

# Preface

During the last century humans have dramatically accelerated alterations and loss of biodiversity worldwide. Changes to our planet's ecosystems by Humans go back tens of thousands of years, but what happened in the last couple hundred years has no precedent in the history of our species. We took habitat change, overexploitation, biotic homogenization, and pollution to a new level. We even started to change the Earth's climate, a feat perhaps never achieved by any other single species. Today, with a human population of already over 7 billion, about 40% of the world's forests and other natural ice-free habitats have been converted to cropland and pasture, we have appropriated 15% of global terrestrial net primary production, and species extinction rates are 100 times greater than the average extinction rate for the Cenozoic fossil record.

But this book is not about this ecological disaster. Instead, this book is about a new conservation strategy that brings hope for restoring some of the lost biodiversity and ecosystem functions. This book is about rewilding. Rewilding is the passive management of ecological succession with the goal of restoring natural ecosystem processes and reducing the human control of landscapes. The opportunity for large-scale rewilding in Europe has been developing over the last few decades through the process of land abandonment, particularly farmland abandonment. Some projections estimate that between 2000 and 2030 as much as 20 million ha may be released from agricultural use in Europe, an area twice the size of Portugal.

Farmland abandonment has been raising much concern in the scientific and policy communities. There are grave social implications, with rural exodus, the aging of rural communities, and the decrease of basic public services for the populations that stay in the abandoned areas. But, there have also been ecological concerns. Many of the abandoned landscapes were associated with low intensity farming systems or semi-natural grasslands that host high biodiversity. The fear has been that, without the maintenance of those systems, much biodiversity and ecosystem services will be lost. Therefore measures such as agro-environmental subsidies and support to least favored areas have been implemented under the Common Agricultural Policy.

Rewilding is an alternative approach to the management of these systems. In rewilding the goal is not to maintain some habitats in a static snapshot of the past. Rewilding embraces change in ecosystems and aims at restoring ecological dynamics

that run their course independent of human intervention, including disturbances such as fire and diseases. Rewilding does not target to conserve species occurrences in a given set of sites, but instead aims at allowing large scale processes involved in population and community dynamics to reestablish themselves. These processes have particularly been hampered for the European megafauna in the last few centuries and therefore rewilding also promotes wildlife comeback. Ultimately, rewilding is better defined by the strategies that aim at allowing natural processes to regain dominance in landscapes rather than by some fixed set of end goals for how the landscape and biodiversity should look like. Rewilding is about having large populations of large herbivores, with space for movements tracking the seasons and interannual variation in resources, but also about having predators that keep these herbivores in check. It is about having healthy necrophagous bird communities living in an unpredictable environment and providing us ecosystem services instead of artificially feeding those communities in vulture restaurants. Rewilding is also a process that is continuously on-going: ecosystems progressively become more natural over time and although effects are already being seen and will be seen in the policy relevant time scale of a few decades, it will continue to evolve during a much longer time frame.

However, we should caution that the rewilding we propose is different from other rewilding approaches, and we shall refer it as ecological rewilding to make the distinction clear. Europe is a densely populated continent that has been deeply modified over the last millennia. By the height of the Roman Empire, much of the European forest had already been cleared, and today Europe is crossed with roads, punctuated by villages, and managed in large regions by foresters and farmers. Ecological conditions today are very different from what they were at the end of the Pleistocene. Europe is now much warmer (and becoming warmer) and wetter. Soils have been highly modified by agriculture, and almost no place is more than a few kilometers away from human settlements. In such a context, something akin to Pleistocene rewilding, where the goal is to go back to some historic baseline, for instance by bringing back the ecological equivalents of the mammoth and the cave lion, can only perhaps be implemented in a zoo fashion: with fences separating people from animals. Instead, in ecological rewilding we recognize that in Europe, as in many other parts of the world, we manage a complex socio-ecological system where humans are an integral component of our landscapes. Historical baselines are useful to inspire our management strategies in ecological rewilding as they help us understand how ecosystems function in the relative absence of human intervention, but they are not the goals of ecological rewilding. Ecological rewilding is about using that historical information and the best available ecological knowledge to design conservation strategies, sometimes involving at the beginning active management. It aims at restoring ecosystems where human control of ecological processes is much reduced, wildlife thrives, and non-extractive ecosystem services such as carbon sequestration and recreation are provided. Ecological rewilding is also not centered in species reintroductions. Reintroductions may be advantageous in many rewilding projects, but they need to be assessed case by case, and they need to be

incorporated in a wider strategy to restore natural disturbance regimes and natural succession.

This book brings together contributions from thirty authors across nine different countries to discuss rewilding of abandoned landscapes in Europe. We bring together scientists and practitioners, as rewilding is at the interface of science and society, and we target as well an audience of thinkers and doers. We do not shy away from controversy or critical views, and some of the chapters present different perspectives from the book editors' on how to manage biodiversity and farmland abandonment. The book has a clear European focus, but the approaches, results and discussion is certainly relevant worldwide, as abandonment is at least a local phenomenon in all parts of the world.

The first part of the book aims at developing the basis of a theory of rewilding. Chapter 1 by Pereira and Navarro lays out the basic ideas for the book, and is a reprint of our original paper on this topic in the journal *Ecosystems*. The chapter questions traditional paradigms of managers and scientists on European landscapes, such as the sustainability of traditional farming practices, the quality of life of rural populations, and the efforts to maintain museum landscapes. The authors argue that farmland abandonment is inexorable and that concerns with negative impacts on biodiversity may be unfounded as the relationship between species diversity and land-use has not been examined at large scales. The authors identify winner and loser species of rewilding and argue that rewilding can drive important changes in community composition. The chapter examines the benefits of rewilding based on an ecosystem service framework, and concludes by identifying some challenges associated with rewilding such as conflicts with wildlife and limits to ecological resilience.

Chapter 2, by Ceașu and colleagues, discusses the concept of wilderness by analyzing how it can be mapped in space. The chapter briefly reviews the historical concepts of wilderness and wilderness metrics, discussing the subjectivity of wilderness perception. The authors map wilderness areas in Europe using four concepts: (1) remoteness from roads and settlements; (2) absence of light pollution; (3) distance to potential natural vegetation; and (4) proportion of primary productivity harvested by humans. They show that wilderness areas are concentrated in high latitudes and in mountainous regions and that they overlap with areas of high megafauna species richness. Surprisingly, they find even higher values of wilderness in areas of Natura 2000 than in the nationally protected areas. Finally, the authors argue that farmland abandonment will occur in areas of intermediate wilderness values, releasing additional areas for wild ecosystems.

Chapter 3, by Cerqueira and colleagues, examines the consequences of rewilding for ecosystem services. Using a spatial map of the distribution of the different types of ecosystem services in Europe, the authors investigate the spatial distribution of indicators of ecosystem services in Europe before analyzing the spatial overlap between wilderness and areas delivering provisioning, regulating and cultural services. They then proceed to a quantitative analysis of the average supply of services between areas of wilderness, areas under agricultural use, and areas projected to be abandoned. Their analysis suggests that wilderness areas provide important

recreation services, carbon sequestration, nitrogen retention. Furthermore, the agricultural productivity of areas to be abandoned is much lower than of areas that are currently used for agriculture, suggesting that the impact of abandonment in food production in Europe is limited. The chapter concludes with an analysis of the economic benefits of the cultural services associated with rewilding.

The second part of the book discusses the consequences of rewilding for biodiversity. Chapter 4, by Boitani and Linell, reviews the wildlife comeback in Europe and suggests a new conservation strategy for large carnivores. After the near extinction of wolves, bears, and Eurasian lynxes, in the first half of the twentieth century, these species have experienced a continent wide recovery. The chapter examines the causes for this recovery, which are a complex interaction between changes in public opinion towards wildlife, species protection including by better hunting management, reintroductions, and habitat recovery after abandonment. Next, the authors examine how to move from conservation strategies targeted at averting extinction to strategies targeted at sustaining recovery, and question how far that recovery should go. They present a critical view of rewilding, and instead argue for a strategy aiming at orientated coexistence between wildlife and humans by avoiding human-wildlife conflicts.

Chapter 5, by Cortés-Avizanda and colleagues, discusses the conservation of avian scavengers in the context of farmland abandonment and rewilding. Vultures originally depended on the availability of wild ungulate carcasses. With the progressive domestication of Europe, vultures switched to livestock as their main food source. However, in the last few decades, poisoning and the decrease in availability of livestock carcasses due to sanitary regulations, lead to a dramatic decline of these species. In response, a conservation strategy was developed based on supplementary feeding at “vulture restaurants”. This was largely successful for the targeted species, but changed the spatial-temporal nature of food resources, shifting the balance in scavenger communities towards those target species. The authors examine alternatives to vulture restaurants opened by rewilding, such as the increase in wild ungulate populations, and consider complementary approaches, such as the promotion of extensive agro-grazing practices. The chapter concludes with a review of the ecosystem services provided by vultures.

Chapter 6, by Merckx, looks at two taxonomic groups that are not often discussed in the context of rewilding: moths and butterflies. As other aspects of biodiversity, butterflies and moths have been in decline in Europe, and although agricultural intensification is behind decreases in both groups, farmland abandonment has also been involved in butterfly declines. The nocturnal and endothermic behavior of moths and their association to forest habitats are a possible explanation for this difference. Merckx then presents a study of macro-moth diversity in a landscape undergoing abandonment in the Peneda mountain range. He finds that across a range of spatial scales, forest-dominated landscapes have higher species diversity than shrub-dominated or meadow dominated landscapes. Furthermore, the diversity of closed-biotope species increases faster with spatial scale than the diversity of open-biotope species, suggesting some of the positive effects of rewilding can only be identified at larger scales.

Chapter 7, by Benayas and Bullock, discusses the challenges of restoring forests on agricultural land where tree recruitment is limited either by soil degradation or limited seed dispersal, and frame that discussion in the “land sharing” versus “land sparing” debate. They advocate a proactive approach closer to land sharing based on the strategic revegetation of farmed fields. The idea is to plant woodland islets and hedgerows in a tiny fraction (<1 %) of the target area. This will have an immediate positive impact on biodiversity, by creating a more heterogeneous landscape and providing habitat for forest dependent species. In case the landscape becomes abandoned, dispersal of seeds by wind and animals from the woodland islets and hedgerows will allow for a faster revegetation. They conclude by examining options for forest restoration in a land separation (i.e. lands sparing) context, comparing passive rewilding with forest plantations.

Chapter 8, by Navarro and colleagues, examines the role of disturbance in rewilding. Many species are associated with open habitats created by disturbances. The chapter discusses two important disturbances in pre-Neolithic landscapes: fire and herbivores. Next, it examines the relationship between a disturbance regime and biodiversity. Intermediate levels of disturbance are often associated with higher species diversity, as both early colonizers and more late-successional species can co-occur. Therefore it is important to maintain, at large scales, a heterogeneous landscape where disturbances have a stochastic distribution. The chapter concludes with a discussion of how to reestablish natural regimes of these disturbances. The authors briefly examine which situations are more amenable for natural recolonization of ungulates and in which situations active reintroduction should be preferred. Prescribed burning is discussed as a technique to help reintroducing more natural fire dynamics in ecosystems.

The third and final part of the book examines examples of how rewilding can be put in practice. Chapter 9, by Wouter and colleagues, presents the Rewilding Europe initiative, which aims at restoring wilderness on 1million ha of abandoned farmland. The Rewilding Europe initiative is built around three pillars: the conservation actions targeted at rewilding, communicating rewilding to the public, and developing local enterprises. The chapter presents the 5 locations across Europe where the Rewilding Europe Foundation teamed up with local NGOs to implement the rewilding of an area. It discusses the challenges faced in each location and the different local contexts and goals for rewilding.

Ultimately, for rewilding to be successful it must also help the local economies. Chapter 10, by Jobse and colleagues, further elaborates on on-going efforts to support the development of enterprises associated with rewilding, through an education program. The chapter presents an Erasmus Intensive Program, which is training a new generation of wilderness entrepreneurs. The chapter discusses the design of the curriculum, the competences that the program aims to develop, and the learning environment that is promoted. This discussion is based on the experience of the first year of the program, where students visited and developed activities in the Rewilding Europe site of Western Iberia.

The book concludes with a chapter on laying the foundations for a European policy for rewilding. Chapter 11, by Navarro and Pereira, starts by providing a short

historical perspective on nature conservation. It discusses current policies with relevance for nature conservation in the EU, including the Nationally Designated Protected Areas, the Habitats and the Birds Directives, and the second pillar of the Common Agricultural Policy. The authors argue that wilderness protection has received little attention in Europe, although there are encouraging recent developments. The chapter discusses on how to build on those developments to widen the scope of policies targeted towards wilderness protection and rewilding. Finally, the authors argue that rewilding can play a major role in achieving some of the 2020 targets of the Convention on Biological Diversity and the EU Biodiversity Strategy.

We hope that this book inspires more research on rewilding and more practitioners to push the boundaries of conservation strategies. Nature is resilient but we need to learn how to better support that resilience. We conclude with a personal note on that resilience and on its limits. Henrique has been doing fieldwork in Peneda-Gerês National Park in Northern Portugal for over 25 years. Back in the early 1990's this was an area where observing a wild boar or a roe deer was a rare event. A neighbor of Henrique's in Castro Laboreiro shared once that his grandmother, whom lived through most of the twentieth century, had never seen a wild boar. Now, things have changed. Today you can hardly spent more than a few weeks in the region without seeing a wild boar or a roe deer. A combination of farmland abandonment, reduced livestock grazing, and species protection with limited hunting was probably behind this wildlife comeback. Yet, there was a species that would not have come back by itself as it went locally extinct in the beginning of the twentieth century: the Iberian Ibex (*Capra pyrenaica*). The species has been successfully reintroduced in the Spanish side of the Gerês mountain range in the 1990s and in the Spanish side of the Laboreiro mountains in the late 2000s. They now can be seen in both regions in the Peneda-Gerês National Park. And what an amazing sight it is to watch these agile animals climbing the large granite domes!

We wish to dedicate this book to all the managers, scientists and last but not the least, the local communities, which made this wildlife return possible.

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