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Perspective

Challenges of ecological restoration: Lessons from forests in northern Europe

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ABSTRACT

The alarming rate of ecosystem degradation has raised the need for ecological restoration throughout different biomes and continents. North European forests may appear as one of the least vulnerable ecosystems from a global perspective, since forest cover is not rapidly decreasing and many ecosystem services remain at high level. However, extensive areas of northern forests are heavily exploited and have lost a major part of their biodiversity value. There is a strong requirement to restore these areas towards a more natural condition in order to meet the targets of the Convention on Biological Diversity. Several northern countries are now taking up this challenge by restoring forest biodiversity with increasing intensity. The ecology and biodiversity of boreal forests are relatively well understood making them a good model for restoration activities in many other forest ecosystems. Here we introduce northern forests as an ecosystem, discuss the historical and recent human impact and provide a brief status report on the ecological restoration projects and research already conducted there. Based on this discussion, we argue that before any restoration actions commence, the ecology of the target ecosystem should be established with the need for restoration carefully assessed and the outcome properly monitored. Finally, we identify the most important challenges that need to be solved in order to carry out efficient restoration with powerful and long-term positive impacts on biodiversity: coping with unpredictability, maintaining connectivity in time and space, assessment of functionality, management of conflicting interests and social restrictions and ensuring adequate funding.

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1. Introduction

Twenty years ago in Rio, the global battle against biodiversity loss made its way to the premier global political agenda. The battle has continued ever since, and the COP 10 Convention on Biological Diversity in Nagoya, Japan (CBD, 2010) resulted in a strategic plan including 20 significant new targets for conservation of biodiversity and maintenance of ecosystem services. The Convention recognizes that severe ecosystem degradation has occurred throughout all biomes (Foley et al., 2005), and in its Strategic Plan, it is stated that we need "*continuing direct action to safeguard and, where necessary, restore biodiversity and ecosystem services*" (CBD, 2010). The European Union has adopted the COP 10 Strategic plan and the Aichi targets into the EU 2020 Biodiversity strategy (Council of the European Union, 2010; European Commission, 2010). Restoration of natural habitats is emphasized as one of the main tools, and the declared target is "*halting the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and restoring them in so far as feasible, while stepping up the EU contribution to averting global biodiversity loss*".

The Society for Ecological Restoration International (SER) has defined ecological restoration as: "*the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed*" (SER, 2004). Central to this definition is "*assisting the recovery*", which implies two things: (i) the aim of ecological restoration is to return the system to some previous state and (ii) active management is the appropriate means for achieving this return. Accordingly, we use the term "*ecological restoration*" here, to refer to actions aimed at assisting the recovery of ecosystems, rather than broadening the definition to include practically any target, such as a novel ecosystem (Hobbs et al., 2009; Jackson and Hobbs, 2009). Although not necessarily aiming to restore a pristine ideal (Higgs, 1997; Clewell and Aronson, 2006), restoration should be seen as a key element in achieving conservation and natural resource management goals (Hobbs et al., 2011).

Given the dynamic state of the world, the question of what and how to restore is further challenged by uncertainties about future climate and environmental change. This complicates the choice of optimal conservation actions (Moilanen et al., 2009; Polasky et al., 2011; Strange et al., 2011) and influences intervention risk (Matthews and Turner, 2009). Thus, the ultimate long term goal of restoration should be to maintain biodiversity together with the resilience and adaptive capacity of ecosystems to environmental change. The aim should therefore be to secure the natural complexity of the whole landscape in a way that helps the ecosystems to resist degradation in the future (Jackson and Hobbs, 2009). It is clear that single restoration measures often have more local and short-term objectives, such as restoration of some lost structures in a stand. Nevertheless, these actions should be taken acknowledging the long-term landscape level targets.

Restoration ecology is a relatively young science. A search for the topics "forest AND (restoration ecology)" and "restoration ecology" in the Thomson Reuters (formerly ISI) Web of Science shows that the use of these terms has doubled since 2000, but has somewhat stabilized recently. The countries publishing most actively on forest restoration ecology include United States of America, Australia, and Brazil, while the North European countries are relatively rarely represented in the literature. This may partly be due to the different usage of terminology. In some parts of the world, forest restoration is currently equated with the traditional discipline of silviculture, with the aim of re-establishing trees required for timber, fuel, or to increase carbon stocks (Burton and Macdonald, 2011; Suding, 2011). In northern Europe, forest restoration is understood in a broader ecological context, as the aim is to reintroduce natural forest structures, species and processes that are currently scarce or completely lacking, due to human influence.

This paper is based on discussions started in a workshop organized by PRIFOR, Nordic working group on the history of primeval boreal forests. The workshop focused on the ecological effects of restoration of North European forests. Even though the experience of the researchers at the workshop was mainly from boreal and hemiboreal regions, we believe that the conclusions are general rather than specific to North European Forests, and the paper will be relevant for researchers working on different forest ecosystems. In this paper, we discuss the objectives, theory, practice and problems related to ecological restoration of forests. We focus on the North European restoration tradition, which predominantly focuses on promoting biodiversity values as an essential part of the ecosystem services that forests provide. We find the restoration of North European forests to be highly illustrative in this con-