Restoration priorities and strategies

Restoration to protect biodiversity and enhance Green infrastructure:
Nordic examples of priorities and needs for strategic solutions

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Summary

Ecological restoration needs better prioritizing to protect biodiversity and enhance Green Infrastructure

Restoration is a tool to achieve several of the strategic targets of The Convention on Biological Diversity (CBD) from 2010. It is also a target in itself, as restoring 15% of damaged ecosystems within 2020 is specifically stated in the CBD Aichi target 15. The increasing need for restoration actions and allocation of resources to restoration calls for prioritization.

As most often resources for nature management and protection (including restoration) are limited, it is essential to set priorities in order to optimise available funding and human resources, solve the most urgent problems, and contribute to the optimal protection and restoration of biodiversity. Prioritizing is an essential element in any systematic conservation planning, but setting priorities for restoration and management is a relatively new approach in conservation. There is a need for improved priority models, and also to incorporate experiences from strategic prioritizing programmes into these models. Cooperation between the Nordic countries and Estonia can contribute to improving the implementation of restoration priorities in these countries.

The aim of this project was mainly to exchange knowledge between the Nordic countries and Estonia regarding experiences and examples of restoration and priority setting with a landscape perspective. Using case examples from the countries, the project explores and discusses approaches for setting priorities, and suggests possible ways of developing improved approaches for future prioritization. This also includes how to improve Green Infrastructure and measures for protection of species and habitats in fragmented landscapes. The project attempts to make some links between prioritization in terrestrial and freshwater ecosystems. The aim is not to provide a complete overview of approaches used in the Nordic countries and Estonia, but rather to illustrate examples using different approaches, and in doing so, to provide ideas, reflections and “take-home messages” to enhance development and future prioritization.

A former Nordic restoration Aichi project supported by Nordic Council of Ministers and TEG (2014–2015) emphasized the need for national plans and priorities for restoration rather than working on single objects,

and the need to place restoration in a broader context of nature conservation. The current project brings these findings further and uses national case examples to illustrate different models of prioritization, ranging from scientific and quantitative approaches to structured analyses and more opportunistic and site specific decisions. Fourteen case examples from all the countries are described and they include a range of habitats, scales, organizations and types of prioritization. The observations from the case examples are discussed in relation to a theoretical frame, based on published literature on priorities in conservation.

The types of prioritization reported in the case examples are a mix of quantitative and qualitative data and considerations, although in different proportions. Legal requirements and political recommendations, such as the Habitats Directive or National Environmental Objectives, are often important in deciding which habitats/species that should be the initial focus, but they rarely show how priorities should be made *between* habitats or species. The results of the Finnish Restoration Prioritization working group that is presented as one of the examples in this report shows how simultaneous prioritization within as well as between ecosystem types can indicate cost-effective restoration priorities.

A comparison between terrestrial work and the requirements of the Water Framework Directive (WFD) shows some fundamental differences in the chosen approach and priorities. The water legislation identifies specific conservation levels (in relation to a reference condition) to be met in every water body within a clearly stated deadline. Such clear deadlines or targets are lacking in the legislation covering terrestrial habitats. The WFD also sets minimum levels that are to be reached, i.e. that the most heavily degraded water bodies will get priority. In the terrestrial work, efforts are normally directed to areas that have a low or moderate degree of degradation, and thus a higher potential for developing high nature values.

During the last two decades, a number of systematic methods have been developed related to setting priorities for environmental management focused on biodiversity. The emphases on ecosystem services in restoration will potentially entail some new criteria for setting priorities, as the human benefits achieved from a given restoration will be in focus. This can lead to a risk that ecosystem quality and ecological functions are not considered, and a conflict with the protection of biodiversity.

A general finding from the case examples was that quantitative and transparent methods are data-demanding and tedious, that political/qualitative approaches give a good overview but lack focus, and that op-

opportunistic methods might produce good results but lack an overall priority. Simplified prioritization has its place and time, but easily misses factors such as the cost-effectiveness, complementarity or connectivity of the solution. Complex comprehensive analyses offer excellent tools to view the trade-offs, synergies and possibilities, but may suffer from a gap between the analyses and their implementation, requiring separate implementation strategies and improving of the science-society dialogue. In essence, it is likely profitable to maximize cost efficiency by careful systematic prioritization planning while allowing some flexibility with respect to rising opportunities. There are always trade-offs resulting from investing in one restoration measure or one ecosystem type over another. This can be controversial, and even sometimes mixed up with ethical positions. It can be painful to let go of some valuable and wonderful sites, but in the world of competing interests and limited resources, prioritizing is actually about realizing that for every sensible thing we do is another sensible thing we do not.

Currently, there is no standard for how to set priorities for restoration. This report has shown that there is a need for more work with a greater emphasis on the prioritization aspects of restoration. Good models and strategies are needed to support wise use of resources for the long-term protection of biodiversity.

We have listed six take-home messages to develop improved prioritization strategies of restoration in the Nordic countries and Estonia:

1. A development of large-scale plans is necessary to make cost-effective large-scale solutions and to deliver synergies with all ongoing small-scale plans.
2. Use cost-efficiency analysis as the basis for any prioritization.
3. Combine the theoretical with the opportunistic to achieve better solutions.
4. Plans must be implemented, as the planning and prioritization as such means nothing to biodiversity without implementation.
5. Restoration will give better results if the priorities consider a landscape perspective.
6. Aim for Green Infrastructure to avoid ecological impact and recover lost attributes in nature, rural as well as urban areas.

Preface

“Every good thing we do is another we don’t” (Gilbert 2011)

Major parts of the Nordic landscapes are heavily negatively influenced by human activities due to forestry, agriculture, long-term overgrazing, infrastructure development, and invasive species. Changes in natural and traditional disturbance regimes have also caused severe problems. Abandonment of traditional management of semi-natural grasslands has led to massive losses of species and habitats over the last century. The lack of natural forest fires has reduced biodiversity in the taiga, and the heavily changed hydrology of rivers and wetlands (including mires) has led to substantial losses of wetland and freshwater biodiversity. The pressures on biodiversity are increasing, and the situation is dramatic for habitats and species in some areas. This calls for an expanded view of nature conservation, and in this context, ecological restoration of species, habitats, and landscapes is an important supplement to traditional protection. The restoration of degraded environments will be essential in changing the negative trends for species and habitat types, as pointed out in international policies and national priorities.

This report is a contribution to the Nordic effort to develop strategies for setting priorities for the restoration of ecosystems and ecosystem services. It is a follow-up to previous work related to the CBD Aichi target of 15% restoration of degraded ecosystems by 2020. The ambition of the present project has been to collect, compare and discuss different approaches to setting priorities, to promote further development of methods and strategies.

The study has been carried out by a working group with members from Estonia, Finland, Iceland, Norway and Sweden. It has consisted mainly of collecting and discussing of a set of examples of restoration priorities used in the involved countries in recent years. The aim has been to find examples that present different approaches to prioritization, not to get an extensive list of all restoration work. The examples should have a connection to spatial aspects such as landscape level priorities or green infrastructure. The group has also reviewed and discussed different perspectives and challenges that need to be addressed when setting restoration priorities, including a description of theoretical methods for designing and prioritizing restoration measures in relation to Green Infrastructure.

The countries and organizations that have participated in the working group are:

- Estonia: Estonian Ministry of Environment.
- Finland: Parks & Wildlife Finland (Metsähallitus), University of Jyväskylä.
- Iceland: The Soil Conservation Service Iceland.
- Norway: Norwegian Environmental Agency, Norwegian Institute for Nature Research.
- Sweden: Swedish Environmental Protection Agency, Swedish Agency for Marine and Water management.

The examples used in this project are presented in the Appendix. They are described and discussed in chapter 4, with the aim to identify general patterns and conclusions rather than to make a detailed analysis of each method. In Finland, a framework for assessing and reversing ecosystem degradation has been developed, and it is presented in some detail, since it represents the most thorough effort to set systematic restoration priorities in relation to the Aichi 15% target.

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1. Introduction

The importance of ecological restoration for improving the conditions of degraded land and ecosystems has become more evident in recent years, and ecological restoration has been more clearly stated in politics, management and science (see e.g. Benayas *et al.* 2009, Comín 2010, Bullock *et al.* 2011, Suding 2011, Halme *et al.* 2013). Ecological restoration is “the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed”, relating to the recovery of ecosystem health, integrity and sustainability (SER 2004).

The Convention of Biological Diversity (CBD) has formulated 20 strategic targets for 2010–2020, known as the Aichi targets. Restoration is a tool to achieve several of these targets (directly and indirectly; see e.g. target 14 in the box), and restoration itself is a target, as stated in target 15 (see box). The restoration target was recently restated in the sustainability development goals (goal 15) that came into effect 1 January 2016 (<https://sustainabledevelopment.un.org/?menu=1300>). The EU and the Nordic countries are committed to the Aichi targets, and the Nordic strategy for sustainable development clearly states the importance of vigorous ecosystems and CBD (Nordiska ministerrådet 2013). The EU biodiversity strategy “Our life insurance, our natural capital: an EU biodiversity strategy to 2020” includes restoration under target 2.

Aichi target 14

“Ecosystems that provide essential services ... and contribute to health, livelihoods and well-being, are restored and safeguarded ...”

Aichi target 15

“By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification”.

A previous project funded by the Nordic Council of Ministers/TEG has addressed the possibilities, limitations, and challenges for how restoration can contribute to the Aichi targets in the Nordic countries (Hagen *et al.* 2015). The project was a contribution to management and political authorities in the Nordic countries to pave the way for the restoration of degraded ecosystems. One outcome of the project was the formulation of seven actions (see below) for further work towards more effective restoration (see Hagen *et al.* 2015 for details).

**Seven actions towards more effective restoration in the Nordic countries
(from Hagen *et al.* 2015)**

- A progress towards the Aichi 15 target calls for a clear vision and national plans for ecological restoration.
- In a situation of limited resources for restoration it is essential to develop good models for priority setting.
- Integration and cooperation are needed to formulate realistic goals for restoration, and restoration must be integrated into all sectors of land-use management.
- The focus must be on restoration activities and output, so 15% itself must not take the focus away from what this really is about: to reduce ecosystem degradation and to head towards improved and more ecological restoration.
- More and improved restoration will need initiatives at the national level (such as strategic plans and programmes) and integration of all local initiatives, and these should be made into a top-down and bottom up approach.
- Procedures to identify limiting factors are essential for effective restoration, and should be developed for countries/habitats.
- Measurable descriptors for producing statistics on progress of restoration must be developed.

1.1 Restoration calls for priority setting

One of the actions suggested by the Nordic working group (Hagen *et al.* 2015) and an essential element in any systematic conservation planning (Margules & Pressey 2000, Kukkala & Moilanen 2013) is *Priority setting* – in this case for ecological restoration. The argument for prioritizing some things above other is obvious; in a situation with limited resources for nature management and protection (including restoration), it is essential to set priorities in order to make the best use of available funding and human

resources, solve the most urgent problems, and contribute to the optimal protection and restoration of biodiversity.

The need for prioritization stems from the failure to have resources for everything (species, ecosystems, areas or actions). Prioritization means that we identify something as more important or urgent than something else, and follow this ranking in resource allocation for different biodiversity features, areas, or actions. Prioritization can help managers to choose among protection, management or restoration actions, between species and/or habitats (Noss *et al.* 2009), e.g. according to red list statuses, or between populations of a particular species at different sites considering their landscape ecological value (Westphal *et al.* 2003). More complex prioritization can consider additive biodiversity and ecosystem service values over large areas balanced with site-specific costs and social needs (e.g. Nelson *et al.* 2009, Wilson *et al.* 2011, Kareksela *et al.* 2013, Schemama & Levrel 2015). Prioritization can even include spatial information related to the social feasibility of restoration actions in a form of anthropogenic land-use pressure (Yoshioka *et al.* 2014).

Priority setting is of particular importance in restoration since restoration activities can be more expensive than traditional protection efforts. However, priority setting is an important part of all nature management actions and setting priorities for restoration can make direct use of contributions and approaches from more established activities. Theories, models, and methods for priority setting have been an issue for spatial conservation planning (see e.g. Moilanen *et al.* 2009a), such as in the protection of land and “how to get the most out of it”.

1.2 Ecological restoration in conservation policy

The concept of ecological restoration functions at very different levels in international biodiversity policy; it can be an objective, a target or a tool (Jørgensen 2015). Along with ecosystem recovery, the preservation of biodiversity is the core issue of restoration, and the link to the Aichi targets is strong and obvious. Restoration of degraded land can be multifaceted and can involve diverse activities, including very different types of projects with different objectives (Falk *et al.* 2006, Hagen *et al.* 2013). Today we also see an increasing interest in restoration as a tool for restoring ecosystem services in general, or individual services (such as recreation, carbon sequestration, flood reduction) (Bullock *et al.* 2011, Wortley *et al.* 2013). This is reflected in the scoping document of the Intergovernmental Science Policy Platform for Biodiversity and Ecosystem Services (IPBES)

for the Assessment of Land Degradation and Restoration (IPBES 2015). This document states that “Degraded land is defined as the state of land which results from the persistent decline or loss in biodiversity and ecosystem functions and services that cannot fully recover unaided within decadal time scales”. Even passive restoration such as the set-aside of protected areas can be considered to contribute if it reduces further degradation that would otherwise take place, and allows spontaneous recovery of naturalness. Experts disagree on the extent to which this can be considered a restoration action (Prach & Hobbs 2008). The definition and attributes of ecological restoration are described in “SER International Primer on Ecological Restoration” (<http://www.ser.org/>).

Despite some discussion of what is “real” and “true” restoration, it can be argued that numerous activities contributing to *improving the conditions for ecosystems* can in some sense be considered restoration, since they are beneficial to biodiversity (Figure 1). This means the discussion of what is restoration covers a very broad scope of actions including a large range of “typical” restoration activities, as well as the legal protection of areas, management of semi-cultural landscapes, and interventions to re-create green infrastructure in urban and rural areas. Restoration activities to *improve the condition of ecosystems* can be particularly diverse, ranging from strict set-aside conservation (protection of single population, *in situ* conservation, etc.), to the more traditional restoration and rehabilitation of degraded landscapes (recreating habitats and promoting recovery). More recently it has also been used as a tool for compensation and mitigation in new development projects (Aradottir & Hagen 2012, BBOP 2012, Bull *et al.* 2013, Enetjärn *et al.* 2015). Ecological restoration for the establishment and creation of Green Infrastructure is particularly relevant for biodiversity, as well as recreation and aesthetic experiences in urban and other heavily developed areas. There is an increasing interest in restoration as a tool for offsetting and mitigating negative impacts on biodiversity or ecosystem services in development projects, and despite its many problems (e.g. Maron *et al.* 2012, Gordon *et al.* 2015, Quetier *et al.* 2013, Moilanen & Laitila 2015), it may have potential to make a substantial contribution to preserving biodiversity. However, new approaches that focus on ecosystem services and mitigation need to be carefully examined to avoid unnecessary pitfalls (Lindenmayer *et al.* 2012, Maron *et al.* 2012), and the future success of these types of projects will depend on strategic decisions and priorities, experience sharing and new knowledge.

Figure 1: Restoration covers a very broad scope of actions that are beneficial to biodiversity. Spreading Sphagnum fragments to promote vegetation recovery of peatland is one such action, used in Estonia

Photo: Herdis Fridolin.

1.3 Green Infrastructure

The concept of Green Infrastructure is usually used to address the need and importance of viewing biodiversity from a landscape perspective, such as “making space for nature to provide valuable ecosystem services” (European Commission 2010). The landscape context is important for every species to survive, grow, reproduce and spread within and between living areas and habitats. The definitions of Green Infrastructure differ slightly between stakeholders at different regional and national and multi-national levels, but the core concept is similar. According to the European Commission, “Green Infrastructure can be broadly defined as a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings” (European Commission 2013).

Working with Green Infrastructure means applying a perspective that considers all ecological functions of a landscape in land- and water-use planning. This planning should be long-term and involve all relevant stakeholders. The goal of planning for Green Infrastructure is to achieve positive ecological, economic and social effects through nature-based solutions, and that ecosystem functions are considered. The Green Infrastructure perspective builds on the insight that biodiversity and species survival need sufficient habitats of suitable quality, interconnected at a landscape level. Conserving biodiversity is insurance in maintaining important ecosystem services necessary for human well-being and health.

In practice, working with Green Infrastructure means that ecosystem functions and natural processes are considered when planning for the protection, conservation management, restoration and re-creation of habitats. This should hold true for physical planning as well as in on-going land and water use. Green Infrastructure needs to be considered an integrated part of the strategies for local and regional development (Figure 2).

Figure 2: Reopening piped river and restoration of a green corridor from shoreline to a forest area in an urban area, Trondheim, Norway. Restoration in urban areas illustrates in particular the importance of considering Green Infrastructure as an integrated part of local and regional development

Photo: Dagmar Hagen.

1.4 Objectives and content of the current report

The Convention on Biological Diversity (CBD) lists the restoration of 15% of degraded ecosystems before 2020 as a strategic target (Aichi target #15). Given the ambitious nature of this target (Kotiaho *et al.* 2015b), attaining it clearly requires focus, knowledge and structured efforts. Cooperation between the Nordic countries and Estonia can contribute to improving the implementation of restoration priorities in these countries.

The current project had three objectives:

- To exchange knowledge between the Nordic countries and Estonia regarding experiences and examples of restoration and priority setting of restoration with a landscape perspective.
- To explore and discuss existing approaches that the different countries use to set priorities for different types of restoration actions, including both systematic and more ad-hoc methods, and to suggest possible ways of developing improved approaches for future prioritization based on these approaches.
- To compare the work on priorities in terrestrial and freshwater ecosystems, in particular work undertaken in compliance with the Water Framework Directive.

The first objective was also the main objective. Participants exchanged experiences and knowledge in both meetings and workshops. When compiling the examples from the countries, we took a broader view than restoration and included examples drawn from conservation management. This work also includes how to improve Green Infrastructure and measures for protection of species and habitats in fragmented landscapes. Limiting factors and prerequisites have been given special attention.

The current report also provides a more theoretical overview of the considerations that need to be addressed when setting conservation or restoration priorities, especially at a landscape level. Here an attempt was made to link this to individual examples (see the Appendix). The case projects include examples of restoration of biodiversity at all levels. To illustrate the methodological approach, we have also included examples from other types of projects, such as the selection of protected areas, since the experiences from this type of priority setting are relevant

for restoration priorities as well. The aim is not to provide a complete overview of approaches used in the Nordic countries and Estonia, but rather to illustrate selected cases that have used different approaches, and in doing so, to provide ideas, reflections and “take-home messages” that can be used in future efforts.

2. On-going policies for restoration priority in the Nordic countries

When compared to central and western Europe, the Nordic countries contain large areas with relatively intact and well-functioning ecosystems. The main focus of conservation efforts to date has thus been to preserve existing values. Important tools have been formal protection (of species and areas), payments for management and restoration of semi-natural landscapes, and requirements for general consideration of environmental needs in on-going land use. Ecological restoration has also been used in conservation, as in the hydrological restoration of wetlands, liming of acidified lakes and rivers, prescribed burning of forests and a number of single projects in other habitats (see e.g. Hagen *et al.* 2012, Similä *et al.* 2014).

However, in spite of the relatively low degradation levels compared to more populated areas, major parts of the Nordic landscapes are heavily negatively influenced by human activities due to forestry, agriculture, long-term overgrazing (in some regions), infrastructure development, and invasive species (Halldorsson *et al.* 2012, Kotiaho *et al.* 2015a). Changes in natural and traditional disturbance regimes have also caused severe problems (Halme *et al.* 2013). Abandonment of traditional management of semi-natural grasslands has led to massive losses of species and habitats over the last century. The lack of natural forest fires has reduced biodiversity in the taiga, and the heavily changed hydrology of rivers and wetlands (including mires) has led to substantial losses of wetland and freshwater biodiversity. The pressures on biodiversity are increasing, and the situation is dramatic for habitats and species in some areas (see Framstad (ed.) 2015, Naturvårdsverket 2015, Ross *et al.* 2016, Virkkala 2016, and the Red Lists). This calls for an expanded view of nature conservation, and in this context, ecological restoration of species, habitats, and landscapes is an important supplement to traditional protection. The restoration of degraded environments will be essential in changing the negative trends for species and habitat types, as pointed out in international policies and national priorities.

In spite of this, most countries work with restoration in an ad hoc manner rather than as a strategically integrated conservation tool. The status for restoration in the Nordic countries was assessed in the NCM/TEG project “Restoration in the Nordic countries” (ReNo), which showed that all countries have restoration projects in most habitats and at various scales (Haldorsson *et al.* 2013). The report concluded that habitat types determine the methods used for ecological restoration (how to do restoration), whereas socio-economic drivers are more important for decisions concerning the timing and location of restoration (where and when to do restoration) (Hagen *et al.* 2013). The findings also indicate that factors other than land-use pressure determine the priorities and efforts for restoration, and only Finland has so far developed strategies and plans for restoration on a national level (Kotiaho *et al.* 2016a, 2016b). The NCM/TEG project “The Nordic restoration Aichi project” had as its goals to gather knowledge and contribute to the countries’ commitments to achieve Aichi target 15, using the EU four-level conceptual model for reducing degraded land (Lammerant *et al.* 2014) and available statistics (Hagen *et al.* 2015). The project emphasized the need for national plans and priorities for restoration, rather than working on single objects, and also the need to place restoration in a broader context of nature conservation. The current project brings these findings one step further and will use national case examples to illustrate different models of prioritization, ranging from scientific and quantitative approaches to structured analysis and more opportunistic and site specific decisions.

2.1 Priority work at the EU and Nordic national levels

As a part of the EU Biodiversity Strategy, the European Commission established a “Green Infrastructure and Restoration Prioritization Framework Working Group”. The group suggested a conceptual 4-level model of ecosystem restoration (Lammerant *et al.* 2014). The underlying principle of the model is that levels of degradation can be defined for all habitats, in such a way that each level and changes between levels are quantifiable. Restoration of degraded land is then defined as any increase in levels to a less degraded state. There are a number of challenges in this model that need to be resolved if it is to be taken from the conceptual stage into active application (as described by Lammerant *et al.* 2014 and further discussed from a Nordic perspective by Hagen *et al.* 2015 and Kotiaho *et al.* 2016a).

The European Commission is currently paying particular attention to finding methods to achieve and measure improvements in the conservation status of habitats and species covered by the EU Birds Directive and EU Habitats Directive. Target 1 of the EU Biodiversity Strategy calls for substantial improvements to be made before 2020. In this context, restoration will be an essential part of the efforts needed to achieve the target. All EU member states have also been required to produce Prioritized Action Frameworks (PAF) describing the needs for conservation actions in the Natura 2000 network. The PAFs can include descriptions of restoration actions, if the current conservation state in the Natura 2000 areas is unfavourable. The EU Water Framework Directive requires that the water bodies covered by the Directive should have a Good Ecological Status (GES) before 2027. Consequently, there are binding requirements for improvement actions in all cases where the current status is not good. Many rivers and lakes will need restoration measures to improve their status, and all EU member states have had to prepare Action Plans describing how these improvements will be achieved. These often include restoration measures.

In Iceland, rehabilitation and restoration measures have been organized by governmental agencies for more than a century, driven strongly by catastrophic erosion (Aradóttir *et al.* 2013). This reflects the enormous scale of soil erosion and desertification in Iceland (Arnalds *et al.* 2001, Arnalds 2015), and the early attempts in rehabilitation were due to the desire to prevent farms from being abandoned due to drifting sand and subsequent soil erosion (Croft 2011, Arnalds 2015). Over the years projects have been prioritized primarily based on the need to halt active soil erosion, and secondly in the lowland, where the population lives. Norway has so far mainly conducted restoration activities on a single project basis, with the exception of subsidies for the management of semi-cultural landscapes and biotope interventions in regulated rivers (Hagen *et al.* 2013). A national plan for the restoration of mires is currently under preparation. Norway is also committed to the EU Water Framework Directive, which means that planning, intervention and prioritization for improvement in water bodies is on-going.

2.2 Restoration prioritization work in Finland

Finland has paid particular attention to restoration prioritization in recent years. On 10 February 2014, the Finnish Ministry of the Environment appointed a restoration prioritization working group. The objective of the

working group was to create a framework for assessing and reversing ecosystem degradation and to establish criteria for prioritizing restoration measures, taking into account the benefits, costs and the cost efficiency of the measures in order to support the national implementation of Target 2 of the EU strategy for biodiversity. The working group was charged with specifying restoration needs according to national policies, drafting a proposal for restoration prioritization, and assessing the overall costs of the proposal. The work was completed and submitted to the Ministry in June 2015 (Kotiaho *et al.* 2015a, 2016a). The work involved approximately 100 individuals from government ministries, state organizations, academia, and NGOs.

The Finnish restoration prioritization working group found that the 15% target for ecosystem restoration is overly optimistic and it simply cannot be met, certainly not by 2020. This finding was published in “Nature” (Kotiaho *et al.* 2015b). The framework developed for assessing and reversing ecosystem degradation takes into account biodiversity in some detail and ecosystem services at a coarser scale (e.g. carbon sequestration and load on water bodies). It is worth noting that there are some highly sophisticated methods for optimal allocation of habitat restoration (e.g. Noss *et al.* 2009, Wilson *et al.* 2011, Pouzols & Moilanen 2013). These methods are comparatively data demanding, require specialist skills, and their finer points may become lost in a process that unavoidably involves many stakeholders, limited time, and serious compromise to reach anything like the 15% restoration target. Because we do not have the tools to reach this target, the Finnish Restoration Prioritization working group started by developing procedures i) to systematically estimate the magnitude of degradation from which the 15% should be calculated, ii) to evaluate the magnitude of improvement that different restoration measures can offer, and iii) to prioritize restoration measures within and between ecosystem types. The procedure was developed from a real-world perspective where time is limited and operational feasibility is imperative, while still retaining the most ecologically relevant components. Data were used whenever available; however, all aspects of the operational procedure are also fully based on quantitative estimates or expert opinion.

The guiding principle adopted for the development of the procedure was to treat all ecosystems that are not in their natural state as degraded. However, it is worth emphasizing that the objective is not to reach the natural state of the ecosystems, but to reduce the degree of ecosystem degradation using restoration (see Kotiaho *et al.* 2015a, 2016a, 2016b).

2.3 Green Infrastructure in Nordic policy

The European Commission has put protection and restoration of Green Infrastructure high on the agenda, and has highlighted the need for restoration measures and priorities in the EU biodiversity policy (See e.g. target 2, action 6 a in the EU Biodiversity Strategy for 2020). Habitat degradation and degradation of Green Infrastructure in rural and urban landscapes put a pressure on biodiversity, which will also most likely increase under a changing climate (e.g. Virkkala 2016). Among the Nordic countries outside EU, the necessity of considering landscape ecology in the planning of conservation measures and sustainable land use is widely acknowledged. The landscape planning aspects of Green Infrastructure are partly addressed under different names, such as “Ecological Infrastructure”. Both Iceland and Norway use a network of conservation areas based on the Emerald network (<http://www.coe.int/en/web/bern-convention/emerald-network>), which have strong similarities to the Natura 2000 network in the EU countries (both networks are the result of implementing the Bern convention).

Even though the concept of Green Infrastructure is relatively easy to understand, it is challenging to work with, as it calls for addressing complicated ecological questions at different scales. Conflicts of interest between different land uses, as well as different ecological priorities, have to be addressed. There are also substantial knowledge gaps that increase the challenges. Putting Green Infrastructure into practice raises a number of different questions and each project (or plan) must be specific about its aims and achievements; a plan can be strictly descriptive (e.g. focusing on the population numbers of red-listed species), or more analytic (e.g. identifying the most valuable sites of a specific habitat type within a given area), or more general (e.g. addressing how existing land use can be modified to improve the protection and restoration of ecosystem services). Ecological principles apply at all scales, and working with Green Infrastructure has to take place at national, regional and local management levels.

Regional authorities in Sweden (the County Administrative Boards) are currently developing regional action plans for Green Infrastructure, linking different ecosystems and integrating water and terrestrial habitats. The linkage between conservation priorities, ecosystem services and landscape is a clear focus, and priorities for restoration will be a part of some plans. National priorities make up the basis for the plans, but the work will be done in the regions. Close cooperation between national, regional and local authorities is essential, as well as contact with and participation of landowners and other stakeholders in developing the plans.

As a first step, analyses will be based on expert judgements, which should provide the basis for learning, improved data and knowledge for future and improved analyses.

The Nordic countries have generally relied on spatial prioritization approaches for conservation and land-use planning, which in fact relates to the concept of Green Infrastructure. There are several analyses that address a combination of rural and urban areas at relatively local scales in the identification of ecologically valuable areas (e.g. in Helsinki and Jyväskylä city and surrounding regions, and see also cases 4, 5, 10). This puts great emphasis on occurrence and connectivity for both biodiversity and ecosystem services in the landscape. For example, larger, national-scale analyses for forests and peatlands have been carried out in Finland to guide conservation decision, making in the expansion of a state-owned protected area network (case example 4) and private stakeholders voluntary protecting their forest habitats (see: <http://www.metsa.fi/web/en/zonation>, for a national project promoting the use of spatial conservation planning). The use of the spatial conservation planning methods has also been extended to guide economic land use, e.g. by identifying areas where peat mining in the province of Central Finland would be of least harm to the ecological values (and thus the GI) within the province (Kareksela *et al.* 2013). All of these spatial conservation planning analyses include landscape-level connectivity considerations to increase the continuance of the observed ecological values.

2.4 Prioritization and the Water Framework Directive

One of the main purposes of the Water Framework Directive (WFD) is to prevent further deterioration and to protect and enhance the status of aquatic ecosystems and terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems (Directive 2000/60/EC). Each water body (e.g. a homogenous stretch of a river or a lake) is classified and given a current status (e.g. poor, good, high) and the status it should achieve by a set deadline (2015 or, for approved exceptions, 2027). The existing status is compared to a reference condition that would reflect conditions where there was no human impact. This is done by measuring biological indicators and using expert judgements when data are missing (Figure 3).

Figure 3: Water Framework Directive (WFD) identifies specific conservation levels to be met in every waterbody. Lake Åsnen in southern Sweden is an example of a lake in good condition

Photo: Anna Lindhagen.

The motivation for this directive is to ensure the long-term and sustainable use of water resources, i.e. the ecosystem services water provides for humans. The WFD covers all waters: inland surface waters, transitional waters, coastal waters and groundwater. It overlaps with the Marine Strategy Framework Directive (2008/56/EC) in the coastal zone. In Sweden, home to some 100,000 lakes and 30,000 watercourses, for practical reasons, lakes smaller than 1 km² and catchments smaller than 10 km² are usually not included as water bodies. Each water body is analysed according to the DPSIR scheme, which is a model to describe the causality between society and environment (drivers; D). In short, the analysis identified human pressures (P), and provides a description of the state (S) of the water due to the pressure, the impact (I) the pressures have on the water biology and what responses (R) or measures are necessary to meet goals or environmental quality objectives. Each water body is assessed according to its current status (e.g. poor, moderate, good, or high). High status is considered to be the reference condition of the water body, without human pressures and impacts on the biology, chemistry and morphology/hydrology. The reference condition varies for different types of waters, and thus covers ecological regions across Europe.

The assessment of the current status includes biological, chemical and hydro-morphological quality elements. Measurable indicators are developed for each element, e.g. biological quality elements include “composition and abundance of aquatic flora” and “composition, abundance and

age structure of fish fauna". When data are missing, the approach provides protocols on how to include expert judgements. It also includes a built-in hierarchy, in that biological quality elements have precedence over hydro-morphological quality elements. The assessment also relies on a "one out-all out", i.e. the quality element with poorest status set the overall status of the water body. A monitoring programme is developed to follow the progress of enhancing/restoring the status and to assure that no status deteriorates, with the goal of reaching the status that has been identified by a set deadline (2015 or, for approved exceptions, 2027). The goal for most waters is to achieve a *good status*, which, in contrast to a high status, allows for some human impact. The status refers to how well the water ecosystem (at the water body level) functions, and is not related to the biodiversity value of the water as such. This is different than other conservation management approaches and the Habitat Directive, where threatened species and biodiversity in general are the primary targets. Another difference with the Habitat Directive is that the WFD includes clearly stated deadlines.

The prioritization in the WFD consists of means to improve the environmental objectives for the waters based on costs, technology, and socio-economic need. If a water body is damaged due to an activity that the society needs, e.g. hydropower, it is possible, in some circumstances, allow for those damages by setting a lower target. Case example 14 from Sweden shows how a national analysis compared the biodiversity and energy value in each catchment to give guidance for where one should, and should not, apply less stringent objectives.

The approach to conservation targets and objectives according to the WFD has some fundamental differences compared to terrestrial work. To start with, it is fairly unique that the water legislation identifies conservation levels that are to be met, and also defines deadlines for this work. The EU habitats directive contains overarching targets about Favourable Conservation Status for the habitats and species concerned by the directive, but does not specify when this status should be achieved. Nor does it present a binding requirement for member states to have achieved an acceptable (good) ecological status for all habitat "bodies". Such clear conservation targets are also missing in the national legislation. The WFD sets minimum levels that are to be reached, i.e. that the most heavily degraded water bodies will need particular attention. In the terrestrial work, some projects have a focus on restoration, particularly degraded areas (e.g. eroded land in Iceland or heavy polluted urban areas in Sweden). However, the efforts are more often directed to areas that have a low or moderate degree of degradation, and thus a higher potential for developing high nature values.

3. Nordic priority case examples

We have used examples to illustrate some of the variation and different aspects of prioritization that is currently underway in the Nordic countries and Estonia. We have chosen a subjective sample of case examples, based on knowledge of participants in the project groups regarding ongoing strategies and activities in their countries. The aim was to include a range of habitats, scales (time and space), organizations and types of prioritization.

Given these parameters, 14 case examples were selected. Table 1 lists examples from Finland (3), Iceland (1), Norway (3), Estonia (3), and Sweden (4). The case studies are presented here to allow a comparison of approaches, rather than to provide detailed information about each project. The table indicates if a landscape (spatial/connectivity) dimension has been included in the priority model. Each entry also includes a template that systematically describes key attributes that illustrate the case, and allows users to compare and contrast them (the Appendix). There is also a one-page description of each case example, with more details and links to further reading (the Appendix). A number of the examples cover projects or initiatives that have a wider conservation scope, instead of a strict focus on ecological restoration. We propose that restoration prioritization can use the approach and methods used for prioritization of conservation or other management activities.

Table 1: Case examples of on-going or recent prioritization in the Nordic countries and Estonia. The table specifies for each project if any landscape perspectives or connectivity has been considered as part of the priority-setting. For further details about the case examples, see the Appendix

No	Title	Country	Topic/focus	Spatial priorities
1	Prioritized Action Framework (PAF) for Natura 2000	Estonia	Conservation of habitat types and species in Habitat Directive	Partly considered
2	Species national action plans	Estonia	Stabilize and increase population size of rare species	Considered
3	Action Plan for semi-natural grasslands	Estonia	Preserve semi-natural grassland and plan conservation measures	Considered
4	Mire conservation prioritization in Finland	Finland	Analysis for the conservation of mires	Important part
5	Controlled burning	Finland	Analysis for prioritizing areas for burning (fire continuum areas)	Important part
6	Framework for assessing and reversing ecosystem degradation	Finland	Scientifically derived procedure for prioritization of restoration measures within ecosystem types and allocating resources across ecosystem types	Current procedure non-spatial, connectivity will be important in implementation
7	Restoration of birch woodland	Iceland	Conservation and restoration of native forest	Not considered
8	Mire restoration	Norway	Selecting areas for mire restoration	Partly considered
9	Wetland restoration	Norway	Selecting areas for wetland restoration	Partly considered
10	Representative areas for nature protection	Norway	Gap analysis and assessment to get a representative selection of protected nature	Important part
11	Species Action Programmes	Sweden	Conservation of threatened species	Considered in most programmes
12	WWF	Sweden	Conservation of semi-natural grasslands	Not considered
13	Prioritized Action Framework (PAF) for Natura 2000	Sweden	Conservation measures in Natura 2000 areas	Not considered
14	National trade-off between biodiversity and hydropower	Sweden	WFD – conflict between energy and biodiversity	Not considered

Most examples have been initiated over the last few years, with some exceptions (2, 12). Some programmes are in a pilot stage or have just been established (3, 8). There are also a number of projects presented for conservation of threatened species and habitats in the countries (1, 4, 10, 11). Most of the examples are part of national plans or strategies, but with regional implementation of priorities and actions (5, 7, 14). A majority of the examples have a habitat/ecosystem approach (focused on one or a limited number of habitats), a few have a species focus, and one has a focus on land use / pressure (the power plants in example 14). The following sections compare and contrast examples under different topics to illustrate the benefits and disadvantages of different approaches used in priority setting. The case examples show that prioritization has not been used that much to date directly for specific *restoration* prioritization.

It seems that political recommendations, such as the Habitat Directive or National Environmental Targets, often are important in deciding which habitats/species should be the initial focus. However, the results of the Finnish Restoration Prioritization working group shows how simultaneous prioritization within and among all ecosystem types is effective in delivering significant economic benefits. Indeed, the group concluded that if we focus on restoring 15% of one ecosystem type at a time, which is the *modus operandi* in many parts of the world, the overall cost of meeting the 15% restoration target is more than doubled compared to the prioritization approach they developed. More specifically, focusing on the restoration of each ecosystem type separately and reducing the degree of degradation in each by 15% would cost EUR 38 billion in Finland by 2050. However, prioritization within and among all ecosystem types could reduce the overall cost of meeting the 15% restoration target in Finland to EUR 16 billion.

3.1 From quantitative analyses to pragmatic opportunities

The prioritization in a large majority of our case examples is based on a mix of quantitative and qualitative data and considerations, although in different proportions. The baseline in some of the examples is based on quantitative data (from species inventories, monitoring programmes, modelling, etc.; see 4, 6, and partly 10). In other examples, the approach has been more opportunistic (as in case 12).

The case examples illustrate the variation in models and types of priorities that apply to different projects, and in some cases even within sin-

gle projects. The framework for assessing and reversing ecosystem degradation in Finland (6) is a quantitative approach that identifies the most cost-efficient restoration measures within each ecosystem type, and allocates resources between ecosystems or habitat types at any scale. In the conservation of semi-natural grassland in Sweden (12), available sites are selected based on a dialog with landowners, and identifies available opportunities based on these findings. A mix of political, opportunistic, ad hoc, and even qualitative priorities are used.

Setting priorities is nearly always a hierarchical process. In our case sample, the first step often is the decision (likely political or strategic) about priority ecosystems, species (Noss *et al.* 2009) or areas (the burning example in Finland, 5 (Figure 4)). Priorities are then established for separate species or ecosystem level plans (e.g. Plan for semi-natural grasslands in Estonia, 3 (Figure 5) and Species Action Program in Sweden, (11)). An exception is the case of the Finnish framework for assessing and reversing ecosystem degradation (6). Here the cost-effectiveness analysis set the priority for the ecosystems, and the priority as such was the outcome of the cost-effectiveness analysis.

Figure 4: The first step of setting priority is to decide about habitat types and areas, such as find areas for controlled burning in a protected area in Finland. Narrow firebreaks are created by removing ground vegetation and watering is used to avoid fire spreading outside the burnt area

Photo: Saara Lilja-Rothsten.

Figure 5: Setting priority within habitat types includes to decide about separate species in e.g. coastal meadow restoration, such as this by-hand restoration project in Estonia

Photo: Merike Linnamägi.

It is also possible to rely purely on pragmatic and realistic opportunities when setting priorities, such as availability for restoration activities. In case 11, semi-natural habitats were given priority due to their poor conservation status. This is an example of prioritization on a national level. Likewise, priorities between regions were made on a national level. However, the specific site selection required priorities based on local conditions and the interests of stakeholders. The project has resulted in substantial areas of restored land, even though there has not been any detailed strategy for choosing the sites to be restored. The only guidance has been to pick sites of potentially high values for management-dependent biodiversity in the selected regions.

The benefit of the simpler ecosystem-types or species-level action plans is that they are potentially more accurate (e.g. Westphal *et al.* 2003, Wilson *et al.* 2011) and easier to implement. Dynamic spatial models suffer from computational challenges (Possingham *et al.* 2009), as well as lack of robust data, although less complex models certainly have their place in solving modern conservation challenges (6). In other words, methods relying on quantitative measures of goals, actions, effects and

costs (Ferrier & Wintle 2009, Moilanen *et al.* 2009a) still usually include significant qualitative elements.

3.2 Diversity of approaches – from politics and policy to ecological attributes

3.2.1 *Objectives and targets of the projects*

The nature of the starting point for prioritization is not always obvious in the case examples. It is not even obvious what kind of choice is being made (“priority at the expense of what”).

All the case examples have an overall goal, although they are at very different scales and accuracies (which is partly related to the scope of the case in general). The most frequent words used to describe overall goals are *increase* and *improve*, including improve ecological status of different habitat types, increase population sizes. More general goals linked to improved management and conservation are also frequently mentioned. One case (14) specifically describes making trade-offs between different types of values.

3.2.2 *Approaches building on EU commitments*

For the EU countries, prioritization according to the Habitat Directive is based on the directive’s annexes with lists of species and habitat types. The EU Habitats Directive (Council *Directive 92/43/EEC*) requires the member states to work to maintain or restore a Favourable Conservation Status for habitats and species listed in the directive. In order to contribute to this work, the member states have to designate protected areas, called Natura 2000 sites, and apply strict protection to a set of species. In the Natura 2000 sites, the member states must carry out the actions needed to preserve the species and habitats that the site was designated for, and restoration is part of this in a large number of sites. According to article 8 in the directive, the member states should develop prioritized action frameworks (PAFs) for the Natura 2000 network, and ideally, they should point out cost-efficiency measures for key priorities. The PAFs should describe necessary actions and financial needs for achieving a favourable conservation status in the sites. PAFs from Sweden and Estonia are included among the examples collected in this study (cases 1 and 13), since the PAFs describe priorities that also address restoration. The Esto-

nian PAF has more specific targets and goals for restoration than the Swedish PAF. These targets and goals will make it easier to use the PAF for planning specific actions, and also to evaluate and follow up on any achievements. The Swedish PAF highlights restoration priorities on a more general level, and simultaneously points out the habitat groups where restoration is of particular importance (Figure 6). This can be helpful in further work with restoration priorities in relation to the requirements of the directive.

The work according to the Water Framework Directive (case 14) is also based on EU legislation. An important principal difference between this directive and the habitats directive is that the WFD sets out specific timeframes for when results are to be achieved.

Figure 6: The restoration of overgrown former wooded pastures is an important priority in the Swedish PAF. In some situations, the same succession phase can also be considered as a developing natural mixed woodland and an engaged discussion of which habitat that is more desirable can follow. Both habitats a prioritized on national level and in the PAF

Photo: Anna Lindhagen.

3.2.3 Approaches building on national conservation priorities, including red lists

Cases 4 and 10 show how priorities are related to a specific conservation target at a national level, the protection of representative nature types. The examples do not cover restoration in particular, but the principles are

of general interest for nature conservation and management priorities. Similar approaches are used in other Nordic countries, but we have limited ourselves to these examples. The Norwegian case (10) relies on gap analysis to identify a representative selection of protected areas. This is partly a quantitative approach used to identify what is missing to achieve national commitments to the protection network. The same approach and method can be applied to other management instruments, such as restoration, if sufficient data are available. The National Mire Conservation Plan in Finland (4) has taken this one step further and relied on 91 different biodiversity features to identify which areas will make highest value addition to the existing protected area network, also with respect to the potential for restoration.

Cases 2 and 11 are examples of priorities based on national red lists and threatened species. This type of work has also been carried out in other countries, although it is not included in the examples. At a national level, there is no spatial aspect to these priorities, but they can be important in the specific programmes for species.

Sweden has started with a much larger number of species included in the initial priorities. More than 200 programs have been initiated, but due to budget restrictions, the actual work that has been carried out has covered fewer actions and species in Sweden than was originally intended. In Estonia, fewer programmes have been developed. The programmes have focused on nationally and internationally protected species that do not have a favourable conservation status. One-quarter of planned species action plans have been adopted and the rest are in preparation.

3.2.4 Approaches to specific habitats or ecosystems

The majority of the examples have a habitat focus. For some, the habitat has been selected for some obvious reasons, mainly its degradation status (such as the birch forest in Iceland, 7) or changing land use (such as the semi-natural grasslands in Sweden, 12). Hardly any systematic priorities were used when establishing a focus in these specific habitats.

Mire and wetland restoration are getting more attention at present since their role in mitigating climate changes through carbon storage has been recognized by the international community. Wetland draining and rewetting (WDR) was added as eligible activity under the climate convention (Decision 2/CMP 7 of the Durban COP 17), thereby emphasizing preservation of wetland carbon stock. These habitats are valued for their ecosystem service value (especially carbon capture and sequestration) in addition

to biodiversity and ecological function, and in Norway, for example, the “Climate Conciliation” (Klimaforliket) from the 2015 Norwegian Parliament allocated resources to a National Plan for Mire Restoration in 2016 (case 8, Figure 7). In March 2016 the Minister for the Environment and Natural Resources in Iceland launched an action plan on wetland restoration with the aim of increasing restoration activities and to mitigate climate change (https://www.umhverfisraduneyti.is/media/PDF_skrar/sk160307_endurheimt_votlendis.pdf).

Figure 7: Restoration of mires and wetland are getting more political attention due to the ecosystem service they produce. In Norway a National Plan for Mire restoration is under preparation. Plugging ditches is a typical measure in mire restoration

Photo: The Norwegian Nature Inspectorate (SNO).

3.2.5 Landscape consideration

A spatial analysis is a core part of two of the examples provided (4 and 5), but spatial considerations and priorities are still important in many of the examples. In the case of the species action programmes (cases 1 and 13), spatial priorities may not have been included in the selection of the prioritized species, but they are often very important in the programmes for each species.

Landscape or spatial considerations with an ecological perspective often concern two things: Connectivity, which is important for all species but where the requirements are very species specific, or complementarity/representativity. Because species communities change over large distances, one cannot save everything by concentrating all efforts in one place. The scope broadens substantially when the analysis involves ecosystem services, since the analyses can include a wide array of aspects from flows of nutrients or pollutants to recreational values or expected effects of climate change.

3.3 Involved stakeholders

National public authorities generally have a large influence on land-use and management issues in the Nordic countries (Hagen *et al.* 2012, Aradóttir *et al.* 2013), and they generally are strong actors in restoration. A large majority of restoration projects in the region have some public presence (op. cit.). In other parts of the world, private initiatives, volunteer work and private fund-raising play a larger role and are partly organized in programmes paid for by commercial companies, but are mainly based on some public regulations (Reydi *et al.* 2005, Anon. 2016). By far, most of the examples in this report are incentives and activities driven by national public authorities (such as cases 2, 4, 5, 6, 7 (Figure 8), 8 and 11).

Case 12 is a stakeholder-based bottom-up approach, partly funded by public money and with some overall strategy for prioritizing between sites. This project has worked with specific restoration interventions for more than 25 years. Volunteer work in general depends more on enthusiasm and engagement, which can easily lead to “alternative” or ad hoc priority.

Figure 8: Most restoration projects are driven by national public authorities, and have links and cooperation with local actors. Restoration of birch woodland in severely degraded land at Thorsmörk, Iceland

Photo: Kristin Svavarsdottir.

3.4 Strengths and weaknesses in the case examples

Members of the project group have indicated the strengths and weaknesses of the prioritization models in the case examples template. Interestingly, the same kind of approaches have both strengths and weaknesses; e.g. quantitative and transparent methods are data-demanding and tedious, political/qualitative approaches give a good overview but lack focus, opportunistic methods might produce good results but lack an overall priority.

Lack of resources and limited frameworks are listed as weaknesses in some of the examples, and so are the lack of socio-economic analysis and link between plans and practical implementation. The strength of the models varies according to their priority and focus. The reported strengths are: increased effectiveness for management, good overview, good focus, demonstrating trade-offs, and increased knowledge. We find that this mix within and between the models supports the importance of combining systematic planning and opportunistic doing, and developing these tools should have a focus in future efforts.

4. Theoretical background of restoration prioritization

4.1 A need for resource allocation

The optimal comprehensive conservation solution would be to set aside and protect everything that has conservation value and restore everything that is degraded. However, this is optimal only from a fundamental conservation perspective since other societal goals would suffer, and even when resources are ample we are rarely given a chance to make conservation decisions as freely as we would like (e.g. Wilson *et al.* 2009, Mermet *et al.* 2013). The restrictions can be quantitative or qualitative and often opportunistic, resulting in a need to intelligently prioritize our actions to best meet our high-level conservation goals, taking into account ecological, economic, and social elements. The variety of restrictions also results in many different forms and scales of conservation and restorations plans, as demonstrated by the different case examples presented in this report.

At the core of every prioritization problem lie goals, actions, effects, and costs. Each of these are needed to find cost-effective ways to reach detailed targets that best satisfy higher-level goals such as the preservation of biodiversity and ecosystem services (Moilanen *et al.* 2009b). This is not to say that these concepts are always considered in prioritization (Game *et al.* 2013), but missing key elements in any of them makes the solution less optimal. Resource allocation problems should include all these components to be cost-effective. In addition, more simplistic ecological models can be upgraded to include spatial ecology, such as connectedness (Wilson *et al.* 2011), different ways of valuing functioning ecosystems (e.g. ecosystem service benefits per unit of area and/or effort, as in Schemama & Levrel 2015), likelihood of success (Wilson *et al.* 2011), consideration of a time discount for uncertainty in delayed effects (Schemama & Levrel 2015), and usefulness in comparing benefits of restoration projects (Schemama & Levrel 2015, Kotiaho *et al.* 2016a, example 6). Ecological patterns, processes and spatial and temporal scales that are relevant with respect to selected goals play major roles in building the models and choosing the most optimal approaches (e.g. Moilanen *et al.* 2009b) as well as in determining how we evaluate a solution's success.

For example, how much time should we give an ecosystem post restoration before declaring it a failure or job well done (Moreno-Mateos 2012, 2015; Kareksela *et al.* 2015)? Should we decide not to help populations that have the most urgent need for action so that we can assist populations that have not reached a critical state so that we maximize biodiversity over the long run? This is a time-scale question related to conservation triage, which may be part of many if not every conservation decision (Bottrill *et al.* 2008). These questions alone already emphasize the need to properly address goals and translate them as comprehensively as possible into problem formulations that can be addressed with systematic approaches to prioritization.

Unfortunately, “Every good thing we do is another we don’t” (Gilbert 2011, see also Bottrill *et al.* 2008, Kotiaho & Halme 2014). This means that prioritization needs to be carefully planned, because even when the goals are clear and actions are working well, resource limitation necessarily means that there are other good things left undone. The problem is that the things left undone may actually often be more important for biodiversity than things done, given that we often may fail in our priority setting: human decision making tends to be inclined to errors (Gilbert 2011, Game *et al.* 2013). In other words, simply setting priorities does not guarantee decisions that are cost-efficient or optimal from more than one (or any!) perspective, thus challenging the whole motivation behind prioritization in the first place.

During the last two decades, a number of systematic planning methods have been developed related to setting priorities for protecting and conserving biodiversity (e.g. Margules & Pressey 2000, Moilanen *et al.* 2009a). Recently, the emphasis has been on spatial conservation prioritization (Moilanen *et al.* 2009a, Kukkala & Moilanen 2013). Scientific studies show how to support or select areas to reflect general principles, such as representativeness, complementarity, flexibility, irreplaceability, and cost-effectiveness (Margules *et al.* 2002, Margules & Sarkar 2007, Wilson *et al.* 2009, Kukkala & Moilanen 2013). Other supportive criteria for setting priorities are critical pressures (drivers), the stated “value” of species and nature types, and the international or national responsibilities for species and nature types (Framstad *et al.* 2010). Recently, however, the focus has turned from conservation planning to more general land-use planning (e.g. Kareksela *et al.* 2013). The idea is that rather than only identifying the most important areas for biodiversity that are then set aside for conservation, the areas that have the least ecological value are identified and allocated to development. This is also known as ecological impact avoidance (Kareksela *et al.* 2013).

4.2 Targets, costs and benefits in restoration priorities

4.2.1 *Cost-effectiveness and trade-offs*

Restoration prioritization can mean at least three different things: prioritizing restoration actions in relation to other actions such as protection or management, prioritizing between different habitat types and sites, or between different restoration actions. All these approaches are relevant to setting priorities. Although the emphasis is often on the last (e.g. most examples in this report), the first step is to find out (estimate) whether increasing the value of already protected land by restoration, allocating the resources for establishment of new protected areas, or a combination of the two really is the most efficient conservation approach (e.g. Hyman & Leibowitz 2000, Possingham *et al.* 2015). Adding restoration to the conservation action portfolio makes the systematic planning of conservation resource allocation more complex, since it adds another (and dynamic) element (Possingham *et al.* 2009). This is a challenge for creating a meaningful problem formulation and a functional ecological model (Kotiaho & Moilanen 2015, Kotiaho *et al.* 2015b), and also a massive computational challenge (Possingham *et al.* 2009).

Perhaps the most simplified actions (which are still somewhat relevant) for a single site are 1) doing nothing, 2) protection, and 3) protection and restoration/management. The optimality of an action would then be a function of the effect of the applied action and its cost (Figure 9 and 10). Over larger group of areas the aim would then be to choose areas, and take actions that take us as close to the higher level goal as possible given limited resources (maximum coverage problem), or reaching the goals with as low costs (area, money, etc.) as possible (minimum set problem) (Margules & Pressey 2000, ReVelle *et al.* 2002, Margules & Sarkar 2007). These problem formulations (or their modifications) can be applied to detailed single species or habitat prioritizations (Swedish species actions plans 11; Estonian examples 1 and 2; Icelandic example 7), or to a broader perspective allocation of conservation resources that considers multiple biodiversity features (Mire conservation prioritization in Finland, 4 and Framework for assessing and reversing ecosystem degradation, 6).

Figure 9: The function of cost, time and quality of restoration is the core for good solution in management. Native birch regeneration for restoration of birch woodland in Iceland

Photo: Kristin Svavarsdottir.

Figure 10: The function of cost, time and quality of restoration is the core for good solution in management. Amphibian pond digging in Estonia

Photo: Merike Linnamägi.

When it comes to protection, but especially with ecological restoration, the effects of the actions must be adequately defined. In spatial conservation prioritization analyses, the effects of different solutions or scenarios are most often presented as static levels of protected species or habitat distributions (e.g. Kareksela *et al.* 2013). For restoration, defining the effects of the alternative actions can be a lot more complicated (Suding *et al.* 2004, Suding & Hobbs 2009, Moreno-Mateos 2012, 2015, Kareksela *et al.* 2015, see examples 6 & 11). Restoration effects can have site-related thresholds and alternative states (Suding *et al.* 2004, Suding & Hobbs 2009) and the time needed to achieve determined effects can be long (Moreno-Mateos 2012, 2015) resulting in more complex cost-efficiency considerations through time discounting, for example (e.g. Laitila *et al.* 2014, Schemama & Levrel 2015).

Costs and considerations of cost-effectiveness are key elements (although often neglected, see Game *et al.* 2013) in prioritization. Finding a way to effectively compare costs and benefits of different actions is thus an important factor in building a prioritization model. Although costs are not often easily included in a prioritization analysis, we are still usually somewhat aware that some locations or actions are more costly than the others, at least when putting the plans into action. In the most simple prioritizations, cost-effectiveness can be approached by avoiding the more costly action or location when several actions or locations seem to otherwise give more or less the same outcome or gains. However, more costly areas often tend to have higher ecological value (e.g. through ecosystem productivity) or the most desired biodiversity features are so rare that our freedom to choose is limited, making it complicated to find the best trade-offs.

The ecosystem services approach to restoration will also potentially entail some new criteria for setting priorities, as the benefit achieved from a given restoration is the focus (e.g. de Groot *et al.* 2013). A way to calculate cost-efficient restoration priorities would then be to assess the level of ecosystem services delivered by different projects, and give priority to those that deliver most (related to cost) (Schemama & Levrel 2015). An obvious risk would then be that ecosystem quality and ecological function are not considered, and the priority could be in direct conflict with the protection of biodiversity (see Bullock *et al.* 2011, Lindenmayer *et al.* 2012).

In addition to computational problems, the consideration of restoration effects and having comprehensive data on habitat distributions and restoration costs is highly complicated, and is reflected as an absence of all-inclusive restoration prioritization models (Wilson *et al.* 2011) and recognized limitations in the existing ones (Kotiaho & Moilanen 2015, Kotiaho *et al.* 2015a,b, 2016a). For example, the European Commission

model (Lammerant *et al.* 2014) for approaching the 15% restoration target (CBD 2010) includes a huge potential for opportunism if it is implemented, and even in its ecologically most effective scenario it falls short from reaching an actual 15% increase in ecosystems' ecological value (Kareksela 2015, Kotiaho *et al.* 2015a). Another example of a difficulty in restoration prioritization and including the costs comes from a recent study by Egoh *et al.* (2014), who evaluated options for meeting the restoration target in the EU. The evaluation was based on a target-based spatial conservation prioritization analysis across threatened habitats, species and ecosystem services in the EU's 27 member states. In addition, they explored how inclusion of the restoration cost in different member states influenced prioritization. Unfortunately, the cost data compiled by Egoh *et al.* (2014) was not appropriate and caused a bias in the results (Kotiaho & Moilanen 2014). More specifically, Egoh *et al.* (2014) reviewed information about the financial resources required by each EU Member State from the European Commission LIFE programme for restoration activities in Natura 2000 sites, and formed an aggregate per hectare restoration cost for each of the member states. What Egoh *et al.* (2014) did not consider was that such an aggregate cost ignored the type of habitat restored and the type of restoration measure undertaken. Therefore, their measure was highly unlikely to be independent from the consequent improvement in ecosystem condition. Including such arbitrary cost information in the analysis caused a bias in the allocation of restoration efforts in their analysis towards countries where improvements in ecological conditions were likely to be smallest.

4.2.2 Targets, reference state and baseline

From an ecological perspective, ecosystem degradation or improvement has a minimum of two dimensions: the extent of area that has become degraded or improved and the degree of the degradation (or improvement) at any given location (Kotiaho *et al.* 2015a, b, 2016a; Kotiaho & Moilanen 2015). Knowledge of the *extent* of the degraded area alone is not sufficient for providing a conceptually sound estimate of the *degree* of ecosystem degradation or improvement, because from an ecological perspective it makes a great deal of difference whether an ecosystem has been only slightly degraded, or is almost completely lost. The current degree of degradation at each location can be obtained by subtracting the current ecosystem condition from the pre-degradation baseline condition (Kotiaho *et al.* 2016b). This has not been a core issue in the case examples, and we might identify two underlying "dimensions" of baselines: 1) The natural

ecosystem, where the ideal target for restoration is to approach the functions and composition of an intact and undisturbed ecosystem (as in cases 4, 6, 7, 8), and 2) Semi-natural habitats, where the target is to maintain a state of disturbance to protect biodiversity or other ecosystem services (cases 3, 12). Case 5 is an interesting combination, where the target is to establish a long-term continuum infrastructure, by restoring the natural disturbance regime (fire). The definition of a natural (or semi-natural) state baseline that the current state could be compared to is problematic, and has only been specified in case 6, the Framework for assessing and reversing ecosystem degradation.

Generally, we can directly observe and measure the current state of an ecosystem at any given location. However, in the absence of any other knowledge, the current state alone provides almost no useful information about the degree of degradation. In the case of biodiversity and ecosystem services, we are often interested in trends. To detect a trend, some reference state is required. For example, in an attempt to establish a Red List of the world's ecosystems, one of the reference states that has been suggested to assess change is the time period of the past 50 years (Keith *et al.* 2013; but see Boitani *et al.* 2015). However, choosing 50 years ago as a reference is arbitrary and conceals ambiguity in assessing both the direction and magnitude of the change (Kotiaho *et al.* 2016b). What is needed is a pre-degradation baseline, or in other words a natural state, that will illuminate the potential of a site. A natural state baseline anchors observations and removes the ambiguity in the direction and magnitude of the change (UNEP 2003, Kotiaho *et al.* 2015a, Kotiaho *et al.* 2016b).

It is important to separate the baseline from the target, because the natural state baseline is not the same as a target state of restoration. A natural state baseline is based on results from scientific research, while the target state is a political decision balancing different social, economic and ecological interests (UNEP 2003, Higgs *et al.* 2014, Kotiaho *et al.* 2015a, 2016b). In the Norwegian Nature Index, the definition of reference values has been given special attention. The Nature Index is intended to be an instrument to measure the state of, and changes in, biodiversity in nature and cultural landscapes (Certain *et al.* 2011). One of the main issues for the index is that it should be possible to estimate the reference value for all the indicators (species and habitat data series). This reference value is estimated relative to a reference state that represents an intact ecosystem with little or no human impact. For cultural landscapes, the corresponding reference state is "in good condition" relative to the species that are normally associated with the specific type of habitat in question (Nybø *et al.* 2016). The concept of ecological condition

(økologisk tilstand) is currently on the political agenda in Norway (Anon 2015), as a tool to establish statistics and measures for the development of nature condition, and the Nature Index provides the premise for this effort (Norwegian Environmental Agency, pers.comm.)

4.3 The interplay of quantitative approaches with qualitative and opportunistic priorities

The decision to regard some species or habitats as more important and of higher priority than others is usually based on quantitative data and analysis (e.g. Red Lists). However, the decision to consider only some biodiversity features is qualitative and as such, contains risks that need to be considered with respect to meeting higher-level goals of conserving a wide range of biodiversity and ecosystem services. For example, if we were to define a good solution for allocating restoration efforts for most threatened habitats in the landscape, we need to recognize that the decision to prioritize most threatened habitats was done a priori. Most importantly, the following analysis would be restricted by this a priori prioritization, and it cannot produce information on possible trade-offs and synergies with respect to other habitats, single species distributions, and/or ecosystem service potential if these lower-priority features are not properly presented in the analysis. In general, this means that the qualitative prioritizations are more prone to one-sided decision making, even when they are based on quantitatively analysed information on anthropogenic pressure on habitats or species, for example. Furthermore, while allocating resources based on the national scale, or EU statuses of biodiversity features, but with national scale occurrence data is an intuitive approach for an initial, qualitative, prioritization, it does raise questions. Still, even though analysing the initial prioritization from a broader perspective, such as on an EU scale, might change our view on what can be effectively protected or restored and where, our ability to effectively operate across national borders is still largely limited. These are factors that should be thoroughly understood when detailed models for prioritization analyses are worked out and especially when the results are interpreted.

Simplified prioritization, whether initial or final, is often needed and used, and it definitely has its place and time, but a simplified process easily misses many factors, such as the cost-effectiveness, complementarity or connectivity of the solution. On the other hand, complex comprehensive analyses may suffer from a significant gap between the analyses and

their implementation (Knight *et al.* 2008) requiring separate implementation strategies (Knight *et al.* 2011) and improving the science-society dialogue (Young *et al.* 2014). However, these analyses still offer excellent tools to view the trade-offs, synergies, possibilities, and extremes of the different scenarios and outcomes (e.g. Kareksela *et al.* 2013, example 4).

Areas can also be assigned to protection or restoration via ad-hoc decisions, i.e. according to the urgency of the need and opportunities (Knight & Cowling 2007). In fact, this is probably quite often the case, at least partly, in that major components of the solution may result from prioritization and detailed decisions may result from rising opportunities. Furthermore, it is likely beneficial to systematically pay attention to rising opportunities (Knight & Cowling 2007), although many small-scale opportunities are probably missed in large-scale generic planning approaches as was used in example 6 (Framework for assessing and reversing ecosystem degradation). Furthermore, situations and the world around us both change, and thus the optimal set of areas and actions changes over time, emphasizing the need for some level of flexibility in selected solutions.

Profitable opportunities are perhaps most intuitive for actions that have very low costs. For example, in Finland some seriously endangered species of rich peatland habitat patches are so remote that their restoration (by blocking the ditches) would be extremely expensive. However, they can sometimes be blocked very easily using organic sacks filled with peat near the habitat, and the process can be carried out using voluntary labour. This action can be undertaken in any situation (even for lower priority habitats) without compromising the cost-effectiveness of large-scale systematic planning, and it is a low-cost-intervention. Harmful opportunism may either be costly or involve undertaking actions at low priority sites, or both. This may result from political interests or conservative approaches that then override existing prioritization schemes to execute actions that have always been done. The solution is to balance two perspectives when planning: 1) minimize harmful opportunism and 2) identify potentially rising opportunities and allowing some flexibility in plans to react to rising opportunities (see discussion in Knight & Cowling 2007, Pressey & Bottrill 2008). In addition, plans are hardly ever executed immediately, so that while some opportunities may differ from the most optimal outcome, these opportunities are usually undertaken more quickly than the planned action (by definition). That reduces the risk of losing the opportunity as time passes (see Laitila *et al.* 2014). Simply stated: it is likely profitable to maximize cost efficiency by careful systematic prioritization planning while allowing some flexibility with respect to rising opportunities.

4.4 A matter of scale

Prioritization can be done at different scales – geographic, thematic, resolution and time (Adame *et al.* 2015). In reality, we often observe both overall national priorities and prioritization at a narrower scale, or combinations of both. It is important to recognize and interpret the links between broad and narrow prioritization efforts to find good solutions for landscape management. A *broad level* is not a pre-defined scale or size, however; broad level schemes for prioritization can be undertaken:

- At the country level to give priority among different habitat types.
- At the country level to give priority among locations on a national list within habitat types.
- At the habitat level to give priority to single species.
- At the species level to give priority among populations.
- Among habitats or sites or population to give priority over time.

Conflicts might arise in the trade-off between the holistic and broad perspectives on the one hand, and more specific, pointed decisions on the other. Such conflicts can be directly linked to access to money, time and other resources, but can also be more strategic regarding what is the “right” level of knowledge to support management decisions. Simplifications can be used to provide an overview, but can also hide details and key issues. Trade-offs in time and scale must always be the focus in nature management, just as they are in all other policy and social matters, and the best approach is to be aware of this, use the best available knowledge, and identify knowledge gaps.

4.4.1 *Setting priorities with a spatial perspective*

Spatial perspectives are currently widely used in conservation planning and the diversity of approaches is quite large. From the examples presented in the Appendix, the fire continuum (5) has a very simple spatial extension of clustering actions in a certain area to promote a continuum of burned habitats at relevant spatial and temporal scales. The mire zonation project (4) includes several spatial considerations, from biodiversity connectivity measures to the use of a combination of local and national scale priorities and weights for biodiversity features and areas. The goal in this case is conform with the overall prioritization of peatland areas with high local and national value. A spatial approach has to be considered

to protect or restore a representative part of nature attributes. Without this approach, the typical habitat types will systematically be down-weighted and lose in the “competition” with specific areas with special values and high biological biodiversity (Figure 11).

Figure 11: Restoring the typical, or representative, part of nature attributes can easily lose in the “competition” with specific areas with special values if a spatial approach is not considered. Restoration in a representative peatland area in Sipoonkorpi National Park, Finland. If no ditch-digging spoil is available to infill ditches, hydrological conditions can be restored by damming

Photo: Päivi Leikas.

Single large or several small plans

The theory of restoration ecology has been very oriented towards ecosystem dynamics (e.g. Suding and Hobbs 2009, Suding *et al.* 2004). Current conventions (such as the CBD and Sustainable Development Goals (SDG)) with their large-scale prioritization goals put pressure to combine ecosystem dynamics models (e.g. 6, 11) with modern spatial conservation prioritization elements and methods (Wilson *et al.* 2009, 2011). The aim is to promote cost efficiency and the persistence of the solution as related to connectivity (e.g. mire zonation, 4). This of course adds complexity to the models, computational and data availability challenges, and challenges our ability to implement the plans (Knight *et al.* 2008, Young *et al.* 2014). More complex and larger scale approaches often tend to need a higher level of integration with societal decision making and at the same time their results are more complicated to interpret.

As discussed in this report, different scale approaches have different benefits: a large-scale, more comprehensive analysis allows for better cost-effectiveness considerations (e.g. Pressey & Bottrill 2008, Game *et al.* 2013) while species- or habitat-level planning allows a higher level of ecological accuracy (Wilson *et al.* 2011) and perhaps easier identification of beneficial opportunities (Knight & Cowling 2007). Together the different modern conservation approaches produce a highly comprehensive portfolio to counteract the degradation of nature. The Nordic examples provided here (Table 1, Appendix), include a number of different stages:

- species-level plans with highly detailed ecological considerations about ecosystem-types and red list statuses
- those that target a landscape-level continuum of actions
- those that use detailed ecosystem-type GAP analyses or produce restoration cost-effect analyses that extend over all ecosystem types
- those that link restoration needs and potential to large-scale and detailed spatial conservation prioritization plans.

Still, none of these examples alone deal with all the aspects needed for full-scale multi-ecosystem spatial restoration prioritization. Comprehensive approaches that consider the cost-effectiveness of restoration, protection, and management actions in an ecologically relevant spatial context are extremely complicated. For example, the framework for assessing and reversing ecosystem degradation, which is the most complicated model used in the examples provided and that covers almost all terrestrial ecosystem types in Finland (c. 300,000 km²), still lacks detailed species-level responses to restoration actions. In addition, as it stands now, the approach is non-spatial. Thus, even though this approach is very useful in prioritizing the most cost-effective restoration measures in ecosystem types and allocating resource among the ecosystem types, it is still not enough. The allocation of restoration measures for the landscape still requires linking the results from prioritization with spatial land-use planning to consider issues such as connectivity. This means that there is still plenty of work to be done to develop these models and approaches. Nevertheless, they also need to be implemented in spite of their limitations to promote their further development.

In the end, these analyses and planning methods are only tools to help decision making, meaning that decisions still need to be made, often when many other relevant considerations cannot be fully included in analyses and plans. However, the example cases in this report collectively provide

a large set of management and restoration approaches for the conservation prioritization portfolio. The efficient and complementary use of these small- and large-scale solutions provides a prominent path towards the effective best practice of conservation prioritization.

Priority and time

Time is an essential dimension in any consideration of restoration. No matter how massive a restoration effort may be, it usually takes several decades or even longer to reach its full goals (Moreno-Mateos *et al.* 2012, 2015). The case examples in this report illustrate that prioritization in restoration is quite novel in nature management, and we could expect any output of decisions like these to take some time. Ecosystem recovery after restoration in general is a long-term process, particularly in northern ecosystems (Halldorsson *et al.* 2012). With the time needed for the ecosystem to attain restoration goals, the uncertainty also increases, thus challenging our ability to increase habitat area quickly enough for declining populations (Kuussaari *et al.* 2009). A strategic decision would also be to include some descriptors (or indicators) to describe the improved function of a system over the short term (e.g. monitoring physical structure in ombrotrophic mires, not only original species composition).

In the simplest form of restoration action, evaluation time is not considered and the ecosystem is given its estimated end value in the model without any discount through time. In more sophisticated (but also complicated) models, the time needed to reach targeted impacts is used to calculate the time discount (i.e. uncertainty discount as a function of time) for the restoration effects. This means that a multiplier is used to determine the size of the restoration offsetting that is needed to compensate for ecological losses from development actions (e.g. Laitila *et al.* 2014, Schemama & Levrel 2015). Time discounting is especially relevant in target-based compensation. In cases of “normal” restoration planning, it is most important to recognize that not all the structural and functional components of an ecosystem will be re-established at same rate and regaining some relevant functions or re-establishing populations of rare species can take a very long time (from decades to centuries) or need active re-introduction (e.g. Hedberg *et al.* 2012). When these kind of ecological delays are recognized, measures to alleviate their effects can be added to the action palette and the effects and costs of efforts such as species re-introductions can be weighed and balanced in a prioritization process along with other restoration measures.

Prioritization and deciding what not to do

Conservation triage is an unavoidable step in any process of allocating limited resources, including restoration of ecosystems (Bottrill *et al.* 2008, 2009, Kotiaho & Halme 2014). The discussion around triage has been somewhat controversial (e.g. Pimm 2000), but because it is unavoidable in reality, it should not be confused with taking ethical positions. To effectively restore ecosystems to aid the long-term persistence of species and ecosystem functioning, it is vital that decision makers and practitioners explicitly acknowledge that there are always trade-offs resulting from investing in one restoration measure or one ecosystem type over another. A good example of a restoration triage is the Finnish project that prioritizes restoration measures within ecosystem types and across ecosystems (Kotiaho *et al.* 2015a). If we initiate separate conservation or restoration programmes for each of the ecosystem types as we have tended to do (e.g. the voluntary forest conservation programme METSO (<http://www.metsonpolku.fi/en-US>) or the peatland protection programme (mire conservation in Finland, 4) the overall cost will be very high. Restoring 15% of the terrestrial area of Finland evenly across all ecosystems would cost about EUR 38 billion by the year 2050. However, if we acknowledge that some ecosystem types are much more expensive to restore than others and that there are more ecological values in some ecosystem types than in others and prioritize the ecosystems accordingly, the same 15% reduction in degradation can be reached at less than half the cost, or for EUR 16 billion by 2050 (Kotiaho *et al.* 2015a, 2016a). This prioritization will mean, for example, that semi-natural grasslands that are very expensive to manage will be allocated less resources. Thus, some of their values will be lost and most of the resources used to improve agricultural area biodiversity will be diverted elsewhere. Semi-natural grasslands does a good job of illustrating of what can be achieved with the same resource, if the focus of the prioritization is skewed more strongly towards cost-effectiveness. In the Finnish prioritization, reducing the area of diverse but very expensive semi-natural grassland by 25,000 hectares makes resources available for other ecosystems, such that more than 1,000,000 ha of other ecosystem types could be restored with the same resource by 2050 (Kotiaho *et al.* 2016a). It is painful to let go of some of the wonderful semi-natural grasslands but in the world of competing interests and limited resources, it helps to understand that every sensible thing we do is another sensible thing we do not (Gilbert 2011, Game *et al.* 2013).

5. Conclusions and take-home messages

This report has shown that there is a need for more work that has a greater emphasis on the prioritization aspects of restoration. The strong need to develop prioritization approaches is a good indication of the difficulty of both planning and implementing proper cost-efficient restoration actions; if it was easy, we would most likely have made more progress by now. The need for restoration is increasing (due to further degradation of landscape and nature values). International and member states of the different biological conventions have sent political signals that support restoration as a tool to protect biodiversity and support ecosystem services. Restoration is also about to become a part of national policy in the Nordic countries and Estonia. In this diversity of interests and initiatives, there is a need for good models and strategies to support wise use of resources for the long-term protection of biodiversity. It is possible to restore and manage ecosystems without a priority plan, but then it is also more than likely that it will be very hard to achieve international and national ambitions. A clear strategy is essential to take the right decisions, to link restoration with other conservation tools, and to include a spatial component that supports the restoration of Green Infrastructure.

Currently, there is no standard for how to set priorities for restoration. A number of approaches have been used, including quantitative cost-efficiency models (based on theory from spatial conservation planning) and more ad hoc and less systematic procedures. Setting priorities in management is usually a mix of procedures, as it is most likely profitable to maximize cost-efficiency by careful systematic prioritization planning (based on quantitative models) while allowing some flexibility with respect to rising opportunities (including ad hoc decisions or urgent needs). Successfully combining these two approaches will help minimize the risk of harmful and ineffective decisions.

By linking the case examples in this report to the background theory we have illustrated that prioritization is a hierarchical process, and priorities should be considered at different spatio-temporal scales and cover

biological hierarchy. Properly setting priorities requires considering different scales, and both broad and specific goals need to be defined. What do we want to achieve? How much, when, and at what cost?

Six take-home messages to develop improved future prioritization of restoration in the Nordic countries and Estonia:

1. *Develop large-scale plans.* The aim should be to develop high-end ecological planning to support decision making with cost-effective large-scale solutions. Without being informed by a large-scale plan, a small-scale plan cannot deliver all potential synergies and mitigate trade-offs to maintain biodiversity and ecosystem services.
2. *Use cost-efficiency analysis.* Systematic cost-efficiency analysis should be the basis for any prioritization. It is important not to underestimate the value of expert knowledge. Expert knowledge is valuable and can be incorporated into the analysis with any data that are available.
3. *Combine the theoretical with the opportunistic.* There are different models for prioritization. None are wholly right or wrong, but we are more likely to find better solutions if quantitative models and opportunistic allocation are combined in a good way.
4. *Plans must be implemented.* Planning and prioritization are very important, but they amount to nothing without implementation. Plans have to be implemented if they are to help maintain biodiversity and ecosystem services.
5. *Have a landscape perspective.* Restoration will give better results if priorities consider the landscape element. De-fragmentation, re-colonization and deliveries of ecosystem services all depend on where the restoration is carried out (in relation to other actions, like protection, management, etc.).
6. *Aim for Green Infrastructure.* Even in relatively well preserved regions, important parts of the Green Infrastructure can be significantly damaged, and the only way to recover these lost attributes is by well-planned restoration activities. Avoiding unnecessary ecological impacts in urban planning can turn much of the grey infrastructure into a green one.

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Sammendrag

Dersom økologisk restaurering skal bli et bidrag for å bevare biodiversitet og fremme Grønn Infrastruktur må det gjøres flere og bedre prioriteringer.

Restaurering er pekt på som et virkemiddel for å oppnå flere av de strategiske målene i Biodiversitetskonvensjonen (CBD) fra 2010. Restaurering er samtidig et mål i seg selv, der CBD sitt Aichi-mål 15 slår fast at innen 2020 skal 15 % av degraderte områder skal være restaurert. Det store behovet for ressurser til restaureringstiltak framover krever prioriteringer.

Det er begrenset tilgang på ressurser til forvaltning og vern av natur (inkludert restaurering). Dermed er det viktig å gjøre gode prioriteringer for optimal bruk av penger og menneskelige ressurser til bevaring og restaurering av biodiversitet. Prioritering er en helt avgjørende for systematisk planlegging innen bevaringsbiologien, men til tross for dette er det forholdsvis nytt å gjøre systematiske prioriteringer i forbindelse med restaurering og forvaltning. Det er behov for bedre prioriteringsmodeller som også tar opp i seg erfaringer fra strategisk prioritering. Samarbeid mellom de nordiske landene og Estland kan bidra til å implementere erfaringer fra prioritering av restaurering i landene.

Målet med dette prosjektet var først og fremst utveksling av erfaringer og eksempler på restaurering og prioritering mellom de nordiske landene og Estland. Gjennom å bruke konkrete eksempler fra alle landene vil prosjektet beskrive og drøfte ulike tilnærminger for å gjøre prioriteringer, spesielt i et landskapsperspektiv. Basert på dette foreslås retninger for bedre arbeid med framtidige prioriteringer. Dette omfatter også forbedring av Grønn Infrastruktur og bevaring av arter og habitater i framgmenterte landskap. Prosjektet skal også forsøke å dra noen linjer mellom prioritering i økosystemer på land og i ferskvann. Målet er ikke å gi en fullstendig oversikt over prioriteringer brukt i Norden og Estland, men heller å vise eksempler på ulike måter. Gjennom dette vil prosjektet forsøke å fremme ideer, refleksjoner og gi noen gode råd for framtidige prioriteringer.

I et tidligere Nordisk Aichi restaureringsprosjekt, som også mottok støtte fra Nordisk Ministerråd og TEG (2014–2015), ble behovet for

nasjonale planer og prioritering av restaurering understreket. Restaurering må ha en breiere fokus enn enkeltprosjekter og objekter. I dette prosjektet tar vi nå dette perspektivet et steg videre og bruker eksempler fra landene for å illustrere prioriteringsmodeller, fra vitenskapelige og kvantitative strukturerte analyser til mer opportunistiske og steds spesifikke avgjørelser. Fjorten eksempler fra alle landene er inkludert og omfatter et mangfold av habitater, skalaer, organisering og typer prioritering. Innholdet i eksemplene diskuteres i et teoretisk rammeverk, basert på publisert litteratur om prioritering av vern.

De ulike måtene å prioritere på som er rapportert her viser en blanding av kvalitative og kvantitative data og vurderinger. Juridiske og politiske anbefalinger som Habitatdirektivet og Nasjonale miljømål, er ofte utgangspunkt for hvilke habitater eller arealer som får fokus, men bare unntaksvis sies det noe om hvordan prioriteringer skal gjøres *mellom* habitater og arter. Den nasjonale finske arbeidsgruppa for prioritering av restaurering er et av prosjektene som presenteres og som illustrerer hvordan samtidig prioritering både innen og mellom økosystemer kan være kostnadseffektivt.

En sammenlikning mellom terrestre økosystemtyper og kravene i Vannforskriften (WFD) viser at det er noen fundamentale forskjeller i tilnærming og prioriteringer. Lovverket for ferskvann har satt konkrete forvaltningsnivåer (i forhold til en definert referansetiltand) som skal oppnås i alle vannforekomster innen et gitt tidspunkt. Slike klare mål finnes ikke i lovverket som styrer forvaltning på land. Vannforskriften setter minimumsnivåer i forhold til måloppnåelse, slik at de mest forringede vannforekomstene skal prioriteres. I terrestre miljøer er det mer vanlig at tiltakene rettes mot områder med små eller moderate nivåer av påvirkning og som dermed har størst potensial for å gjenopprette store naturverdier.

Gjennom de siste par tiårene er det utviklet mange systematiske metoder for å kunne gjøre prioriteringer av forvaltningstiltak for biodiversitet. Det legges samtidig i økende grad vekt på økosystemtjenester i restaureringsprosjekter og dette vil trolig utløse nye kriterier for prioriteringer, der fokus ligger på den nytten og de godene som restaurering produserer. Det er en risiko for at dette kan gi mindre oppmerksomhet på kvalitet og økosystemfunksjon og at det til og med kan oppstå en konflikt i forhold til bevaring av biodiversitet.

Generelt viser eksemplene i denne rapporten at a) kvantitative og etterprøvbare metoder krever svært omfattende datatilgang og databehandling, b) at politiske/kvalitative tilnærminger gir et godt

overblikk, men dårligere fokus, og c) at mer opportunistiske metoder kan gi gode resultater, men mangler en egentlig overordnet prioritering. Forenklet inngang til prioritering kan fungere i noen tilfeller, men mangler generelt kost-nytte-vurderinger, komplementaritet og sammenheng i beslutningene. Omfattende og komplekse analyser er et svært godt verktøy til å gjøre avveininger, synergier og muligheter, men kan mangle en god tilbakekobling til anvendelse og gjennomføring i praksis, inkludert brukermedvirkning. For å oppsummere så blir prioriteringene trolig mest effektive dersom utgangspunktet er systematisk planlegging, men som kombineres med litt fleksibilitet og pragmatisme. Det vil alltid være en avveining når det tas valg om å gjøre tiltak i et økosystem på bekostning av et annet. Dette kan bli kontroversielt og også utløse en etisk debatt. Det kan være smertefullt å ofre noen vedifulle områder, men i en situasjon der det ikke er nok ressurser til å gjøre alt handler prioritering om å innse at alle fornuftige tiltak vil gå på bekostning av noe annet.

Her og nå er det ingen vedtatte standarder for prioritering av restaureringstiltak i terrestre økosystemer. Denne rapporten har vist at det er behov for større fokus på nettopp dette aspektet ved restaurering. Det trengs gode modeller og strategier for å kunne bruke ressurser på en fornuftig måte som på sikt er bra for bevaring av biodiversitet.

Vi har satt opp ei liste med seks viktige momenter som vil bidra til bedre prioritering av restaurering i Norden og Estland:

1. Utvikling av overordna planer er avgjørende for kostnadseffektiv og storskala løsninger og for å utløse synergier mellom alle pågående småskala prosjekter.
2. Kost-nytte-analyser må være utgangspunkt for alle prioriteringer.
3. Teori og opportunisme må kombineres for å oppnå bedre løsninger.
4. Planer og prioriteringer må gjennomføres, de har ingen egenverdi dersom de ikke gjennomføres i praksis.
5. Restaurering vil fungere bedre dersom prioriteringene tar et landskapsperspektiv.
6. Vær spesielt oppmerksom på Grønn Infrastruktur både for å unngå negative påvirkning på økosystemer og ved restaurering av tapt natur i byer, på landsbygda og ute i naturområder.

Appendix: 14 case examples

Case 1: Prioritized Action Framework (PAF) for Natura 2000

Table 2: Prioritized Action Framework (PAF) for Natura 2000

Name (of examples) and country	Prioritized Action Framework (PAF) for Natura 2000, Estonia
Background information	
Overall topic (habitat type/species/management issue)	Planning of financing – Prioritized Action Framework
National/Regional?	National
Who took the initiative (local actors or from central agency/organization)?	Central institution (MoE)
Timeframe	Planning 2012, implementation 2014–2020
Priority model	
Focus (rare species/habitats, particular restoration problem, local improvement, etc.)	Habitats Directive Annex I habitat types, Annex II and IV species, Birds Directive Annex I species and migratory species
Overall goal of priority (one or several)	PAF was intended as planning tools aimed at identifying key priorities and providing an integrated overview of how to achieve them having regard to different financing instruments 2014–2020.
Source of data (nationally available data/special inventories/other information)?	Nationally available data, expert recommendations
What model of priority and what criteria have been used?	PAF was based on National Nature Conservation Development Plan and its priorities
What parameters are measured to follow up if the prioritization has worked as planned (scientific, social, political, logistic or other)?	Surface area of habitats supported to improve conservation status
Expected outcome	Implementation of PAF via different EU Funds (e.g. Cohesion Fund, EAFRD, LIFE) and national funding
“Evaluation”	
Does the same model include other conservation measures than restoration?	Yes
Can it be applied to other areas (geographic, habitat, political)?	No
What is good about the model, and what are the weaknesses?	National planning for restoration and other conservation activities. Does not consist of socio-economic analysis.
Publications/references/link to more data:	http://www.envir.ee/sites/default/files/elfinder/article_files/paf_est.pdf

The Estonian PAF was based on the Nature Conservation Development Plan (NCDP) to 2020, which was approved by Estonian Government in 2012. The Estonian NCDP is serving as the National Biodiversity Strategy and Action Plan. The aims of the PAF were to define conservation priorities and to propose measures to achieve these priorities. To this end, measurable quantitative targets have been set for semi-natural grasslands, mire habitats and for several other habitats. Specific measures to achieve the targets were listed and potential financing sources were identified. According to the PAF, habitat restoration that would be financed from EU Funds would be ERDF/CF and LIFE. The measurable habitats restoration targets established in the PAF were:

Semi-natural grasslands

1630: 350 ha of habitat type will be restored, the managed area will be increased from the currently managed 10,000 ha to 10,350 ha; management quality will be improved so the area is more suitable for threatened bird species (Charadriiformes).

6210, 6270, 6280, 6530, 8240: The currently managed area will be maintained, the additional areas will be restored, with increases in the managed area as follows:

- 6210 from the currently managed 1,000 ha to 2,250 ha
- 6270 from 1,000 ha to 1,800 ha
- 6280 (including 8240) from 2,850 ha to 7,350 ha
- 6530 from 700 ha to 3,150 ha.

5130, 6410, 6430, 6450, 6510, 9070: The currently managed area will be maintained, additional areas will be restored, and managed area will be increased as follows:

- 5130 from the currently managed 200 ha up to 2,925 ha
- 6410 from the currently managed 100 ha up to 675 ha
- 6450 from 6,600 up to 11,700 ha
- 6510 from 500 ha up to 1,275 ha
- 9070 from 1,500 to 1,575 ha.

In addition: the water regime for 6450 will be improved in several sites, the quality of the management will be improved, infrastructure needed for the management will be restored and in place in the most important areas, and the habitat quality of 9070 will improved.

Dunes and heaths

2130: 400 ha of 2130 will be restored to provide habitats for *Lacerta agilis*.

4030: 50–100 ha of 4030 will be restored – important habitat for *Lacerta agilis*.

Peatlands and other mire habitats

7110: The area of restored habitats will increase from 100 ha up to 8,000 ha.

7120, 7140, 7150, 7160, and 7230: About 2,000 ha of the habitats will be restored.

Forests: degraded wet forest habitats will restored (2000 ha)

The Estonian PAF was completed at the beginning of 2013. Funding information for the implementation of habitat restoration activities described in the PAF:

- EUR 26.7 million expected from the Cohesion Fund (2014–2020) to restore at least 9,000 ha of protected habitats.
- LIFE Nature Project (Life to alvars) to restore 2,500 ha of alvars grassland (6280) in Estonia started in 2014, total cost EUR 3.7 million, of which 75% is from the LIFE Fund.
- LIFE Mires Estonia, started in 2015, restoration area will affect approximately 5800 ha of mires, of which 3450 ha are Natura 2000 priority habitats (7110, 91D0, 9080, 9110). The project is expected to plug approximately 240 km of drainage ditches and restore mire habitats in 50 ha of abandoned peat mining areas located in nature conservation areas. Total cost EUR 2.8 million, of which 74.6% is from the EU.

Case 2: Action plan for conservation and management of species in Estonia

Table 3: Action plan for conservation and management of species in Estonia

Name (of examples) and country	Species national action plans (Golden eagle, White-tailed eagle, Lesser spotted eagle), Estonia
Background information	
Overall topic (habitat type/species/management issue)	Species
National/Regional?	National
Who took the initiative (local actors or from central agency/organization)?	Ministry of the Environment
Timeframe	Short term 5 years (including budget); Long term goals 15 years
Priority model	
Focus (rare species/habitats, particular restoration problem, local improvement, etc.)	Rare species (I protection category)
Overall goal of priority (one or several)	To increase and/or stabilize population size.
Source of data (nationally available data/special inventories/other information)?	State monitoring (all known nesting sites are checked at least once per 3 years)
What model of priority and what criteria have been used?	Scientific – population trend; Political – protection category; Social – Eagles as symbols of nature conservation.
What parameters are measured to follow up if the prioritization has worked as planned (scientific, social, political, logistic or other)?	
Expected outcome	Same as overall goal.
“Evaluation”	
Does the same model include other conservation measures than restoration?	Yes
Can it be applied to other areas (geographic, habitat, political)?	They are used for planning conservation areas.
What is good about the model, and what are the weaknesses?	Conservation measures are set. Sometimes shortage of human/financial resources for implementation of the plans.
Publications/references/link to more data:	http://www.envir.ee/sites/default/files/elfinder/article_files/kk_1134_lisa_2013.pdf http://www.envir.ee/sites/default/files/elfinder/article_files/vaike-konnakotka_kaitse_tegevuskava.pdf http://www.envir.ee/sites/default/files/elfinder/article_files/kk_1135_2013_lisa.pdf

An action plan has been prepared to organize the protection of species in the protected category I. It has been initiated to ensure that species have a favourable conservation status, if the results of a species inventory indicate that current measures fail to do this, or if required because of international obligations. The plan is also for species management if the results of the species inventory indicate a significant negative impact to the environment caused by the increase in the population of the species, or a danger to the health or property of individuals.

An action plan includes biological data, population dynamics data and information on the range of the species. It also includes the conditions required to guarantee an endangered species can achieve a more favourable conservation status, as well as risk factors for the species. Other components include the objectives for conservation or management, and a prioritization and schedule for measures needed to bring the species to a favourable conservation status or for its management, and a budget for the organization of conservation or management.

An action plan will be established by the Minister of the Environment and will be published on the website of the Ministry of the Environment. Plans are funded through state budgets, the Environmental Investment Centre and LIFE projects.

Since 2000, action plans for conservation or for conservation and management have been put in place for 58 species. Action plans for conservation are currently being created for 172 species. Action plans should be approved for category I species in the Habitat Directive by 2020. These are species for which most urgent and restrictive measures are needed.

Case 3: Action Plan for semi-natural grasslands, Estonia

Table 4: Action Plan for semi-natural grasslands, Estonia

Name (of examples) and country	Action Plan for semi-natural grasslands, Estonia
Background information	
Overall topic (habitat type/species/management issue)	To preserve semi-natural grasslands and to plan protection measures.
National/Regional?	National Biodiversity Strategy
Who took the initiative (local actors or from central agency/organization)?	Ministry of the Environment
Timeframe	2014–2020
Priority model	
Focus (rare species/habitats, particular restoration problem, local improvement, etc.)	Habitats: 6280*; 6530*; 6210; 6270*; 4030; 7230; 1630*; 6450; 9070; 6410; 6510; 6430.
Overall goal of priority (one or several)	Several: 1) keep managing the land that's already under management; 2) improve the quality of management; 3) 45,000ha under management; 4) increased awareness; 5) improved data acquisition
Source of data (nationally available data/special inventories/other information)?	Nationally available data + special inventories
What model of priority and what criteria have been used?	Scientific, logistic.
What parameters are measured to follow up if the prioritization has worked as planned (scientific, social, political, logistic or other)?	Quality of habitat, area of managed habitats.
Expected outcome	45,000 ha properly managed habitats by 2020.
"Evaluation"	
Does the same model include other conservation measures than restoration?	Yes (protection also)
Can it be applied to other areas (geographic, habitat, political)?	No, the plan compiled just for semi-natural grasslands.
What is good about the model, and what are the weaknesses?	Good overview to plan for nature conservation measures and management.
Publications/references/link to more data:	http://www.keskkonnaamet.ee/keskkonnakaitse/looduskaitse-3/pool-looduslikud-kooslused-2/ Under headline "Poollooduslike koosluste hoolduskava" are management guidelines for semi-natural grasslands in English.

The action plan for semi-natural grasslands (2014–2020) has been approved by the Minister of the Environment. The basis of the action plan is the nature conservation action plan, which is in force until 2020. The action

plan for semi-natural grasslands has been drawn up to enable planning for protection measures.

The action plan provides an overview of the existing situation, risk factors, objectives until 2020 and measures to achieve them:

- The existing situation describes the situation in protected areas – how many of the semi-natural areas are being maintained and how many are being restored. It also describes financial resources and gives a brief overview of habitat inventory and national monitoring. The maintenance and restoration of semi-natural grasslands is divided among several agencies, so the plan also describes the different groups and their areas of responsibility.
- The plan also describes the main threats to semi-natural areas, which are the risk of becoming bushland, inadequate maintenance techniques and quality, cultivation, fragmentation, building and the risk of being drained. Another problem is the patchy data underlying the information.
- Issues that are relevant to reach the goals set in the action plan are described – the need to improve the quality of maintenance, the need to raised awareness of the importance of semi-natural grasslands, the risk of development and the need to organize databases.
- Measures to reach the goals are also described. For example, the plan prioritizes grasslands in need of restoration. The plan also identifies supporting infrastructure that needs to be restored or constructed, provides advice on how to improve the quality of maintenance, and addresses issues related to large scale areas and sustainable management.
- The plan describes a timetable and a budget, including funding sources for restoration, maintenance and investments.
- It also includes an evaluation of successes.

The Environmental Board, in cooperation with specialists and scientists, has created guidelines for semi-natural grassland management. These are an important source of information about semi-natural grassland habitat types, and their conservation values, management and the restoration process. <http://www.keskkonnaamet.ee/keskkonnakaitse/looduskaitse-3/pool-looduslikud-kooslused-2/>

Brief overview of Estonian semi-natural grasslands: http://www.keskkonnaamet.ee/public/PLK/poollooduslikud_kooslused_ENG.pdf

Case 4: Prioritization analysis for mire protected area network expansion

Table 5: Prioritization analysis for mire protected area network expansion

Name (of examples) and country	Mire conservation prioritization in Finland
Background information	
Overall topic (habitat type/species/management issue)	Conservation prioritization analysis for mires in Finland
National/Regional?	National + regional
Who took the initiative (local actors or from central agency/organization)?	Analysis was commissioned by Ministry of Environment.
Timeframe	2013–2014
Priority model	
Focus (rare species/habitats, particular restoration problem, local improvement etc.)	Conservation and restoration of habitats and threatened species
Overall goal of priority (one or several)	Mire biodiversity conservation
Source of data (nationally available data/special inventories/other information)?	Large scale field survey, remote sensing data, and national data-bases
What model of priority and what criteria have been used?	Overall biodiversity with weighing according to RED list statuses Complementarity, connectivity, restoration needs, and cost-effectiveness are considered (biodiversity per area)
What parameters are measured to follow up if the prioritization has worked as planned (scientific, social, political, logistic or other)?	Complementarity and overall performance of the prioritization analysis are evaluated by monitoring representation of 91 different biodiversity features in the solution.
Expected outcome	Set of areas that when protected and restored (if needed) make highest value addition to the existing protected area network
“Evaluation”	
Does the same model include other conservation measures than restoration?	YES; allocation of areas to protection
Can it be applied to other areas (geographic, habitat, political)?	YES
What is good about the model, and what are the weaknesses?	Highly comprehensive analysis with good result evaluation options. But the model is data hungry and relatively demanding process (the more data the better).
Publications/references/link to more data:	http://www.metsa.fi/web/en/zonation

A Zonation prioritization analysis was commissioned by the Finnish Ministry of Environment for a roughly 100,000 ha expansion of the mire protected area network in Finland, as a part of the supplementary mire conservation programme. The purpose of the analysis was to offer an additional tool for the expert working group preparing a systematic scoring of candidate mire sites for the expansion. The analysis was constructed to consider and balance regional and national scale persistence of multiple biodiversity features, along with complementarity, connectivity, cost-efficiency and restoration considerations. The analysis method that was used, Zonation, is freely available prioritization software, which enables prioritization over the whole landscape, balancing the persistence of a large number of biodiversity features simultaneously against the costs of the solution. The data in the project consisted of over 90 biodiversity feature layers (species, habitats, etc.) compiled through extensive fieldwork, use of remote sensing methods, and national databases. The overall analysis area (candidate sites and already protected areas) was close to one million hectares. The planning units were defined by expert work to form hydrological functional units, including areas that require restoration for the condition of the planning unit to retain or potentially increase its value. Including the restoration cost as evaluated (or the required area) in a planning unit's overall costs makes it possible to balance the total costs of protection and restoration against the biodiversity value of a set of planning units considered for protection. Higher costs and larger degraded areas to be restored need to be weighed against higher biodiversity values for a planning unit to be included in the set selected for expansion of the protected area network. A significant part of the implementation of any prioritization analysis is its integration with expert knowledge. One goal of the focal analysis process was to demonstrate how the results of a spatial prioritization analysis can be coupled with regional targets and expert knowledge. This was done by identifying thresholds in complementarity development (i.e. how gaps in a protected area network are filled) when mire areas are iteratively added to the set of areas to be protected as suggested by the analysis. Inspecting the threshold allowed us define the most effective proportion of the additional protection according to the prioritization and the proportion that can be chosen by other priorities (e.g. local value) without compromising the complementary effect of the whole solution. The methods presented here offer a way towards effective evaluation and implementation of prioritization results and also towards more holistic conservation decision making.

Figure 12: Field survey, remote sensing data and national databases together make up the basis for the expansion of the Finnish mire protected area network

References

Zonation prioritization analysis for supplementary mire conservation program in Finland. <http://www.metsa.fi/web/en/zonation>

Case 5: Forest burning is concentrated in fire continuum areas in Finland

Table 6: Forest burning is concentrated in fire continuum areas in Finland

Name (of examples) and country	Controlled burning, Finland
Background information	
Overall topic (habitat type/species/management issue)	Forest burnings are concentrated to fire continuum areas in Finland
National/Regional?	National + regional
Who took the initiative (local actors or from central agency/organization)?	Analysis was commissioned by Ministry of Environment.
Timeframe	2010–2050
Priority model	
Focus (rare species/habitats, particular restoration problem, local improvement etc.)	Restoration of forest habitats and threatened species
Overall goal of priority (one or several)	Forest biodiversity conservation
Source of data (nationally available data/special inventories/other information)?	Expert opinion, GIS data
What model of priority and what criteria have been used?	Every fire continuum area must support the fire continuum network functionality. Also protected areas that are suitable for burning must exist in the area.
What parameters are measured to follow up if the prioritization has worked as planned (scientific, social, political, logistic or other)?	Burnt forests and their connection to fire continuum areas are reported every year
Expected outcome	Functional network for fire-dependent and fire-favouring species in Finland
“Evaluation”	
Does the same model include other conservation measures than restoration?	NO
Can it be applied to other areas (geographic, habitat, political)?	YES
What is good about the model, and what are the weaknesses?	Concentration to fire continuum areas is cost-effective. However, burnings in other than fire-continuum areas are rare
Publications/references/link to more data:	Map of the fire continuum areas in Finland. See Similä & Junninen (2011) (in Finnish with English abstract), page 32. https://julkaisut.metsa.fi/assets/pdf/lp/Bsarja/b157.pdf

Early successional habitats generated by forest fires are, by definition, patchy and transient, and as an adaptation to this characteristic, many organisms dependant on fire habitats have developed an excellent ability to emigrate and colonize new sites over long distances. However, there needs to be a sufficient number of new suitable patches to colonize in order to maintain a viable population size, because each habitat patch remains habitable for a limited period. Maintenance of this type of metapopulation dynamics requires continuous regeneration and successful colonization of new habitat patches. Forest management methods involving the use of fire are currently the most important tool for regenerating these habitat patches.

Finland has established a nationwide network of 50 fire continuum areas in order to maintain sufficient coverage of burned forest by continually implementing controlled burning according to a regional plan. The fire continuum plan is a regional (1–3,000 km²) long-term (20–50 years) plan with the objective of secure the continuity of fire habitats both in time and space. Continuous establishment of these ephemeral habitats is necessary for the long-term survival of several endangered fire-dependent species. Forest fires create habitats that are critical for numerous specialized species.

Fire continuums are maintained mainly by controlled burns in Natura 2000 sites and other conservation areas, and to a lesser degree, by prescribed burns in state-owned commercially managed forests. In some cases, the area of forests suitable for controlled burns in a single Natura 2000 site is too low to maintain a long-term fire continuum, thus a fire continuum area consists of a network of several Natura 2000 sites within a ca. 20 km distance. The optimum period between consecutive fires inside a fire continuum area is 3–5 years. Fires at this interval are able to maintain populations of both fire-dependent and fire-favouring endangered species in the area.

References

Map of the fire continuum areas in Finland. See Similä & Junninen (2011) (in Finnish with English abstract), page 32. <https://julkaisut.metsa.fi/assets/pdf/lp/Bsarja/b157.pdf>

Figure 13: Map of the fire-continuum areas in Finland

Case 6: Framework for the prioritization of restoration measures within ecosystem types and allocation of resources across ecosystem types

Table 7: Framework for the prioritization of restoration measures within ecosystem types and allocation of resources across ecosystem types

Name (of examples) and country	Framework for assessing and reversing ecosystem degradation, Finland
Background information	
Overall topic (habitat type/species/management issue)	Scientifically derived methods for prioritization of restoration measures within ecosystem types and allocating resources across ecosystem types
National/Regional?	Applicable to any scale
Who took the initiative (local actors or from central agency/organization)?	Work was initiated by the Finnish Ministry of Environment in order to fulfil international commitments (CBD Aichi targets and EU BD strategy targets)
Timeframe (planning, application, duration, stage, periods)	10.2.2014–31.5.2015
Priority model	
Focus (rare species/habitats, particular restoration problem, local improvement etc.)	Prioritizing restoration measures within ecosystem types and allocating resources among ecosystem types.
Overall goal of priority (one or several)	i) to detect cost effective restoration measures within each of the ecosystem types, ii) to prioritize ecosystem types for allocating restoration resources and iii) to estimate the cost of any targeted amount of reduction in degree of degradation (e.g. 15%)
Source of data (nationally available data/special inventories/other information)?	Expert opinion and national databases (e.g. National Forest Inventory and red data book)
What model of priority and what criteria have been used?	Effectiveness of each restoration measure in reducing degradation, per hectare cost of each restoration measure, ecosystem service effect of each restoration measure, practical applicability of each restoration measure
What parameters are measured to follow up if the prioritization has worked as planned (scientific, social, political, logistic or other)?	Based on the work Finnish Ministry of Environment is about to prepare a plan of action to be presented to the parliament of Finland.
Expected outcome	Priority sets of restoration measures within ecosystem types, priority of ecosystem types to be restored and costs of meeting alternative restoration targets
“Evaluation”	
Does the same model include other conservation measures than restoration?	YES; method allows quantification of offsets needed for any development project where No Net Loss or some other target is desired
Can it be applied to other areas (geographic, habitat, political)?	YES
What is good about the model and what are the weaknesses?	It is quantitative and transparent. Priorities can be recalculated if data or expert opinion is found to be incorrect. Scale independent. Tedious to collect all the necessary information. Not yet spatial
Publications/references/link to more data:	https://helda.helsinki.fi/bitstream/handle/10138/156982/SY_8_2015.pdf and Kotiaho <i>et al.</i> 2016a

In this project we developed a procedure that answers the questions: how can we achieve and document the achievement of any target (e.g. 15%) for the restoration of degraded ecosystems in a way that is scientifically valid, and what is the cost of reaching the target? First, we established that from an ecological perspective, ecosystem degradation or improvement has a minimum of two components: the extent of area that has been degraded or restored and the magnitude of the degradation or improvement at any given location (1–3). Second, we derived a pragmatic decision support and assessment tool that allowed the prioritization of cost-efficient restoration measures within ecosystem types and across ecosystems. In Fig. 1, we illustrate the four phases and ten steps involved in the prioritization. Finally, our results pinpoint that prioritization across ecosystem types is very effective in reducing the cost of restoration. If the target for the whole of Finland is set to 15%, the cost of restoration with prioritized restoration measures but without prioritizing across ecosystem types (i.e. all ecosystem types would be restored by 15%) would be EUR 38 billion, while after careful prioritization among ecosystem types (i.e. some ecosystem types are restored more and some less than 15%) the cost is reduced to EUR 16 billion (4–5).

Figure 14: The four phases (coloured columns) and 10 steps in the prioritization of restoration. Steps 1–5 quantify the degree of degradation in the current ecosystem condition, 6–8 the reduction in ecosystem degradation due to restoration, 9 is prioritization of restoration measures and 10 prioritization among ecosystem types. Mathematical formalization for steps 5 and 10 are detailed (3)

References

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Case 7: Restoration of birch woodland, Iceland

Table 8: Restoration of birch woodland, Iceland

Name (of examples) and country	Restoration of birch woodland, Iceland
Background information	
Overall topic (habitat type/species/management issue)	To restore birch woodland (<i>Betula pubescens</i>)
National/Regional?	National and regional
Who took the initiative (local actors or from central agency/organization)?	Ministry for the environment and natural resources
Timeframe (planning, application, duration, stage, periods)	Initiated in 2012. This is seen as a long-term task. The priority setting is still in a planning phase, and due to a lack of financial support from the ministry it has not yet been applied
<i>Priority model <make sure that it is obviously clear what has been the priority, where and when></i>	
Focus (rare species/habitats, particular restoration problem, local improvement etc.)	The birch woodland ecosystem
Overall goal of priority (one or several)	Conservation and restoration of the birch woodland ecosystem, the only native forest type in Iceland
Source of data (nationally available data/special inventories/other information)?	National databases, expert knowledge
What model of priority and what criteria have been used?	Conservation, restoration needs, and cost-effectiveness were considered. Data on birch woodland distribution, and population dynamics were used
What parameters are measured to follow up if the prioritization has worked as planned (scientific, social, political, logistic or other)?	No method developed
Expected outcome	Increasing distribution of birch woodland
"Evaluation"	
Does the same model include other conservation measures than restoration?	Management and restoration
Can it be applied to other areas (geographic, habitat, political)?	No
What is good about the model, and what are the weaknesses?	NA. The model is unclear and the follow-up is weak
Publications/references/link to more data:	http://www.umhverfisraduneyti.is/frettir/nr/2046

Restoration of birch woodlands has been carried out since early in the 20th century. Early attempts focused mostly on excluding sheep grazing from birch remnants (Eysteinnsson 2011), followed by subsequent projects in which planting and amelioration of conditions were included to enhance recruitment and ecosystem development (e.g. Aradóttir 2007, Óskarsson 2011, Óskarsson *et al.* 2011). Based on a status report on the conditions of the birch woodland ecosystem in Iceland and what was needed to conserve and restore it (Skarphedinsdóttir *et al.* 2007), the Minister for the Environment and Natural Resources initiated efforts in 2011 to increase the distribution of birch woodlands. The proposal for the work (http://www.umhverfisraduneyti.is/media/PDF_skrar/birkiskogaskýrsla-feb-2012-PDF.pdf) provided general prioritization of the approaches to be used. The main steps recommended were:

- An increase in financial support for the Hekluskógar restoration project, to allow the project to expand.
- The two relevant governmental agencies, the Icelandic Forest Service and the Soil Conservation Service of Iceland, should initiate efforts to explore possibilities and assumptions for new projects similar to the Hekluskógar project with the aim of enhancing ecosystem resilience near active volcanoes.
- The Ministry should establish a working group with stakeholders to identify efficient ways for improved grazing management and to increase animal owners' responsibility.

Following this proposal, the largest birch woodland restoration project in Iceland, Hekluskógar, was prioritized and financial support was increased in 2013. However, since that time, funding has dropped. Thus, the current effort in birch restoration is mostly related to the Hekluskógar project and due to cuts in its budget, it has not been able to grow as planned. This project emphasizes the importance of financial support being secured concurrently with any decisions on new policies and priority setting.

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Case 8: Mire restoration, Norway

Table 9: Mire restoration, Norway

Name (of examples) and country	Mire restoration, Norway
Background information	
Overall topic (habitat type/species/management issue)	Mire restoration
National/Regional?	National (regional – East- and Central Norway)
Who took the initiative (local actors or from central agency/organization)?	Ministry of Climate and Environment
Timeframe	2014–2020*
Priority model	
Focus (rare species/habitats, particular restoration problem, local improvement etc.)	Climate mitigation and ecological status
Overall goal of priority (one or several)	Mitigating climate changes and enhancing ecological status in a cost-effective way
Source of data (nationally available data/special inventories/other information)?	Expert inventory and input from County governors and municipalities
What model of priority and what criteria have been used?	Criteria set by MCE, the project shall mitigate effects of climate change, improve ecological status, and be cost effective. These are further supported by criteria from NEA (protected mires with threatened habitats, candidates for being a “Chosen Type of Nature” (a special management status in Norway), and special biodiversity.
What parameters are measured to follow up if the prioritization has worked as planned (scientific, social, political, logistic or other)?	Vegetation, hydrology, carbon emission, flood control, extensive and intensive.
Expected outcome	Increased water level and consequently improved ecological status. and carbon storage
“Evaluation”	
Does the same model include other conservation measures than restoration?	No
Can it be applied to other areas (geographic, habitat, political)?	Other type of mires
What is good about the model, and what are the weaknesses?	By using protected areas as target, we did not have to use a lot of time deal with landowners and stakeholders. A weakness is the limited time frame.
Publications/references/link to more data:	None (yet). http://www.miljodirektoratet.no/no/Nyheter/Nyheter/2015/Mars-2015/Pilotprosjekt-for-restaurering-av-myrrer/

Note: * The description above is linked to the pilot project for 2015, but the project has now been extended.

The pilot project for mire restoration for 2015 identified 18 potential areas for restoration. One of these was a fen, and the others were raised bogs. Out of these 18, seven mires will be restored in 2015, and three more will be restored in 2016.

As this project only lasted one year, it had a very tight schedule, from the start of project planning to undertaking restoration measures in the field.

The Norwegian Environment Agency (NEA) was responsible for selecting areas and doing the planning for restoration measures for each site. The County Governor or the local municipality was responsible for field activity. In some cases, landowners also took part in the fieldwork.

Restoration goals will be set to monitor the effects of restoration. In addition, a monitoring programme will be established in three of the sites. A pre-measure survey was done in 2015. Restoration measurements are planned for 2016. Follow-up monitoring will be done when the restoration measures have been finalized.

Due to the tight time schedule, NEA decided to focus on protected areas (it is not obligated to do this in protected areas), as these areas have a management regime that is very suited to such measures. In addition, these areas will also be protected in the future, meaning that both monitoring programmes and restoration measures will be easy to follow up.

Case 9: National Plan for restoring wetlands, Norway

Table 10: National Plan for restoring wetlands, Norway

Name (of examples) and country	National Plan for restoring wetlands, Norway
Background information	
Overall topic (habitat type/species/management issue)	Wetlands (Definition follows the Ramsar definition of wetlands)
National/Regional?	National (regional priorities)
Who took the initiative (local actors or from central agency/organization)?	Ministry of Climate and Environment
Timeframe	2012 (preliminary national plan). Actions from 2014 –
Priority model	
Focus (rare species/habitats, particular restoration problem, local improvement etc.)	Ecological value, red-listed species and habitats
Overall goal of priority (one or several)	Increase the ecological status of wetland areas in Norway
Source of data (nationally available data/special inventories/other information)?	Different sources, nationally, regionally, reports etc.
What model of priority and what criteria have been used?	A potential for a great increased ecological status, Ramsar sites, known localities for red listed species and/or habitats, localities that were highly prioritized by the County governor. Case by case approach.
What parameters are measured to follow up if the prioritization has worked as planned (scientific, social, political, logistic or other)?	Each projects needs to develop restoration goals.
Expected outcome	Better ecological status
“Evaluation”	
Does the same model include other conservation measures than restoration?	Recreation
Can it be applied to other areas (geographic, habitat, political)?	Yes
What is good about the model, and what are the weaknesses?	N/A
What are the weaknesses?	N/A
Publications/references/link to more data:	https://www.fylkesmannen.no/Page-Files/652844/Prosjektbeskrivelse%20versjon%202.pdf https://www.fylkesmannen.no/Vest-Agder/Miljo-og-klima/Verneomrader/Statsrad-Tine-Sundtoft-apnet-Slevdalsvannet-naturreservat-med-friluftstiltak/

In 2015, the Norwegian Environment Agency produced a four-year plan on behalf of the Ministry of Climate and Environment for the restoration of wetlands in Norway.

Wetlands in Norway are under constant pressure. Lowland wetlands in particular face great pressure from activities related to industry, infrastructure development, and urbanization. The Nature Index for Norway shows that lowland productive areas are at high risk of development for infrastructure and the like. The index also shows that the ecological status of such areas in Norway is decreasing more or less all over the country.

The restoration plan was developed in close cooperation with the County Governors. Other relevant agencies in Norway were also included.

Four criteria were used for the selection of localities:

- Potential for better ecological status.
- Ramsar site.
- Localities with red-listed species and/or red-listed nature types.
- Localities prioritized by the County Governor.

Fifteen localities were initially selected as potential restoration sites. After more thorough examination and after discussions among sector authorities, NGO, municipalities and landowners, 5 localities were excluded. The remaining 10 localities are expected to respond well to ecological restoration. These localities will improve ecosystem services (such as mitigation of flooding), improve conditions for conserving biodiversity and contribute to human well-being.

Case 10: Nature protection in Norway

Table 11: Nature protection in Norway

Name (of examples) and country	Representative areas for nature protection, Norway
Background information	
Overall topic (habitat type/species/management issue)	Nature protection
National/Regional?	National
Who took the initiative (local actors, central agency/organization)?	Governmental
Timeframe	Ongoing
Priority model	
Focus (rare species/habitats, particular restoration problem, local improvement etc.)	Habitats, species
Overall goal of priority (one or several)	Representative protection of habitats
Source of data (nationally available data/special inventories/other information)?	National data
What model of priority and what criteria have been used?	Different between different kinds of habitats.
What parameters are measured to follow up if the prioritization has worked as planned (scientific, social, political, logistic or other)?	Scientific
Expected outcome	A representative selection of protected areas
"Evaluation"	
Does the same model include other conservation measures than restoration?	-
Can it be applied to other areas (geographic, habitat, political)?	Yes
What is good about the model, and what are the weaknesses?	-

Norway has a goal to protect a representative selection of the natural environment. In addition to representative protection, protected areas are also important for biodiversity conservation.

Norway has a more than 100-year-long history of protecting its natural environment, but most protected areas have only been established over the last 30–40 years. Today, approximate 17% of the country's land area is protected as nature reserves, national parks and the like.

Two assessment reports that examine protected areas have been written to evaluate how well the representative selection of natural environments has worked, and for forest in particular.

- In 2002, an assessment of gap analyses for forest protection was undertaken (Fremstad *et al.* 2002).
- In 2010, an assessment of natural variation and qualities of Norwegian conservation sites was published (Fremstad *et al.* 2010).

These two assessments provide the foundation for ongoing work in nature protection in Norway today.

There remain a number of gaps in areas of nature protection in Norway, and there is in particular a need for more forest protection in nearly every county in Norway. However, the largest gaps (lack of protection) are found in the southern part of Norway (productive forests in the lowland) and along the coastal areas.

Aichi target 17 states that “By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan”. It is expected that this plan will consider and provide recommendations for further work for nature protection in Norway.

References

- Framstad *et al.* 2002. <http://www.nina.no/archive/nina/PppBasePdf/fagrappport/054.pdf>
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Case 11: Actions programs for threatened species, Sweden

Table 12: Actions programs for threatened species, Sweden

Name (of examples) and country	Species Action Programs, Sweden
Background information	
Overall topic (habitat type/species/management issue)	Conservation of threatened species
National/Regional?	National
Who took the initiative (local actors or from central agency/organization)?	Central Agency (SEPA)
Timeframe	The work with SAPs has been ongoing since 2004. Most programs have a duration of about 5 years.
Priority model	
Focus (rare species/habitats, particular restoration problem, local improvement etc.)	Threatened species/habitats in a national perspective.
Overall goal of priority (one or several)	Improved conservation status of species
Source of data (nationally available data/special inventories/other information)?	Nationally available data and special inventories
What model of priority and what criteria have been used?	See Focus above. Among the SAPs, priorities have also been made in relation to conservation status etc. Within each SAP, priorities are made between different actions.
What parameters are measured to follow up if the prioritization has worked as planned (scientific, social, political, logistic or other)?	No method developed
Expected outcome	-
"Evaluation"	
Does the same model include other conservation measures than restoration?	Yes, restoration is however an important part in many programs
Can it be applied to other areas (geographic, habitat, political)?	The approach with SAPs can be used in other countries and different species and habitats
What is good about the model, and what are the weaknesses?	Broad scope of threatened species covered. The work has highlighted attention on the needs of particular species to improve their status, and has contributed to a substantial increase in knowledge. The division of tasks between regional and central level has been effective when for reaching local implementation and understanding. The budget doesn't match the action needs, and has made the programs more like visions than as concrete guidelines for actions. Priorities can differ between regions and may lead to a less effective work from a national perspective. The large number of active programs may lead to resources being "scattered out", and thus leads to few concrete results for each species.
Publications/references/link to more data:	http://www.naturvardsverket.se/Miljoarbete-i-samhallet/Miljoarbete-i-Sverige/Uppdelat-efter-omrade/Naturvard/Art-bevarande/Atgardsprogram-for-hotade-arter/

Actions programs for threatened species, Sweden

Since 2004, the Swedish Environmental Protection Agency has produced species action programmes for threatened species. The programmes are intended to function as a complementary conservation tool, alongside a broader effort with site protection and the management of semi-natural grassland financed via CAP. That function was a starting point for the drafting of the original list of species and habitats that needed special programmes.

Around 200 programmes have been initiated and together, they cover more than 400 species and 7 specific habitats. More than 150 programmes have finalized, and they typically run for 3–5 years (after that they are reviewed, and revised or cancelled, depending on the outcome). They describe the ecological requirements for the concerned species, and suggest conservation actions that are needed to reach short-term (programme period) or long-term goals.

The costs for the suggested actions are estimated, but there is no specific budget set aside for each programme –financing is handled through a joint budget for all programmes, where money is allocated to regional authorities (County Administrative Boards, CABs) through a model based on the number of programmes that they are affected by. The CABs can then decide which programmes they will prioritize. Since 2010, the total budget for the programme work has been much below estimated needs, which has accentuated the need for setting priorities between programmes and actions within each programme. Some national guidance has been provided on this issue, but much of the priority setting is still done on the local level even though the programmes have a national scope.

References

<http://www.naturvardsverket.se/Miljoarbete-i-samhallet/Miljoarbete-i-Sverige/Uppdelat-efter-omrade/Naturvard/Artbevarande/Atgardsprogram-for-hotade-arter/>

Case 12: WWF work with restoration of semi-natural grasslands, Sweden

Table 13: WWF work with restoration of semi-natural grasslands, Sweden

Name (of examples) and country	Restoration of semi-cultural grassland, Sweden
Background information	
Overall topic (habitat type/species/management issue)	Conservation of semi-natural grasslands
National/Regional?	Specific priorities have been made on regional level, although there has been a national prioritization of regions
Who took the initiative (local actors or from central agency/organization)?	The concrete conservation work has been based on local initiatives to a large extent
Timeframe	Has been on-going for more than 20 years
Priority model	
Focus (rare species/habitats, particular restoration problem, local improvement etc.)	Restoration of semi-natural grasslands in valuable regions
Overall goal of priority (one or several)	Increased amount and improved quality of semi-natural grasslands
Source of data (nationally available data/special inventories/other information)?	Not specified, but probably national data about valuable grassland, complemented by local knowledge and site inventories
What model of priority and what criteria have been used?	Pragmatic, based on stakeholder interest and the existence of habitats suitable for restoration
What parameters are measured to follow up if the prioritization has worked as planned (scientific, social, political, logistic or other)?	No method developed
Expected outcome	-
"Evaluation"	
Does the same model include other conservation measures than restoration?	No
Can it be applied to other areas (geographic, habitat, political)?	Yes, but the model is very much built up step by step by involved stakeholders
What is good about the model, and what are the weaknesses?	It has led to substantial results, with good participation from local stakeholders. However, this is not really a priority model, rather for reaching results in relation to a general problem. The exact location of the restoration measures has been of less concern than the presence of interested stakeholders. There has however always been a focus on restoration of semi-natural grasslands with high potential for biological biodiversity of management-dependent species.
Publications/references/link to more data:	-

The project has focused on restoration of semi-natural grasslands to prevent their continuing decline. The work was started 25 years ago, with the successful approach of establishing contacts with interested actors as well as local and regional organizations with similar ideas. This has allowed the development of sound models for cooperation. The role of WWF has largely been in the overarching planning, economic support and national coordination. Local and regional efforts have been carried out by different partners, in close contact with landowners and livestock producers.

The work has been concentrated in regions where the cultural landscape still has high biodiversity values. The baseline for this project is that it needs to be an infrastructure of semi-natural grasslands in the landscape, and interested landowners and livestock owners are important for these type of actions.

This complex effort has developed step-wise, and led to very substantial results – more than 30,000 ha of restored grasslands. It has also had important side effects, such as better a financial situation and increased cooperation between farmers, and improved access for the general public to restored areas. The sites are spread out over several regions in Sweden with high values associated with semi-natural grasslands. In several cases, the restoration efforts have been important for species groups such as butterflies or wetland birds.

In spite of this successful work, the total amount of managed semi-natural grasslands in Sweden has decreased by around 70,000 ha between 2004 and 2014, which shows that further measures are necessary.

Figure 15: Close cooperation with local stakeholders have been essential for the successive restoration of semi-natural landscape in this Swedish project

References

WWF. 2015. Naturbetesprojekt under 25 år – Världsnaturfonden WWF

Case 13: Prioritized Action Framework (PAF) for Natura 2000, Sweden

Table 14: Prioritized Action Framework (PAF) for Natura 2000, Sweden

Name (of examples) and country	Prioritized Action Framework (PAF) for Natura 2000, Sweden
Background information	
Overall topic (habitat type/species/management issue)	Financing of conservation measures in Natura 2000 areas
National/Regional?	National
Who took the initiative (local actors or from central agency/organization)?	Central Agency (SEPA)
Timeframe	The first PAF was developed in 2012, an update is desirable in 2016
Priority model	
Focus (rare species/habitats, particular restoration problem, local improvement etc.)	The PAF should describe and prioritize conservation measures in Natura 2000 areas, in order to identify financial needs.
Overall goal of priority (one or several)	Improved conservation status of habitats species in Natura 2000 network
Source of data (nationally available data/special inventories/other information)?	Article 17 report, information from work with national environmental objectives, expert opinions. Mostly nationally available data. Data for specific Natura 2000 sites was not available.
What model of priority and what criteria have been used?	The Swedish priorities were based on conclusions from the art 17 report, and other national knowledge of typical conservation needs for different habitats and species. Habitats and species with a bad conservation status were given priority.
What parameters are measured to follow up if the prioritization has worked as planned (scientific, social, political, logistic or other)?	No method developed
Expected outcome	-
“Evaluation”	
Does the same model include other conservation measures than restoration?	Yes
Can it be applied to other areas (geographic, habitat, political)?	Yes. All EU member states should develop PAFs
What is good about the model, and what are the weaknesses?	Broad scope, covers large part of protected areas in SE, but it does not have clear link to practical implementation
Publications/references/link to more data:	http://www.naturvardsverket.se/upload/stod-i-miljoarbetet/vagledning/natura-2000/paf-se-mar-2013.pdf

The requirement to develop PAFs comes from article 8 in the EU Habitats Directive. PAFs should describe the most important conservation measures in the Natura 2000 sites, and how they can be financed. In 2012, the European Commission developed a draft structure for PAFs, and encouraged the member states to develop draft PAFs by 2013, so they could serve as background documents when national implementation programmes for the EU fund for 2014–2020 were developed.

In Sweden, the PAF priorities were based on conclusions on conservation status of species and habitats (reported according to article 17 of the directive), as well as conservation needs identified in the work with the evaluation of the Swedish national Environmental Objectives. Expert opinions were also collected. In the PAF, the following overarching principles were identified:

- *Maintain* biodiversity values where they exist (prevent damage or deterioration, protection if necessary, recurring management of semi-natural habitats).
- *Restore* habitats.
- Reduction or avoidance of negative activities.
- Improvement of connectivity.
- Investments.

Regarding restoration, the following specific needs were highlighted:

- Prescribed burns in fire-dependent woodland/forest habitats.
- Hydrological restoration of wetlands (class 1).
- Restoration and re-introduction of management in semi-natural grasslands, wooded pastures and wetlands dependent on traditional management.
- Hydrological restoration of wet forest habitats.
- Restoration of degraded dunes and sand habitats.
- Restoration of watercourses, including restoration of hydrological regimes.
- Restoration of marine reefs and sandbanks.
- Improvement measures for certain species (listed in the PAF).

Specific priorities for conservation measures were also identified for different landscape types (marine, coastal, lakes and rivers, semi-natural grasslands, wetlands, forests, etc.). The Swedish PAF has not been implemented in any structured way, although the priorities have been used in some contexts, such as in setting priorities for LIFE projects.

References

<http://www.naturvardsverket.se/upload/stod-i-miljoarbetet/vagledning/natura-2000/paf-se-mar-2013.pdf>

Case 14: National trade-off between biodiversity and hydropower, Sweden

Table 15: National trade-off between biodiversity and hydropower, Sweden

Name (of examples) and country	National trade-off between biodiversity and hydropower, Sweden
Background information	
Overall topic (habitat type/species/management issue)	Obligations within the Water Framework Directive, Habitats Directive and the Renewable Energy Directive can be in conflict.
National/Regional?	National and regional. Sweden has some 2,000 hydropower plants in 84 out of 119 catchments. All 84 were included in the analysis.
Who took the initiative (local actors, central agency/organization)?	Central agencies; Swedish Agency for Marine and Water Management and the Swedish Energy Agency
Timeframe	The national project was started and completed in 2013. It will continue at a regional level and more detailed scale until at least 2017.
Priority model	
Focus (rare species/habitats, particular restoration problem, local improvement etc.)	Focus is on how to reach the national environmental quality goals in areas where they come in conflict. These national goals include the EU directives.
Overall goal of priority (one or several)	A national strategy showing where environmental and energy measures should be located. A trade-off between catchments on whether environmental values or energy values have precedence.
Source of data (nationally available data/special inventories/other information)?	Analyses were made in a GIS-environment. Some data were already available in national scale and some were aggregated from regional sources.
What model of priority and what criteria have been used?	Decide which value should have precedence and how, using a multi-criteria analysis.
What parameters are measured to follow up if the prioritization has worked as planned (scientific, social, political, logistic or other)?	A maximum of 2.3% (1.5 TWh) of the annual production can be used for environmental measures. All measures rendering a loss of production will be noted in a database.
Expected outcome	A national strategy showing where environmental and energy measures should be located. 6 groups of catchments were identified on a scale from importance for energy production to important for environment.
“Evaluation”	
Does the same model include other conservation measures than restoration?	The model only deals with measures that have a negative influence on the energy value such as fish-passages and ecologic flows. Other measures like habitat restoration can still be used in catchments with a high energy value.
Can it be applied to other areas (geographic, habitat, political)?	Yes, it has been used in a similar way when making trade-offs between water values and agricultural values. Collaboration between the Swedish Board of Agriculture and Swedish Agency for Marine and Water management.
What is good about the model, and what are the weaknesses?	The analysis shows that the environmental objectives can be reached at a national level but not in every catchment. The actual trade-off can be made in different ways giving slightly different outcomes. Before measures are carried out there is a need for a more thorough analysis in each catchment. Especially in areas with important values in both energy and environment. Many measures will be decided within the legal system so they have to make rulings based on this strategy if it should give the intended effect.

The Water Framework Directive (WFD), the Habitats Directive and the Renewable Energy Directive may be in conflict. Hydropower is an important renewable energy source in Sweden and Europe but has a negative effect on the ecological status and biodiversity in water-dependent ecosystems. Sweden has some 2,000 hydropower plants in 84 out of 119 catchments. This has led to a deterioration of habitats that are in need of restoration according to the WFD and the Habitats Directive. Since it is possible to take socioeconomic needs into consideration within the WFD, the two central agencies responsible for the water environment and energy started a joint project to clarify how these issues could be resolved. The objective was to formulate a national strategy showing where measures for biodiversity and energy should be located. In all 84 catchments with hydropower, the energy value and the biodiversity value were calculated in a GIS environment based on indicators. Indicators for energy values were regulatory ability, installed capacity, and production. Thirty-eight indicators were used to show the biodiversity value and included factors such as threatened species (N2000 and red listed), protected areas (N2000 and nature reserves), key habitats and previous restoration measures. Data were identified in existing national databases and by aggregating data from regional sources.

The energy values and biodiversity values were grouped into six groups of catchments using K-means cluster analysis (ranging from catchments with a high biodiversity value and low energy value and vice versa and areas where the two values coincide). A target was calculated that allows for 1.5 TWh (2.3%) of the energy production to be used for biodiversity measures in hydropower (e.g. ecological flows and fauna passages). Measures beyond this target are considered as having a significant adverse effect on the national energy and regulatory capacity of renewable energy production from hydropower. The analysis shows that the different environmental objectives all can be reached at a national level but not in every catchment. A more detailed analysis in each of the catchments is underway.

Figure 16: The value of each catchment for a) biodiversity, b) energy and c) groups based on combined values. The resulting groups have separate strategies, but groups 1 and 2 have high energy values and high biodiversity values, while groups 5 and 6 have low energy values and high biodiversity values. In a) and b) only catchments with hydropower are visible

References

<https://www.havochvatten.se/hav/samordning--fakta/samverkansomraden/energi/nationell-strategi-for-vattenkraft-och-vattenmiljo.html> (in Swedish)

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Restoration priorities and strategies

Restoration is a tool to achieve several of the strategic targets of The Convention on Biological Diversity from 2010. Currently, there is no standard for how to set priorities for restoration. The aim of this project was to exchange knowledge between the Nordic countries and Estonia regarding experiences of restoration and priority setting with a landscape perspective. Using case examples, the project explores and discusses approaches for setting priorities, and suggests possible ways of improved approaches for prioritization. This includes how to improve Green Infrastructure and measures for protection of species and habitats in fragmented landscapes. The case examples use different approaches, and provide ideas, reflections and take-home messages to enhance future prioritization. This report shows that there is a need for greater emphasis on the prioritization aspects of restoration.

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