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Perspective

# Transforming forest management through rewilding: Enhancing biodiversity, resilience, and biosphere sustainability under global change

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## SUMMARY

Forests are crucial for biodiversity, climate stability, and human well-being, yet rising pressures from climate change and conventional forestry practices threaten their resilience and sustainability. Approximately 30% of global forests are managed intensively, often as monoculture plantations, compromising biodiversity conservation, carbon sequestration, and ecosystem stability. Here, we propose integrating rewilding-inspired forestry as a transformative approach to restore ecosystem processes and resilience. By emphasizing trophic complexity, natural disturbances, and species dispersal, rewilding-inspired forestry can enhance biodiversity, increase resilient carbon storage, and improve social-ecological resilience. We provide practical recommendations for implementation, including fostering natural regeneration, reintroducing keystone species, and adopting assisted migration where necessary. We also discuss ecological, economic, sociocultural, and policy challenges and opportunities inherent in this urgently needed systematic transformation. We call for a global commitment to rewilding-inspired forestry as a complementary strategy to protected areas, offering a nature-based solution for stewarding sustainable forest landscapes and biosphere in the Anthropocene.

## INTRODUCTION

Humanity stands at a critical crossroads, faced with the dual planetary crises of biodiversity loss and climate change.[1] As climate change accelerates and species disappear at an accelerating rate, it is necessary to radically rethink the relationship with nature and reshape land management strategies.[2,3] Forests cover approximately 31% of the world's land surface and play an invaluable role in global climate regulation, biodiversity conservation, and sustaining human livelihoods and well-being. Forests comprise around 80% of terrestrial biodiversity (FAO and UNEP[4]). Forests are also, however, threatened by widespread habitat loss and fragmentation from human activities.[5,6] Deforestation and forest degradation account for about 10% of global greenhouse gas emissions.[7] Alarmingly, only one-fourth of global forests remain intact—in other words, naturally regenerated and primary forests without clear signs of human management[8] (Figure 1).

Conventional forestry practices, which we define as the intensive management of planted forests and plantation forests (rotation period of up to 15 years) primarily for wood biomass production from periodic clear-cutting,[9] are often characterized by establishing even-aged stands composed of one or two native or non-native tree species with regular spacing. Globally, 44% of planted forests are dominated by non-native species, with significant regional differences, such as predominantly native species in North and Central America and nearly exclusive reliance on non-native species in South America.[10] This form of management is prevalent in South America and countries such as Sweden, the United States, and China, where large-scale monoculture plantations like Norway spruce, aspen/poplar, and Dahurian larch are commonly grown. However, in countries such as Slovenia, principles of close-to-nature (or continuous cover) forestry guide forest management, promoting biodiversity and ecosystem resilience through mixed-species and uneven-aged stands.[11,12] Similarly, in the Amazon, indigenous and traditional forest management emphasizes sustainable use and conservation, contrasting with the production-driven focus of conventional forestry. The ecological capacity of intensively managed forests to conserve biodiversity and sequester carbon is often very small or even negative,[13–16] especially when plantations are established in naturally open or non-forest ecosystems subject to intensifying climate-related disturbance regimes.[17–19] The outcome is that these plantations have largely failed to slow or reverse biodiversity loss and carbon depletion, sometimes even exacerbating the ongoing biodiversity and climate crises.[20–23]

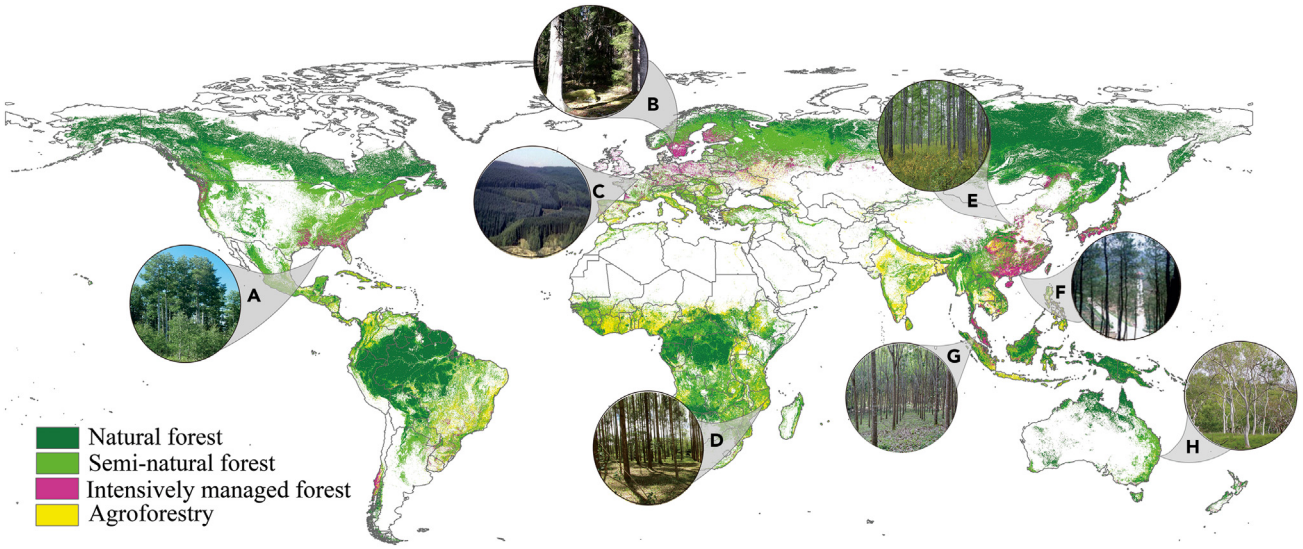


**Figure 1. The global extent of forests under different management regimes in 2015**

This map is based on data produced by Lesiv et al.[9] following forest definition with more than 10% canopy cover of trees higher than 5 m by the Food and Agriculture Organization, which includes natural woodlands and savannas. "Natural forest" indicates forests without notable signs of management activities, including primary forests. "Semi-natural forest" refers to naturally regenerated forests with signs of human management, for example, logging and clear-cutting. "Intensively managed forest" includes planted forests and plantation forests (rotation period of up to 15 years) composed of native or non-native tree species. Examples of plantation forests worldwide are (A) aspen/poplar (*Populus*) in the United States (photograph by Doug Page), (B) Norway spruce (*Picea abies*) in Sweden (photograph by K. Nota), (C) Sitka spruce (*Picea sitchensis*) in Scotland (photograph by James R. Boyle), (D) Eucalypts (*Eucalyptus*) in Africa (photograph by B.G. Kluthe), (E) Dahurian larch (*Larix gmelinii*) in northern China (photograph by Guangsheng Zhou), (F) Masson's pine (*Pinus massoniana*) in southern China (photograph by William M. Ciesla), (G) rubber (*Hevea brasiliensis*) in Thailand (photograph by E. Warren-Thomas), and (H) Eucalypts (*Eucalyptus*) in Australia (photograph by Jeannie Fletcher).

Rewilding, the process of restoring the functioning and resilience (resistance, recovery, and adaptive capacity) of ecosystems so that they can autonomously sustain high ecological complexity and biodiversity, is not intended to create the wilder past but to restore critical natural processes or elements in a changing Anthropocene world.[24] More specifically, the restoration of trophic (food web) complexity, dispersal, natural stochastic disturbances, and their interactions are identified to be critical to maintaining biodiversity and ecosystem resilience.[25,26]

Rewilding is not a new concept in restoring degraded ecosystems,[27,28] yet its global potential remains underutilized, especially concerning intensively managed forests, including planted forests and plantation forests. In contrast to the impression of carbon neutrality from wood harvests, the latest global evaluation suggests that forest harvests could bring 3.5–4.2 Gt $CO_2$e carbon costs per year between 2010 and 2050, approximating estimated land-use change-induced annual emissions from agricultural expansion.[29] With such increasing realization that human well-being and prosperity are intertwined with the integrity of global forest ecosystems, we must restore the ecological potential of these compromised forest landscapes as backbones of biodiversity maintenance and climate regulation.[16,30] In this context, rewilding-inspired forestry emerges as a seemingly radical but urgently needed approach to address these intertwined crises and promote regional to global social-ecological sustainability.[24,31–33]

In this Perspective, we scrutinize the limitations of conventional forestry and plantation forests globally while exploring the transformative potential of rewilding-inspired approaches. We delve into the concept, components and multifaceted sustainability benefits of rewilding-inspired forestry and its emphasis on the restoration, conservation, and sustainable utilization of existing intensively managed production forest landscapes.[34] Furthermore, we present 10 practical strategies for implementing rewilding-inspired forestry. We discuss the associated multidimensional challenges that must be addressed and opportunities to be harnessed for its large-scale adoption. By shedding light on the shortcomings of conventional plantation forests and highlighting the promise of rewilding-inspired forestry, we aim to underscore the significance and urgency of forestry rewilding as a social-ecologically sustainable solution in combating global biodiversity loss and climate change. In doing so, we hope to contribute to the stewardship of more biodiverse, resilient, and sustainable forest landscapes and terrestrial biosphere for both people and nature in a changing Anthropocene world.

## The limitations of conventional forestry and intensively managed forests

### *Reduced biodiversity*

Conventional forestry practices often prioritize monoculture tree plantations or limited species mixes and are almost devoid of shrub or herbaceous undergrowth and large vertebrates (i.e., "empty forests"), resulting in oversimplified ecosystems with reduced biodiversity and ecological interactions compared to natural forests.[13,35–38] Reduced native diversity of trees makes forests more prone to the invasion of non-native species.[39] Furthermore, although these simplified ecosystems appear to have a high level of vegetation cover, they provide limited habitats and food sources for a wide range of plant, animal, and

microbial species, leading to biodiversity loss.[6,40] A particularly concerning aspect of these narrow-minded forestry practices is their implementation in naturally open ecosystems, which support diverse grassy biomes and savannahs worldwide, including open woodlands.[17,41] Recent studies have shed light on the negative ecological and climate implications of introducing plantation forests into these open ecosystems.[42,43] These investigations highlight the risks of undermining the multifunctionality of these ecosystems, which extends well beyond carbon sequestration, and the potential for such practices to disrupt the ecological integrity of grassy biomes renowned for their biodiversity and ecosystem services.[20,21,43,44]

### Habitat loss and fragmentation

Clear-cutting, a common practice in conventional forestry, involves the periodic removal of entire stands of trees and the construction of road infrastructure, leading to fragmented forest landscapes. The contribution of forest roads to fragmentation is complex, involving permanent and temporary roads, logging routes within stands, and the creation of forest edges. Most roads are undocumented "ghost roads," the leading driver of tropical forest loss in the Asia Pacific region.[45] Forest roads also cause significant hydrological disturbances, altering water flow and affecting soil moisture and nutrient dynamics.[46] This fragmentation disrupts the connectivity between habitats, making it challenging for species to find mates, forage, or migrate.[47] Fragmented forests are more vulnerable to invasive species, diseases, and the adverse effects of climate change, further compromising their ecological integrity.[6,48]

### Impaired carbon sequestration and climate benefit

While plantation forests can sequester carbon, their capacity to function as long-term carbon sinks is often inferior to that of natural forests.[7,16,49] For example, despite considerable afforestation (10% increase in forest area) over the past 250 years, managed forests in Europe contribute to climate warming rather than mitigating it because of carbon release (3.1 Pg) from wood extraction and changes in albedo and evapotranspiration from the massive conversion of natural or semi-natural broadleaved forests to monoculture conifer plantations.[49] Monoculture plantations lack structural complexity, being even-aged stands. They have shorter rotation cycles (e.g., logged every 10–60 years) and less resource use efficiency, resulting in reduced carbon storage potential compared to biodiverse forest landscapes, which are characterized by a greater variety of tree species, age classes, and structural complexity, including diverse undergrowths.[16,50] Additionally, carbon emissions resulting from clear-cutting and the conversion of natural forests to plantations can offset the carbon sequestration benefits of tree plantations.[51]

### Disruption of ecological processes

Conventional forestry practices, such as clear-cutting and intensive management, can drastically alter soil structure, nutrient cycling, and hydrological regimes.[52] Some tree species in plantations, like eucalyptus, are notably water-intensive, potentially exacerbating increasing water scarcity in certain regions. Removing ground vegetation cover and disturbance of soil structure can result in severe soil erosion, nutrient leaching, and decreased soil fertility,[53] negatively impacting forest health and the ability of forests to adapt to changing climatic conditions. It often takes years or decades for soil to recover from massive clear-cutting impacts.

Additionally, it is imperative to address the consequences of excluding large herbivores from plantation forests at functional densities, a common practice intended to mitigate tree damage.[36] Whether it concerns wild species or those extensively managed by pastoralists, this exclusion represents a significant deviation from ecological norms.[54–56] Large herbivores play pivotal roles in forest landscapes by facilitating nutrient cycling, dispersing plant seeds, and creating and maintaining open habitats beneficial for other species through physical disturbances.[57–59] They contribute to forest dynamics by browsing on young trees and shrubs, which prevents overgrowth and promotes diverse vegetation mosaics. These mosaics enhance biodiversity by providing various habitats for different species and supporting plant diversity and new growth, which benefits a wide array of wildlife. By maintaining dynamic and diverse habitats, large herbivores enhance the resilience of forest ecosystems to environmental changes.[58] The absence or insufficient presence of these keystone species at their natural densities can lead to ecological imbalances and homogenization of forest landscapes, compounding challenges to forest resilience to climate change.[24,58,60]

### Lack of resilience to climate change

Intensively managed forests are more vulnerable and less resilient to direct and indirect impacts of climate change due to their limited genetic, species, and structural diversity.[61–64] For example, monocultures lack diversity in rooting depth and draw water from just one level in the ground, leading to a greater risk of droughts and floods and disrupting the natural water cycle.[65–67] Their oversimplified structures and functions result in a more vulnerable soil-water-vegetation continuum that is less able to withstand fires, pests, diseases, and extreme weather events.[15,18] In particular, plantation forests comprising highly flammable species such as pine and eucalyptus are more vulnerable to increased fire risks from a warmer and drier climate, suggesting that any carbon stored risks catastrophic release in the future.[18] The possibility of plantation-induced mega-fires from continuous and homogenized fuel loads also threatens the sustainability of surrounding natural ecosystems and human settlements.[68]

### Social-ecological disconnections

Conventional forestry practices often prioritize timber production at the expense of other ecosystem services and utilization of forest landscapes and resources. This narrow focus harms indigenous and local communities relying on natural forests for their livelihoods and cultural traditions.[69,70] For example, contrary to the expectation of increasing employment and income for local populations, expanding large-scale tree plantations in southern Chile has exacerbated poverty and inequality among them.[71] In northern Europe, the Sami culture relies on natural boreal forests, which supply shelter and food for their semi-domesticated reindeer and materials for Sami handicrafts. The ongoing clear-cutting practices have significantly compromised reindeer husbandry by destroying critical habitats for ground and tree-living lichens, the primary food resource for reindeer.[72] By neglecting the broader ecosystem services and livelihoods provided by natural forests, conventional forestry undermines the potential of forests to contribute to global Sustainable Development Goals beyond timber extraction.[73]

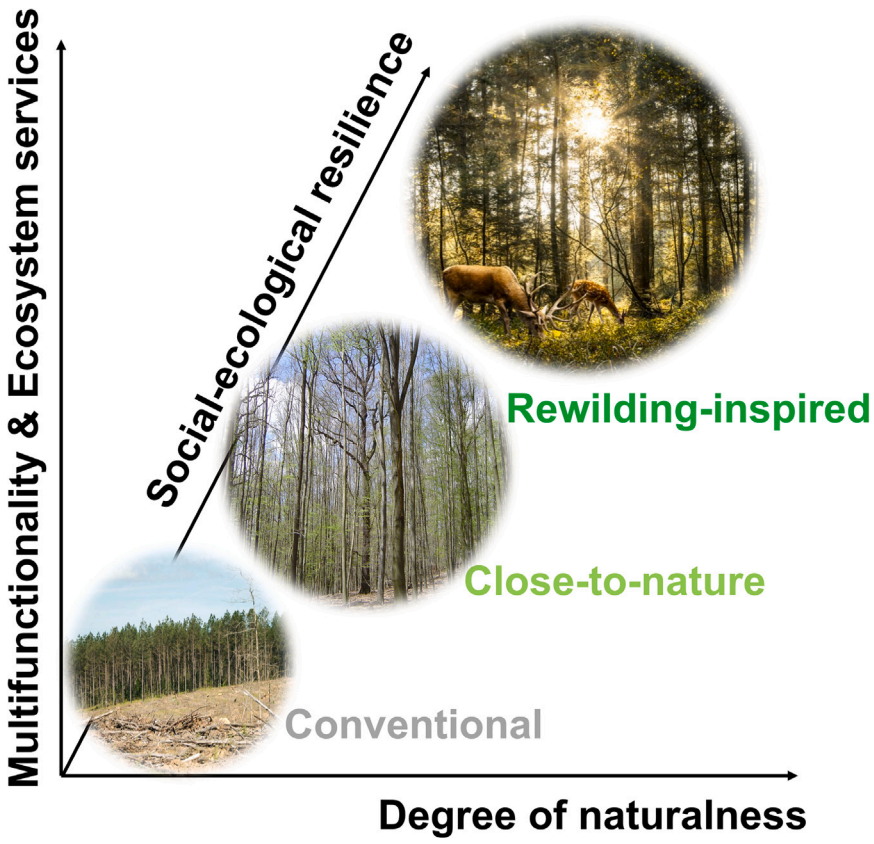


**Figure 2. A conceptual framework for rewilding-inspired forestry as a nature-based solution for biosphere sustainability**

The figure positions rewilding-inspired forestry within a three-dimensional space that distinguishes it from conventional and other green forestry paradigms, such as close-to-nature (or continuous cover) forestry. The framework is defined by three axes: the degree of naturalness, representing the restoration and reliance on natural processes such as trophic interactions, stochastic disturbances, and species dispersal; the multifunctional delivery of ecosystem services, including biodiversity conservation, climate mitigation, and socio-economic benefits; and social-ecological resilience to global change (e.g., climate change, pest invasion). Conventional forestry is placed in the lower left, focusing on intensive management for wood production, with minimal reliance on natural processes and lower resilience. Close-to-nature forestry occupies an intermediate position, reflecting moderate dependence on natural processes, ecosystem service delivery, and resilience. Rewilding-inspired forestry is situated in the upper right, emphasizing very high naturalness through trophic complexity, natural stochastic disturbances, and long-distance dispersal, fostering biodiverse, resilient forest landscapes that adapt to climate change while delivering multifunctional ecosystem services. The framework highlights rewilding-inspired forestry as a nature-based, holistic, forward-looking approach with the largest potential (represented by the size of the circular illustrations) to promote biosphere sustainability under global change. Credit for the image illustrating rewilding-inspired forestry: mixed reality.

## Rewilding-inspired forestry as a nature-based solution for biosphere sustainability

In the context of the United Nations Decade on Ecosystem Restoration, we propose rewilding-inspired forestry as a nature-based sustainable solution to address the limitations of conventional forestry while tackling the dual planetary crises of biodiversity loss and climate change.[1,31–33] This concept does not simply rest on the incremental "greening" of forestry, such as through close-to-nature or retention forestry, but rather expands beyond these frameworks by emphasizing the restoration of trophic complexity, stochastic disturbances, and long-distance dispersal as integral processes driving resilient forest landscapes[25,26] (Figure 2). In synergy with ongoing rewilding initiatives in global rangelands,[28] we envision that such "rewilded" production landscapes worldwide can help address the crucial gap in biosphere sustainability efforts as a land-sharing action complementary to expanding protected areas.[1,74] We highlight that rewilding-inspired forestry should emphasize the integrated restoration, conservation, and sustainable utilization of existing production forest landscapes by maintaining resilience-promoting natural processes as much as possible.[34] By allowing natural processes to restore and self-sustain ecosystems,[25] rewilding-inspired forestry aims to create more biodiverse, multifunctional, and social-ecologically resilient forest landscapes that provide multiple ecosystem services, including carbon sequestration, heterogeneous habitats for a wide range of species,[57] especially those that are threatened or endangered, and sustainable livelihoods.[13,75,76]

Rewilding-inspired forestry can draw valuable lessons from and create synergies with less impact on silvicultural systems to maximize its applicability. Close-to-nature forestry, considered a cornerstone of the European Green Deal (EU Biodiversity and Forest Strategies for 2030),[11,77] shares several principles with rewilding-inspired forestry. This approach emphasizes the emulation of old-growth forest structures, promoting uneven-aged and mixed-species stands through methods such as selection cutting.[78] These practices enhance forest biodiversity and complexity, making forests more resilient to environmental changes and disturbances. Slovenian forests, for instance, are renowned for their biodiversity and multifunctionality, thanks to the application of these principles.[11] Rewilding-inspired forestry builds upon these principles but places a stronger emphasis on restoring trophic interactions (e.g., through the presence of large herbivores or predators), allowing natural stochastic disturbances (e.g., windthrows, wildfires) to shape structural heterogeneity and supporting long-distance dispersal of species to new habitats.[25] Importantly, rewilding-inspired forestry promotes more heterogeneous vegetation mosaics, including open and semi-open areas with higher light availability and richer habitat diversity, whereas close-to-nature forestry tends to favor closed-canopy conditions with more shaded understories, with the former clearly more advantageous for biodiversity overall. As a result, rewilding-inspired forestry aims for a more dynamic

equilibrium that can enhance social-ecological resilience and enable forest landscapes to adapt more readily to climate change while still delivering multiple ecosystem services to society.

Aligning with the trophic complexity-stochastic disturbances-dispersal framework for rewilding complex ecosystems,[25,26] we suggest that rewilding-inspired forestry comprises four complementary, context-dependent components. First, passive natural regeneration and recolonization leverage the inherent capacity of forest landscapes to self-repair, guided by dispersal dynamics and the unpredictable yet enriching role of natural stochastic disturbances.[79] Second, assisted natural regeneration and recolonization catalyze trophic complexity through strategic restorative interventions that enhance natural species dispersal, thus accelerating ecosystem recovery. Third, reintroductions of keystone tree and animal species directly infuse ecosystems with necessary biodiversity, reestablishing trophic complexity and introducing beneficial natural stochastic disturbances. Lastly, assisted migration and colonization is a forward-thinking strategy that not only anticipates future ecological shifts but also promotes adaptability and resilience within and across changing forest landscapes, ensuring the continuity and functionality of trophic networks and dispersal mechanisms under climate change. By integrating these components into a coherent strategy anchored in rewilding principles, rewilding-inspired forestry stands apart as a holistic, forward-looking approach to forestry that simultaneously advances biodiversity conservation, ecosystem resilience, and sustainable resource use.

## Sustainability benefits of rewilding-inspired forestry

The multiple rewilding benefits are spatiotemporally far-reaching and interconnected, extending across ecological, economic, and social dimensions, thus championing the stewardship of broader forest landscapes and regional to global social-ecological sustainability.[80,81]

### *Biodiversity conservation*

Rewilding-inspired forestry is essential for combating biodiversity loss. By promoting heterogeneous vegetation structure, forestry rewilding encourages the recovery of diverse tree, undergrowth, animal, and microbial species, providing connected and expansive habitats for various organisms.[13,82,83] By restoring natural forest processes, such as seed dispersal and natural regeneration, rewilding-inspired forestry facilitates the return and expansion of native species, including those threatened or endangered.[84–86]

### *Climate change mitigation*

Rewilding-inspired forestry plays a crucial role in mitigating climate change by enhancing the capacity of forests to sequester $CO_2$.[76,87–90] Through rewilding, forests can regenerate naturally with diverse plant species, creating structurally complex ecosystems that maximize resource use efficiency and carbon storage potential.[14,16,30] Without periodic clear-cutting and the conversion of natural forests to plantations, carbon losses associated with wood extraction, transportation, soil scarification, and land reclamation are reduced. Furthermore, maintaining a continuous forest cover avoids significant greenhouse gas emissions typically released during the clear-cut phase without vegetation.[51] Consequently, rewilded forests tend to have higher carbon sequestration rates and long-term storage capacity, making them valuable carbon sinks that help offset greenhouse gas emissions.[25,91]

It is essential, however, to acknowledge the ongoing debate and uncertainty surrounding carbon sequestration in different types of forests and management regimes.[92] Some studies suggest that young, fast-growing managed forests may sequester carbon more rapidly than old-growth forests in the short term due to higher growth rates. In contrast, old-growth forests provide long-term carbon storage and contribute to maintaining ecosystem stability and resilience.[30,93] Moreover, the substitution of forest raw materials for fossil-based products in managed forests can also contribute to climate change mitigation, although the balance of these benefits varies by context, and biodiversity costs are often not considered.[92]

### *Enhanced ecosystem resilience and adaptability*

Rewilding intensively managed forests is a strategic approach that significantly enhances ecosystem resilience and adaptability.[63,82,84,94] It underscores the need for dynamic management strategies that can adapt to the varying rates of ecological responses to climate change.[95,96] When rewilding forests, we restore natural resilience-promoting elements and processes and promote them to their natural complexity, reinstating native flora and fauna that are evolutionarily adapted to varied conditions. This process nurtures and maintains the widest possible array of tree species, particularly those with traits (e.g., hydraulic, phenological) to endure increasing disturbances such as droughts, fires, and alien biotic agents, which in turn bolsters ecosystem resilience and reduces the likelihood of ecosystem collapse.[61,65,97–99] In a rewilded forest landscape, ecosystems become more self-regulating and robust, capable of resisting and recovering quickly after disturbances.[100] Thus, rewilding is a powerful tool to enhance forest resilience and adaptability, essential for navigating our uncertain future in the Anthropocene.[80,95,101]

### *Improved ecosystem multifunctionality*

In essence, rewilding enhances ecosystem multifunctionality, thereby driving multiple sustainability benefits.[102–104] These functions span carbon sequestration, nutrient cycling, soil retention, water regulation, and pollination—all pivotal for mitigating climate change and supporting ecosystem health. Meanwhile, forestry rewilding builds robust and resilient ecosystems that withstand a wider range of environmental changes and disturbances,[19] thus improving ecosystem stability. Beyond the ecological sphere, rewilding can also facilitate sociocultural and economic benefits, including supporting local livelihoods, enhancing cultural values, and creating opportunities for nature-based tourism.[105,106] By transitioning from a production-centric approach to one that emphasizes multifunctionality, rewilding-inspired forestry promises to foster a more biodiverse, resilient, and sustainable future of forest landscapes.

### *Economic benefits*

While the primary goal of forestry rewilding is ecosystem restoration and conservation, it inherently supports sustainable utilization of forest resources, except for some rewilded forest landscapes to be protected to fulfill the "30 by 30" deal.[74] This nuanced approach advocates for integrating selective harvesting within rewilded forests, aligning with natural stochastic disturbances to maintain ecological integrity. Forestry practices such as selective logging of timber and harvesting non-timber

forest products can be conducted sustainably by carefully mimicking the stochastic nature of these disturbances in terms of location, frequency, and magnitude.[107] This method not only contributes to local economies by improving livelihoods but also adheres to rewilding principles.[69]

Moreover, with their rich biodiversity and scenic landscapes, rewilded forests emerge as prime destinations for ecotourism, offering substantial economic opportunities for local communities through employment, tourism-related enterprises, and the promotion of local crafts and products.[108] These activities bolster regional and national economic development. Furthermore, the superior carbon sequestration capabilities of rewilded forests offer the prospect of generating carbon credits.[81] This market-based incentive not only provides financial returns but also encourages ongoing conservation and rewilding initiatives. This dual strategy—melding sustainable forestry with rewilding—illustrates a forward-looking model for managing landscapes outside strictly protected areas, ensuring both ecological integrity and economic sustainability.

### *Social benefits*

The integration of rewilding with sustainable forestry practices offers significant social benefits to indigenous peoples and local communities, extending beyond ecological and economic dimensions.[109] This inclusive approach fosters a sense of stewardship and pride among community members, enhancing social cohesion and ensuring the longevity of rewilding projects through local engagement.[80,110] The diverse relationships between indigenous communities and nature mean that the benefits of rewilding can vary widely. For instance, in the Amazon rainforest, indigenous communities have integrated traditional ecological knowledge with rewilding efforts, restoring degraded lands and reviving biodiversity.[111] This not only enhances ecosystem health but also reinforces cultural traditions and strengthens communal ties to the land. Similarly, in North America, reintroducing bison on tribal lands has provided ecological benefits and cultural revitalization for Native American communities.[112]

By restoring ecosystems to a state with high ecological integrity, rewilding initiatives resonate deeply with the cultural and spiritual values of local communities, strengthening ancestral ties to the land. This reconnection with natural heritage enriches cultural identity and promotes a collective commitment to ecosystem preservation. Additionally, the recreational opportunities afforded by rewilded and sustainably managed forests, such as hiking, bird watching, and nature photography, play a crucial role in enhancing human health and well-being. Encouraging public access and engagement with these landscapes supports mental and physical health, fostering societal appreciation for the intrinsic and instrumental values of natural ecosystems. For example, in Japan, "shinrin-yoku," or forest bathing, has gained popularity for its mental health benefits.[113] Thus, sustainable forestry integrated with rewilding principles emerges as a holistic approach that honors and leverages the land outside protected areas for the mutual benefit of biodiversity conservation, economic development, and social well-being.[114]

## How to "rewild" forestry and intensively managed forests?

Rewilding intensively managed forests involves letting natural processes self-sustain forest landscapes upon the termination of conventional forestry practices and accomplishment of any necessary initial active interventions rather than actively managing them. A locally adapted and regionally embedded integrated approach is imperative for the worldwide success of this approach, which encompasses ecological restoration, socio-economic integration, and sound policymaking and governance. Generally, the newly developed guiding principles for rewilding and reforestation also apply to rewilding-inspired forestry.[115,116] Here, we briefly outline 10 non-exclusive essential strategies or steps in this transformative social-ecological stewardship (Figure 3).

### *Landscape-scale social-ecological assessment*

This foundational strategy involves an extensive inventory and integrated evaluation of the prevailing social-ecological dynamics within expansive forest landscapes, including both degraded and intact areas. Key components include identifying regional keystone species crucial for ecosystem functioning and mapping critical habitats and connectivity zones vital for species migration and genetic diversity. Additionally, assessing soil and hydrological conditions is essential for understanding the forest's capacity to support diverse life and its resilience against environmental changes. Equally important is discerning the presence and impact of invasive species. However, it should be acknowledged that some non-native species may have become integral to certain ecosystems and do not require immediate removal unless they are invasive and detrimental.[117]

Intact forest landscapes, which have experienced minimal human disturbance, are crucial in maintaining biodiversity and ecosystem services and serve as benchmarks for restoration efforts. Recognizing and preserving these intact areas while integrating them into broader rewilding strategies can enhance the overall resilience and connectivity of forest landscapes. In addition, identifying and understanding crucial natural disturbance regimes in intact landscapes can inform the design of rewilding interventions that aim to restore such processes in degraded areas. These disturbances, including wildfires, droughts, windthrows, and pest outbreaks,[19] often drive ecological processes such as nutrient cycling, succession, and habitat heterogeneity, contributing to long-term ecosystem resilience and adaptation. Incorporating these disturbance regimes into rewilding strategies can help mimic natural dynamics and enhance ecosystem functionality.

This assessment also requires a thorough examination of the multifaceted impacts and interests of human activities, such as local community dependence on forest resources, to ensure that rewilding efforts align with both human well-being and ecological integrity. Developing and employing novel tools like satellite remote sensing for broadscale monitoring and ground surveys for detailed, site-specific insights, alongside analyses of natural disturbance regimes, this strategy is necessary for a nuanced understanding of the current social-ecological status of forest landscapes.[118] Such a robust assessment forms the foundation for informed and effective rewilding interventions, ensuring that these initiatives not only restore ecological functions but also integrate human dimensions, thereby fostering a harmonious and sustainable coexistence between nature and society.

### *Objective setting and prioritization*

Setting specific, measurable, achievable, relevant, and time-bound (SMART) objectives[119] for forestry rewilding is crucial.

For instance, a specific and measurable goal might be restoring a degraded forest landscape to its pre-disturbance ecological state within 3 decades, incorporating benchmarks such as successfully reintroducing two native keystone species or achieving a 25% increase in forest cover. Achievability and relevance are reflected in goals like enhancing the forest's carbon sequestration capacity, a tangible objective aligned with global climate change mitigation efforts. Time-bound targets provide clear deadlines, fostering a sense of urgency and enabling regular progress assessment. Prioritization in this context should be informed by a combination of factors: the urgency of ecological restoration (e.g., restoring areas most affected by deforestation), the feasibility of success (e.g., choosing species with a higher likelihood of survival and adaptation), and the ecological significance of the targeted species or habitats (prioritizing those that contribute significantly to biodiversity and ecosystem services). This systematic approach in setting and prioritizing objectives ensures that rewilding initiatives are not only ambitious but also practical and grounded in ecological realities, thereby enhancing their potential for successful and impactful outcomes in fostering resilient and sustainable forest landscapes.

### *Strategic restorative interventions*

Active interventions can be essential for restoring severely degraded areas. These efforts often start by addressing invasive species to mitigate their detrimental impact on native ecosystems. For instance, reducing the dominance of invasive plant species can facilitate the recovery of native flora and associated fauna.[120] Additionally, restoring ecological corridors is vital for reconnecting fragmented forest patches and facilitating species migration and genetic exchange, which is crucial for the resilience and adaptability of wildlife populations.[25,121] Restoring key ecological processes, such as natural fire regimes in fire-dependent ecosystems, can also rejuvenate forest health and diversity.[25,122] However, reconstructing natural fire regimes is particularly complex in regions where the dominant landscape has been extensively cultivated and transformed. For example, in regions of southern and central Europe where landscapes have been heavily transformed by human activities, historical fire regimes may no longer be applicable in the traditional sense. However, in certain Mediterranean regions, fire remains a critical disturbance mechanism. It is essential to adopt a localized approach to rewilding, recognizing that while fire may not be central to all forest landscapes, it remains relevant in specific contexts that still experience natural or semi-natural fire cycles. By actively addressing the most pressing ecological deficits, these interventions set the stage for the gradual recovery and self-sustaining dynamics of rewilded ecosystems.

### *Fostering natural regeneration*

In many contexts, natural regeneration proves both cost-effective and ecologically sound, as it promotes the return of complete, biodiverse, and resilient forest landscapes.[79,84,123,124] Central to this is minimizing human-induced disturbances, such as clear-cut logging or urban encroachment, creating a conducive environment for natural processes to unfold. A critical component of this strategy is trophic rewilding,[26,36,54] which involves restoring trophic complexity and top-down predator control of deer and other mesoherbivores.[58] However, realizing the risks in areas with human populations, the reintroduction of large predators must be carefully considered and managed to mitigate potential conflicts. Near urban areas and settlements, apex predators can pose safety concerns and conflicts with human activities. In such cases, alternative strategies may be employed. For instance, simulating predator presence through selective, regulated hunting may mimic these ecological effects if carefully implemented (hunting for fear[125]), promoting patchy vegetation regeneration and enhancing ecosystem resilience while addressing human safety and economic concerns.

### *Species reintroduction and recolonization*

This strategy targets reintroducing keystone species that have either disappeared or whose populations have drastically declined in specific areas, including various trees, large animals, and other organisms with limited dispersal capacities. Effective rewilding efforts should aim to create conditions supporting the resurgence of both well-known species and those from the regional species pool that are currently absent locally (dark diversity), thereby fostering a more comprehensive restoration of ecosystems.[126] Keystone species, such as large herbivores or apex predators, are of particular interest due to their significant impact on ecosystem dynamics. For example, reintroducing a large herbivore like the European bison can aid in seed dispersal and landscape engineering, while the return of a predator like the gray wolf can initiate top-down trophic cascades, regulating mesoherbivore populations and promoting ecosystem integrity.[58,127–129] These actions are instrumental in enhancing forest resilience by fostering diverse and robust ecological networks, particularly in the face of escalating climate change-related disturbances.

In addition to wild species, the role of domestic livestock grazing in rewilding should be considered. When managed appropriately, domestic livestock can mimic the ecological roles of extinct or extirpated large herbivores, contributing to vegetation management and maintaining open habitats. However, it is essential to carefully manage livestock grazing to prevent overgrazing and ensure that it aligns with broader rewilding goals.[56] Adaptive management practices, such as rotational grazing and the use of mixed livestock species, can optimize the ecological benefits of grazing while minimizing negative impacts.[28]

Furthermore, species reintroductions must be underpinned by robust studies at a regional scale to ensure their success and sustainability. These studies should assess the ecological and climate suitability of habitats, potential interactions with existing species, and the socio-economic implications of reintroduction efforts. Importantly, to employ the emerging strategy of ''prestoration'' in response to climate change, the habitat suitability assessment of species to be (re)introduced must go beyond the present and into the future.[130,131] Additionally, facilitating natural recolonization is equally crucial, which can be achieved by establishing wildlife corridors to connect fragmented habitats or removing barriers that impede species movement. Such interventions not only contribute to the restoration of historical species distributions but they also ensure the long-term sustainability and functionality of forest landscapes.

### *Assisted migration and colonization*

This proactive measure aligns with the rates-focused framework, offering tailored solutions for forest landscapes experiencing fast, slow, or abrupt rates of change.[95,132] Assisted migration

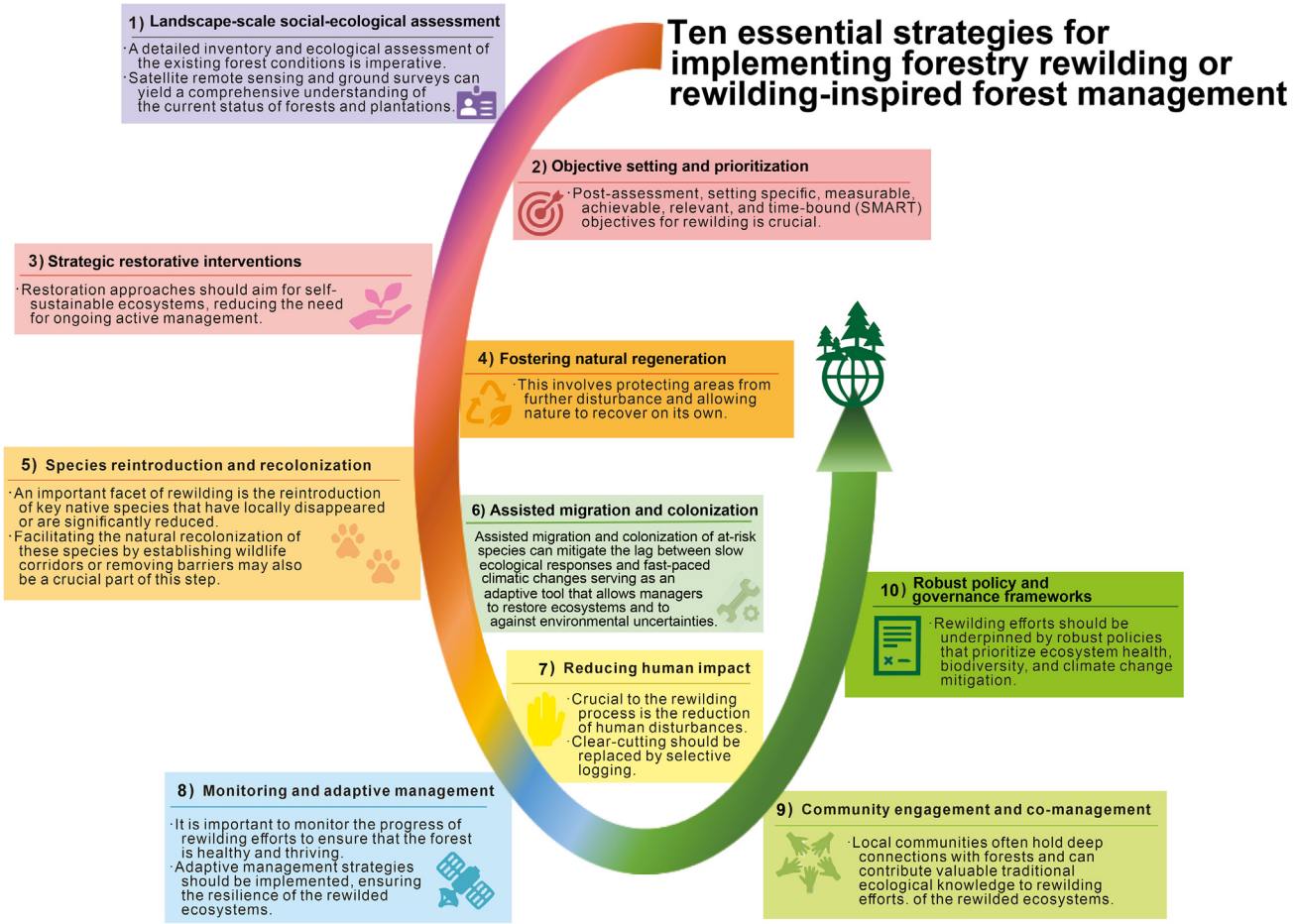


**Figure 3. Ten non-exclusive essential strategies or steps for successfully implementing forestry rewilding or rewilding-inspired forest management**

involves deliberately relocating species to more suitable habitats, particularly those at risk due to climate change.[131] This intervention is particularly relevant in fragmented social-ecological landscapes where human activities hinder natural species migration. For instance, relocating a tree species northward in response to shifting climate zones can mitigate the mismatch between the slower pace of ecological adaptation and rapid climatic shifts, thus reducing ecological disequilibria and enhancing ecosystem resilience.[95,133,134] However, assisted migration should be considered carefully and applied in contexts where natural dispersal is unlikely to occur within decades and where human interventions are necessary to reestablish ecological integrity. By contextualizing assisted migration within these parameters, we can ensure that it is used effectively to enhance the resilience and adaptability of forest landscapes in the face of climate change. As a strategic element of forestry rewilding, assisted migration not only aids in maintaining or restoring ecosystem integrity but also acts as a forward-looking measure to "future-proof" these ecosystems against impending environmental uncertainties.[135,136] This tactic adds a critical layer of adaptability to rewilding initiatives, significantly contributing to the overarching goal of maintaining biosphere sustainability under global change.

### *Reducing human impact*

The essence of this strategy lies in minimizing human interventions that alter the natural course of forest landscapes. This includes scaling back or halting conventional forestry practices such as monoculture tree planting, soil scarification, and draining, which often disrupt natural processes. Restricting access to ecologically sensitive areas helps safeguard them from anthropogenic pressures, allowing ecosystems to regenerate and evolve autonomously. However, it is essential to implement these restrictions in a way that respects and involves indigenous and local communities. Furthermore, allowing natural processes to take their course does not imply complete passivity in all circumstances.[137] For example, natural forest fires can be critical in maintaining habitat diversity and nutrient cycling in certain ecosystems, although their importance can vary depending on the specific ecological context.[138] Decisions about whether to intervene in natural fires should be guided by principles of social-ecological balance.[139] Intervention may be necessary if fires threaten human safety and critical infrastructure or if they could cause disproportionate ecological damage. Otherwise, allowing fires to burn naturally can support ecological resilience and the regeneration of diverse habitats. Similarly, deadwood from windthrows contributes to habitat complexity and nutrient cycling but

may also lead to bark beetle outbreaks.[140] In many cases, allowing windthrows to remain supports ecological succession and habitat diversity. However, proactive measures like monitoring pest populations and implementing localized control strategies when outbreaks pose significant risks may be necessary to prevent broader ecological damage.

An illustrative example of this strategy is transitioning from widespread clear-cutting practices to nature-mimicking selective logging.[141] This shift reduces the ecological impact of timber harvesting by promoting habitat heterogeneity and better resembling natural disturbance regimes, thereby enhancing biodiversity and maintaining ecological integrity. Such an approach not only facilitates the recovery of forest ecosystems but also aligns with broader sustainability goals by fostering ecologically robust landscapes that are less dependent on human management, thereby contributing to the resilience and long-term health of both the forests and the local communities they support.

### *Monitoring and adaptive management*

Continuous monitoring is crucial to gauge the progress and health of rewilded ecosystems,[142] necessitating a range of methods from ground-level surveys to assess plant and animal populations and the growth and health of trees to advanced remote sensing techniques for a broader ecological assessment.[63,143] For instance, tracking the regeneration of native tree species using high-resolution satellite imagery and deep learning can provide insights into the success of reforestation efforts,[144] while wildlife cameras and population surveys can help evaluate the success of species reintroductions. The data gathered from these monitoring activities are instrumental in guiding science-driven adaptive management strategies. This approach allows for fine-tuning rewilding efforts in response to observed outcomes and emerging challenges, ensuring that the interventions remain effective and responsive to changing ecological and climatic conditions. For example, if monitoring reveals an imbalance in predator-prey dynamics, management strategies can be adapted to address these issues, thus maintaining ecological balance and forest health. Such adaptive management not only underscores the resilience and adaptability of rewilding landscapes but also ensures that rewilding practices are continually informed by empirical evidence, thereby enhancing their efficacy and sustainability.[80,145]

### *Community engagement and co-management*

This strategy recognizes the invaluable role of local communities, which often have a profound connection with forest landscapes and possess rich traditional ecological knowledge.[145] Actively involving local communities in the rewilding process also fosters a sense of local ownership and responsibility for conservation efforts. For instance, involving indigenous communities in the monitoring and management of reintroduced species can integrate traditional practices with scientific methods, enhancing the effectiveness and cultural relevance of rewilding initiatives.[146] This collaborative strategy also plays a crucial role in strengthening social-ecological sustainability, as it aligns ecological objectives with local socio-economic needs and aspirations, thereby ensuring broader community support and mitigating potential conflicts. By viewing rewilding not just as a biophysical process but also as a socio-cultural endeavor, it becomes a holistic and inclusive movement that binds ecological restoration with cultural values and community well-being, thereby strengthening the resilience and sustainability of both the ecosystems and the societies that depend on them.

### *Robust policy and governance frameworks*

Lastly, rewilding efforts should be underpinned by robust policies and institutions that prioritize ecosystem resilience of broader forest landscapes and social-ecological sustainability. Essential measures include expanding and fortifying protected area networks to safeguard critical habitats and biodiversity hotspots. Stringent forest conservation policies can deter detrimental practices like illegal logging and habitat destruction. Incentivizing private landowners to participate in rewilding efforts, perhaps through financial or regulatory benefits, can significantly expand the scope and impact of these initiatives. Ownership rights are a critical aspect of rewilding policy. Clearly defining and securing these rights can prevent conflicts and ensure that landowners and indigenous communities have the authority and incentives to engage in rewilding activities. Additionally, the longevity and stability of political and financial initiatives are essential for the success of rewilding projects. Long-term funding commitments and consistent policy support are necessary to maintain rewilding efforts and adaptively manage the ecosystems as they evolve. Creating shared governance structures is also crucial for coordinating and overseeing rewilding initiatives, ensuring that they align with both ecological objectives and social needs.[145] These governance bodies can facilitate stakeholder engagement, ensuring that the interests and knowledge of local communities, conservationists, and policymakers are harmoniously integrated. Such collaborative frameworks can help navigate potential conflicts, balance diverse interests, and leverage the strengths of various stakeholders. By embedding rewilding initiatives within such comprehensive and well-structured policy and governance frameworks, we can ensure their effectiveness, sustainability, and alignment with broader goals of ecological integrity and social well-being.

In summary, rewilding-inspired forestry is a complex, multifaceted endeavor that necessitates a well-coordinated and adaptive implementation. Its potential to conserve biodiversity, mitigate climate change, and promote social-ecological sustainability makes it a transformative strategy for stewarding more resilient and sustainable forest landscapes and terrestrial biosphere.

## Outlook: Challenges and opportunities

The implementation of rewilding-inspired forestry worldwide represents a significant shift toward ecological restoration that simultaneously addresses the intertwined crises of climate change and biodiversity loss. While promising, this endeavor navigates a terrain fraught with both considerable challenges and transformative opportunities.[81,147,148] The journey toward rewilding our planet's forests in current and future production landscapes necessitates a deep and nuanced understanding of the complex social-ecological systems that comprise the Anthropocene biosphere[3] and a commitment to sustainability-driven policies and practices at global and local levels.

### *Ecological challenges*

The loss of species and reduction in genetic diversity are significant barriers to forest resilience, often exacerbated by fragmented landscapes that hinder species migration and reduce genetic exchange.[62] Furthermore, climate change introduces

unpredictable ecological shifts, affecting species distribution and disrupting ecosystem dynamics. These challenges are compounded by the presence of invasive species, which can outcompete native flora and fauna, altering the delicate balance of forest ecosystems, especially in drylands.[149] Addressing these ecological challenges necessitates a robust commitment to scientific research and continuous monitoring of rewilded ecosystems. By leveraging both scientific insights and traditional ecological knowledge, we can enhance adaptive management strategies that respond effectively to dynamic environmental conditions.[145] Although forestry rewilding is a globally relevant strategy, identifying priority areas for rewilding—those with the greatest ecological significance and feasibility—enables focused efforts where they can have the most impact.[150] Priority areas may range from small-scale projects (e.g., 100 ha), which are valuable for restoring localized biodiversity and serving as pilot sites, to landscape-scale initiatives (e.g., 100 $km^2$) that aim to reconnect fragmented habitats and enhance ecosystem functionality, and even to regional planning efforts (>10,000 $km^2$) that integrate large-scale ecological, social, and economic dynamics. Restoring connectivity between fragmented habitats through ecological corridors and removing barriers to species movement is essential at all scales, fostering genetic diversity, ecological resilience, and long-term sustainability. A mixed approach, tailored to specific ecological and social contexts, allows rewilding efforts to maximize their impact across spatial scales.

### *Economic and financial constraints*

Transitioning from conventional forestry to rewilding-inspired practices presents significant economic and financial challenges. Initially, these practices may disrupt existing value chains in forestry and traditional income streams from timber and non-timber forest products, creating economic uncertainties. Additionally, the upfront costs of rewilding projects, such as restoring degraded lands and implementing new management practices, can be substantial. Limited access to financial resources and investment can hinder the scale and speed of rewilding efforts, especially in regions with constrained economic conditions. To address these economic and financial constraints, it is essential to diversify income sources through initiatives such as ecotourism, sustainable harvesting of non-timber forest products, and participation in carbon credit markets.[107,151] These alternative income streams can offset the initial economic impacts and provide long-term financial stability. Developing public-private partnerships can also attract investment and share the financial burden of rewilding projects. Moreover, international funding mechanisms and grants dedicated to climate change mitigation and biodiversity conservation can provide crucial support for rewilding initiatives. By aligning rewilding projects with global environmental goals, it is possible to tap into financial resources allocated for sustainable development and climate action.

### *Socio-cultural acceptance and engagement*

Forestry rewilding also faces socio-cultural challenges, particularly resistance to changes in land use and forestry practices. These changes can disrupt established livelihoods and cultural traditions, leading to potential conflicts with local communities that depend on conventional forestry for their livelihoods. Implementing rewilding-inspired forestry requires a collaborative and integrative approach that respects and incorporates local cultural contexts. Actively involving local communities in the planning and execution of rewilding initiatives fosters a sense of ownership and aligns ecological objectives with socio-economic needs. By integrating traditional practices with scientific methods, rewilding projects can gain broader community support and ensure successful implementation. Education and outreach programs can further promote understanding and support for rewilding, ensuring that these initiatives are culturally resonant and socially sustainable.

### *Policy and institutional barriers*

Policy and institutional barriers present significant hurdles to the progress of forestry rewilding initiatives. Existing forestry and land-use policies may not support, or may even contradict, rewilding principles,[34] hindering the adoption of these strategies. Overcoming these barriers requires comprehensive policy reform and the establishment of science-policy interfaces that facilitate dialog and collaboration among stakeholders across relevant spatial scales at all levels (e.g., International Model Forest Network). Promoting policies supporting rewilding principles and creating flexible policy frameworks adaptable to diverse socio-economic contexts are essential. Establishing shared governance structures that involve a wide range of stakeholders, including government agencies, local communities, conservationists, and the private sector, can harmonize efforts and resolve conflicts. The current global environmental crisis, characterized by rapid biodiversity loss and climate change, presents an urgent opportunity to integrate rewilding principles into policy frameworks. This urgency is driving shifts in environmental and conservation policy. Notably, the European Union's June 2024 adoption of the Nature Restoration Law provides a unique and timely opportunity to implement rewilding-inspired forestry at a continental scale. By aligning our proposed strategies with this policy, forestry rewilding can contribute to achieving the restoration targets of the EU and serve as a model for integrating rewilding principles into national and international environmental legislation.

In conclusion, the grand biosphere sustainability challenges posed by biodiversity loss and climate change require urgent transformative actions that move beyond conventional forestry and conservation practices on a global scale. Rewilding intensively managed forests, including plantations, offers a powerful nature-based solution for restoring ecological processes, enhancing resilience, and achieving global sustainability goals.[73] Despite the challenges, ranging from ecological complexities to socio-economic and policy hurdles, rewilding-inspired forestry presents significant opportunities for biodiversity conservation, climate change mitigation, and social-ecological resilience. Harnessing these opportunities necessitates a strong commitment to science-based policymaking, global cooperation, and active engagement of all stakeholders, from international policymakers to local communities. By integrating rewilding principles into forest management, we can steward more biodiverse, multifunctional, and resilient landscapes, fostering a sustainable and harmonious coexistence of people and nature in the Anthropocene.

## RESOURCE AVAILABILITY

### Lead contact

The lead contact is Lanhui Wang (lanhui.wang@nateko.lu.se).

### Materials availability

This study did not generate new unique materials.

### Data and code availability

This study did not generate original data and code. The global forest management data for 2015 used to produce Figure 1 are available from https://zenodo.org/records/4541513.

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## AUTHOR CONTRIBUTIONS

L.W. and J.-C.S. conceived the work. L.W. wrote the first draft. All authors contributed to the writing, reviewing, and editing of the manuscript.

## DECLARATION OF INTERESTS

J.-C.S. is a member of the *One Earth* advisory board.

## REFERENCES

1. Pörtner, H.-O., Scholes, R.J., Arneth, A., Barnes, D.K.A., Burrows, M.T., Diamond, S.E., Duarte, C.M., Kiessling, W., Leadley, P., Managi, S., et al. (2023). Overcoming the coupled climate and biodiversity crises and their societal impacts. Science *380*, eabl4881. https://doi.org/10.1126/science.abl4881.
2. Arneth, A., Shin, Y.J., Leadley, P., Rondinini, C., Bukvareva, E., Kolb, M., Midgley, G.F., Oberdorff, T., Palomo, I., and Saito, O. (2020). Post-2020 biodiversity targets need to embrace climate change. Proc. Natl. Acad. Sci. USA *117*, 30882–30891. https://doi.org/10.1073/pnas.2009584117.
3. Folke, C., Polasky, S., Rockström, J., Galaz, V., Westley, F., Lamont, M., Scheffer, M., Österblom, H., Carpenter, S.R., Chapin, F.S., 3rd, et al. (2021). Our future in the Anthropocene biosphere. Ambio *50*, 834–869. https://doi.org/10.1007/s13280-021-01544-8.
4. FAO and UNEP (2020). The State of the World's Forests 2020: Forests, biodiversity and people (Rome). https://doi.org/10.4060/ca8642en.
5. Wang, L., Wei, F., and Svenning, J.-C. (2023). Accelerated cropland expansion into high integrity forests and protected areas globally in the 21st century. iScience *26*, 106450. https://doi.org/10.1016/j.isci.2023.106450.
6. Gibson, L., Lynam, A.J., Bradshaw, C.J.A., He, F., Bickford, D.P., Woodruff, D.S., Bumrungsri, S., and Laurance, W.F. (2013). Near-Complete Extinction of Native Small Mammal Fauna 25 Years After Forest Fragmentation. Science *341*, 1508–1510. https://doi.org/10.1126/science.1240495.
7. Shukla, P.R. Skeg, J., Buendia, E.C., Masson-Delmotte, V., Pörtner, H.O., Roberts, D.C., Zhai, P., Slade, R., Connors, S., Van Diemen, S. et al. (2019). Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. IPCC. https://www.ipcc.ch/srccl/https://www.ipcc.ch/srccl/
8. Grassi, G., House, J., Kurz, W.A., Cescatti, A., Houghton, R.A., Peters, G.P., Sanz, M.J., Viñas, R.A., Alkama, R., Arneth, A., et al. (2018). Reconciling global-model estimates and country reporting of anthropogenic forest CO2 sinks. Nat. Clim. Chang. *8*, 914–920. https://doi.org/10.1038/s41558-018-0283-x.
9. Lesiv, M., Schepaschenko, D., Buchhorn, M., See, L., Dürauer, M., Georgieva, I., Jung, M., Hofhansl, F., Schulze, K., Bilous, A., et al. (2022). Global forest management data for 2015 at a 100 m resolution. Sci. Data *9*, 199. https://doi.org/10.1038/s41597-022-01332-3.
10. Payn, T., Carnus, J.M., Freer-Smith, P., Kimberley, M., Kollert, W., Liu, S., Orazio, C., Rodriguez, L., Silva, L.N., and Wingfield, M.J. (2015). Changes in planted forests and future global implications. For. Ecol. Manag. *352*, 57–67. https://doi.org/10.1016/j.foreco.2015.06.021.
11. Bončina, A., Simončič, T., and Rosset, C. (2019). Assessment of the concept of forest functions in Central European forestry. Environ. Sci. Pol. *99*, 123–135. https://doi.org/10.1016/j.envsci.2019.05.009.
12. Pommerening, A., and Murphy, S.T. (2004). A review of the history, definitions and methods of continuous cover forestry with special attention to afforestation and restocking. Forestry An International Journal of Forest Research *77*, 27–44. https://doi.org/10.1093/forestry/77.1.27.
13. Hua, F., Bruijnzeel, L.A., Meli, P., Martin, P.A., Zhang, J., Nakagawa, S., Miao, X., Wang, W., McEvoy, C., Peña-Arancibia, J.L., et al. (2022). The biodiversity and ecosystem service contributions and trade-offs of forest restoration approaches. Science *376*, 839–844. https://doi.org/10.1126/science.abl4649.
14. Liao, C., Luo, Y., Fang, C., and Li, B. (2010). Ecosystem Carbon Stock Influenced by Plantation Practice: Implications for Planting Forests as a Measure of Climate Change Mitigation. PLoS One *5*, e10867. https://doi.org/10.1371/journal.pone.0010867.
15. Chazdon, R.L. (2008). Beyond Deforestation: Restoring Forests and Ecosystem Services on Degraded Lands. Science *320*, 1458–1460. https://doi.org/10.1126/science.1155365.
16. Mo, L., Zohner, C.M., Reich, P.B., Liang, J., de Miguel, S., Nabuurs, G.J., Renner, S.S., van den Hoogen, J., Araza, A., Herold, M., et al. (2023). Integrated global assessment of the natural forest carbon potential. Nature *624*, 92–101. https://doi.org/10.1038/s41586-023-06723-z.
17. Parr, C.L., te Beest, M., and Stevens, N. (2024). Conflation of reforestation with restoration is widespread. Science *383*, 698–701. https://doi.org/10.1126/science.adj0899.
18. Anderegg, W.R.L., Trugman, A.T., Badgley, G., Anderson, C.M., Bartuska, A., Ciais, P., Cullenward, D., Field, C.B., Freeman, J., Goetz, S.J., et al. (2020). Climate-driven risks to the climate mitigation potential of forests. Science *368*, eaaz7005. https://doi.org/10.1126/science.aaz7005.
19. Seidl, R., Thom, D., Kautz, M., Martin-Benito, D., Peltoniemi, M., Vacchiano, G., Wild, J., Ascoli, D., Petr, M., Honkaniemi, J., et al. (2017). Forest disturbances under climate change. Nat. Clim. Chang. *7*, 395–402. https://doi.org/10.1038/nclimate3303.
20. Aguirre-Gutiérrez, J., Stevens, N., and Berenguer, E. (2023). Valuing the functionality of tropical ecosystems beyond carbon. Trends Ecol. Evol. *38*, 1109–1111. https://doi.org/10.1016/j.tree.2023.08.012.
21. Silveira, F.A.O., Arruda, A.J., Bond, W., Durigan, G., Fidelis, A., Kirkman, K., Oliveira, R.S., Overbeck, G.E., Sansevero, J.B.B., Siebert, F., et al. (2020). Myth-busting tropical grassy biome restoration. Restor. Ecol. *28*, 1067–1073. https://doi.org/10.1111/rec.13202.
22. McWethy, D.B., Pauchard, A., García, R.A., Holz, A., González, M.E., Veblen, T.T., Stahl, J., and Currey, B. (2018). Landscape drivers of recent fire activity (2001-2017) in south-central Chile. PLoS One *13*, e0201195. https://doi.org/10.1371/journal.pone.0201195.
23. Stevens, N., and Bond, W.J. (2024). A trillion trees: carbon capture or fuelling fires? Trends Ecol. Evol. *39*, 1–4. https://doi.org/10.1016/j.tree.2023.09.015.
24. Svenning, J.-C. (2020). Rewilding should be central to global restoration efforts. One Earth *3*, 657–660. https://doi.org/10.1016/j.oneear.2020.11.014.
25. Perino, A., Pereira, H.M., Navarro, L.M., Fernández, N., Bullock, J.M., Ceauşu, S., Cortés-Avizanda, A., van Klink, R., Kuemmerle, T., Lomba, A., et al. (2019). Rewilding complex ecosystems. Science *364*, eaav5570. https://doi.org/10.1126/science.aav5570.
26. Svenning, J.-C., Buitenwerf, R., and Le Roux, E. (2024). Trophic rewilding as a restoration approach under emerging novel biosphere conditions. Curr. Biol. *34*, R435–R451. https://doi.org/10.1016/j.cub.2024.02.044.
27. Wang, L., Pedersen, P.B.M., and Svenning, J.-C. (2023). Rewilding abandoned farmland has greater sustainability benefits than afforestation. NPJ Biodivers. *2*, 5. https://doi.org/10.1038/s44185-022-00009-9.
28. Simba, L.D., Te Beest, M., Hawkins, H.J., Larson, K.W., Palmer, A.R., Sandström, C., Smart, K.G., Kerley, G.I.H., and Cromsigt, J.P.G.M. (2024). Wilder rangelands as a natural climate opportunity: Linking climate action to biodiversity conservation and social transformation. Ambio *53*, 678–696. https://doi.org/10.1007/s13280-023-01976-4.
29. Peng, L., Searchinger, T.D., Zionts, J., and Waite, R. (2023). The carbon costs of global wood harvests. Nature *620*, 110–115. https://doi.org/10.1038/s41586-023-06187-1.

30. Keith, H., Kun, Z., Hugh, S., Svoboda, M., Mikoláš, M., Adam, D., Bernatski, D., Blujdea, V., Bohn, F., Camarero, J.J., et al. (2024). Carbon carrying capacity in primary forests shows potential for mitigation achieving the European Green Deal 2030 target. Commun. Earth Environ. *5*, 256. https://doi.org/10.1038/s43247-024-01416-5.

31. Cromsigt, J.P.G.M., Te Beest, M., Kerley, G.I.H., Landman, M., le Roux, E., and Smith, F.A. (2018). Trophic rewilding as a climate change mitigation strategy? Philos. Trans. R. Soc. Lond. B Biol. Sci. *373*, 20170440. https://doi.org/10.1098/rstb.2017.0440.

32. Davis, A.S., Jacobs, D.F., and Dumroese, R.K. (2012). Forest Landscape Restoration. In Integrating Natural and Social Sciences, J. Stanturf, D. Lamb, and P. Madsen, eds. (Springer Netherlands), pp. 293–308.

33. Lindenmayer, D.B., Franklin, J., Lõhmus, A., Baker, S., Bauhus, J., Beese, W., Brodie, A., Kiehl, B., Kouki, J., Pastur, G.M., et al. (2012). A major shift to the retention approach for forestry can help resolve some global forest sustainability issues. Conserv. Lett. *5*, 421–431. https://doi.org/10.1111/j.1755-263X.2012.00257.x.

34. Dandy, N., and Wynne-Jones, S. (2019). Rewilding forestry. For. Pol. Econ. *109*, 101996. https://doi.org/10.1016/j.forpol.2019.101996.

35. Liang, J., Crowther, T.W., Picard, N., Wiser, S., Zhou, M., Alberti, G., Schulze, E.D., McGuire, A.D., Bozzato, F., Pretzsch, H., et al. (2016). Positive biodiversity-productivity relationship predominant in global forests. Science *354*, aaf8957. https://doi.org/10.1126/science.aaf8957.

36. Galetti, M., Pires, A.S., Brancalion, P.H., and Fernandez, F.A. (2017). Reversing defaunation by trophic rewilding in empty forests. Biotropica *49*, 5–8. https://doi.org/10.1111/btp.12407.

37. Fornoff, F., Klein, A.-M., Blüthgen, N., and Staab, M. (2019). Tree diversity increases robustness of multi-trophic interactions. Proc. R. Soc. A B. *286*, 20182399. https://doi.org/10.1098/rspb.2018.2399.

38. Liu, C.L.C., Kuchma, O., and Krutovsky, K.V. (2018). Mixed-species versus monocultures in plantation forestry: Development, benefits, ecosystem services and perspectives for the future. Global Ecol. Conser. *15*, e00419. https://doi.org/10.1016/j.gecco.2018.e00419.

39. Delavaux, C.S., Crowther, T.W., Zohner, C.M., Robmann, N.M., Lauber, T., van den Hoogen, J., Kuebbing, S., Liang, J., de-Miguel, S., Nabuurs, G.J., et al. (2023). Native diversity buffers against severity of non-native tree invasions. Nature *621*, 773–781. https://doi.org/10.1038/s41586-023-06440-7.

40. Rosenvald, R., and Lõhmus, A. (2008). For what, when, and where is green-tree retention better than clear-cutting? A review of the biodiversity aspects. For. Ecol. Manag. *255*, 1–15. https://doi.org/10.1016/j.foreco.2007.09.016.

41. Pearce, E.A., Mazier, F., Normand, S., Fyfe, R., Andrieu, V., Bakels, C., Balwierz, Z., Bińka, K., Boreham, S., Borisova, O.K., et al. (2023). Substantial light woodland and open vegetation characterized the temperate forest biome before Homo sapiens. Sci. Adv. *9*, eadi9135. https://doi.org/10.1126/sciadv.adi9135.

42. Rohatyn, S., Yakir, D., Rotenberg, E., and Carmel, Y. (2022). Limited climate change mitigation potential through forestation of the vast dryland regions. Science *377*, 1436–1439. https://doi.org/10.1126/science.abm9684.

43. Kristensen, J.Å., Barbero-Palacios, L., Barrio, I.C., Jacobsen, I.B.D., Kerby, J.T., López-Blanco, E., Malhi, Y., Le Moullec, M., Mueller, C.W., Post, E., et al. (2024). Tree planting is no climate solution at northern high latitudes. Nat. Geosci. *17*, 1087–1092. https://doi.org/10.1038/s41561-024-01573-4.

44. Bond, W.J., Stevens, N., Midgley, G.F., and Lehmann, C.E.R. (2019). The Trouble with Trees: Afforestation Plans for Africa. Trends Ecol. Evol. *34*, 963–965. https://doi.org/10.1016/j.tree.2019.08.003.

45. Engert, J.E., Campbell, M.J., Cinner, J.E., Ishida, Y., Sloan, S., Supriatna, J., Alamgir, M., Cislowski, J., and Laurance, W.F. (2024). Ghost roads and the destruction of Asia-Pacific tropical forests. Nature *629*, 370–375. https://doi.org/10.1038/s41586-024-07303-5.

46. Wemple, B.C., Browning, T., Ziegler, A.D., Celi, J., Chun, K.P.S., Jaramillo, F., Leite, N.K., Ramchunder, S.J., Negishi, J.N., Palomeque, X., and Sawyer, D. (2018). Ecohydrological disturbances associated with roads: Current knowledge, research needs, and management concerns with reference to the tropics. Ecohydrology *11*, e1881. https://doi.org/10.1002/eco.1881.

47. Brockerhoff, E.G., Jactel, H., Parrotta, J.A., Quine, C.P., and Sayer, J. (2008). Plantation forests and biodiversity: oxymoron or opportunity? Biodivers. Conserv. *17*, 925–951. https://doi.org/10.1007/s10531-008-9380-x.

48. Kupfer, J.A., Malanson, G.P., and Franklin, S.B. (2006). Not seeing the ocean for the islands: the mediating influence of matrix-based processes on forest fragmentation effects. Global Ecol. Biogeogr. *15*, 8–20. https://doi.org/10.1111/j.1466-822X.2006.00204.x.

49. Naudts, K., Chen, Y., McGrath, M.J., Ryder, J., Valade, A., Otto, J., and Luyssaert, S. (2016). Europe's forest management did not mitigate climate warming. Science *351*, 597–600. https://doi.org/10.1126/science.aad7270.

50. Skytt, T., Englund, G., and Jonsson, B.-G. (2021). Climate mitigation forestry—temporal trade-offs. Environ. Res. Lett. *16*, 114037. https://doi.org/10.1088/1748-9326/ac30fa.

51. Vestin, P., Mölder, M., Kljun, N., Cai, Z., Hasan, A., Holst, J., Klemedtsson, L., and Lindroth, A. (2020). Impacts of Clear-Cutting of a Boreal Forest on Carbon Dioxide, Methane and Nitrous Oxide Fluxes. Forests *11*, 961.

52. Bowd, E.J., Banks, S.C., Strong, C.L., and Lindenmayer, D.B. (2019). Long-term impacts of wildfire and logging on forest soils. Nat. Geosci. *12*, 113–118. https://doi.org/10.1038/s41561-018-0294-2.

53. Wang, F., Zou, B., Li, H., and Li, Z. (2014). The effect of understory removal on microclimate and soil properties in two subtropical lumber plantations. J. For. Res. *19*, 238–243. https://doi.org/10.1007/s10310-013-0395-0.

54. Svenning, J.C., Pedersen, P.B.M., Donlan, C.J., Ejrnæs, R., Faurby, S., Galetti, M., Hansen, D.M., Sandel, B., Sandom, C.J., Terborgh, J.W., and Vera, F.W.M. (2016). Science for a wilder Anthropocene: Synthesis and future directions for trophic rewilding research. Proc. Natl. Acad. Sci. USA *113*, 898–906. https://doi.org/10.1073/pnas.1502556112.

55. Swanson, H.A., Svenning, J.C., Saxena, A., Muscarella, R., Franklin, J., Garbelotto, M., Mathews, A.S., Saito, O., Schnitzler, A.E., Serra-Diaz, J.M., and Tsing, A.L. (2021). History as grounds for interdisciplinarity: promoting sustainable woodlands via an integrative ecological and socio-cultural perspective. One Earth *4*, 226–237. https://doi.org/10.1016/j.oneear.2021.01.006.

56. Svenning, J.-C., Lemoine, R.T., Bergman, J., Buitenwerf, R., Le Roux, E., Lundgren, E., Mungi, N., and Pedersen, R.Ø. (2024). The late-Quaternary megafauna extinctions: Patterns, causes, ecological consequences and implications for ecosystem management in the Anthropocene. Camb. prisms. Extinction *2*, e5. https://doi.org/10.1017/ext.2024.4.

57. Wang, L., Cromsigt, J.P., Buitenwerf, R., Lundgren, E.J., Li, W., Bakker, E.S., and Svenning, J.C. (2023). Tree cover and its heterogeneity in natural ecosystems is linked to large herbivore biomass globally. One Earth *6*, 1759–1770. https://doi.org/10.1016/j.oneear.2023.10.007.

58. Malhi, Y., Lander, T., le Roux, E., Stevens, N., Macias-Fauria, M., Wedding, L., Girardin, C., Kristensen, J.Å., Sandom, C.J., Evans, T.D., et al. (2022). The role of large wild animals in climate change mitigation and adaptation. Curr. Biol. *32*, R181–R196. https://doi.org/10.1016/j.cub.2022.01.041.

59. Trepel, J., le Roux, E., Abraham, A.J., Buitenwerf, R., Kamp, J., Kristensen, J.A., Tietje, M., Lundgren, E.J., and Svenning, J.C. (2024). Meta-analysis shows that wild large herbivores shape ecosystem properties and promote spatial heterogeneity. Nat. Ecol. Evol. *8*, 705–716. https://doi.org/10.1038/s41559-024-02327-6.

60. Kowalczyk, R., Kamiński, T., and Borowik, T. (2021). Do large herbivores maintain open habitats in temperate forests? For. Ecol. Manag. *494*, 119310. https://doi.org/10.1016/j.foreco.2021.119310.

61. Falk, D.A., van Mantgem, P.J., Keeley, J.E., Gregg, R.M., Guiterman, C.H., Tepley, A.J., JN Young, D., and Marshall, L.A. (2022). Mechanisms of forest resilience. For. Ecol. Manag. *512*, 120129. https://doi.org/10.1016/j.foreco.2022.120129.

62. Fady, B., Cottrell, J., Ackzell, L., Alía, R., Muys, B., Prada, A., and González-Martínez, S.C. (2016). Forests and global change: what can genetics contribute to the major forest management and policy challenges of the twenty-first century? Reg. Environ. Change *16*, 927–939. https://doi.org/10.1007/s10113-015-0843-9.

63. Forzieri, G., Dakos, V., McDowell, N.G., Ramdane, A., and Cescatti, A. (2022). Emerging signals of declining forest resilience under climate change. Nature *608*, 534–539. https://doi.org/10.1038/s41586-022-04959-9.

64. Schaberg, P.G., DeHayes, D.H., Hawley, G.J., and Nijensohn, S.E. (2008). Anthropogenic alterations of genetic diversity within tree populations: Implications for forest ecosystem resilience. For. Ecol. Manag. *256*, 855–862. https://doi.org/10.1016/j.foreco.2008.06.038.

65. Schnabel, F., Liu, X., Kunz, M., Barry, K.E., Bongers, F.J., Bruelheide, H., Fichtner, A., Härdtle, W., Li, S., Pfaff, C.T., et al. (2021). Species richness stabilizes productivity via asynchrony and drought-tolerance diversity in a large-scale tree biodiversity experiment. Sci. Adv. *7*, eabk1643. https://doi.org/10.1126/sciadv.abk1643.

66. Mueller, K.E., Tilman, D., Fornara, D.A., and Hobbie, S.E. (2013). Root depth distribution and the diversity–productivity relationship in a long-term grassland experiment. Ecology *94*, 787–793. https://doi.org/10.1890/12-1399.1.

67. Wolf, J., Asch, J., Tian, F., Georgiou, K., and Ahlström, A. (2023). Canopy responses of Swedish primary and secondary forests to the 2018 drought. Environ. Res. Lett. *18*, 064044. https://doi.org/10.1088/1748-9326/acd6a8.

68. Schug, F., Bar-Massada, A., Carlson, A.R., Cox, H., Hawbaker, T.J., Helmers, D., Hostert, P., Kaim, D., Kasraee, N.K., Martinuzzi, S., et al. (2023). The global wildland–urban interface. Nature *621*, 94–99. https://doi.org/10.1038/s41586-023-06320-0.

69. Nambiar, E.S. (2019). Tamm Review: Re-imagining forestry and wood business: pathways to rural development, poverty alleviation and climate change mitigation in the tropics. For. Ecol. Manag. *448*, 160–173. https://doi.org/10.1016/j.foreco.2019.06.014.

70. Razafindratsima, O.H., Kamoto, J.F., Sills, E.O., Mutta, D.N., Song, C., Kabwe, G., Castle, S.E., Kristjanson, P.M., Ryan, C.M., Brockhaus, M., and Sunderland, T. (2021). Reviewing the evidence on the roles of forests and tree-based systems in poverty dynamics. For. Pol. Econ. *131*, 102576. https://doi.org/10.1016/j.forpol.2021.102576.

71. Hofflinger, A., Nahuelpan, H., Boso, À., and Millalen, P. (2021). Do Large-Scale Forestry Companies Generate Prosperity in Indigenous Communities? The Socioeconomic Impacts of Tree Plantations in Southern Chile. Hum. Ecol. *49*, 619–630. https://doi.org/10.1007/s10745-020-00204-x.

72. Sandström, P., Cory, N., Svensson, J., Hedenås, H., Jougda, L., and Borchert, N. (2016). On the decline of ground lichen forests in the Swedish boreal landscape: Implications for reindeer husbandry and sustainable forest management. Ambio *45*, 415–429. https://doi.org/10.1007/s13280-015-0759-0.

73. Blicharska, M., Smithers, R.J., Mikusiński, G., Rönnbäck, P., Harrison, P.A., Nilsson, M., and Sutherland, W.J. (2019). Biodiversity's contributions to sustainable development. Nat. Sustain. *2*, 1083–1093. https://doi.org/10.1038/s41893-019-0417-9.

74. Dinerstein, E., Vynne, C., Sala, E., Joshi, A.R., Fernando, S., Lovejoy, T.E., Mayorga, J., Olson, D., Asner, G.P., Baillie, J.E.M., et al. (2019). A Global Deal For Nature: Guiding principles, milestones, and targets. Sci. Adv. *5*, eaaw2869. https://doi.org/10.1126/sciadv.aaw2869.

75. Palli, J., Mensing, S.A., Schoolman, E.M., Solano, F., and Piovesan, G. (2023). Rewilding is Restoring Mediterranean Mountain Forest Ecosystems. Bulletin Ecologic. Soc. America *104*, e02034. https://doi.org/10.1002/bes2.2034.

76. Chen, X., Taylor, A.R., Reich, P.B., Hisano, M., Chen, H.Y.H., and Chang, S.X. (2023). Tree diversity increases decadal forest soil carbon and nitrogen accrual. Nature *618*, 94–101. https://doi.org/10.1038/s41586-023-05941-9.

77. Lier, M., Köhl, M., Korhonen, K.T., Linser, S., Prins, K., and Talarczyk, A. (2022). The New EU Forest Strategy for 2030: A New Understanding of Sustainable Forest Management? Forests *13*, 245.

78. O'Hara, K.L. (2015). What is close-to-nature silviculture in a changing world? Forestry: An International Journal of Forest Research *89*, 1–6. https://doi.org/10.1093/forestry/cpv043.

79. Williams, B.A., Beyer, H.L., Fagan, M.E., Chazdon, R.L., Schmoeller, M., Sprenkle-Hyppolite, S., Griscom, B.W., Watson, J.E.M., Tedesco, A.M., Gonzalez-Roglich, M., et al. (2024). Global potential for natural regeneration in deforested tropical regions. Nature *636*, 131–137. https://doi.org/10.1038/s41586-024-08106-4.

80. Messier, C., Puettmann, K., Chazdon, R., Andersson, K., Angers, V., Brotons, L., Filotas, E., Tittler, R., Parrott, L., and Levin, S. (2015). From Management to Stewardship: Viewing Forests As Complex Adaptive Systems in an Uncertain World. Conservation Letters *8*, 368–377. https://doi.org/10.1111/conl.12156.

81. Pichancourt, J.-B., Firn, J., Chadès, I., and Martin, T.G. (2014). Growing biodiverse carbon-rich forests. Glob. Chang. Biol. *20*, 382–393. https://doi.org/10.1111/gcb.12345.

82. Palli, J., Mensing, S.A., Schoolman, E.M., Solano, F., and Piovesan, G. (2023). Historical ecology identifies long-term rewilding strategy for conserving Mediterranean mountain forests in south Italy. Ecol. Appl. *33*, e2758. https://doi.org/10.1002/eap.2758.

83. Stein, A., Gerstner, K., and Kreft, H. (2014). Environmental heterogeneity as a universal driver of species richness across taxa, biomes and spatial scales. Ecol. Lett. *17*, 866–880. https://doi.org/10.1111/ele.12277.

84. Morel, L., Barbe, L., Jung, V., Clément, B., Schnitzler, A., and Ysnel, F. (2020). Passive rewilding may (also) restore phylogenetically rich and functionally resilient forest plant communities. Ecol. Appl. *30*, e02007. https://doi.org/10.1002/eap.2007.

85. Sobral-Souza, T., Lautenschlager, L., Morcatty, T.Q., Bello, C., Hansen, D., and Galetti, M. (2017). Rewilding defaunated Atlantic Forests with tortoises to restore lost seed dispersal functions. Perspectives in Ecology and Conservation *15*, 300–307. https://doi.org/10.1016/j.pecon.2017.08.005.

86. Fernandez, F.A., Rheingantz, M.L., Genes, L., Kenup, C.F., Galliez, M., Cezimbra, T., Cid, B., Macedo, L., Araujo, B.B., Moraes, B.S., et al. (2017). Rewilding the Atlantic Forest: Restoring the fauna and ecological interactions of a protected area. Perspectives in Ecology and Conservation *15*, 308–314. https://doi.org/10.1016/j.pecon.2017.09.004.

87. Schmitz, O.J., Sylvén, M., Atwood, T.B., Bakker, E.S., Berzaghi, F., Brodie, J.F., Cromsigt, J.P.G.M., Davies, A.B., Leroux, S.J., Schepers, F.J., et al. (2023). Trophic rewilding can expand natural climate solutions. Nat. Clim. Chang. *13*, 324–333. https://doi.org/10.1038/s41558-023-01631-6.

88. Poorter, L., Bongers, F., Aide, T.M., Almeyda Zambrano, A.M., Balvanera, P., Becknell, J.M., Boukili, V., Brancalion, P.H.S., Broadbent, E.N., Chazdon, R.L., et al. (2016). Biomass resilience of Neotropical secondary forests. Nature *530*, 211–214. https://doi.org/10.1038/nature16512.

89. Chazdon, R.L., Broadbent, E.N., Rozendaal, D.M.A., Bongers, F., Zambrano, A.M.A., Aide, T.M., Balvanera, P., Becknell, J.M., Boukili, V., Brancalion, P.H.S., et al. (2016). Carbon sequestration potential of second-growth forest regeneration in the Latin American tropics. Sci. Adv. *2*, e1501639. https://doi.org/10.1126/sciadv.1501639.

90. Silva Pedro, M., Rammer, W., and Seidl, R. (2015). Tree species diversity mitigates disturbance impacts on the forest carbon cycle. Oecologia *177*, 619–630. https://doi.org/10.1007/s00442-014-3150-0.

91. Broughton, R.K., Bullock, J.M., George, C., Hill, R.A., Hinsley, S.A., Maziarz, M., Melin, M., Mountford, J.O., Sparks, T.H., and Pywell, R.F. (2021). Long-term woodland restoration on lowland farmland through passive rewilding. PLoS One *16*, e0252466.

92. Gustavsson, L., Haus, S., Lundblad, M., Lundström, A., Ortiz, C.A., Sathre, R., Truong, N.L., and Wikberg, P.E. (2017). Climate change effects of forestry and substitution of carbon-intensive materials and fossil fuels. Renew. Sustain. Energy Rev. *67*, 612–624. https://doi.org/10.1016/j.rser.2016.09.056.

93. Osuri, A.M., Gopal, A., Raman, T.R.S., DeFries, R., Cook-Patton, S.C., and Naeem, S. (2020). Greater stability of carbon capture in species-rich natural forests compared to species-poor plantations. Environ. Res. Lett. *15*, 034011. https://doi.org/10.1088/1748-9326/ab5f75.

94. Messier, C., Bauhus, J., Sousa-Silva, R., Auge, H., Baeten, L., Barsoum, N., Bruelheide, H., Caldwell, B., Cavender-Bares, J., Dhiedt, E., et al. (2022). For the sake of resilience and multifunctionality, let's diversify planted forests. Conservation Letters *15*, e12829. https://doi.org/10.1111/conl.12829.

95. Williams, J.W., Ordonez, A., and Svenning, J.-C. (2021). A unifying framework for studying and managing climate-driven rates of ecological change. Nat. Ecol. Evol. *5*, 17–26. https://doi.org/10.1038/s41559-020-01344-5.

96. Wei, F., Wang, S., Fu, B., Wang, L., Zhang, W., Wang, L., Pan, N., and Fensholt, R. (2022). Divergent trends of ecosystem-scale photosynthetic efficiency between arid and humid lands across the globe. Glob. Ecol. Biogeogr. *31*, 1824–1837. https://doi.org/10.1111/geb.13561.

97. Sanchez-Martinez, P., Mencuccini, M., García-Valdés, R., Hammond, W.M., Serra-Diaz, J.M., Guo, W.Y., Segovia, R.A., Dexter, K.G., Svenning, J.C., Allen, C., and Martínez-Vilalta, J. (2023). Increased hydraulic risk in assemblages of woody plant species predicts spatial patterns of drought-induced mortality. Nat. Ecol. Evol. *7*, 1620–1632. https://doi.org/10.1038/s41559-023-02180-z.

98. Guo, Q., Fei, S., Potter, K.M., Liebhold, A.M., and Wen, J. (2019). Tree diversity regulates forest pest invasion. Proc. Natl. Acad. Sci. USA *116*, 7382–7386. https://doi.org/10.1073/pnas.1821039116.

99. Anderegg, W.R.L., Konings, A.G., Trugman, A.T., Yu, K., Bowling, D.R., Gabbitas, R., Karp, D.S., Pacala, S., Sperry, J.S., Sulman, B.N., and Zenes, N. (2018). Hydraulic diversity of forests regulates ecosystem resilience during drought. Nature *561*, 538–541. https://doi.org/10.1038/s41586-018-0539-7.

100. Thakur, M.P., Bakker, E.S., Veen, G.C., and Harvey, J.A. (2020). Climate Extremes, Rewilding, and the Role of Microhabitats. One Earth *2*, 506–509. https://doi.org/10.1016/j.oneear.2020.05.010.

101. Colangelo, M., Camarero, J.J., Gazol, A., Piovesan, G., Borghetti, M., Baliva, M., Gentilesca, T., Rita, A., Schettino, A., and Ripullone, F. (2021). Mediterranean old-growth forests exhibit resistance to climate warming.

Sci. Total Environ. *801*, 149684. https://doi.org/10.1016/j.scitotenv.2021.149684.

102. Manning, P., van der Plas, F., Soliveres, S., Allan, E., Maestre, F.T., Mace, G., Whittingham, M.J., and Fischer, M. (2018). Redefining ecosystem multifunctionality. Nat. Ecol. Evol. *2*, 427–436. https://doi.org/10.1038/s41559-017-0461-7.

103. Zhou, G., Lucas-Borja, M.E., Liu, S., Hu, H., He, J., Wang, X., Jiang, Z., Zhou, X., and Delgado-Baquerizo, M. (2023). Plant and soil biodiversity is essential for supporting highly multifunctional forests during Mediterranean rewilding. Funct. Ecol. *37*, 420–431. https://doi.org/10.1111/1365-2435.14230.

104. Zhou, G., Zhou, X., Eldridge, D.J., Han, X., Song, Y., Liu, R., Zhou, L., He, Y., Du, Z., and Delgado-Baquerizo, M. (2022). Temperature and Rainfall Patterns Constrain the Multidimensional Rewilding of Global Forests. Adv. Sci. *9*, 2201144. https://doi.org/10.1002/advs.202201144.

105. Koninx, F. (2019). Ecotourism and rewilding: the case of Swedish Lapland. J. Ecotourism *18*, 332–347. https://doi.org/10.1080/14724049.2018.1538227.

106. Schou, J.S., Bladt, J., Ejrnæs, R., Thomsen, M.N., Vedel, S.E., and Fløjgaard, C. (2021). Economic assessment of rewilding versus agri-environmental nature management. Ambio *50*, 1047–1057. https://doi.org/10.1007/s13280-020-01423-8.

107. Thomas, P.W., and Jump, A.S. (2023). Edible fungi crops through mycoforestry, potential for carbon negative food production and mitigation of food and forestry conflicts. Proc. Natl. Acad. Sci. USA *120*, e2220079120. https://doi.org/10.1073/pnas.2220079120.

108. Poponi, S., Palli, J., Ferrari, S., Filibeck, G., Forte, T.G.W., Franceschini, C., Ruggieri, A., and Piovesan, G. (2020). Toward the development of sustainable ecotourism in Italian national parks of the Apennines: insights from hiking guides. Ecol. Soc. *25*, art46. https://doi.org/10.5751/ES-11996-250446.

109. Berkes, F. (2007). Community-based conservation in a globalized world. Proc. Natl. Acad. Sci. USA *104*, 15188–15193. https://doi.org/10.1073/pnas.0702098104.

110. Chapin, F.S., III, Carpenter, S.R., Kofinas, G.P., Folke, C., Abel, N., Clark, W.C., Olsson, P., Smith, D.M.S., Walker, B., Young, O.R., et al. (2010). Ecosystem stewardship: sustainability strategies for a rapidly changing planet. Trends Ecol. Evol. *25*, 241–249. https://doi.org/10.1016/j.tree.2009.10.008.

111. Root-Bernstein, M., Galetti, M., and Ladle, R.J. (2017). Rewilding South America: Ten key questions. Perspectives in Ecology and Conservation *15*, 271–281. https://doi.org/10.1016/j.pecon.2017.09.007.

112. Shamon, H., Cosby, O.G., Andersen, C.L., Augare, H., BearCub Stiffarm, J., Bresnan, C.E., Brock, B.L., Carlson, E., Deichmann, J.L., Epps, A., et al. (2022). The Potential of Bison Restoration as an Ecological Approach to Future Tribal Food Sovereignty on the Northern Great Plains. Front. Ecol. Evol. *10*, 826282. https://doi.org/10.3389/fevo.2022.826282.

113. Morita, E., Fukuda, S., Nagano, J., Hamajima, N., Yamamoto, H., Iwai, Y., Nakashima, T., Ohira, H., and Shirakawa, T. (2007). Psychological effects of forest environments on healthy adults: Shinrin-yoku (forest-air bathing, walking) as a possible method of stress reduction. Publ. Health *121*, 54–63. https://doi.org/10.1016/j.puhe.2006.05.024.

114. Fedele, G., Donatti, C.I., Bornacelly, I., and Hole, D.G. (2021). Nature-dependent people: Mapping human direct use of nature for basic needs across the tropics. Global Environ. Change *71*, 102368. https://doi.org/10.1016/j.gloenvcha.2021.102368.

115. Carver, S., Convery, I., Hawkins, S., Beyers, R., Eagle, A., Kun, Z., Van Maanen, E., Cao, Y., Fisher, M., Edwards, S.R., et al. (2021). Guiding principles for rewilding. Conserv. Biol. *35*, 1882–1893. https://doi.org/10.1111/cobi.13730.

116. Di Sacco, A., Hardwick, K.A., Blakesley, D., Brancalion, P.H.S., Breman, E., Cecilio Rebola, L., Chomba, S., Dixon, K., Elliott, S., Ruyonga, G., et al. (2021). Ten golden rules for reforestation to optimize carbon sequestration, biodiversity recovery and livelihood benefits. Glob. Chang. Biol. *27*, 1328–1348. https://doi.org/10.1111/gcb.15498.

117. Brundu, G., Pauchard, A., Pyšek, P., Pergl, J., Bindewald, A.M., Brunori, A., Canavan, S., Campagnaro, T., Celesti-Grapow, L., Dechoum, M.d.S., et al. (2020). Global guidelines for the sustainable use of non-native trees to prevent tree invasions and mitigate their negative impacts. NeoBiota *61*, 65–116.

118. Burrell, N.C., Jeffers, E.S., Macias-Fauria, M., and Willis, K.J. (2024). The inadequacy of current carbon storage assessment methods for rewilding: A Knepp Estate case study. Ecol. Solut. Evid. *5*, e12301. https://doi.org/10.1002/2688-8319.12301.

119. Hughes, A.C., Qiao, H., and Orr, M.C. (2021). Extinction Targets Are Not SMART (Specific, Measurable, Ambitious, Realistic, and Time Bound). Bioscience *71*, 115–118. https://doi.org/10.1093/biosci/biaa148.

120. Zavaleta, E.S., Hobbs, R.J., and Mooney, H.A. (2001). Viewing invasive species removal in a whole-ecosystem context. Trends Ecol. Evol. *16*, 454–459. https://doi.org/10.1016/S0169-5347(01)02194-2.

121. Christie, M.R., and Knowles, L.L. (2015). Habitat corridors facilitate genetic resilience irrespective of species dispersal abilities or population sizes. Evol. Appl. *8*, 454–463. https://doi.org/10.1111/eva.12255.

122. Lindenmayer, D.B., Bowd, E.J., and Gibbons, P. (2023). Forest restoration in a time of fire: perspectives from tall, wet eucalypt forests subject to stand-replacing wildfires. Philos. Trans. R. Soc. Lond. B Biol. Sci. *378*, 20210082. https://doi.org/10.1098/rstb.2021.0082.

123. Sasaki, N., Asner, G., Knorr, W., Durst, P., Priyadi, H., and Putz, F. (2011). Approaches to classifying and restoring degraded tropical forests for the anticipated REDD+ climate change mitigation mechanism. iForest *4*, 1–6. https://doi.org/10.3832/ifor0556-004.

124. Crouzeilles, R., Beyer, H.L., Monteiro, L.M., Feltran-Barbieri, R., Pessôa, A.C.M., Barros, F.S.M., Lindenmayer, D.B., Lino, E.D.S.M., Grelle, C.E.V., Chazdon, R.L., et al. (2020). Achieving cost-effective landscape-scale forest restoration through targeted natural regeneration. Conservation Letters *13*, e12709. https://doi.org/10.1111/conl.12709.

125. Cromsigt, J.P., Kuijper, D.P., Adam, M., Beschta, R.L., Churski, M., Eycott, A., Kerley, G.I., Mysterud, A., Schmidt, K., and West, K. (2013). Hunting for fear: innovating management of human–wildlife conflicts. J. Appl. Ecol. *50*, 544–549. https://doi.org/10.1111/1365-2664.12076.

126. Lewis, R.J., de Bello, F., Bennett, J.A., Fibich, P., Finerty, G.E., Götzenberger, L., Hiiesalu, I., Kasari, L., Lepš, J., Májeková, M., et al. (2017). Applying the dark diversity concept to nature conservation. Conserv. Biol. *31*, 40–47. https://doi.org/10.1111/cobi.12723.

127. Marjakangas, E.-L., Genes, L., Pires, M.M., Fernandez, F.A.S., de Lima, R.A.F., de Oliveira, A.A., Ovaskainen, O., Pires, A.S., Prado, P.I., and Galetti, M. (2018). Estimating interaction credit for trophic rewilding in tropical forests. Philos. Trans. R. Soc. Lond. B Biol. Sci. *373*, 20170435. https://doi.org/10.1098/rstb.2017.0435.

128. Bump, J.K. (2018). Fertilizing riparian forests: nutrient repletion across ecotones with trophic rewilding. Philos. Trans. R. Soc. Lond. B Biol. Sci. *373*, 20170439. https://doi.org/10.1098/rstb.2017.0439.

129. Estes, J.A., Terborgh, J., Brashares, J.S., Power, M.E., Berger, J., Bond, W.J., Carpenter, S.R., Essington, T.E., Holt, R.D., Jackson, J.B.C., et al. (2011). Trophic Downgrading of Planet Earth. Science *333*, 301–306. https://doi.org/10.1126/science.1205106.

130. Butterfield, B.J., Copeland, S.M., Munson, S.M., Roybal, C.M., and Wood, T.E. (2017). Prestoration: using species in restoration that will persist now and into the future. Restor. Ecol. *25*, S155–S163. https://doi.org/10.1111/rec.12381.

131. Wessely, J., Essl, F., Fiedler, K., Gattringer, A., Hülber, B., Ignateva, O., Moser, D., Rammer, W., Dullinger, S., and Seidl, R. (2024). A climate-induced tree species bottleneck for forest management in Europe. Nat. Ecol. Evol. *8*, 1109–1117. https://doi.org/10.1038/s41559-024-02406-8.

132. Wang, L., Tian, F., Wang, Y., Wu, Z., Schurgers, G., and Fensholt, R. (2018). Acceleration of global vegetation greenup from combined effects of climate change and human land management. Glob. Chang. Biol. *24*, 5484–5499. https://doi.org/10.1111/gcb.14369.

133. Svenning, J.-C., and Sandel, B. (2013). Disequilibrium vegetation dynamics under future climate change. Am. J. Bot. *100*, 1266–1286.

134. Han, Q., and Keeffe, G. (2021). Promoting climate-driven forest migration through large-scale urban afforestation. Landsc. Urban Plann. *212*, 104124. https://doi.org/10.1016/j.landurbplan.2021.104124.

135. Schwartz, M.W., Hellmann, J.J., McLachlan, J.M., Sax, D.F., Borevitz, J.O., Brennan, J., Camacho, A.E., Ceballos, G., Clark, J.R., Doremus, H., et al. (2012). Managed Relocation: Integrating the Scientific, Regulatory, and Ethical Challenges. Bioscience *62*, 732–743. https://doi.org/10.1525/bio.2012.62.8.6.

136. Pedlar, J.H., McKenney, D.W., and Lu, P. (2021). Critical seed transfer distances for selected tree species in eastern North America. J. Ecol. *109*, 2271–2283. https://doi.org/10.1111/1365-2745.13605.

137. Mauerhofer, V., Ichinose, T., Blackwell, B., Willig, M., Flint, C., Krause, M., and Penker, M. (2018). Underuse of social-ecological systems: A research agenda for addressing challenges to biocultural diversity. Land Use Pol. *72*, 57–64. https://doi.org/10.1016/j.landusepol.2017.12.003.

138. Certini, G. (2005). Effects of fire on properties of forest soils: a review. Oecologia *143*, 1–10. https://doi.org/10.1007/s00442-004-1788-8.

139. Götmark, F. (2013). Habitat management alternatives for conservation forests in the temperate zone: Review, synthesis, and implications. For. Ecol. Manag. *306*, 292–307. https://doi.org/10.1016/j.foreco.2013.06.014.

140. Mori, A.S., and Kitagawa, R. (2014). Retention forestry as a major paradigm for safeguarding forest biodiversity in productive landscapes: A global meta-analysis. Biol. Conserv. *175*, 65–73. https://doi.org/10.1016/j.biocon.2014.04.016.

141. Cerullo, G.R., and Edwards, D.P. (2019). Actively restoring resilience in selectively logged tropical forests. J. Appl. Ecol. *56*, 107–118. https://doi.org/10.1111/1365-2664.13262.

142. Boonstra, R., Boutin, S., Jung, T.S., Krebs, C.J., and Taylor, S. (2018). Impact of rewilding, species introductions and climate change on the structure and function of the Yukon boreal forest ecosystem. Integr. Zool. *13*, 123–138. https://doi.org/10.1111/1749-4877.12288.

143. Thers, H., Bøcher, P.K., and Svenning, J.-C. (2019). Using lidar to assess the development of structural diversity in forests undergoing passive rewilding in temperate Northern Europe. PeerJ *6*, e6219.

144. Lake, T.A., Briscoe Runquist, and Moeller, D.A. (2022). Deep learning detects invasive plant species across complex landscapes using Worldview-2 and Planetscope satellite imagery. Remote Sens. Ecol. Conserv. *8*, 875–889. https://doi.org/10.1002/rse2.288.

145. Jackson, W., Freeman, M., Freeman, B., and Parry-Husbands, H. (2021). Reshaping forest management in Australia to provide nature-based solutions to global challenges. Aust. For. *84*, 50–58. https://doi.org/10.1080/00049158.2021.1894383.

146. Wilder, B.T., O'Meara, C., Monti, L., and Nabhan, G.P. (2016). The Importance of Indigenous Knowledge in Curbing the Loss of Language and Biodiversity. Bioscience *66*, 499–509. https://doi.org/10.1093/biosci/biw026.

147. García-Ruiz, J.M., Lasanta, T., Nadal-Romero, E., Lana-Renault, N., and Álvarez-Farizo, B. (2020). Rewilding and restoring cultural landscapes in Mediterranean mountains: Opportunities and challenges. Land Use Pol. *99*, 104850. https://doi.org/10.1016/j.landusepol.2020.104850.

148. Pawson, S.M., Brin, A., Brockerhoff, E.G., Lamb, D., Payn, T.W., Paquette, A., and Parrotta, J.A. (2013). Plantation forests, climate change and biodiversity. Biodivers. Conserv. *22*, 1203–1227. https://doi.org/10.1007/s10531-013-0458-8.

149. Stavi, I., Xu, C., and Argaman, E. (2024). Climate-smart forestry in the world's drylands: A review of challenges and opportunities. The Anthropocene Review *11*, 67–90. https://doi.org/10.1177/20530196231182354.

150. Chiarucci, A., and Piovesan, G. (2020). Need for a global map of forest naturalness for a sustainable future. Conserv. Biol. *34*, 368–372. https://doi.org/10.1111/cobi.13408.

151. Canadell, J.G., and Raupach, M.R. (2008). Managing Forests for Climate Change Mitigation. Science *320*, 1456–1457. https://doi.org/10.1126/science.1155458.