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Restoring wilder landscapes for people and biodiversity

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Rewilding is a restoration approach with the goal focused on restoring and protecting natural processes and the capacity of ecosystems to respond to global change. This is essential to ensure that ecosystems continue to provide benefits to societies and can adapt under a changing climate.

Why is there a need for restoration?

Humanity has shaped nature for millennia, for example by harvesting plants and animals, converting forests to farmland, constructing cities and roads, or channeling rivers. These actions provide societies with important resources, such as food or timber, protect us from natural hazards, such as floods, and provide infrastructure that connect cities and settlements, such as roads or channeled rivers. However, all this has come at a cost: species have disappeared or do poorly and many ecosystems have been degraded and are unable to supply important services such as flood regulation, erosion control and pest regulation. There is growing concern that such tamed and human-dominated landscapes are more vulnerable to climate change and other impacts of global change.

Restoring landscapes that benefit biodiversity and provide ecosystem services to society has become a central goal worldwide and the United Nations have declared the 2020s as the *UN Decade on Restoration*. However, ecosystem degradation has often happened so slowly or so long ago that people are unaware of what actually has been lost. Because of this so-called *shifting baseline syndrome*, few people today ask questions such as “*How did landscapes look before large-scale human influence?*”, “*Which species have lived in these landscapes?*” or “*How did ecological processes shape wild landscapes during*

these times?” For these reasons, it is easy to underestimate the potential for biodiversity in our current and future landscapes – and we risk getting trapped in degraded landscape states. Rewilding seeks to put today’s ecosystems in the context of the natural processes that have shaped them during their wilder past – not to recreate that past, but to restore key natural processes to ensure more resilient, more biodiverse future ecosystems.

What is meant by rewilding?

Rewilding aims to restore the functionality of ecosystems so that they can sustain themselves with as little as possible human interventions. The ecosystems that evolve in such a way are typically complex, heterogeneous, and rich in biodiversity. In contrast to other restoration approaches, rewilding does not seek to restore a particular state of an ecosystem, such as a particular type a forest. Likewise, rewilding is not about re-creating the past, for instance to restore ecosystems as they were before people settled in an area. Rather, rewilding looks back to see what has been lost in terms of key elements and processes of an ecosystem – and brings them back to the extent possible. In the case of a forest, this could entail moving from only one to many tree species, from even-aged stands to trees of different ages, or to more widely accept natural disturbances, such as fire. In contrast to what many believe, rewilding does not necessarily entail

a purely hands-off approach, but can involve targeted interventions, particularly at the beginning of a restoration project, to speed up the restoration of ecological integrity. For example, it can be beneficial to harvest an even-aged monoculture to afterwards allow for a more diverse, heterogeneous forest to develop.

Rewilding typically seeks to restore the ecological integrity of a landscape along one or more of three main dimensions:

- **Connectivity and dispersal:** Many ecosystems have been fragmented and are today 'islands', for example wetlands in agricultural landscapes or old-growth forest remnants in monoculture production forests. Likewise, human infrastructure, such as highways or fences, form barriers for many species. Restoring connectivity means to re-connect ecosystems, habitats and ecological processes, for instance through green infrastructure projects or wildlife overpasses over highways.
- **Trophic complexity:** Rewilding focuses on restoring interactions between wild species; interactions that disappeared when species went locally extinct. Certain species are disproportionately important because they provide key functions in ecosystems and these species are often those that have been lost. Large grazers may for example affect vegetation biomass and help recy-

cle nutrients or spread seeds, beavers reshape their environment by building dams and beaver ponds, and large predators strongly influence entire food webs. Bringing back species that provide such key functions, or adding ecological replacements for species that have gone extinct, increases the trophic complexity of an ecosystem and helps to restore its functionality.

- **Dynamics and disturbance:** Ecosystems are not static but are typically undergoing change, sometimes gradually and sometimes abruptly in response to disturbances. Such disturbances, including windthrows, floods, fire and parasite outbreaks, are important elements in ecosystems as they redistribute biomass and nutrients and increase heterogeneity, and thereby provide habitat for many species. Yet, people typically have suppressed natural disturbance regimes e.g., by channeling rivers or preventing wildfires. Restoring disturbance regimes, for instance by leaving trees felled by a windthrow in the forest, contributes to higher ecosystem complexity and increased diversity over time. An important aspect here is that in nature, disturbances happen stochastically, meaning that they vary in space and time, sometimes affecting small and sometimes large areas, and sometimes occurring frequently and sometimes rarely. This differs fundamentally from anthropogenic disturbances, e.g., when forests are harvested by clear-cuts.

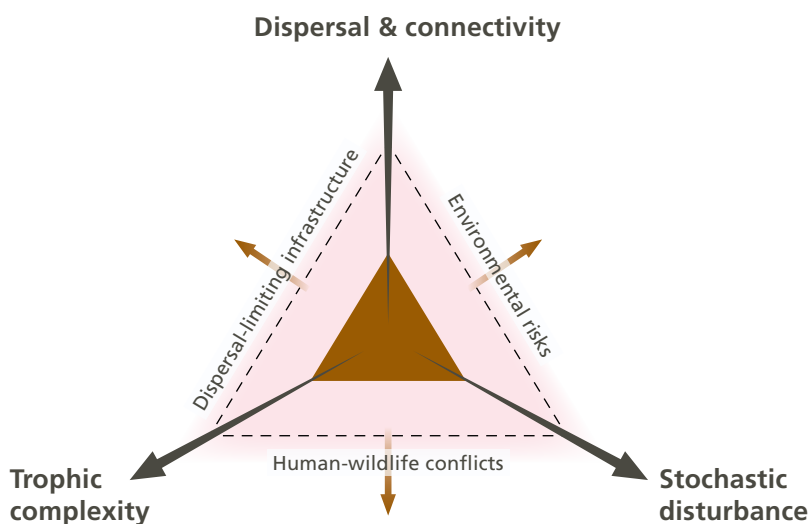


Fig. 1. The three dimensions of ecological processes that rewilding aims to restore. The bronze coloured pyramid shows where we are today, the pink the maximum that can be restored. The dashed line marks what is desirable and feasible. Adapted from Perino et al. 2019. *Rewilding complex ecosystems.* Science

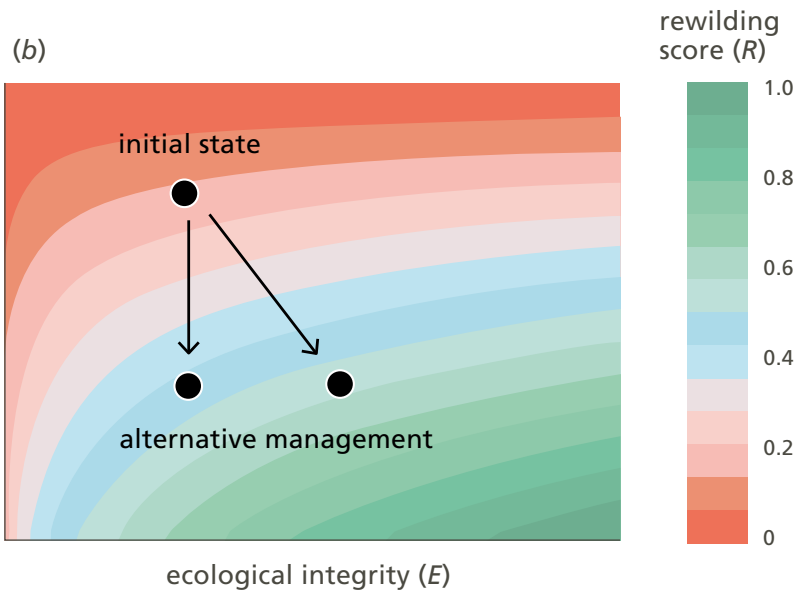


Fig. 2. Rewilding progresses when human pressure decreases (for example by reducing inputs to an ecosystem) or when ecological integrity increases. Typically, both of these processes occur simultaneously. *Adapted from Torres et al. 2018. Measuring rewilding progress. Phil. Trans. B 373:20170433.*

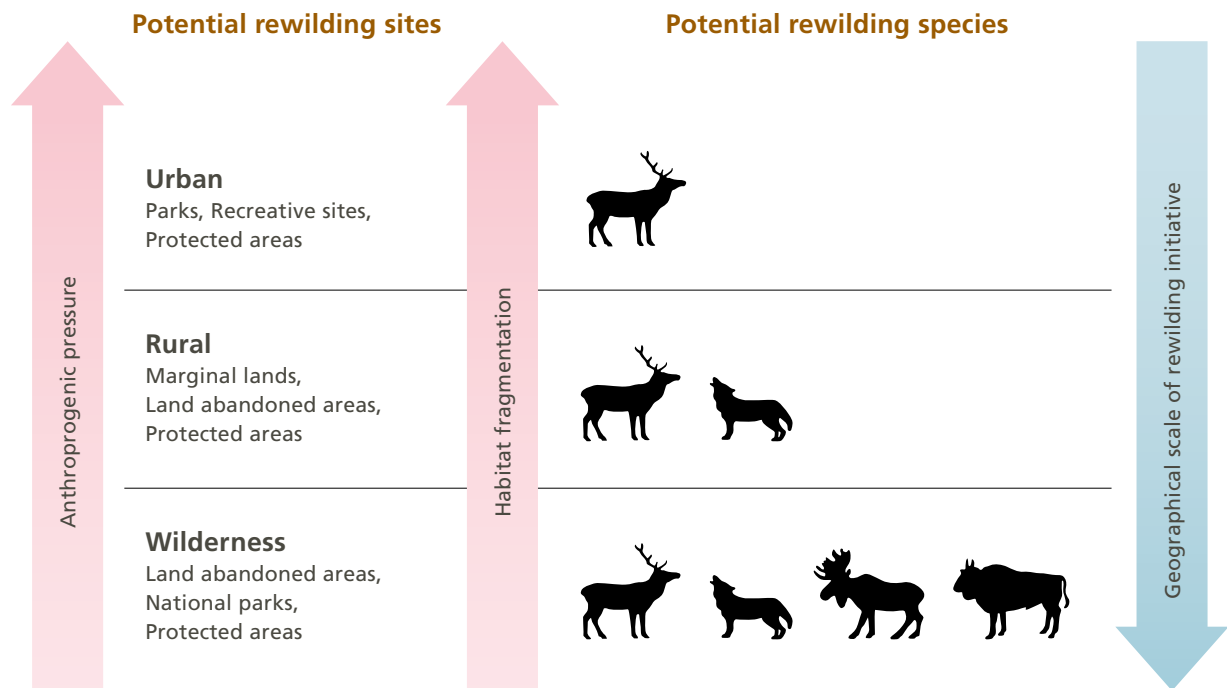


Fig. 3. Rewilding can be implemented in a range of landscapes differently affected by people, and at different spatial scales. The figure illustrates implications both have for one dimension of rewilding: the restoration of trophic complexity. *Adapted from Pedersen et al. 2020. Trophic Rewilding Advancement in Anthropogenically Impacted Landscapes (TRAIL): A framework to link conventional conservation management and rewilding. Ambio 49:321-244.*

Above all, rewilding calls for a shift in perspective: there is no one ideal ecosystem that can be or should be created. Instead, it is important to examine the species and processes found in an ecosystem and restore those elements that have been disrupted or lost to the extent possible, while reducing human intervention over time. In a floodplain landscape, for example, this could be achieved by removing dams that are no longer needed, thereby allowing floodplain forests to submerge. This could create habitats for animals and plants that were lost historically, reduce flooding risk, and retain water in landscapes that are increasingly affected by droughts. Another key feature of rewilding is its open-endedness: where the restored ecosystem is heading is unclear and entirely new ecosystems can arise. However, these ecosystems have a higher ecological integrity and are more diverse, and thus likely more resilient to the challenges of global change.

Rewilding with and for people, not against them

Although rewilding seeks to reduce the overall human control over ecosystems, it does not seek to exclude people from natural landscapes. Rewilding projects must always consider the local geographical and societal conditions and involve local communities. This requires compromises between what is theoretically possible and what is actually feasible and acceptable in a given landscape. In some regions, socioeconomic trends might create larger opportunities for rewilding than in others. Where agriculture is abandoned and people migrate from the countryside to cities, bringing back large mammals such as European bison or wild horses is less controversial than in densely populated and intensively farmed landscapes. Importantly though, rewilding measures can be taken from small to large scales. Even in densely populated landscapes measures such as to remove channeling of a creek, adopting more biodiversity-friendly forestry or implementing green infrastructure projects will make important contributions to restoring degraded or lost functionality and biodiversity. Implementing rewilding projects should therefore be an iterative process, involving assessing the ecological status of an area, identifying management options to restore lost functionality in light of social-ecological constraints, and continuously evaluating progress made as well as changes in so-

cial-ecological constraints and opportunities over time. As healthy ecosystems are dynamic, so must be our management approaches.

Importantly, rewilding should benefit both nature and people. Rewilding does not exclude human use of natural resources, and may even bring new opportunities for sustainable resource use. Restoring an ecosystem also means that, in many cases, it will be aesthetically more attractive, stimulate tourism, and help to reconnect people and nature. More broadly, as key ecosystem functions are restored, society at large can benefit through ecosystem services such as increased flood protection where rivers can flow more freely or increased carbon storage in forests that are allowed to grow old.

Opportunities for rewilding in Sweden

Rewilding is already ongoing in Sweden – Although the concept of rewilding is still young, Sweden provides interesting rewilding examples from long before the concept itself was formulated. One example is the establishment of the Swedish Association of Hunting and Management in the mid-19th century that has helped to prevent the loss of large ungulates from Sweden (i.e., moose, red deer, roe deer), and restored them from small to currently very large populations throughout the country. Similarly, the Swedish Society for Nature Conservation, formed in the early 20th century, has played an important role in safeguarding the dwindling populations of large carnivores. Successful reintroduction programmes have brought back the Eurasian beaver, red deer, Eurasian otter, eagle owl, peregrine falcon and white stork. Likewise, initiatives to strengthen so-called green infrastructure, with all regional county boards developing concrete plans, can be regarded as a large-scale rewilding initiative recreating connectivity. Finally, in some conservation projects, such as the restoration of dry sandy grasslands, the objectives have moved from preservation to active disturbance.

Despite these examples, and although a few Swedish rewilding initiatives have recently started (e.g., Rewilding Lapland and Rewilding Lankälven), the rewilding concept itself has so far not been integrated in restoration and conservation planning in Sweden. Given the growing interest in protecting biodiversity and promoting

ecosystem services provided by natural areas, rewilding principles can be a powerful inspiration for forward-looking restoration.

Integrated rewilding in ongoing conservation and restoration efforts – Implementing rewilding principles more widely would provide major public benefits such as recreational value, water regulation, climate change mitigation or even increased hunting opportunities. However, these principles may also entail costs to individual landowners, making it important to be transparent about both costs and benefits of rewilding and that society needs to be prepared to share costs that provide public benefits. A key step in this direction is to better adapt the rewilding narrative to the Swedish context. Sweden’s culture is strongly connected to the land and to using it sustainably (e.g., via the famous *allemanrätt*). Currently, however, many in Sweden oppose the idea of rewilding because they associate it with an exclusion of people from landscapes, with hands-off protection, and nature that flourishes without people using its resources. Rewilding, as we described above, is far from that, and instead promotes the idea of human-inclusive nature, and ties in with many already ongoing conservation and restoration initiatives in Sweden. We exemplify this along the three main dimensions of rewilding as outlined above.

Connectivity – Increasing connectivity is a central goal of policies and programmes aimed at green infrastructure in Sweden. Rewilding thinking could help to consider what level of connectivity is needed, where connectivity restoration should take place, and what measures should be chosen. For example, old-growth forests continue to decline in Sweden and often occur as islands in a matrix of production forest. Managing for connectivity between old-growth forest remnants via targeted restoration measures would benefit biodiversity linked to old-growth forests, make these species more resilient in the face of climate change, and provide opportunities for increasing the biodiversity of managed forests in which old-growth forest networks are embedded. The recent national forest evaluation (*Skogsutredningen*) is particularly interesting in this regard, as it proposes the full protection of a 1,000 km long forest belt along the Scandinavian mountain range. Much of these forests are currently managed as

production forests. Rewilding perspectives could play a key role in supporting discussions on the benefits and costs of such a forest corridor.

Trophic complexity – Compared to other regions in Europe, Sweden hosts a relatively complete species assemblage. Major restoration successes have been achieved recently (see above) and rewilding could inspire further progress to bringing back lost species and their functions, thereby helping to protect threatened biodiversity in Sweden. For example, the density of Swedish forests has increased due to management for productivity, while forest grazing has declined. Both these processes have negative consequences for biodiversity, particularly for many of Sweden’s red-listed “farmland species” that require open habitats that were historically maintained by wild large herbivores. Bringing back currently missing wild grazers, such as European bison, and establishing natural grazing regimes, including forest grazing, could play an important role in preventing forest densification and woody encroachment of abandoned agricultural land across Sweden. Conversely, after historical population crashes, large ungulates in Sweden today occur at high densities in many parts of the country, leading to concerns about their impact on production forests. More generally, there are many species that, if restored, could potentially provide currently missing ecological functions, such as wild reindeer in central Sweden, black storks, or the European pond turtle.

Natural disturbance regimes – Recent disturbances in the Swedish forests, including storms, forest fires during hot summers and the recent bark beetle explosion, have exemplified the vulnerability of monoculture production forests. From a biodiversity perspective, such disturbances can be positive and entail opportunities, especially since many boreal and nemoral species in Sweden are adapted to or depend on fire for their long-term survival. Allowing such disturbances to happen, minimizing salvage logging of disturbed sites, and allowing forests to regenerate spontaneously following disturbances could make major contributions to biodiversity conservation. Moreover, this could be an effective and economically sustainable strategy for mitigating the effects of climate change as small-scale disturbances substantially reduce the risks of large fires. Finally, the more diverse

and structurally complex forests that result from natural disturbance regimes can simultaneously increase tree production and the provisioning of ecosystem services (e.g., soil carbon storage, berry production, and hunting opportunities).

Final remarks: Scaling up rewilding initiatives

Biodiversity loss and climate change are two major challenges for society in the 21st century – and the severe impacts for life on earth of both are only starting to unfold. The conservation and restoration of ecosystems and their species, and the many ecosystem services they provide, has therefore never been more important. At the same time, there is an increasing recognition that we need to seriously scale up conservation and restoration efforts to prevent the loss of these environmental values. Rewilding can make major contributions to help protect nature *and* the climate, while fostering co-benefits for people. We

argue that making use of these opportunities requires us to leave behind narrow definitions of rewilding and to be open to novel and progressive perspectives that rewilding can bring about. Adopting rewilding principles is ultimately more about changing our mindset and adjusting already ongoing initiatives (e.g., green infrastructure development) than about defining and implementing specific rewilding policies and projects. This should entail a process of co-creation between stakeholders and scientists, where rewilding principles are not implemented top-down but instead used as a point of departure to find conservation strategies that protect biodiversity and restores ecological complexity – without compromising local livelihoods. A particularly exciting opportunity to foster such a process could be the creation of Biosphere Regions, which aim to promote the United Nations Sustainable Development Goals in a collaborative process involving relevant stakeholders and sectors.



A forest in the north of Skåne that hasn't been managed for many decades, with trees of different ages and lying and standing dead wood – some of the key features of a biodiverse forest. Photo: Tobias Kuemmerle.

This policy brief is the result of a workshop held in conjunction with the Wallenberg Seminar "*Rewilding as a new paradigm for nature conservation?*" at the Royal Swedish Academy of Agriculture and Forestry KSLA in 2019 as part of Professor Tobias Kuemmerle's Wallenberg guest professorship.

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