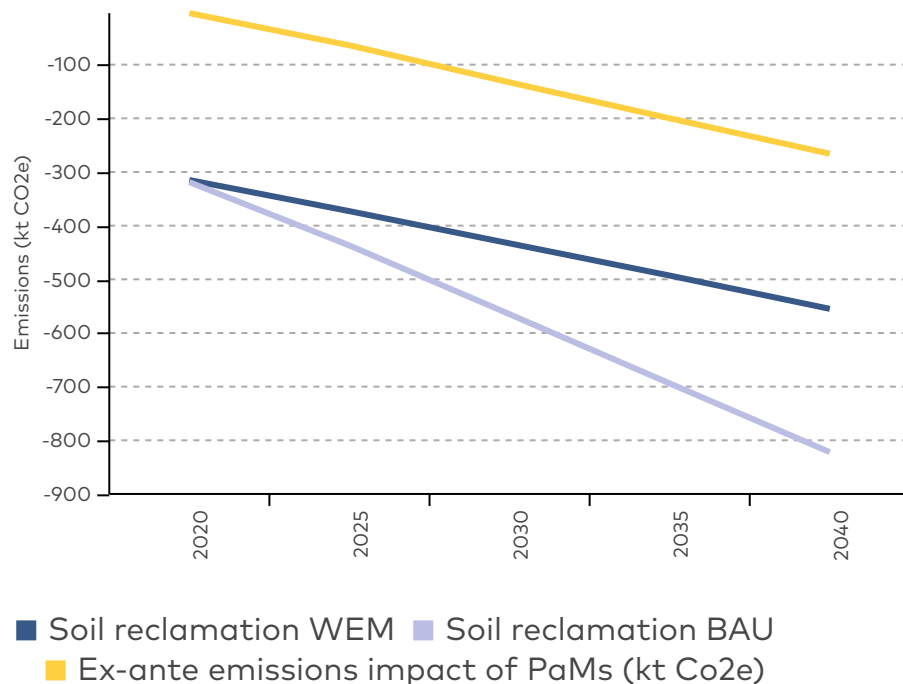


Figure 6. Projection showing net CO₂ emissions will change under two different scenarios for soil reclamation Business as usual (BAU) and with existing measures (WEM). The two scenarios are projected up until 2040. The figure shows how the biggest reduction in emissions occur under the WEM scenario. Figure from: Environment Agency of Iceland, Icelandic Forest Service & Soil Conservation Service of Iceland (2022): Report on Policies, Measures, and Projections.

Biodiversity

The latest Biodiversity action plan for Iceland is from 2013. A big part of the efforts during the last decades have been in research, documentation and monitoring Icelandic biodiversity, to increase data on the current state of biodiversity, and to ensure the right measures are implemented moving forward. 11 of the 48 actions concern restoration of degraded habitats, especially focusing on revegetation by afforestation and natural succession enabled by a reduced grazing pressure.^[339] In 2019 Iceland published a status report for the sustainable development goals (SDGs). Under goal 15: Life on Land the government affirms plans to increase support for land restoration, to benefit both biodiversity and mitigate climate change impacts.^[340]

339.Ministry for the environment and natural resources (2004)
340.Government of Iceland (2019)

Pollution

Iceland is located on the Mid-Atlantic Ridge, and many of its volcanoes are still active. When volcanoes erupt, they can eject tephra. Tephra is air borne volcanic material.^[341] Tephra-fall events impacts air quality and hydrology negatively, the impacts are greatest in degraded ecosystems. Wood- and shrubland can better endure tephra-disturbances, and limits secondary transportation of tephra. Revegetation efforts can therefor play an important role in disaster risk reduction, since it increases resilience of degraded ecosystems, and reduces societal costs after eruption events.^{[342],[343]}

The Hekluskógar Project: Soil reclamation at the foot of an active volcano

The project was initiated in 2007 and covers 90,000 ha of degraded land (approximately 1% of Iceland).^[344] The project was partly government funded initiated by the SCSi and executed together with the Icelandic Forest service and other stakeholders. Before human settlement, the area around the volcano Mt. Hekla was covered by native birch, but today the land is bare, and the soil is heavily eroded. By restoring the native woodlands in the area, the ecosystem resilience to volcanic ash deposits from Mt. Hekla have increased. Records show that before human settlement volcanic ash deposits were layered on the forest floor, but after human settlement the landscape changed due to deforestation and extensive grazing, and volcanic eruptions exhalated severe soil erosion. The birch forests are one of the few ecosystems that can survive being covered in ashes.^[345] The overall project goals were:

1. Eliminate drifting sand, revegetate eroded land to improve reforestation
2. Establishing seed sources of native birch and willow shrubs
3. To facilitate natural distribution and expansion from established woodlands

A lot of the land in the area is privately owned, and farmers have been encouraged to join the project. By 2014 a total of 210 landowners have joined the project and are promoting reforestation measures on their own and public land.^[346] Many other volunteers have participated in the project, including schools, private companies, and private citizens.^[347] It is expected that 50,000–60,000 ha will be reforested 50 years after project initiation.^[348] Positive results have already been observed, since sandstorms once frequent in the area have halted.^[349]

341. Tephra is air borne Vulcanus materiel

342. Ágústsdóttir (2015)

343. Aradóttir et al. (2000)

344. Óskarsson (2009)

345. Óskarsson (2009)

346. Óskarsson (2009)

347. Iceland's Forest Service (2022)

348. Óskarsson (2009)

349. Thorsson & Petursdóttir (2015)

Promoting Synergy Projects – National Subsidy Program in Denmark

The majority of the area of Denmark is used for agriculture, and only ten percent of the land is protected nature. Furthermore, nature is under pressure in many places, especially from agriculture, which is a source of nitrogen pollution that threatens both terrestrial biotopes and waterbodies. In 2016, money was set aside for a subsidy program for synergy projects as part of a governmental adopted nature package. Danish municipalities could apply for funding to climate adaptation projects that also co-benefit nature, decrease nitrogen pollution and create local recreational value. The subsidy fund proved to be very popular and a total of 12 projects received funding and were carried through.

In 2016, the Danish Government passed a nature package, constituting an Action Plan for Nature Management Policies in Denmark ("Naturpakken" in Danish). The key targets in the plan were to ensure climate change adaptation, increase nature areas, decrease nitrogen releases to the environment, and improve outdoor recreation facilities.^[350] As part of the action plan, a subsidy program for synergy projects was established. All municipalities were able to apply for funding, and the synergy projects should combine climate adaptation with creating new nature areas or restoring existing nature, providing recreative facilities, and/or ensuring nitrogen retention. The funding should help to achieve synergies for municipal projects across the prioritized areas.^[351]

The projects were described as "lighthouse projects", meant to inspire other municipalities or state entities with the possibilities to create synergistic effects across different policy areas in collaboration with multiple stakeholders.^[352] The Government wished to illustrate that climate adaptation is more than improved sewer systems and can provide multiple benefits for society.^[353] Therefore, reporting and documentation of process and results were mandatory.

The projects should focus on flood-prone areas, mapped in the municipal climate adaptation plans and must include climate adaptive measures able to withhold or delay water from heavy rainfalls or other upland waterbodies. It was not required that projects included synergies with all the other goals being nature, recreation and nitrogen pollution. However, the chances of getting funding increased when all were incorporated. The projects were ranked after score, and the different criteria scored differently based on what was considered most

350. Miljø- og Fødevareministeriet (2016)

351. Ministeriet for Fødevarer, Landbrug og Fiskeri (2016A)

352. Ministeriet for Fødevarer, Landbrug og Fiskeri (2016B)

353. Ministeriet for Fødevarer, Landbrug og Fiskeri (2016C)

important.^[354]

Different types of synergies and levels of stakeholder involvement

The project grants were given to very different projects, combining different types of synergies. Re-meandering of streams, establishing dykes, and restoring biodiversity and habitats were among the most frequent actions, whereas afforestation was one of the least implemented activities.

In order to carry through the projects, different stakeholders were involved in the project planning and implementation, with the municipalities as common denominator.

The table below provides an overview of all the selected projects that were implemented, the focus areas, the measures applied, and stakeholders that were part of the process.

Project	Restoration								Stakeholders			Focus			
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Odsherred Municipality – the brook "Grønnehave bæk"	X		X			X	X	X	X	X	X	X	X	X	X
Randers Municipality – The meadow "Storkeengen"			X		X				X		X	X			X
Vejle Municipality – Grejs river valley			X			X		X	X	X		X		X	X
Kolding Municipality – the stream "Seest Mølleå"	X				X	X	X	X	X			X	X	X	X
Odense Municipality – Seden beachtown	X				X		X	X	X		X	X	X	X	X
Allerød Municipality – Kedelsø-Langesø stream – The living river valley	X		X		X	X	X		X	X	X	X	X		X

Næstved Municipality – the stream “Ellebækken”	X				X	X	X		X			X	X		X
Aarhus municipality – The water in Malling		X	X	X		X	X	X	X			X	X	X	X
Thisted Kommune – Tingstrup lake	X				X	X		X	X			X		X	X
Assens Municipality – Tommerup	X	X	X			X	X	X	X	X	X	X	X	X	X
Favrskov Municipality – Kollerup meadows					X	X		X	X			X		X	X
Næstved Municipality – the brook” Rønnebækken”	X			X	X	X	X		X	X		X	X		X

A = Re-meander streams

B = Reopen piped water ways

C = Creation of rainwater basin

D = Afforestation

E = Dyke Construction

F = Lake or wetland establishment

G = Habitat restoration/ creation

H = Nitrogen removal

I = Municipality

J = Civil Society Organization

K = Utility company

L = Climate adaptation

M = Nature and Biodiversity

N = Pollution prevention

O = Recreational value

The synergy project in Odsherred Municipality

The Municipality of Odsherred received funding to establish a wetland area and re-meander the stream Grønnehave Bæk to protect parts of the city Nykøbing Sjælland against flooding. Rainwater from the local residence area is now led through the newly created wetlands together with water from the surrounding agricultural upland. Nitrogen and other nutrients are filtered out of the water, while passing through the wetland area, before it reaches the Bay, minimizing eutrophication and improving the coastal water and habitat quality. The municipality expects that re-meandering and restoring the stream will bring back sea trout and eel. It is also expected that the wetland will increase carbon storage, thus contributing to climate mitigation.^[355] It is not likely that the project would have been initiated without funding from the national subsidy program, making the funding scheme a crucial factor for implementing a synergetic approach.

The actual effects have not been evaluated

The synergy subsidy pool had synergies at its core, but the high interest shows that there is willingness and an interest from the Danish municipalities to target multiple agendas simultaneously and in the same project, when funding is provided. However, it is important to acknowledge that the projects have not been evaluated. Some of the climate adaptive measures have been successfully tested by heavy rainfalls, but the projects have not been evaluated in relation to nature and biodiversity, so the success of the subsidy pool to achieve multiple goals across several agendas have not been assessed.



Photo: David Buchmann

Preserving Biodiversity through Payment for Ecosystem Services: The Forest Biodiversity Programme METSO in Finland

Based on a long tradition, forest land in Finland is primarily privately owned. In 2016, state owned forest covered 26%, while private forests covered about 60% of all forested land.^[356]

Privately owned forests are located predominantly in southern Finland, where the relatively warm climate sustains the richest biodiversity. Until the turn of the Millennium, there were a shortage of policies and practices for actively protecting and enhancing biodiversity in privately owned forests. The METSO Programme, a Payment for Ecosystem-services Programme, offering compensation to landowners for conserving forest areas for biodiversity, was initiated in 2008. It draws on multidisciplinary scientific research and runs in Southern Finland. Currently (2022), it is set to continue until 2030.^[357]

The population of Finland is 5.5. million, the number of forest owners is 620,000, and an average forest holding covers 30.5 ha. In Southern Finland, 72% of the forests are privately owned.^[358] There is a large variety in these areas, both ecologically and societal, which needs to be considered when prioritizing biodiversity protection. The METSO programme is designed to focus on ecologically unique forests on lands, where the forest owner is interested and willing to act for the promotion of biodiversity. The METSO programme is a joint action plan between the Ministry of the Environment, the Ministry of Agriculture and Forestry, and various stakeholders. METSO is aimed to support both nature protection and nature restoration. The compensation to landowners is tax-free and is adjusted proportional to the potential income from timber sales.

Different options for different needs

METSO is based on three pillars: permanent protection as private nature reserves, fixed-term conservation, and nature management and restoration projects (see Box X). The potential sites to be included into the METSO Programme are ranked according to their ecological structure and their value for biodiversity. Regional environmental and forest authorities determine whether a site is accepted into the programme.

356.LUKE (2022A); Tikka & Kauppi (2003); Mayer & Tikka (2006)

357. Tikka & Kauppi (2003)

358. Ministry of the Environment & Statistics Finland (2017)

Administrative options within METSO

Permanent protection as private nature reserves

Land ownership remains unchanged, but the forest is permanently protected. Regional authorities cover a fee, which is exempt from taxation.

Selling the land to the State for conservation purposes, thus building up the network of protection areas on public land.

In both cases the regional authorities assess the environmental values of the property and may accept or reject the landowner's METSO application.

Fixed-term conservation

Environmental forestry subsidy agreement (10 years)

Land ownership remains unchanged, but forest management operations are paused for 10 years. The subsidy is proportional to the economic value of the standing trees.

Temporary nature reserve (20 years)
Land ownership is unchanged, but the forest is protected from logging for 20 years. Regional authorities offer a monetary compensation.

Nature management and restoration projects

The Finnish Forest Centre (FFC) prepares several restoration plans which extend geographically over forests of several landowners. FFC declares that these plans are potentially available for restoration subsidy. Entrepreneurs or active citizens apply for project leadership, accepting the responsibility to carry out the restoration project. Finally, FCC decides which plans will be activated, and reserves the necessary funds.

The goal for METSO is to protect 96,000 ha of forest through the program before the end of 2025.^[359] After 2021, 88% of the goal was fulfilled with protection of 84,000 ha forest.

Public perception and funding as enablers

Finnish NGOs and the civil society initially criticised METSO for the low level of ambition. More recently, as the program has evolved, this criticism has weakened, and critical voices have demanded more METSO funding into the government budget.

During 2008–2021, METSO projects covered a total of 71,147 ha on private lands ha.^[360] In 2021, the government of Finland reserved a further funding of 9.3 million € for the METSO Programme. In comparison, stumpage earnings from forest harvesting amounted to 2,370 million € in forests of non-industrial private

359.METSO (2022)
360.Koskela et al. (2022)

owners.^[361] Funding limitations imply that nature protection based on the METSO Programme cannot cover a very large fraction of Finnish private forests, but the unique value of METSO is in targeting biodiversity preservation at the best sites, and in ensuring collaboration with the landowner.

Climate change and the METSO Programme

METSO was designed during 1997–2008, when climate change mitigation and adaptation were discussed, but not yet prioritized in environmental policy. Co-benefits between policies addressing biodiversity and climate change are likely to exist, especially for adaptation and the implementation methods. When productive forestry use is restricted due to permanent protection or fixed term conservation or restoration efforts, it provides an opportunity for increased carbon storage. With less carbon removed from the forest as harvest, there is build-up of carbon stock both in standing wood as well as on the forest floor. This is part of a process where the forest transitions towards more natural carbon cycling. The potential for carbon sequestration and storage is regulated by several factors, including soil type, climatic conditions, age of forest, and tree species mix. The rate of carbon uptake decreases over time in forest ecosystems, moving on a gradient from carbon sink to carbon stock. Protecting young forest can therefore have relatively higher climate benefit. Meanwhile, preserving old-growth forest has higher biodiversity benefit, while it also stores larger amounts of carbon. There are as such several criteria to consider maximising the synergies between climate change mitigation and adaptation, and biodiversity conservation.

A study from Southern Finland provides an example of a prioritisation of land areas to maximise benefits and concludes that it is possible to significantly improve biodiversity and carbon uptake with optimal allocation of no harvest-areas. There is also ongoing scientific work to evaluate trade-offs and synergies of policies on the sustainability of forest systems; however, these do not specifically evaluate the METSO Programme. Given the complexities of the possible positive impacts on climate mitigation and adaptation, a credible assessment of METSO's co-benefits with climate policies remain objectives for future scientific work.



9. FINDINGS AND CONCLUSIONS

The 15 analysed cases cover a wide range of different policies and management measures. As illustrated in the overview table below, the cases were selected to cover as many different types of successful practices as possible. There are many similarities between the Nordic countries, how their regulatory systems are structured, how they have divided administrative governance, and they are also obligated to many of the same international agreements.

The wish to achieve synergies in environmental governance is not new. As early as 2002, the UNEP Governing Council called for enhancing linkages and synergies among multilateral environmental agreements, to improve connectivity in our tackling of environmental challenges,^[362] and - as discussed earlier - an important part of the IUCN NbS Standard. Multiple studies and initiatives have aimed to map the enablers for creating synergies. Several initiatives have been focusing on how to improve coordination and knowledge management across different internal entities to better achieving synergies namely at local scale. In recent years, the awareness of the intrinsic interconnectedness of the nature and climate crises has increased rapidly, and there has been a shift to focus on measures that can achieve one goal while contributing positively to achieving others.^[363] This can create incentives for increasing measures that generally face obstacles such as lack of prioritisation or funding. This is especially the case for many conservation measures. This shift in focus among the wider society serves as an enabling factor, as well as the increasing acknowledgement of nature's essentiality for human existence.

Measures suitable for achieving synergies

When considering the selected cases, all countries see the potential in wetland

362. Visseren-Hamakers (2015)

363. United Nations Environment Programme World Conservation Monitoring Centre (2020)

restoration and afforestation. These measures are promoted in all the individual countries' climate mitigation plans. Several of the analysed cases have incorporated multiple interdisciplinary goals from the beginning of project initiation, and the literature shows an increasing acknowledgement of the necessity to address these issues simultaneously in order to ensure that agendas do not counteract each other and to ensure the most effective ways of implementation. Sometimes policy measures have been promoted simultaneously but independently in different action plans e.g., climate change and biodiversity.

Limited land area makes it necessary to make prioritisations in land use. Incorporating ecosystem-based management approaches and applying an adaptive management approach can be a way to actively minimize trade-offs. An example is seen with the CFC management approach, that improves the quality and connectivity of forests habitats, while still allowing forestry practices.

This is one of the major strengths of nature-based solutions – that the standard's structure allows for identifying potential synergies across sectors early in the process, and that these are included in monitoring and evaluation, so unintentional effects and trade-offs can trigger an adaptive management response.^[364]

Case	Policy type				Scope			NbS measure				
	A	B	C	D	E	F	G	H	I	J	K	L
Green Roofs in Copenhagen (DK)				X			X			X		
Lowland soil projects (DK)	X			X	X			X				
The synergy projects (DK)	X				X			X				
The METSO programme (FI)	X	X	X	X		X		X			X	X
Finnish Peatlands (FI)		X	X		X			X				
Shoreline forests (FI)		X	X		X						X	X
Icelandic afforestation strategy (IS)			X	X	X			X				
Wetland conservation (IS)			X		X							X
Revegetation (IS)			X	X		X		X				

Wetland restoration (NO)	X	X	X	X
Municipal Flowers (NO)	X	X	X	X X X
Riparian vegetation (NO)	X	X		X
Action programme for endangered species (SE)	X	X	X	X X
Continuous cover forestry (SE)	X	X		X
Eelgrass meadows (SE)	X	X		X

A = Financial
B = Management
C = Law & regulations
D = Voluntary
E = National
F = Regional
G = Local
H = Ecosystem restoration approaches
I = Issue-specific ecosystem-related approaches
J = Infrastructure-related approaches
K = Ecosystem-based management approaches
L = Ecosystem protection approaches

Cases with a national scope are overrepresented in this study which is expected since the study has a focus on policy. Policies promoting joint measures for biodiversity, climate change and pollution are still most common at the national scale. However, the practical execution of national action plans is often done by municipalities. Some of the cases exemplify the policies through local examples, where national action plans are executed at local scale.

State funding where private landowners are paid for managing ecosystem services are key part of multiple initiatives and programmes and are present in all the Nordic countries. Many of the financial measures in use are combined with voluntary agreements in order to respect private ownership and minimize conflicts.

Although the Nordic countries have many similarities, there are also differences between them and what they prioritize when governing environment and spatial

planning. This mirrors the different problems they face, as well as their history of land use change. While Iceland has a century- long focus on afforestation, Denmark has focus on handling flooding, cloudbursts and taking lowland soils out of agricultural production. Norway and Sweden both focus on re-establishing peatlands, and Sweden considers more sustainable forestry practices, which is also highlighted in Finland's action plans for biodiversity. Another key focus in Finland is to improve biodiversity protection; especially in the southern part of the country.

This project also identified the following key enablers for achieving synergies in the cases analysed, across different policy measures and across different scales:

- Spatial awareness – considerations of suitability and the surrounding landscape
- Proper funding and cost-effectiveness
- Stakeholder involvement on multiple levels
- "In-house" coordination across multiple entities and between multi-level governance
- Knowledge sharing
- Multiple and concise objectives from the beginning

Spatial awareness – considerations of suitability and the surrounding landscape

Taking a holistic view and surveying the landscape prior to project implementation contributes to increasing habitat connectivity at a regional scale. This can also contribute to identifying potential trade-offs. Prior to the establishment of flower meadows in the municipality of Porsgrunn in Norway, the entire area was mapped to find the most suitable location for the pollinator flower meadows, thereby ensuring the best possible connection with the surrounding landscape to secure the best possible habitat connectivity for the pollinators.

The Finnish Peatland Strategy and the Finnish Conservation Programme also ensure, as far as possible, that activities considered harmful are limited to already drained or altered peatlands, instead of damaging pristine areas. In several of the programmes that involve privately owned land, the land area is screened prior to approval to determine if the area is suitable, and if so, to identify the most suitable location for implementation or conservation. This approval process is part of the Icelandic Afforestation Project, the Finnish METSO Programme, the Danish lowland

projects, and the Norwegian wetland restoration projects.

A study from Southern Finland provides examples of how prioritising land areas allows for maximising benefits and concludes that it is possible to significantly improve biodiversity and carbon uptake with optimal allocation of no harvest-areas. Lastly, as also described in several of the cases when conducting restoration, the results generally improve when the area is in the proximity of undisturbed ecosystems.

Proper funding and cost-effectiveness

The lack of funding is often identified as a key barrier even for projects otherwise considered to be successful. In the Swedish Threatened Species Programme, lack of funding has been identified as an obstacle for ensuring long-term strategic planning. When progress and successful outcomes have been accomplished, it is a pity if these are discontinued due to lack of funding.

The Icelandic farmers participating in the afforestation scheme also reported how unsteady funding leads to an uneven supply of tree saplings which can hamper the afforestation processes. It can often be more cost-efficient to prioritise conservation, as in the case of the Swedish eelgrass meadows, where conserving the remaining eelgrass meadows outside of Gothenburg and providing conditions for natural extension was far more resource effective than planting new eelgrass meadows.

This also highlights the importance of carefully considering all alternative options before damaging or altering a pristine ecosystem, since once lost re-establishment of an ecosystem to a former state is not only challenging and potentially very expensive, but it is not always possible. Thereby not saying that restoration of already degraded ecosystems should not be prioritized; this is highly necessary if the Nordics shall live up to their climate and biodiversity commitments. Restoration efforts are also parts of the Nordic countries' climate action plans and biodiversity action plans.

Stakeholder involvement at multiple levels

When applying nature-based solutions, numerous stakeholders are involved at the different stages of the process. Several successful measures presented in the analysed cases have involved private landowners, often receiving payment for protecting ecosystem services. Examples are the Finnish METSO Programme, the Icelandic Afforestation Projects, the Swedish Endangered Species Act, and the Danish Lowland Scheme.

All the cases analysed involve the use and management of land in one way or another. Land management often comes with a risk of conflict due to different interests colliding on finite space. In connection to this, both how and when stakeholders are involved is important. How landowners are compensated or engaged vary across the different cases. There are examples of private land and forest owners getting funding and education for new types of land management such as forestry, or the state offers to buy their land for conservation, or farmers and foresters themselves can apply for funding for habitat protection or more sustainable management practices. Others have simply volunteered their land for revegetation efforts as the Hekluskógar project in Iceland. This shows that there are multiple ways to successfully engage stakeholders.

Some of the analysed cases illustrate collaboration and stakeholder engagement from national and regional levels down to a local level. The Swedish National Action Plan for Threatened Species and Habitats is a success story showing how national agencies collaborated across sectors with NGO's, municipalities, and private landowners to determine and implement rewarding measures. Different collaborations have been engaged at different stages, first in collaboration with the Swedish University of Agricultural Sciences, the Swedish Environmental Protection Agency and the Swedish Agency for Marine and Water Management to decide on specific action plans, later during actual implementation at the landscape level between the agencies, county administrative boards and infrastructure agencies, and lastly with the executioners e.g., private landowners or contractors.

There is an increasing focus on improving collaboration between different stakeholders involved with national action plans, both internally and across agencies, and between multilateral levels of governments. This was part of the new Norwegian governmental plan, where there is increased focus on strengthening local municipalities due to their responsibility in land-use management. In Sweden, their newest strategy for biodiversity and ecosystem services entails a practical division of responsibility at a national level, and the responsibility to provide proper guidance and access to knowledge at the regional level for counties and at the local level for municipalities.

Accumulating knowledge and sharing knowledge

In a landscape as complex as environmental management, it is very important to ensure information flows to stakeholders. The analysed cases hold multiple examples of how this is done successfully. For instance, the Icelandic Afforestation Scheme provide forestry education for the farmers. There are many different terms and definitions in play in the environmental field, it is therefore important to streamline and ensure that the same definitions and approaches are applied. In Sweden the forest agency has issued guidelines that clarify the definitions of Continuous Cover Forestry (CCF), to clarify definitions for stakeholders and contribute to spreading knowledge with stakeholders. Our ecosystems are changing fast, this calls for taking more dynamic approaches. In 2018, Finland launched the six-year project 'IBC-Carbon' that aims to provide knowledge on the effects of climate change through forest growth modelling, biodiversity modelling, as well as knowledge of carbon budgeting, and ecosystem services.

Multiple and concise objectives from the beginning

Several of the analysed cases had multiple objectives from the start, also spanning across different topics. Focusing on achieving multiple benefits instead of just one allows actors to better identify, mitigate and manage trade-offs and other potential conflicts.^[365] When managed right, this is one of the key attributes to practising nature-based solutions that the entire ecosystem is taken into consideration. The Danish synergy project is one example of synergies being the core of the project. When restoring mires and peatlands, achieving several targets such as carbon sequestration and restoring threatened biotopes were a key part of the national action plans in both Finland and Norway.

Have the measures been evaluated?

Many of the cases have not been evaluated. Some of the cases are still being implemented or have recently been implemented. Evaluation is an important factor in identifying unintentional synergies that can be better incorporated in future project and ensuring that implemented measures generate the expected effects. There are still great uncertainties regarding the effects of some ecosystem-based measures including rewetting, wetland restoration and afforestation schemes, and monitoring and evaluation can contribute to addressing this.

365.Sharifi (2016)

It is important that the measures implemented lead to the expected effects, and if not that it is acknowledged. However, it can take a long time for some effects to manifest, potentially making it difficult to evaluate. There are very few examples of grand scale NbS, making it especially important that these are evaluated in order to contribute to expanding the knowledge foundation concerning the effectiveness of large-scale NbS.

Additional data can provide information on synergies ensured, and the cost-effectiveness of implementing NbS.^[366] Applying adaptation management can help in identifying these, since it provides the possibility for adjustments to practice.

When an evaluation is carried out, it is often the results that are evaluated and not the policy process itself. This makes it more difficult to identify the initiatives and policy instruments that as part of the process contribute to synergies in the finished project.

Were further effects achieved? (Cultural, economic value etc.)

Several of the cases achieved other effects than climate mitigation and/or adaptation, pollution prevention, and biodiversity protection. Other goals were also often part of the initial scope in several of the projects. Especially recreational values were often a project objective alongside the environmental objectives.

Improving local recreational facilities was a key part of several of the Danish synergy projects. The Icelandic afforestation projects have also contributed to local recreational activities; this was not one of the original objectives for the project, but it is now highlighted as an additional benefit of the afforestation project. The afforestation project can also contribute by increasing private farmers economic income, when they over time develop a forest resource on their land, providing income by selling timber. Furthermore, several farmers have identified an improvement in the microclimate on their farms that is beneficial for their other farming practices. Continuous cover forestry is considered to improve the recreational values of the forests since the landscape is experienced as more scenic than in forests applying clear-cut forestry, that causes large empty lots disrupting the forest connectivity.

Initiatives that foster green cities are appraised for contributing to improving mental health and social health for urban citizens. Green roofs or establishment of green urban areas like the Norwegian pollinator meadows contribute to improving the local environment for urban citizens. Several of the Danish synergy projects also provided new recreational options for the local urban residents.

Protected areas such as the Swedish eelgrass meadows, the METSO protected forests in Finland and the Eyja Bakkar wetlands in Iceland can also improve recreational facilities. In the case of Sweden, the eelgrass meadows can provide improved conditions for anglers, and in Iceland the conservation area contributes to preserving an iconic landscape that sustains tourism. Revegetation around the volcano Mount Hekla can contribute to disaster risk reduction when eruptions occur and reduce impacts on the surrounding area.

Without necessarily being part of the targeted goals, many of the analysed cases can enhance water quality due to the soil's natural filtration abilities that retain or break down pollutants or excess nutrients.

Can the identified successful measures or projects (ensuring synergies) be applied in other countries/different regulatory settings?

As illustrated by the case examples, knowledge concerning successful measures has already been accumulated, but the awareness of success stories elsewhere is sometimes limited; both between countries and more locally. Many of the measures that enable synergies have the potential to be implemented and practiced in other countries, regions, or settings, since the general methods are not site specific, and the threats from biodiversity loss, climate change and pollution prevention are similar, even though the local environment and ecosystems need to be considered individually. There is as such great potential to transfer knowledge and experience between different countries, regions, municipalities, and between different levels of governance. For instance, applying measures such as payment for ecosystem services, prioritising conservation, allocation of proper funding to restoration projects, and safeguarding those practices implemented creates connectivity and contributes to diminishing fragmentation. Furthermore, good general management practices such as proper involvement of stakeholders in the various stages of the implementation can contribute to increased achievement of synergies, just as an analysis of the surrounding environment also increases the chance of achieving better results and minimizes the risk of trade-offs. Most of the measures implemented have been introduced to meet international regulations and agreements from the EU and the UN, many of which all the Nordic countries have committed to; this increases the opportunities for implementation elsewhere as they must contribute to achieve the same regulatory and agreed upon goals regardless of country.

Beyond the scope of this project

Another consideration that is beyond the scope of this project is tele coupling effects and off-sets in areas beyond the Nordics. In many cases, western embedded companies off-set their pollution by buying or afforesting land in other parts of the world, that might damage local biodiversity or violate the rights of local populations. It is important to be aware of how good intentions can be mismanaged, and here decision makers have an important responsibility. Another observation beyond the scope of this study is that many NbS projects are executed with public funding. To ensure a wider implementation of NbS solutions, better involvement of the private and financial sector is necessary, if we aim to implement NbS at a sufficient scale to achieve our targets.



10. SUCCESS STORIES – BUT NOT WITHOUT BARRIERS

Barriers for implementing integrated policy solutions

This project focuses on examples with successful outcomes in case studies practising or enabling nature-based solutions. The purpose is to garner inspirations by illustrating how it is possible to achieve policy synergies across different agendas. However, each case is context dependent. Success is not automatically guaranteed but depends on multiple conditions. To achieve successful synergies when implementing policy measures, it is important to be aware of potential blind spots, trade-offs, and spill over effects. It is not guaranteed that the respective agendas on biodiversity, climate change and pollution prevention will coincide and be mutually beneficial and synergistic; sometimes the separate objectives will be in conflict. Biodiversity and ecosystem services are impacted both by the consequences of climate change and our responses to the crisis through implementation of mitigation and adaptation measures. For instance, afforestation to sequester carbon might not benefit local biodiversity, if the forest is monocultural or the forest replaces a native and natural ecosystem.^[367] However, actions to halt the loss of biodiversity generally benefit the climate agenda and provide more resilient ecosystems to better withstand climate change.^{[368],[369]}

An important step from policy development to realised effect is the implementation of the selected solutions. When working with NbS, access to land use and initiation of land use change will very often be a key parameter. Common barriers in such processes are access to financing as well as opposition from landowners against setting aside areas; especially when there is a need to take land out of production. Access to financial compensation as well as thorough stakeholder involvement in such circumstances is key.

367. Seddon et al. (2021)
368. Shin et al. (2022)
369. IPCC (2022)

Nature-based solutions – Do we get the benefits promised

Bridging the gap between different administrative levels and between different policy sectors is important, but it can be challenging. There is a need for mainstreaming NbS objectives across different sectors that often differ in point of views. Cross-sectoral legislation and mechanisms at both national and municipal levels might enable this. Better knowledge bases on NbS are needed, and studies show that it is especially important to improve the evidence base for the benefits of NbS to motivate local authorities to consider NbS solutions. A wider adoption of the NbS is needed to ensure its success, and furthermore there is a need for more large-scale examples. Many experiences with NbS are currently locally embedded, and often down to an object scale, e.g., green roofs. There is a need for combining this object scale with a larger strategy with a whole system perspective to ensure the expected impacts.^[370] Such initiatives are luckily well underway. Examples are the University of Oxford NbS initiative, and the IUCN Global Standard for NbS to ensure a uniform understanding. It should be noted that this definition differs slightly from the one applied by the EU. Furthermore, NbS themselves can be climate sensitive and this can hamper the anticipated results. The multiple stressors from the crises we are facing impact ecosystem resilience in multiple ways. Furthermore, many of the benefits of NbS are non-monetary and can be hard to measure especially on a short timeframe.^{[371],[372]}

Nature-based solutions are praised for their ability to handle multiple crises. However, there are risks of blind spots. In recent years, a large part of climate mitigation has focused on carbon sequestration by afforestation and wetland creation or restoration, as also seen in the selected cases for this project. The possibility to create synergies to achieve greater biodiversity is highly dependent on the approach. For example, if plantations of monocultures with non-native species are used in afforestation projects, then the benefits for local biodiversity will be limited or even harmful. This again highlights the importance of engaging people with different fields of expertise and breaking down silos, to ensure that successfully achieving one goal does not undermine the achievement of other goals.^[373] Some also question the cost effectiveness of NBS compared with engineered grey alternatives, and again further research is needed to determine the validity of this concern. There are also ongoing experiments with different combinations of grey and green infrastructure creating hybrid solutions.^[374]

The IUCN identified one of the biggest barriers for implementing NbS to be the

370. Calliari et al. (2022)
371. Price (2021) et al. (2022)
372. Seddon et al. (2020)
373. Seddon et al. (2020)
374. Anderson et al. (2022)

challenge of estimating impacts, benefits and cost-effectiveness in quantitative terms. These uncertainties might make people hesitant to implement NbS.^[375] Lastly, even though NbS are heavily promoted as a key measure in tackling both the nature and climate crises, the support is not unanimous, and the concept has been rejected by several NGOs, IPOs and grassroots movements who consider it a dangerous distraction from the urgent need to drastically cut our GHG emissions and minimize our resource exploitation to handle the crises.^{[376],[377]}

Nature is complex and so is the political landscape

A tree is not just a tree; which type of tree is planted when greening urban areas is important for its ability to reduce air pollution and improve air quality. A tree's capacity to reduce air pollution varies between species, and some trees even emit volatile compounds contributing to poor air quality.^[378] Furthermore, the plantation practice can also impact the ecosystem carbon stock and the forest's ability to sequester carbon. Trials of different management practices like the management practice of continuous forest cover explained in the Swedish case are therefore important.^[379] The ecosystem complexity is also the reason why it can be difficult to achieve the desired effects in afforestation projects such as the ones from Iceland. These are further complicated by the fact that the only native woodland tree species are threatened by climate change and might not thrive in a warmer Iceland.

These examples illustrate the level of complexity faced when working with natural systems. Ecological restoration is also often practised in an interplay between different sectors and different political interests both when it comes to specific projects and entire programmes. The political landscape concerning environmental policies is complex with hundreds of different multilateral agreements,^[380] this can make it difficult to navigate and obtain the right synergies by aligning agendas in the environmental field. Policy frameworks are ever changing, and priorities sometimes shift when the local or national governments change, potentially disrupting ongoing projects and practices.^[381] The ever-changing nature of natural landscapes only complicates it further. Moreover, ecosystem changes are sometimes irreversible, and a result of an underlying change in the biotic and/or abiotic factors

A Swedish study from 2016 mapped the public funding of ecological restoration across Sweden to clarify what governs the allocation of public funds.^[382] Ecological

375. Network for Nature (2022)
376. Seddon et al. (2021)
377. Melanidis & Hagerman (2022)
378. European Commission (2015)
379. Liao (2010)
380. Visseren-Hamakers (2015)
381. Baker & Eckerberg (2013)
382. Borgström et al. (2016)

restoration efforts were highly dependent on regional administrative capacity rather than the environmental need or population size. Furthermore, in several cases recreational and economic motives rather than environmental concerns seemed to be the main reason since some nature types generally were favoured above others. Ecological restoration was not a long-term investment, most efforts were done on a small scale and with a short-term perspective. The aforementioned paper concludes that since this was the situation in Sweden, a country often appraised for being in the lead when it comes to the environment, the situation in other countries is expected to be the same or even more pronounced.

Other studies also identify the general tendency of under-funding environmental governance as a key barrier to the wider implementation of NbS.^[383] For projects such as the municipal flower meadows in the Norwegian municipality to be continuously successful also after implementation, long-term funding is needed to ensure continuous upkeep and management of the semi-natural landscape.



11. RECOMMENDATIONS FOR NORDIC COOPERATION

Proposals for joint Nordic initiatives that can maximize synergies between biodiversity, climate and pollution initiatives in the Nordic region and globally

- Establish a joint information site presenting evidence and cases that support engagement and can inform decision-making at different levels of governing.
- Consider development of a cross sector planning framework including major international obligations. This can be done by using the British example from 2013 as a guidance template.
- Encourage integration of concrete NbS provisions in policies at different levels: at an EU level, at a cross-Nordic level, at a national and local level.
- Support the implementation of one NbS standardisation scheme to be used at all governing levels e.g., the IUCN Global standard for Nature based Solutions.
- Allocate resources to inform and promote the possibilities NbS entails in terms of impacts, benefits, and cost-effectiveness.
- Provide specific guidance for NbS financing mechanisms.
- Initiate evaluations of the effects of collaboration both between countries, within government, both within national, regional and local government, and between sectors, in order to provide an effect-based guide for these processes

Recommendations for national government level in the Nordic Countries

- Support the implementation of a cross-sectoral planning framework on a national level, incorporating national legislation and objectives together with international ones.
- Enable, motivate, and encourage private financial investments towards NbS – the majority NbS investments are currently done with public funds.
- Some measures shall be encouraged with care, e.g. off-setting. Support the hierarchy that provides the order of conservation first, then managing, then restoration, and if unavoidable then practice off-setting.
- Ensure knowledge-sharing and knowledge building, e.g. by launching information campaigns both targeting municipalities, landowners, and the general public on the importance of joint actions for tackling biodiversity loss, climate change and pollution,
- Support and encourage local government officials to get further educated by providing the necessary resources to increase municipal and regional knowledge capacity on NbS
- Knowledge already exists, but there is a need to create higher awareness and make it more accessible and applicable.
- Mainstream the process of screening new measures for synergies, when developing policies and strategies for areas such as nature/biodiversity, physical planning, the agricultural/forestry sector, the energy sector, climate mitigation, climate adaption, pollution prevention, and waterbodies including freshwater lakes, streams and the seas.

Recommendations for screening methods of laws, policies, and management practices to reveal untapped synergies between climate change, pollution, and biodiversity measures

Based on the mapping and assessments of existing screening methods as well as on the insights provided through the study of synergetic measures, and the uncovered cases, we have identified and listed 10 core principles for a policy measure screening process. The 10 principles are to be seen as recommendations for a policy process entailing development of new or implementation of known measures related to biodiversity, climate and pollution. It would, although, very

likely be relevant to screen a broader portfolio of measures within environmental policy and physical planning in order to identify and promote untapped synergies.

The 10 principles are:

1. Ensure a common understanding and consistent use of the key essential terms and phrases that are in use in the policy documents and in the more guiding implementation tools for the measure; especially in terms of the technical phrases related to nature-based solutions, biodiversity conservation/management, as well as climate mitigation and prevention.
2. Include both national and international policies and strategies in the screening process in order to ensure that all levels of regulation are assessed. This is especially important for governing measures that have legal or regulatory influence on underlying regulatory levels.
3. Ensure that the screening process is resource effective, so it can and will be mainstreamed and will entail all measures with relevance for biodiversity, climate, pollution, and physical planning. A mainstreamed process can help ensure that untapped and unintentional synergies can be identified and supported with the necessary supportive means, effective implementation and relevant monitoring programmes. In the same vein, unintended trade-offs can be eliminated or minimized.
4. The screening of synergies of national policy measures must entail the full policy process from government level to local implementation and management, as the synergies are not necessarily clear at macro level but can be promoted in the actual implementation. As part of this policy value chain screening it is important to uncover the need for resources in order to utilize the synergy potential, as well as the source of funding for management.
5. Develop or identify sector specific parameters and indicators for the screening. The set of indicators can be based on or inspired by indicators from national nature- and climate monitoring programmes, but it should be noted that these sets of indicators may be at a level of detail that is difficult to apply in an ex ante phase for other measures than actual management. Another source of inspiration can be publications such as the IUCN Global Standard for Nature-based Solutions and the European Commission Practitioners Guide "Evaluating the Impact of Nature-based Solutions".
6. The screening of policy measures must be knowledge based and transdisciplinary. There is a necessity to involve the relevant experts from all relevant disciplines in the development of screening parameters and consider whether an external review of the selected parameters might be useful.
7. Avoid a silo approach by involving the relevant sector ministries in the screening process.
8. Support targeted knowledge building, training, and sharing of NbS best practices with key stakeholders.
9. Remember to not only screen for the desired effects; be aware of any trade-offs that might be a consequence of the implemented measure.

10. Make use of the developed screening parameters and indicators to develop implementation- and monitoring plans with focus on the identified and expected synergy effects.

REFERENCES

- Aanderaa et al. 2020. Løsningen er naturbasert. En kartlegging av forvaltningens behov for brukerstøtte innen naturbaserte løsninger for klimatilpasning. Asplan Viak. <https://www.miljodirektoratet.no/publikasjoner/2021/januar-2021/losningen-er-naturbasert/>
- Act on Regional Afforestation Programs on Icelandic farms no 95/2006 (Lög um skógrækt á lögbýlum 2006 nr 95 13. júní) <https://nordicforestresearch.org/wp-content/uploads/2019/05/SNS-EFINORD-report-2019.pdf#page=56>
- Aðalskrifstofa (2022) Revegetation and landcare. Retrieved from https://land.is/heim/english/revegetation_landcare_iceland/
- Ágústsdóttir, A.M.(2015) Ecosystem approach for nature hazard mitigation of volcanic tephra in Iceland: building resilience and sustainability. Nat Hazards 78, 1669–1691. Retrieved from: <https://doi.org/10.1007/s11069-015-1795-6>
- Alþingi (2018). Lög um landgræðslu (Law on land reclamation). 2018 nr. 155 21. December. Retrieved from: <https://www.althingi.is/lagas/nuna/2018155.html>
- Alþingi (2019). Lög um skóga og skógrækt (Law on forests and forestry). Retrieved from: <https://www.althingi.is/lagas/152b/2019033.html>
- Anderson, C. C., Renaud, F. G., Hanscomb, S., Gonzalez-Ollauri, A. (2022). Green, hybrid, or grey disaster risk reduction measures: What shapes public preferences for nature-based solutions? Environmental Management, 310, 2022, 114727
- Aradóttir, À. L., Svavarsdóttir, K., Jonnson, T., & Gudbergson, G. (200): Carbon accumulation in vegetation and soils by reclamation of degraded areas. Icelandic Agricultural Sciences. 13:99-113
- Arnalds, A. (1987). Ecosystem Disturbance in Iceland. Arctic and Alpine Research. Vol. 19, No. 4, Nov., 1987. Retrieved from: <https://www.jstor.org/stable/1551417?origin=crossref>
- Arnalds, O., Thorarinsdóttir, E. F., Metusalemsson, S., Jonsson, A., Gretarsson, E., & Arnason, A. (2001). Soil Erosion in Iceland. Soil Conservation Service and Agricultural Research Institute.
- Arnalds O, Gudmundsson J, Oskarsson H, Brink S. H., & Gísladóttir F. O. (2016). Icelandic Inland Wetlands: Characteristics and Extent of Draining. Wetlands 36, 759-769. Retrieved from: <https://doi.org/10.1007/s13157-016-0784-1>
- Ármannsdóttir, H. Þ. (2022). Restoring Icelandic wetlands: challenges in governing

complex ecosystems and restoration efforts. Master thesis. Stockholm's University

Baldursson, S., Hannesdóttir, H., Guðnason, J. & Þ., Þórðarson (2018). Nomination of Vatnajökull National Park, dynamic nature of fire and ice.
<https://www.vatnajokulsthjodgardur.is/static/files/Utgefid-efni/VJP-sameiginlegt/unesco-nomination-of-vatnajokull-national-park-dynamic-nature-of-fire-and-ice.pdf>

Bartlett, J., Rusch, G.M., Kyrkjeeide, M.O., Sandvik, H. & Nordén, J. 2020. Carbon storage in Norwegian ecosystems (revised edition). NINA Report 1774b. Norwegian Institute for Nature Research.

Bauer and Fischer-Bogason (2011): Voluntary Agreements and Environmental Labelling in the Nordic Countries

Baumane, M., Zak, D. H., Riis, T., Kotowski, W., Hoffmann, C. C., & Baattrup-Pedersen, A. (2021). Danish wetlands remained poor with plant species 17-years after restoration. Science of The Total Environment. Volume 798. ISSN 0048-9697. Retrieved from: <https://doi.org/10.1016/j.scitotenv.2021.149146>.

Blankenberg, A.-G. B.; Skarbøvik, E.; Kværnø, S. 2017. Effekt av buffersoner - på vannmiljø og andre økosystemtjenester. NIBIO Rapp. 3(14) 2017. 76 s.
<https://nibio.brage.unit.no/nibio-xmlui/handle/11250/2448787>

Bjørkli & Wiseth. 2018. Ta vare på kantsonen! Vann, No. 2. [Bjorkkli.pdf](http://Bjorkkli.pdf(vannforeningen.no))
[\(vannforeningen.no\)](http://vannforeningen.no)

Bonn, A., Allott, T., Evans, M., Joosten, H., & Stoneman, R. (Eds.). (2016). Peatland Restoration and Ecosystem Services: Science, Policy and Practice (Ecological Reviews). Cambridge University Press.
<https://doi.org/doi:10.1017/CBO9781139177788>

Brears. (2020). Nature-Based Solutions to 21st Century Challenges. Taylor and Francis. <https://doi.org/10.4324/9780429294600>

Stanislava Brnkalakova, Jan Světlík, Sigríður Júlía Brynleifsdóttir, Arnór Snorrason, Viera Baštáková, and Tatiana Kluvankova (2021). Afforesting Icelandic land: A promising approach for climate-smart forestry?. Canadian Journal of Forest Research. 51(12): 1781-1790. <https://doi.org/10.1139/cjfr-2020-0312>

Bruun, H. & Sand-Jensen, K. (2022) Biologer: Sådan sikrer vi biodiversiteten ved vådlægning af lavbundsjarde. Retrieved from
<https://www.altinget.dk/miljoe/artikel/biologer-saadan-sikrer-vi-biodiversiteten-ved-vaadlaegning-af-lavbundsjarde>

Bryn, A., Strand, G.-H., Angeloff, M. & Rekdal, Y. 2018. Land cover in Norway based on an area frame survey of vegetation types. Norsk geografisk tidsskrift 72: 131–145.

Calliari, E., Castellari, S., Davis, M., Linnerooth-Bayer, J., Martin, J., Mysiak, J., Pastor, Teresa., Ramieri, E., Scolobig, A., Sterk, M., Veerkamp, C., Wendling, L.,

Zandersen, M. (2022). Building climate resilience through nature-based solutions in Europe: A review of enabling knowledge, finance and governance frameworks. *Climate Risk Management*. Volume 37, 2022, 100450.

Coalition of Finance Ministers for Climate Action (2022). *Driving Climate Action through Economic and Fiscal Policy and Practice*. Washington, D.C. Coalition of Finance Ministers for Climate Action.

Cohen-Shacham, E., Andrade, A., Dalton, J., Dudley, N., Jones, M., Kumar, C., ... & Walters, G. (2019). Core principles for successfully implementing and upscaling Nature-based Solutions. *Environmental Science & Policy*, 98, 20-29.

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (2016). Nature-based solutions to address global societal challenges. IUCN: Gland, Switzerland, 97, 2016-2036.

Conservation Evidence (2022). Conservation Evidence).
<https://www.conservationevidence.com/>

Convention on Biological Biodiversity (NA). Bioinvasion and Global Environmental Governance: the transnational policy network on invasive alien species. Finland's Actions on IAS. Retrieved from
<https://www.cbd.int/invasive/doc/legislation/Finland.pdf>

Cook-Patton, S.C., Drever, C.R., Griscom, B.W. et al. Protect, manage and then restore lands for climate mitigation. *Nat. Clim. Chang.* 11, 1027–1034 (2021).
<https://doi.org/10.1038/s41558-021-01198-0>

COWI (2009). Levende tage hjælper klimaet. Internationalt nyhedsmagasin fra cowi. Retrieved from
<https://www.kk.dk/sites/default/files/agenda/aa22660cabf5371b5521d50d75ff94a749918673/13-bilag-4.PDF>

Danish Agricultural Agency (2022) Lavbundsprojekter - forundersøgelse og etablering. Retrieved from
<https://lbst.dk/tilskudsguide/lavbundsprojekter/#c49930>

Danish Environmental Agency (2022) Udtagning af lavbundsjorder. Retrieved from
<https://mst.dk/natur-vand/vandmiljoe/tilskud-til-vand-og-klimaprojekter/udtagning-af-lavbundsjorder/>

Danish Environmental Agency (2022b). Luftforureningens effekter på natur og miljø. Retrieved from <https://mst.dk/luft-stoej/luft/hvad-er-luftforurening/luftforureningens-effekter-paa-natur-og-miljoe/>

Danish Environmental Protection agency (2017): *Economic Instruments in Environmental Protection*

Danish Ministry of Climate, Energy and Utilities (2022). *Klimaindsatsen i Danmark*. Retrieved from <https://kefm.dk/klima-og-vejr/klimaindsatsen-i-danmark>

Danish Ministry of Environment (2020B) Natur-og biodiversitetspakke. Retrieved from <https://mim.dk/natur/natur-dyr-og-planter/natur-og-biodiversitetspakke-2020/>

Danish Ministry of Environment (2021) Natur- og biodiversitetspakken. Retrieved from [https://mim.dk/media/217328/aftaletekst - natur-_og_biodiversitetspakken.pdf](https://mim.dk/media/217328/aftaletekst_-_natur-_og_biodiversitetspakken.pdf)

Danish Ministry of Food and Environment (2016) Aftale om naturpakke. Retrieved from <https://mst.dk/media/114023/naturpakke-2016.pdf>

DCA (2021) Vidensyntese om kulstofrig lavbundsjord. Retrieved from https://pure.au.dk/portal/files/214394346/Vidensyntese_kulstofrig_lavbundsjord_30_03_2021_rev.pdf

DIIS (2022) How to support a rights-based approach to nature-based solutions. Retrieved from <https://www.diis.dk/en/research/how-to-support-a-rights-based-approach-to-nature-based-solutions>

Dinesen, L., Højgård Petersen, A., & Rahbek, C. (2021). Synergy in conservation of biodiversity and climate change mitigation: Nordic peatlands and forests. Nordic Council of Ministers.

Duarte, C. M., Kennedy, H., Marbà, N., & Hendriks, I. (2013). Assessing the capacity of seagrass meadows for carbon burial: Current limitations and future strategies. *Ocean and Coastal Management*, 83, 32–38.
<https://doi.org/10.1016/j.ocecoaman.2011.09.001>

Emsens, W. J., van Diggelen, R., Aggenbach, C. J., Cajthaml, T., Frouz, J., Klimkowska, A., ... & Verbruggen, E. (2020). Recovery of fen peatland microbiomes and predicted functional profiles after rewetting. *The ISME journal*, 14(7), 1701-1712.

Energy Research & Social Science, Volume 72, 2021,101872, ISSN 2214-6296,

Environmental Justice Atlas (2022). Retrieved from: <https://www.ejatlasing.org/print/karahnjukar-iceland>

ESA (2020). ESA adopts green forest-management benchmarks for Iceland and Norway. Retrieved from: <https://www.eftasurv.int/newsroom/updates/esa-adopts-green-forest-management-benchmarks-iceland-and-norway>

European Commission (2013). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Green Infrastructure (GI) — Enhancing Europe's Natural Capital. /* COM/2013/0249 final */

European Commission (2015): Towards an EU Research and Innovation policy agenda for Nature-Based Solutions & Re-Naturing Cities

European Commission (2019). The European Green Deal.

European Commission (2019) The European Union, Iceland and Norway agree to deepen their cooperation in climate action. Retrieved from https://ec.europa.eu/clima/news-your-voice/news/european-union-iceland-and-norway-agree-deepen-their-cooperation-climate-action-2019-10-25_en

European Commission (2020a). EU Biodiversity Strategy for 2030.

European Commission (2020b). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS EU Biodiversity Strategy for 2030 Bringing nature back into our lives. COM/2020/380 final.

European Commission (2021). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change. COM/2021/82 final. Retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:82:FIN>

European Commission (2021). New EU Forest strategy for 2030. Brussels, 16.7.2021 COM (2021) 572 final. Retrieved from: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0572>

European Commission (2021): The Nitrates Directive. Retrieved from https://ec.europa.eu/environment/water/water-nitrates/index_en.html

European Commission (2022). Nature Restoration Law. Retrieved from https://environment.ec.europa.eu/topics/nature-and-biodiversity/nature-restoration-law_en

European Commission (2022). Proposal for REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on nature restoration.

European Commission (2022) Status of implementation of the WFD in the Member States. https://ec.europa.eu/environment/water/participation/map_mc/map.htm

European Committee of the Regions (2022) Finland. Retrieved from <https://portal.cor.europa.eu/divisionpowers/Pages/Finland.aspx>

European Environment Agency (2020) Air pollution – State and impacts (Iceland). Retrieved from <https://www.eea.europa.eu/soer/2010/countries/is/air-pollution-state-and-impacts-iceland>

European Green Capital (2022). France announces rooftops must be covered in plants or solar panels. Retrieved from <https://ec.europa.eu/environment/europeangreencapital/france-green-roofs/>

Eyvindson, K., Duflot, R., Triviño, M., Blattert, C., Potterf, M., & Mönkkönen, M. (2021). High boreal forest multifunctionality requires continuous cover forestry as a dominant management. *Land Use Policy*, 100(104918).

<https://doi.org/10.1016/j.landusepol.2020.104918>

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

Felton, A., Löfroth, T., Angelstam, P., Gustafsson, L., Hjältén, J., Felton, A. M., Simonsson, P., Dahlberg, A., Lindbladh, M., Svensson, J., Nilsson, U., Lodin, I., Hedwall, P. O., Sténs, A., Lämås, T., Brunet, J., Kalén, C., Kriström, B., Gemmel, P., & Ranius, T. (2020). Keeping pace with forestry: Multi-scale conservation in a changing production forest matrix. *Ambio*, 49(5), 1050–1064. <https://doi.org/10.1007/s13280-019-01248-0>

Filazzola, A., Shrestha, N. & MacIvor, J. S. (2019, 'The contribution of constructed green infrastructure to urban biodiversity: a synthesis and meta-analysis', *Journal of Applied Ecology* 56(9), pp. 2131-2143 (DOI: 10.1111/1365-2664.13475).

Finland's Ministry of the Environment (2022). Helmi habitats programme aims to strengthen biodiversity. Retrieved from <https://ym.fi/en/helmi-habitats-programme>

Finlex (2019) Environmental Protection Act. Retrieved from https://www.finlex.fi/en/laki/kaannokset/2014/en20140527_20190049.pdf

Finlex (2022) Klimatlag. Retrieved from <https://www.finlex.fi/sv/laki/alkup/2022/20220423>

Finnish Environment Institute (2019) Watercourse regulation. Retrieved from https://www.ymparisto.fi/en-US/Waters/Use_of_water_resources/Watercourse_regulation

Finnish Ministry of the Environment (2019) Assessment of the status of Finland's waters: Status of lakes and rivers about the same as before, coastal waters have deteriorated. Retrieved from [https://www.ymparisto.fi/en-US/Waters/Assessment_of_the_status_of_Finlands_wat\(51377\)](https://www.ymparisto.fi/en-US/Waters/Assessment_of_the_status_of_Finlands_wat(51377))

Finnish Ministry of the Environment (2020). Air Pollution Control. Retrieved from https://www.ymparisto.fi/en-US/Climate_and_air/Air_pollution_control

Finnish Nature Panel (2021). SOIDEN ENNALLISTAMISEN SUOLUONTO-, VESISTÖ- JA ILMASTOVAIKUTUKSET. Retrieved from <https://luontopaneeli.fi/wp-content/uploads/2021/07/suomen-luontopaneelin-julkaisu-3b-2021-soiden-ennallistamisen-vaikutukset.pdf>

Fourqurean, J. W., Duarte, C. M., Kennedy, H., Marba, N., Holmer, M., Mateo, M. A., et al. (2012). Seagrass ecosystems as a globally significant carbon stock. *Nature Geoscience*, 5(7), 505–509. <https://doi.org/10.1038/ngeo1477>

Fraixedas, S., Lindén, A., Meller, K., Lindström, Å., Keišs, O., Kålås, J. A., ... & Lehtikainen, A. (2017). Substantial decline of Northern European peatland bird populations: Consequences of drainage. *Biological conservation*, 214, 223-232.

Frederiksberg Kommune (2013). Grønne tage og taghaver – kombineret med klimatilpasning i form af LAR og energibesparende tiltag. Retrieved from <https://www.frederiksberg.dk/sites/default/files/meetings-appendices/E58F7213-982F-483D-93C5-9C2EBA08C2DE/2251635-2329574-1.PDF>

González del Tánago et al. 2021. Improving river hydromorphological assessment through better integration of riparian vegetation: Scientific evidence and guidelines. *Journal of Environmental Management*. Volume 292. <https://doi.org/10.1016/j.jenvman.2021.112730>

Governing parties in Denmark (2019) Agreement on climate law. Retrieved from <https://kefm.dk/Media/1/D/aftale-om-klimalov-af-6-december-2019%20FINAL-a-webtilg%C3%A6ngelig.pdf>

Government of Iceland (2018). Iceland launches new Climate strategy boosting efforts to reach Paris Goals. Retrieved from: <https://www.government.is/news/article/?newsid=c7ab2ec0-b515-11e8-942c-005056bc4d74>

Government of Iceland (2019). Iceland's National Plan issued in accordance with Declaration related to the Decision of EEA Joint committee No 269/2019 of 25 October 2019. Ministry for the Environment and Natural Resources.

Government of Iceland (2019). Iceland's Implementation of the 2030 Agenda for Sustainable Development. Voluntary National review. Retrieved from https://sustainabledevelopment.un.org/content/documents/23408VNR_Iceland_web_June2019.pdf

Government of Iceland (2020). Iceland's 2020 Climate Action Plan. Retrieved from <https://www.government.is/library/01-Ministries/Ministry-for-The-Environment/201004%20Umhverfissraduneytid%20Adgerdaaetlun%20EN%20V2.pdf>

Government of Iceland (2021): On the path to climate neutrality, Iceland's long-term low emission development strategy. Ministry for the Environment and Natural Resources. Retrieved from: https://unfccc.int/sites/default/files/resource/Iceland_LTS1_2021.pdf

Government of Iceland (2022a). Hydro Power Plants. Retrieved from: <https://www.government.is/topics/business-and-industry/energy/hydro-power-plants/>

Government of Iceland (2022b). International Cooperation. Retrieved from: <https://www.government.is/topics/environment-climate-and-nature-protection/national-parks-and-protected-areas/international-cooperation/>

Government of Norway (2021). Klimaendringer og norsk klimapolitikk. Retrieved with: <https://www.regjeringen.no/no/tema/klima-og-miljo/innsiktsartikler-klima-miljo/klimaendringer-og-norsk-klimapolitikk/id2636812/>

Göteborgs Stad (2019). Yttrande angående – Motion av Karin Pleijel (MP) och Klara Holmin (MP) om att skydda havets ålgräsängar. Retrieved from [https://www4.goteborg.se/prod/intraservice/namndhandlingar/SamrumPortal.nsf/60A97BDB8E18FBB5C125861400544C96/\\$File/3.3_20201111.pdf?OpenElement](https://www4.goteborg.se/prod/intraservice/namndhandlingar/SamrumPortal.nsf/60A97BDB8E18FBB5C125861400544C96/$File/3.3_20201111.pdf?OpenElement)

Göteborgs Stad (2021). Kartering av ålgräs 2020 - Flygbildstolkning och verifiering i fält. Rapportnummer 2021:09. Miljöförvaltningen. Retrieved from https://goteborg.se/wps/wcm/connect/f6d9a0ea-0a6b-4c75-a0c0-48f1d9d28265/N800_R_2021_09+Flyginventering+%C3%A5lgr%C3%A4s.pdf?MOD=AJPERES#:~:text=Inom%20omr%C3%A5det%20p%C3%A5tr%C3%A4ffades%20%C3%A5lgr%C3%A4s%20Page,25%2D75%20%25%20av%20botten.

GTK (2020). Science Blog: The influence of land use on the peatland area and carbon stores of Finland since the 1950s. Retrieved from <https://www.gtk.fi/en/current/science-blog-the-influence-of-land-use-on-the-peatland-area-and-carbon-stores-of-finland-since-the-1950s/>

Guide to Iceland (2022). Eyjabakkar Travel Guide. Retrieved from <https://guidetoiceland.is/travel-iceland/drive/eyjabakkar>

Guillaume Voegeli, David C. Finger. Disputed dams: Mapping the divergent stakeholder perspectives, expectations, and concerns over hydropower development in Iceland and Switzerland, Energy Research & Social Science, Volume 72, 2021,101872, ISSN 2214-6296

Gunnarsson T. G., Gill, J. A., Appleton, G. F., Gíslason, H., Gardarsson, A., Watkinson, A. R., Sutherland, W. J. (2005). Large-scale habitat associations of birds in lowland Iceland: Implications for conservation. Biological Conservation. 265-275.

Günther, A., Barthelmes, A., Huth, V., Joosten, H., Jurasinski, G., Koebisch, F. & Couwenberg, J. 2020. Prompt rewetting of drained peatlands reduces climate warming despite methane emissions. Nature Communications. 11: 1644

Hagen, D., Aarrestad, P.A., Kyrkjeeide, M.O., Foldvik, A., Myklebost, H.E., Hofgaard, A., Kvaløy, P., Hamre, Ø. 2015. Etablering av overvåkingmetodikk for vegetasjon og grunnlagsanalyse før restaureringstiltak på Kaldvassmyra, Aurstadmåsan og Midtfjellmosen. NINA Rapport 1212. Norsk institutt for naturforskning.

Halldorson, G., Oddsdottir, E. S., & Eggertsson, O. (2005): Effects of afforestation on ecosystems, landscape and rural development. TemaNord 2007:508. Proceedings of the AFFORNORD conference. Reykholt, Iceland, June 18-22, 2005. Retrieved from: <https://norden.diva-portal.org/smash/get/diva2:702668/FULLTEXT01.pdf>

Hannerz, M., Nordin, A. & Saksa, T. (2017). Hyggesfritt skogsbruk. En

kunskapssammanställning från Sverige och Finland Finland. Future Forests Rapportserie 2017:1. Sveriges lantbruksuniversitet, Umeå. Retrieved from https://jordensvanner.se/wp-content/uploads/2020/10/ff-rapport_hyggesfritt_skogsbruk_en_kunskapssammanstallning-2017-04-02.pdf

Hansen, M. B. (2020). Grønne tage kan lægge låg på klimaudfordringer. JAktuelt 7 april 2020.

Havs och Vattenmyndigheten (2017). Åtgärdsprogram för ålgräsängar: Zostera spp rapport 2017:24. Retrieved from <https://www.havochvatten.se/data-kartor-och-rapporter/rapporter-och-andra-publikationer/publikationer/2017-09-25-atgardsprogram-for-algrasangar.html#:~:text=Detta%20%C3%A4r%20ett%20%C3%A5tg%C3%A4rdsprogram%20f%C3%B6r,b%C3%B6r%20genomf%C3%B6ras%20perioden%202017%2D2021>

Helles, F., Linddal, M. (1996): Afforestation Experience in the Nordic countries. Nordic Council of Ministers, Copenhagen. Nord 1996:15

Hemes, K. S., Chamberlain, S. D., Eichelmann, E., Anthony, T., Valach, A., Kasak, K., ... & Baldocchi, D. D. (2019). Assessing the carbon and climate benefit of restoring degraded agricultural peat soils to managed wetlands. Agricultural and Forest Meteorology, 268, 202-214.

Hudekova, Z. (2020). Green infrastructure and biodiversity. Retrieved from https://projects2014-2020.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1585149195.pdf

Huth, V., Günther, A., Bartel, A., et al. 2021. The climate benefits of topsoil removal and Sphagnum introduction in raised bog restoration. Restoration Ecology.

Iceland's Forest Service (2022). Retrieved from: <https://www.skogur.is/is/nyskograekt/skoggraedsluverkefni/hekluskogar>

Iceland's Ministry for the Environment and Natural Resources (2018) Iceland's Seventh National Communication and Third Biennial Report Under the United Nations Framework Convention on Climate Change. Retrieved from https://unfccc.int/sites/default/files/resource/Iceland_NC7_BR3_2018_Final_I.pdf

Iceland's Ministry for the Environment and Natural Resources (2021) On the Path to Climate Neutrality: Iceland's Long-Term Low Emission Development Strategy. Retrieved from https://www.stjornarradid.is/library/02-Rit--skyrslur-og-skrar/Iceland_LTS_2021.pdf

Iceland's Ministry of the Environment, Energy and Climate (2022) Climate change. Retrieved from <https://www.government.is/topics/environment-climate-and-nature-protection/climate-change/>

Icelandic Forestry Service (2019) Forest Reference Level 2021-2025: Iceland.
Retrieved from

https://www.skogur.is/static/files/utgafa/nfap_iceland_october_2020.pdf

Icelandic Forest Service (2022a). Forestry and Climate Change. Retrieved from:

<https://www.skogur.is/en/forestry/forestry-in-a-treeless-land/forestry-and-climate-change>

Icelandic forest service (2022b). Retrieved from:

<https://www.skogur.is/en/forestry/forestry-in-a-treeless-land/forestry-in-iceland-by-the-numbers>

Icelandic Institute of Natural History (2022A). Red List for Vascular Plants.

Retrieved from <https://www.ni.is/en/resources/publications/red-lists/plontur>

Icelandic Institute of Natural History (2022B) Red List for Birds. Retrieved from

<https://www.ni.is/en/resources/publications/red-lists/fuglar>

Icelandic Institute of Natural History (2022C) Red List for Mammals. Retrieved

from <https://www.ni.is/en/resources/publications/red-lists/spendyr>

Iceland's Ministry of Food, Agriculture and Fisheries (2022) Soil conservation.

Retrieved from <https://www.government.is/topics/environment-climate-and-nature-protection/soil-conservation/>

Institute of Economic Studies (2009). Potential and economics of wetland restoration as climate change mitigation activity in Iceland. Report nr. C09:05

IPCC (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

IPCC Guidelines (2014). 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands.

IPCC, 2022: Summary for Policymakers [H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem (eds.)]. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3–33, doi:10.1017/9781009325844.001.

Irga, P., Fleck, R., Wooster, E., Torpy, F., Pettit, T., Gill, R., & Ball, J. (2021). Green roof & solar array – Comparative research project final report July 2021. City of Sydney Council

IUCN (2020). IUCN Global Standard for Nature-Based Solutions. Retrieved from:

<https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf>

Jahnke, M., Moksnes, P. O., Olsen, J. L., Serra Serra, N., Nilsson Jacobi, M., Kuusemäe, K., Corell, H., & Jonsson, P. R. (2020). Integrating genetics, biophysical, and demographic insights identifies critical sites for seagrass conservation. *Ecological Applications*, 30(6). <https://doi.org/10.1002/eap.2121>

Jensen, M. B. & Møller, L. F. (2013). Grønne tage – historik og potentiale. Videnblad nr. 04.09-02

Jensen, M. B. & Møller, L. F. (2013). State of the art for grønne tage. Retrieved from <https://docplayer.dk/7959595-State-of-the-art-for-groenne-tage-ip07-kan-groenne-tage-tage-vand-hydrauliske-egenskaber-for-groenne-tage.html>

Jim, C. Y. (2017). An archaeological and historical exploration of the origins of green roofs,

Jim, C. Y. (2017) Green roof evolution through exemplars: Germinal prototypes to modern variants, *Sustainable Cities and Society*, Volume 35, Pages 69-82, ISSN 2210-6707, <https://doi.org/10.1016/j.scs.2017.08.001>.

Jonassen. 2009. Grønnstrukturens betydning for lokalklima og luftkvalitet. <https://folkeaksjonen.files.wordpress.com/2010/05/2009grontplanennotatgrontstrukturensbetydnforlokalklimaogluftkvalitet.pdf>

Juutinen, A., Tolvanen, A., Saarimaa, M., Ojanen, P., Sarkkola, S., Ahtikoski, A., ... & Tuominen, S. (2020). Cost-effective land-use options of drained peatlands–integrated biophysical-economic modeling approach. *Ecological Economics*, 175, 106704.

Key, I., Smith, A., Turner, B., Chausson, A., Girardin, C., Macgillivray, M., & Seddon, N. (2021). Can Nature-Based Solutions Deliver a Win-Win for Biodiversity and Climate Change Adaptation? Preprints 2021, 2021100336

KL – Local Government Denmark (2022). DK2020: Klimaplaner for hele Danmark. Retrieved from <https://www.kl.dk/kommunale-opgaver/klima/dk2020/>

Klimatilpasning (2021) Synergiprojekter. Retrieved from <https://www.klimatilpasning.dk/sektorer/natur/synergiprojekter/>

Klimatilpasning (2022) Klimatilpasning. Retrieved from <https://www.klimatilpasning.dk/>

Koskela, T., Anttila, S., Aapala, K. & Mutttilainen, H. (2022). METSO-tilannekatsaus 2021 : Etelä-Suomen metsien monimuotoisuuden toimintaohjelma 2008–2025. Luonnonvara- ja biotalouden tutkimus 56/2022. Luonnonvarakeskus. Helsinki. 56 s.

Krzeminska et al. 2020. Kantsoner med ulike vegetasjon resultater fra BUFFERKLIMA-prosjektet. NIBIO Faktaark.

https://www.nibio.no/prosjekter/valg-av-vegetasjon-i-buffersoner-for-best-mulig-renseeffekt-og-redusert-erosjon-bufferklima/_/attachment/inline/6cedfe2e-f36e-4bef-817c-264df5368bfb:b75901ca8b5245ad4d268cfccabf5a350a49a5b1/260202_NIBIO%20Nyhetsbrev_BUFFERLKIMA_DK_20200309.pdf

Krzeminska et al. 2022. Beregning av effekter av kantsoner langs vassdrag i gamle Vestfold fylke. Metodeutvikling basert på Agricat 2-modellen.

https://nibio.brage.unit.no/nibio-xmlui/bitstream/handle/11250/2838368/NIBIO_RAPPORT_2022_8_4.pdf

Kuusela, S., Aapala, K., Aalto, J., Heikkinen, R., Leikola, N., Pöyry, J. and Virkkala, R. (2018). Finnish protected area network in a changing climate. 5th European Congress of Conservation Biology. doi: 10.17011/conference/eccb2018/107335

Kyrkjeeide, M.O., Lyngstad, A., Hamre, Ø. og Jokerud, M. 2018. Overvåking av restaureringstiltak i myr. Aurstadmåsan, Kaldvassmyra og Hildremsvannet. NINA rapport 1576. Norsk Institutt for Naturforskning

Kyrkjeeide, M.O., Bartlett, J., Rusch, G., Sandvik, H. & Nordén, J. 2020. Karbonlagring i norske økosystemer (revidert utgave). NINA Temahefte 76b. Norsk institutt for naturforskning.

Kyrkjeeide, M.O., Lunde, L.M.F., Lyngstad, A. & Molværsmyr, S. 2021. Restaurering av myr. Overvåking av tiltak i 2021. NINA Rapport 2051. Norsk institutt for naturforskning

Københavns kommune (2009). Klima København - En vision og en plan. Miljømetropolen. Retrieved from <https://www.kk.dk/sites/default/files/agenda/2b39a97414777d61a5f957b3eb33d78f876130a6/8-bilag-3.PDF>

Københavns Kommune (2012). Grønne tage Det livgivende, klimatilpassede alternativ. Teknik- og Miljøforvaltningen

Københavns Kommune (2015). Bynatur i København - Strategi 2015-2025. Teknik- og Miljøforvaltningen

Lahti Group Administration (2020). Lahti Region Environmental Review. Retrieved from https://www.lahti.fi/uploads/2021/06/baf99b4f-lahtiregionenviromentalreport_2020_en_lr.pdf

Laine, A. M., Mehtätalo, L., Tolvanen, A., Froking, S., & Tuittila, E. S. (2019). Impacts of drainage, restoration and warming on boreal wetland greenhouse gas fluxes. *Science of the Total Environment*, 647, 169–181. <https://doi.org/10.1016/j.scitotenv.2018.07.390>

Landbruks- og matdepartementet (2018) Nasjonal pollinatorstrategi. Retrieved from

<https://www.regjeringen.no/no/dokumenter/nasjonal-pollinatorstrategi/id2606300/>

Larsen (2022). Hogst. Store Norske Leksikon. [https://snl.no/hogst#-Hogstformer i kantsoner langs vassdrag](https://snl.no/hogst#-Hogstformer_i_kantsoner_langs_vassdrag)

Leppälä, M., Laine, A. M., Seväkivi, M. L., & Tuittila, E. S. (2011). Differences in CO₂ dynamics between successional mire plant communities during wet and dry summers. *Journal of Vegetation Science*, 22(2), 357-366.

Lepistö, A., Räike, A., Sallantausta, T., & Finér, L. (2021). Increases in organic carbon and nitrogen concentrations in boreal forested catchments—Changes driven by climate and deposition. *Science of the Total Environment*, 780, 146627.

Liao, C., Luo, Y., Fang, C., Li, B. (2010) Ecosystem carbon stock influenced by plantation practice: Implications for planting forests as a measure of Climate change mitigation. *PLoS ONE* 5 (5): e10867

Linköpings kommun (2020). Riktlinjer för Linköpings kommuns skogsinnehav. Dnr SBN 2020-213. Retrieved from <https://www.linkoping.se/contentassets/b5b3d593065047e5a20f35a42b7571cb/riktlinjer-for-linkopings-kommuns-skogsinnehav.pdf?49cdd8#:~:text=Skogssk%C3%B6tselplanen%20kommer%20successivt%20att%20anpassas%20till%20riktlinjerna%20och%20zoneringen.&text=Den%20%C3%B6vergripande%20m%C3%A5ls%C3%A4ttningen%20med%20f%C3%B6rvaltningen,v%C3%A4rden%20utifr%C3%A5n%20varje%20sk%C3%B6tselomr%C3%A5des%20m%C3%A5lklassning.>

Lovdata (2022). Lov om vern mot forurensninger og om avfall (forurensningsloven). Retrieved from [https://lovdata.no/dokument/NL/lov/1981-03-13-6#KAPITTEL 7](https://lovdata.no/dokument/NL/lov/1981-03-13-6#KAPITTEL_7)

LUKE (2022A) Ownership of forest land. Retrieved from <https://www.luke.fi/en/statistics/ownership-of-forest-land>

LUKE (2022B). Stumpage earnings 2021 (preliminary). Retrieved from <https://www.luke.fi/en/statistics/stumpage-earnings/stumpage-earnings-2021-preliminary>

Lunde, L.M.F., 2022. Summary of mire restoration and evaluation of two methods for monitoring mire restoration in Norway. Master's thesis. NTNU, Faculty of Natural Sciences, Department of Biology.

Magnussen et al. 2017. Naturbaserte løsninger for klimatilpasning. Menon publication. 61. (In Norwegian) [Naturbaserte løsninger for klimatilpasning - Miljødirektoratet \(miljodirektoratet.no\)](https://www.miljodirektoratet.no/publikasjoner/naturbaserte-loesninger-for-klimatilpasning-61/)

Mayer, A. L., & Tikka, P. M. (2006). Biodiversity conservation incentive programs for privately owned forests. *Environmental Science & Policy*, 9(7-8), 614-625.

Melandis, M. S. & Hagerman, S. (2022) Competing narratives of nature-based

solutions: Leveraging the power of nature or dangerous distraction? Science & Policy, 132, June 2022, 273-281.

Meli, Paula & Benayas, José & Balvanera, Patricia & Martinez-Ramos, Miguel. (2014). Restoration Enhances Wetland Biodiversity and Ecosystem Service Supply, but Results Are Context-Dependent: A Meta-Analysis. PloS one. 9. e93507. 10.1371/journal.pone.0093507.

Menberu, M. W., Marttila, H., Tahvanainen, T., Kotiaho, J. S., Hokkanen, R., Kløve, B., & Ronkanen, A. K. (2017). Changes in pore water quality after peatland restoration: Assessment of a large-scale, replicated before-after-control-impact study in Finland. Water Resources Research, 53(10), 8327-8343.

Metsäkeskus Forest Centre (2022) Supported types of work, the Sustainable Forestry Financing Act. Retrieved from <https://www.metsakeskus.fi/en/forestry-subsidies/supported-types-of-work-the-sustainable-forestry-financing-act>

METSO (2022) METSO forest biodiversity. Retrieved from <https://metsonpolku.fi/en/frontpage>

METSO (2022) Nästan 90 procent av METSO-programmets skyddsmål har uppnåtts – ytterligare finansiering behövs till miljöstödsavtal och naturvårdsprojekt. Retrieved from <https://metsonpolku.fi/sv/-/nastan-90-procent-av-metso-programmets-skyddsmal-har-uppnatts-ytterligare-finansiering-behovs-till-miljostodsavtal-och-naturvardsprojekt>

Miljöpartiet (2021). Göteborgs ålgräsängar får skydd. Retrieved from <https://www.mp.se/goteborg/just-nu/goteborgs-algrasangar-far-skydd/>

Miljø- og Fødevarerministeriet (2016). Aftale om Naturpakke. Retrieved from <https://mst.dk/media/114023/naturpakke-2016.pdf>

Miljøministeriet (2021). Bekendtgørelse af lov om naturbeskyttelse. Retrieved from <https://www.retsinformation.dk/eli/lt/2021/1986>

Miljøstyrelsen (2016). Ansøgningsparadigme.

Miljøstyrelsen (2016). Vejledning om tilskud til skabelse af synergi mellem klimatilpasning, ny natur, friluftsliv og kvælstofreducerende tiltag

Miljøstyrelsen (2021). Synergiprojekter. Retrieved from <https://www.klimatilpasning.dk/sektorer/natur/synergiprojekter/>

Miljøstyrelsen (2022). Luftforureningens effekter på natur og miljø. Retrieved from <https://mst.dk/luft-stoej/luft/hvad-er-luftforurening/luftforureningens-effekter-paa-natur-og-miljoe/>

Ministry of Agriculture and Forestry of Finland (2020) Biodiversity. Retrieved from <https://mmm.fi/en/nature-and-climate/biodiversity>

Ministry of Agriculture and Forestry of Finland (2022) Government approves

Climate Plan for Land Use Sector. Retrieved from

<https://mmm.fi/en/-/government-approves-climate-plan-for-lulucf-sector>

Ministry of Food, Agriculture and Fisheries (2022). Bekendtgørelse om tilskud til vådområdeprojekter og lavbundsprojekter. BEK nr 236 af 15/02/2022. Retrieved from <https://www.retsinformation.dk/eli/lta/2022/236>

Ministry for the Environment and Natural Resources & Ministry of Education, Science and Culture (2013). Appendix 4: Vatnajökull National Park Management Plan 2013.

Ministry for the Environment and Natural Resources. (2018). Iceland's 7th National Communication and 3rd Biennial Report. Retrieved from:

https://unfccc.int/sites/default/files/resource/Iceland_NC7_BR3_2018_Final_I.pdf

Ministry of Local Government and Modernisation (2019) National expectations regarding regional and municipal planning 2019–2023. Retrieved from <https://www.regjeringen.no/contentassets/cc2c53c65af24b8ea560c0156d885703/nasjonale-forventninger-2019-engelsk.pdf>

Ministry of Local Government and regional development (2008) Act of 27 June 2008 No. 71 relating to Planning and the Processing of Building Applications (the Planning and Building Act) (the Planning part). Retrieved from

<https://www.regjeringen.no/en/dokumenter/planning-building-act/id570450/>

Ministry for the Environment and Natural Resources (2013). The fourth National Report to the convention on Biological Diversity – Iceland. Retrieved from

<https://www.cbd.int/doc/world/is/is-nr-04-en.pdf>

Ministry for the Environment and Natural Resources. (2018). Iceland's 7th National Communication and 3rd Biennial Report. Retrieved from

https://unfccc.int/sites/default/files/resource/Iceland_NC7_BR3_2018_Final_I.pdf

Ministry of the Environment & Statistics Finland (2017) Finland's Seventh National Communication under the United Nations Framework Convention on Climate Change. Helsinki. 314 p.

Ministry of the Environment, Energy and Climate (2022). Report on Policies, Measures and Projections: Projections of Greenhouse gas emissions in Iceland until 2040. Retrieved from

https://ust.is/library/Skrar/loft/NIR/PaMsProjections_Report%202022_published.pdf

Ministeriet for Fødevarer, Landbrug og Fiskeri (2016). Ny natur skal sikre byer mod oversvømmelser. Retrieved from <https://fvm.dk/nyheder/nyhed/nyhed/ny-natur-skal-sikre-byer-mod-oversvoemmelser/>

Ministeriet for Fødevarer, Landbrug og Fiskeri (2017). Grønt lys til klima-vådområder for 10. Mio. Kroner. Retrieved from

<https://fvm.dk/nyheder/nyhed/nyhed/groent-lys-til-klima-vaadomraader-for-10-mio-kroner/>

Mokany, K., Ferrier, S., Harwood, T.D., Ware, C., Di Marco, M., Grantham, H.S., Venter, O., Hoskins, A.J., Watson, J.E.M. (2020). Reconciling global priorities for conserving biodiversity habitat Proc. Natl. Acad. Sci. USA, 117, pp. 9906-9911

Moksnes, P. O., Röhr, M. E., Holmer, M., Eklöf, J. S., Eriander, L., Infantes, E., & Boström, C. (2021). Major impacts and societal costs of seagrass loss on sediment carbon and nitrogen stocks. Ecosphere, 12(7). <https://doi.org/10.1002/ecs2.3658>

Mürer. 2019. Management responsibility for conservation and restoration of riparian vegetation – a case study of sea trout streams in Verdal municipality. Master thesis. Norwegian University of Life Sciences.

Nature-based Solutions Initiative (2022A) United Nations Environment Assembly agrees Nature-based Solutions definition. Retrieved from <https://www.naturebasedsolutionsinitiative.org/news/united-nations-environment-assembly-nature-based-solutions-definition/>

Nature-based Solutions Initiative (2022B) NbS Case Study platform. Retrieved from <https://casestudies.naturebasedsolutionsinitiative.org/>

Naturvårdsverket (no date). Om åtgärdsprogrammen. Retrieved from <https://www.naturvardsverket.se/amnesomraden/arter-och-artskydd/atgardsprogram/om-atgardsprogrammen/>.

Naturvårdsverket (2018). Sweden's environmental objectives - an introduction. Retrieved from <http://naturvardsverket.diva-portal.org/smash/get/diva2:1477059/FULLTEXT01.pdf>

Naturvårdsverket (2022). Utvärdering av Åtgärdsprogram för hotade arter och naturtyper (ÅGP). RAPPORT 7026. Retrieved from <https://www.naturvardsverket.se/om-oss/publikationer/7000/utvardering-hotade-arter-naturtyper/#:~:text=Rapporten%20 visar%20att%20%C3%85GP%20uppfattas,organismgrupper%20och%20m%C3%A5nga%20olika%20naturtype>

Network for nature (2022) Taking nature-based solutions up the policy ladder: from research to policy action. Retrieved from: <https://networknature.eu/sites/default/files/uploads/networknature-nbs-knowledgebrief01.pdf>

Nielsen, K. B (2019). Politikerbesvarelse til Fanny Broholm om retningslinjer m_m_DOCX.PDF. Teknik- og Miljøforvaltningen. Retrieved from <https://www.kk.dk/sites/default/files/2021-09/12.%20april%202019%20-%20svar%20til%20Fanny%20Broholm%20%28%C3%85%29%20om%20retningslinjer%20for%20gr%C3%B8nne%20tage%20i%20K%C3%B8benhavn.pdf>

NINA (2022) Pollinatortiltak Porsgrunn. Retrieved from <https://www.nina.no/V%C3%A5re-fagomr%C3%A5der/Prosjekter/Pollinatortiltak-Porsgrunn>

Nordic Council of Ministers (1996) Agriculture and Forestry: Afforestation Experience in the Nordic countries

Nordic Council of Ministers (2008) AFFORNORD: Effects of afforestation on ecosystems, landscapes and rural development. Retrieved from <https://www.norden.org/en/publication/affornord>

Nordic Council of Ministers and Nordic Council (2022A) Fakta om Sverige. Retrieved from <https://www.norden.org/da/information/fakta-om-sverige>

Nordic Council of Ministers and Nordic Council (2022B) Fakta om Finland. Retrieved from <https://www.norden.org/da/information/fakta-om-finland>

Nordlund, A., & Westin, K. (2011). Forest Values and Forest Management Attitudes among Private Forest Owners in Sweden. *Forests*, 2, 30–50. <https://doi.org/10.3390/f2010030>

Norwegian Ministry of Climate and Environment, (2015). Nature for life. Norway's national biodiversity action plan. Meld. St. 14 (2015-2016) Report to the Storting (white paper).

Norwegian Environment Agency (2016). Wetland restoration plan in Norway (2016-2020). Norwegian Environment Agency Report M-644.

Norwegian Environment Agency (2020). Wetland restoration plan, Norway (2021-2025). Norwegian Environment Agency Report M-1903.

NIBIO. 2020. Kantsoner. <https://nibio.no/tema/miljo/tiltaksveileder-for-landbruket/vannmilljotiltak/kantsoner>

Norwegian Environmental Agency. 2021. Klimautfordringer. <https://www.miljodirektoratet.no/ansvarsomrader/klima/for-myndigheter/klimatilpasning/klimatilpasning-krever-kunnskap/klimautfordringer/>

Norwegian Environmental Agency. 2022. Veileder: Hvordan håndtere overvann. [Håndtering av overvann - veileder - Miljødirektoratet \(miljodirektoratet.no\)](https://www.miljodirektoratet.no/tema/overvann/handtering-av-overvann-veileder)

Norwegian Environment Agency (2022) Naturområder på land. Retrieved from <https://miljostatus.miljodirektoratet.no/tema/naturomrader-pa-land/>

Norwegian Environment Agency (2022B) Vernet natur. Retrieved from <https://miljostatus.miljodirektoratet.no/tema/naturomrader-pa-land/vernet-natur/>

Norwegian Environment Agency (2022C). Kysten. Retrieved from <https://miljostatus.miljodirektoratet.no/tema/hav-og-kyst/kysten/>

Norwegian Environment Agency (2022D) Miljømål 4.6. Retrieved from

<https://miljostatus.miljodirektoratet.no/miljomal/forurensning/miljomal-4.6/>

Norwegian Ministry of Petroleum and Energy (2021). Electricity production. Retrieved from <https://energifaktanorge.no/en/norsk-energiforsyning/kraftproduksjon/>

Odsherred Kommune (2022). Grønnehave bæk. Retrieved from <https://www.odsherred.dk/da/bo-og-leve/affald-og-en-groen-hverdag/energi-og-klima/groennehave-baek/?text=gr%C3%B8nnehave%20b%C3%A6k&l1=3&l2=3&l3=3&l10=3>

OECD (2003): Voluntary Approaches for Environmental Policy, Effectiveness, Efficiency and Usage in Policy Mix

Öhrn, P., Berlin, M., Elfstrand, M., Krokene, P., & Jönsson, A. M. (2021). Seasonal variation in Norway spruce response to inoculation with bark beetle-associated bluestain fungi one year after a severe drought. *Forest Ecology and Management*, 496(119443). <https://doi.org/10.1016/j.foreco.2021.119443>

Öskarsson, H. (2009): Hekluskogar – Islands største reetablering af birkeskove. Skoven. 01. Retrieved from <https://hekluskogar.files.wordpress.com/2015/04/hekluskogar-skoven-1-09.pdf>

Palmer, M. A. & Stewart, G. H. (2020). Ecosystem restoration is risky ... but we can change that. *One Earth*. Volume 3, Issue 6. ISSN 2590-3322, <https://doi.org/10.1016/j.oneear.2020.11.019>.

Pálsdóttir, A. E., Gill, J. A., Alves, J. A., Pálsson S., Méndez V., Ewing, H., Gunnarsson, G. T. (2022): Subarctic afforestation: Effects of forest plantations on ground-nesting birds in lowland Iceland. *Journal of Applied Ecology*. 59 (10). 2456-2467. <https://doi.org/10.1111/1365-2664.14238>

Peura, M., Burgas, D., Eyvindson, K., Repo, A., & Mönkkönen, M. (2018). Continuous cover forestry is a cost-efficient tool to increase multifunctionality of boreal production forests in Fennoscandia. *Biological Conservation*, 217, 104–112. <https://doi.org/10.1016/j.biocon.2017.10.018>

Price, R. (2021) Nature-based Solutions (NbS) – what are they and what are the barriers and enablers to their use? Institute of development Studies

Pollinatortiltak Porsgrunn (2022) Porsgrunn Poliinator Prosjekt. Retrieved from <https://storymaps.arcgis.com/stories/810923d33f3b48f594f4afa3c60541b3>

Porsgrunn commune (2021) Insektene kan ikke leve på luft og kjærlighet. Retrieved from <https://www.porsgrunn.kommune.no/aktuelt/insektene-kan-ikke-leve-paa-luft-og-kjaerlighet/>

Pörtner, H. O., Scholes, R. J., Agard, J., Archer, E., Arneth, A., Bai, X., ... & Ngo, H. (2021). Scientific outcome of the IPBES-IPCC co-sponsored workshop on biodiversity and climate change.

Prakash, A. (2021) Repurposing Perverse Incentives for Land Restoration. UNCCD Global Land Outlook Working Paper. Bonn.

Prentice, C., Poppe, K. L., Lutz, M., Murray, E., Stephens, T. A., Spooner, A., Helsing-Lewis, M., Sanders-Smith, R., Rybczyk, J. M., Apple, J., Short, F. T., Gaeckle, J., Helms, A., Mattson, C., Raymond, W. W., & Klinger, T. (2020). A Synthesis of Blue Carbon Stocks, Sources, and Accumulation Rates in Eelgrass (*Zostera marina*) Meadows in the Northeast Pacific. *Global Biogeochemical Cycles*, 34.
<https://doi.org/10.1029/2019GB006345>

Pukkala, T., Lähde, E., Laiho, O., Salo, K., & Hotanen, J. P. (2011). A multifunctional comparison of even-aged and uneven-aged forest management in a boreal region. *Canadian Journal of Forest Research*, 41(4), 851–862. <https://doi.org/10.1139/x11-009>

Pukkala, T., Laiho, O., & Lähde, E. (2016). Continuous cover management reduces wind damage. *Forest Ecology and Management*, 372, 120–127.
<https://doi.org/10.1016/j.foreco.2016.04.014>

Pulg et al. 2018. Tiltakshåndbok for bedre fysisk vannmiljø: God praksis ved miljøforbedrende tiltak i elver og bekker. (In Norwegian) [Microsoft Word - Uni Miljø Tiltakshåndbok 2018 11 compr.docx \(miljodirektoratet.no\)](#)

Putkinen, A., Tuittila, E.S., Siljanen, H.M.P., Bodrossy, L. & Fritze, H. 2018. Recovery of methane turnover and the associated microbial communities in restored cutover peatland is strongly linked with increasing Sphagnum abundance. *Soil Biology and Biochemistry*. 116: 110-119

Ramsar (2022). About the Convention on Wetlands. Retrieved from:
<https://www.ramsar.org/about-the-convention-on-wetlands-0>

REAS (2022) Våd natur kan give væsentlig klimaeffekt – men på lang sigt. Retrieved from <https://dm.dk/bio/artikler/alle-artikler/klima/vaad-natur-kan-give-vaesentlig-klimaeffekt-men-paa-lang-sigt>

Rist, L., Felton, A., Samuelsson, L., Sandström, C., Rosvall, O. (2013) A new paradigm for adaptive management. *Ecology & society*, 18(4): 63

Rusch. 2012. Climate and ecosystem services. The potential of Norwegian ecosystems for climate mitigation and adaptation. NINA Report 791. [Microsoft Word - ESS and climate 2012-08-10.docx \(nina.no\)](#)

Sabima (2022) Rødlista. Retrieved from <https://www.sabima.no/rodlista/>

Salomaa, A., Paloniemi, R., & Ekroos, A. (2018). The case of conflicting Finnish peatland management–Skewed representation of nature, participation and policy instruments. *Journal of Environmental Management*, 223, 694-702.

Seddon, N., Chausson, A., Berry, P., Girardin, C. A., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change

and other global challenges. Philosophical Transactions of the Royal Society B, 375(1794).

Seddon, N., Smith, A., Smith, P., Key, I., Chausson, A., Girardin, C., ... & Turner, B. (2021). Getting the message right on nature-based solutions to climate change. *Global change biology*, 27(8), 1518-1546.

SEGES (2019) ERFARINGER FRA LAVBUNDSORDNINGEN - UDTAGNING AF KULSTOFRIGE JORDE SOM KLIMAVIRKEMIDDEL
https://legacy.altinget.dk/misc/Rapport%20samlet_Barrierer%20og%20muligheder%20for%20realisering%20af%20lavbundsprojekter.pdf

Sharifi, A. (2020). Trade-offs and conflicts between urban climate change mitigation and adaptation measures: A literature review. *Cleaner Production*, Vol 276, 2020, 122813, ISSN 0959-6526

Shin, Y., Midgley, G. F., Archer, E. R. M., Arneeth, A., Barnes, K. A., Chan, L., Hashimoto, S., Hoegh-Guldberg, O., Insarov, G., Leadley, P., Levin, L. A., Ngo, H. T., Pandit, R., Pires, A. P. F., Pörtner, H., Rogers, A. D., Scholes, R. J., Settele, J., Smith, P. (2022) Actions to halt biodiversity loss generally benefit climate. *Global Change Biology*, 28 (9), 2846-2874.

Similä, M., Aapala, K., Penttinen, J. (eds) (2014). *Ecological Restoration in Drained Peatlands: Best Practices from Finland*. Metsähallitus, Natural Heritage Services.

Skarbøvik et al. 2018. Treplanting langs vann i jordbruksområde. Overlevelse av trær og grunneiers erfaringer. Våler kommune i Østfold (Vannområde Morsa). NIBIO report 4. [NIBIO Brage: Treplanting langs vann i jordbruksområde. Overlevelse av trær og grunneiers erfaringer. Våler kommune i Østfold \(Vannområde Morsa\).](https://nibio.no/rapporter/2018/Treplanting langs vann i jordbruksområde. Overlevelse av trær og grunneiers erfaringer. Våler kommune i Østfold (Vannområde Morsa).) (unit.no)

Skien commune (2020) Klimahandlingsprogram. Retrieved from <https://www.skien.kommune.no/globalassets/miljo/klimahandl.prgm-2018-2021-vedtatt-bystyret-4.6.20.pdf>

SLU (2017). De naturliga myrarna – kolfälla eller kolkälla? Retrieved from <https://www.slu.se/forskning/kunskapsbank/miljoanalys/de-naturliga-myrarna--kolfalla-eller-kolkalla/>

SLU Artdatabanken. (2020). Ålgräs - *Zostera marina*. Retrieved from <https://artfakta.se/naturvard/taxon/zostera-marina-219616>

SLU (2022). Åtgärdsprogram för hotade arter. Retrieved from <https://www.artdatabanken.se/arter-och-natur/atgardsprogram/>

Solheim, A., Capobianco, V., Oen, A., Kalsnes, B., Wulff-Knutsen, T., Olsen, M., ... & Strout, J. M. (2021). Implementing nature-based solutions in rural landscapes: barriers experienced in the PHUSICOS project. *Sustainability*, 13(3), 1461.

Souliotis, I., & Voulvoulis (2022). Operationalising nature-based solutions for the

design of water management interventions. Nature-Based Solutions. Volume 2. 2022. 100015. ISSN 2772-4115. <https://doi.org/10.1016/j.nbsj.2022.100015>

Spiecker, H., Hein, S., Makkonen-Spiecker, K., & Thies, M. (2009). Valuable broadleaved forests in Europe. Brill.

Statsforvalteren.no (2022) Vann. Retrieved from <https://www.statsforvalteren.no/portal/miljo-og-klima/vann/>

Staubo et al. 2019. Kantvegetasjon langs vassdrag. Norwegian Water Resources and Energy Directorate. [Veileder, bokmål \(nve.no\)](https://www.nve.no/veileder/bokmal)

Stokland, J. 2021. Kantsoner langs vann og myr. In Svensson and Dalen (eds) 2021. Bærekraftig skogbruk i Norge. Norsk institutt for bioøkonomi. <https://www.skogbruk.nibio.no/kantsoner-langs-vann-og-myr>

Sundberg, S. (2006). Åtgärdsprogram för bevarande av rikkärr - inklusive arterna gulyxne Liparis loeselii (NT), kalkkärrsgrynsnäck Vertigo geyeri (NT) och större agatsnäck Cochlicopa nitens (EN). Naturvårdsverket, Rapport 56. Retrieved from <https://www.naturvardsverket.se/om-oss/publikationer/5600/atgardsprogram-rikkarr/>

Swedish Agency Marine and Water Management (2016A) Zero Eutrophication. <https://www.havochvatten.se/en/policy-and-regulation/environmental-objectives/zero-eutrophication.html>

Swedish Agency Marine and Water Management (2016B) Flourishing Lakes and Streams. <https://www.havochvatten.se/en/policy-and-regulation/environmental-objectives/flourishing-lakes-and-streams.html>

Swedish Agency Marine and Water Management (2016C). What is happening to the sea, lakes and watercourses. Retrieved from <https://www.havochvatten.se/en/our-organization/about-swam/what-is-happening-to-the-sea-lakes-and-watercourses.html#h-Whatishappeningtothesealakesandwatercourses>

Swedish Environmental Protection Agency (2018). Sweden's environmental objectives – an introduction. Retrieved from <http://naturvardsverket.diva-portal.org/smash/get/diva2:1477059/FULLTEXT01.pdf>

Swedish Forest Agency (2010) Protokoll Nr 111: Policy för hyggesfritt skogsbruk. Retrieved from <https://www.skogsstyrelsen.se/globalassets/bruka-skog/avverkning/policy-for-hyggesfritt-skogsbruk.pdf>

Swedish Forest Agency (2017). RAPPORT 2017/12 - Projekt Mera tall! 2010–2016. Retrieved from <https://www.skogsstyrelsen.se/globalassets/om-oss/rapporter/rapporter-2017/rapport-201712-mera-tall.pdf>

Swedish Forest Agency (2021a). RAPPORT 2021/8 - Hyggesfritt skogsbruk: Skogsstyrelsens definition. Retrieved from

<https://www.skogsstyrelsen.se/globalassets/om-oss/rapporter/rapporter-20222021202020192018/rapport-2021-8-hyggesfritt-skogsbruk---skogsstyrelsens-definition.pdf>

Swedish Forest Agency (2021b). Metoder för hyggesfritt skogsbruk. Retrieved from <https://www.skogsstyrelsen.se/bruka-skog/olika-satt-att-skota-din-skog/hyggesfritt-skogsbruk/metoder-for-hyggesfritt-skogsbruk/>

Swedish Forest Agency (2022). Levande skogar. Retrieved from <https://www.sverigesmiljomal.se/miljomalen/levande-skogar/>

Swedish Ministry of the Environment (2001). The Swedish Environmental Code A résumé of the text of the Code and related Ordinance. Retrieved from <https://www.svk.se/siteassets/english/dam-safety/environmental-code-and-ordinances---a-summary.pdf>

Swedish Ministry of the Environment (2013) A Strategy for Biodiversity and Ecosystem Services. Retrieved from <https://www.cbd.int/doc/world/se/se-nbsap-v3-en.pdf>

Swedish Ministry of the Environment (2015). Svensk strategi för biologisk mångfald och ekosystemtjänster. Retrieved from <https://www.regeringen.se/artiklar/2015/04/strategi-for-biologisk-mangfald-och-ekosystemtjanster/>

Swedish Ministry of the Environment (2021) Sweden's climate policy framework. Retrieved from <https://www.government.se/articles/2021/03/swedens-climate-policy-framework/>

Swedish Nature Agency (2022). The Swedish Environmental Code. Retrieved from <https://www.naturvardsverket.se/en/laws-and-regulations/the-swedish-environmental-code/>

SYKE (2018). Assessment of threatened habitat types in Finland 2018: The status of natural habitats continues to deteriorate. Retrieved from [https://www.syke.fi/en-US/Current/Press_releases/Assessment_of_threatened_habitat_types_i\(48849\)](https://www.syke.fi/en-US/Current/Press_releases/Assessment_of_threatened_habitat_types_i(48849))

SYKE (2018). Introduction – IBC-Carbon. Retrieved from <https://www.ibccarbon.fi/en-US/Introduction>

SYKE (2019). Ecological compensations are worth taking into use. Views on Environmental Policy. SYKE policy brief. Retrieved from https://issuu.com/suomenymparistokeskus/docs/sykepolicybrief_2019-11-20_ecological-compensation

Terton, A., Tsioumani, E., Förster, J. & Morchain, D. (2022). Synergies between biodiversity- and climate-relevant policy frameworks and their implementation. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), International

Institute for Sustainable Development (IISD), Helmholtz Centre for Environmental Research (UFZ).

The Danish Climate Council (2020) Kulstofrige lavbundsjorder: Forslag til ny model for effektiv regulering og vådlægning. Retrieved from https://klimaraadet.dk/sites/default/files/imorted-file/kulstofrige_lavbundsjorder_-_analyse_af_klimaraadet_0.pdf

The Danish Government (2014). Naturplan Danmark: Vores fælles natur. Retrieved from https://www.regeringen.dk/media/1295/naturplan_danmark_-_vores_faelles_natur.pdf

The Environment Agency of Iceland (2022). Report on policies, measures and projections of greenhouse gas emissions in Iceland until 2040. Retrieved from: https://ust.is/library/Skrar/loft/NIR/PaMsProjections_Report%202022_published.pdf

The Environment Agency of Iceland (2022). Report on Policies, Measures, and Projections. Retrieved from: https://ust.is/library/Skrar/loft/NIR/PaMsProjections_Report%202022_published.pdf

The Finnish Government (2012). VALTIONEUVOSTON PERIAATEPÄÄTÖS SOIDEN JA TURVEMAIDEN KESTÄVÄSTÄ JA VASTUULLISESTA KÄYTÖSTÄ JA SUOJELUSTA. Retrieved from https://mmm.fi/documents/1410837/1516663/MMM-119690-v5-suostrategia_valtionneuvoston_periaatepaatos_v4/005425e8-e3c4-497d-8cff-26f343896c37

The Finnish Government (2013). Saving nature for people The national action plan for the conservation and sustainable use of biodiversity 2013–2020. Retrieved from https://ym.fi/documents/1410903/38439968/National_action_plan2013_SavingNatureforPeople-EA60AA4E_861F_414D_9EFE_E8B967313381-96885.pdf/3fd101e9-6a12-91f8-211c-a2ab1d32794b/National_action_plan2013_SavingNatureforPeople-EA60AA4E_861F_414D_9EFE_E8B967313381-96885.pdf?t=1603260663505

The Icelandic Wetland Fund (2022): Carbon Offset. Retrieved from <https://www.votlendi.is/carbon-offset>

The Island Committee (2007) Finland: land of islands and waters. Ministry of the interior. Nordmanin kirjapaino, Forssa 2007. Retrieved from <https://tem.fi/documents/1410877/2937056/Finland+-Land+of+Islands+and+Waters>

The Ministry of the Environment (2019). The 2019 Red List of Finnish species. Retrieved from <https://www.environment.fi/redlist>

The Norwegian Government (2021) Hurdalsplattformen. Retrieved from <https://www.regjeringen.no/contentassets/cb0adb6c6fee428caa81bd5b339501b0/no/pdfs/hurdalsplattformen.pdf>

- The Norwegian Government (2021B). Klimaendringer og norsk klimapolitikk. Retrieved from <https://www.regjeringen.no/no/tema/klima-og-miljo/innsiktsartikler-klima-miljo/klimaendringer-og-norsk-klimapolitikk/id2636812/>
- The Soil Conservation Services Iceland (SCSI) (2022): Iceland. Retrieved from https://land.is/heim/english/revegetation_landcare_iceland/
- The Swedish Government Office (2015) På väg mot en giftfri vardag – platform för kemikaliepolitiken. Retrieved from <https://www.regeringen.se/rattsliga-dokument/proposition/2013/12/prop.-20131439/>
- The Swedish Parliament (2010) Luftkvalitetsförordning. Retrieved from https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/luftkvalitetsforordning-2010477_sfs-2010-477#P49
- Thorsson, J. & Petursdottir, T. (2015). Restoring ecosystem function and services by overcoming soil threats - The case of Mt. Hekla area in Iceland. EGU General Assembly. Volume 17. Retrieved from <https://meetingorganizer.copernicus.org/EGU2015/EGU2015-13936.pdf>
- Tikka, P., & Kauppi, P. (2003). Introduction to special issue: protecting nature on private land-from conflicts to agreements. Environmental science & policy, 6(3), 193-194.
- Tolvanen, A., Juutinen, A., & Svento, R. (2013). Preferences of local people for the use of peatlands: the case of the richest peatland region in Finland. Ecology and Society, 18(2).
- Tsioumani, E. (2022) Linkages and Synergies Between International Instruments on Biodiversity and Climate Change. Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection.
- Umhverfisstofnun (2021) Greenhouse gas emissions in Iceland. Retrieved from <https://ust.is/english/air-climate/greenhouse-gas-emissions-in-iceland/>
- United Nations Environment Programme (2021). State of Finance for Nature 2021. Nairobi.
- UN (2021) CEPA strategy guidance note on the Science-policy interface March 2021. Retrieved from <https://unpan.un.org/sites/unpan.un.org/files/Strategy%20note%20science%20policy%20interface%20March%202021.pdf>
- UNDP (2019) Pathway for Increasing Nature-Based Solutions in NDCs. Retrieved from <https://www.undp.org/publications/pathway-increasing-nature-based-solutions-ndcs>
- Urban Forestry & Urban Greening, Volume 27, 2017, Pages 32-42, ISSN 1618-8667, <https://doi.org/10.1016/j.ufug.2017.06.014>.
- Vannportalen.no. Kantvegetasjon i regionale vannforvaltningsplaner og kommunal

arealplanlegging <https://www.vannportalen.no/aktuelt/2019/kantvegetasjon-i-regionale-vannforvaltningsplaner-og-kommunal-arealplanlegging/>

Visseren-Hamakers, I. J. (2015) Integrative environmental governance: enhancing governance in the era of synergies. *Current opinion in environmental sustainability*. 14, June 2015, 136-143.

Voegeli, G. Finger, D. C. (2021) Disputed dams: Mapping the divergent stakeholder perspectives, expectations, and concerns over hydropower development in Iceland and Switzerland,

Vulturius, G., André, K., Gerger Swartling, Å., Brown, C., & Rounsevell, M. (2020). Successes and shortcomings of climate change communication: insights from a longitudinal analysis of Swedish Forest owners. *Journal of Environmental Planning and Management*, 63(7), 1177–1195. <https://doi.org/10.1080/09640568.2019.1646228>

Wooster, E.I.F., Fleck, R., Torpy, F., Ramp, D., Irga, P.J. (2022). Urban green roofs promote metropolitan biodiversity: A comparative case study, *Building and Environment*, Volume 207, Part A, 2022, 108458, ISSN 0360-1323, <https://doi.org/10.1016/j.buildenv.2021.108458>.

WWF (2020) Enhancing NDCs through Nature-Based Solutions. Retrieved from https://wwfeu.awsassets.panda.org/downloads/enhancing_ndcs_through_nature_based_solutions.pdf

Zakrisson, A. (2019). Green roofs mitigate air pollution.

Zandersen, M., Jensen, A., Termansen, M., Buchholtz, G., Munter, B., Blemmer, M., Bruun, H. G., & Andersen, A. H. (2014). Ecosystem based approaches to climate adaptation – Urban prospects and barriers. Aarhus University, Department of Environmental Science

Zubizarreta-Gerendiain, A., Pellikka, P., Garcia-Gonzalo, J., Ikonen, V. P., & Peltola, H. (2012). Factors affecting wind and snow damage of individual trees in a small management unit in Finland: Assessment based on inventoried damage and mechanistic modelling. *Silva Fennica*, 46(2), 181–196. <https://doi.org/10.14214/sf.441>

About this publication

Synergies between climate and biodiversity objectives in laws, policies and management practices

Amalie Engelbrecht Hansen, Elvira Borgman, Rikke Fischer-Bogason, Doan Nainggolan, Sigrid Engen, Lajla Tunaal White, Magni Olsen Kyrkjeeide, Megan Sarah Nowell, Stephen Woroniecki, Katharina Heimes and Pekka Kaupi

TemaNord 2023:510

ISBN 978-92-893-7551-1 (PDF)

ISBN 978-92-893-7552-8 (ONLINE)

<http://dx.doi.org/10.6027/temanord2023-510>

© Nordic Council of Ministers 2023

Cover photo: Carlos "Grury" Santos/Unsplash

Top pictures:

David Buchmann: chapter 1

Anne-Grete Buseth Blankenberg: Preface, List of acronyms, chapter 7, chapter 8, chapter 10

Ole Dahlqvist Sørensen: chapter 3

Megan Nowell: chapter 6, chapter 9

Sebastian Sundberg: chapter 2, chapter 4, chapter 5, chapter 11

Published: 28/4/2023

Disclaimer

This publication was funded by the Nordic Council of Ministers. However, the content does not necessarily reflect the Nordic Council of Ministers' views, opinions, attitudes or recommendations.

Rights and permissions

This work is made available under the Creative Commons Attribution 4.0 International license (CC BY 4.0) <https://creativecommons.org/licenses/by/4.0>.

Translations: If you translate this work, please include the following disclaimer: This translation was not produced by the Nordic Council of Ministers and should not be construed as official. The Nordic Council of Ministers cannot be held responsible for the translation or any errors in it.

Adaptations: If you adapt this work, please include the following disclaimer along with the attribution: This is an adaptation of an original work by the Nordic Council of Ministers. Responsibility for the views and opinions expressed in the adaptation rests solely with its author(s). The views and opinions in this adaptation have not been approved by the Nordic Council of Ministers.

Third-party content: The Nordic Council of Ministers does not necessarily own every single part of this work. The Nordic Council of Ministers cannot, therefore, guarantee that the reuse of third-party content does not infringe the copyright of the third party. If you wish to reuse any third-party content, you bear the risks associated with any such rights violations. You are responsible for determining whether there is a need to obtain permission for the use of third-party content, and if so, for obtaining the relevant permission from the copyright holder. Examples of third-party content may include, but are not limited to, tables, figures or images.

Photo rights (further permission required for reuse):

Any queries regarding rights and licences should be addressed to:
Nordic Council of Ministers/Publication Unit
Ved Stranden 18
DK-1061 Copenhagen
Denmark
pub@norden.org

Nordic co-operation

Nordic co-operation is one of the world's most extensive forms of regional collaboration, involving Denmark, Finland, Iceland, Norway, Sweden, and the Faroe Islands, Greenland and Åland.

Nordic co-operation has firm traditions in politics, economics and culture and plays an important role in European and international forums. The Nordic community strives for a strong Nordic Region in a strong Europe.

Nordic co-operation promotes regional interests and values in a global world. The values shared by the Nordic countries help make the region one of the most innovative and competitive in the world.

The Nordic Council of Ministers
Nordens Hus
Ved Stranden 18
DK-1061 Copenhagen
pub@norden.org

Read more Nordic publications on www.norden.org/publications