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Rewilding: Ten Years of Evolution and Development

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Abstract

Rewilding has matured into a mainstream approach in nature conservation. More than 450 academic papers on rewilding have been published since the term first appeared in print in the early 1990s. Rewilding is characterized by a shift in conservation from compositional goals to functional restoration, and its goal is to foster coexistence between humans and nature. Rewilding is a potential climate change mitigation strategy, and rewilding projects can influence carbon cycling and help ecosystems become more resilient to climate change by restoring large herbivores and predators. Rewilding is gaining traction in policy at the national and international levels. Several global policy mechanisms and initiatives now support ecological restoration as part of a broader effort to combat biodiversity loss, climate change, and land degradation. Key debates and uncertainties surrounding rewilding include its relationship to ecological restoration, its role in promoting nonhuman autonomy, and the challenges of achieving transformative change within current paradigms.

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INTRODUCTION

Since the 2015 publication of the first review on the topic of rewilding in this journal (1), interest has continued to grow and the concept has been further developed. Well over 450 academic papers on rewilding have been published since the term first appeared in print in the early 1990s (2). In this article, we build on the 2015 review (**Table 1**) by examining how rewilding is starting to mature and evolve into a mainstream approach in nature conservation, while highlighting some of the remaining debates and uncertainties. Using 2015 as our baseline, we trace the continued development of rewilding beyond its early origins in North America, which focused on the needs of large, wide-ranging animal species (3), and its interpretation in Europe, influenced by the role of large herbivore grazing to create wood pasture (4), to more recent research on establishing global guidelines, rewilding science, and the adoption of rewilding within global and regional policy initiatives.

It is generally understood that rewilding emphasizes functional ecological restoration, with an emphasis on the role of large animals, and aims to create self-sustaining environments, increasing nonhuman autonomy (5). However, definitions can vary depending on focus and context, so much so that Jørgensen (7) describes it as a "plastic" term that is both adaptable and shaped by different contexts, agendas, and interpretations. Jørgensen argues that this conceptual fluidity allows rewilding to be widely applied but, in doing so, creates ambiguity and thus calls for clearer, context-specific definitions that acknowledge the role of humans in shaping contemporary

Table 1 Summary of the 2015 article on rewilding in this journal (1)

Topic	Main themes
Science	Rewilding represents a significant shift in conservation science, moving away from static conservation goals, such as maintaining ecosystems in a particular historical state, toward more dynamic and process-oriented approaches, including restoring trophic interactions (e.g., predator–prey relationships) and natural disturbances (e.g., flooding and fire), which shape ecosystems.
Practice	Rewilding practices vary from passive approaches (allowing nature to take its course) to more active interventions, such as species reintroductions including case studies of rewilding projects, particularly in Europe, where large herbivores and carnivores are being reintroduced to support ecological restoration.
Political and ethical dimensions	Rewilding is politically and ethically contentious, often challenging traditional conservation methods and raising questions about the role of humans in nature, the value of certain species, and the prioritization of specific ecosystems. The authors call for inclusive dialogue to address these tensions, advocating for an approach that considers both ecological and social factors.

landscapes. Such flexibility is not inherently problematic; rather, it can be a strength, enabling the term to be applied to a diverse range of ecological and sociopolitical contexts (6). Nonetheless, there is a need for a carefully articulated definition and set of guiding principles for rewilding that can be applied across all scales and contexts.

This review focuses on the progress toward definitions of rewilding and associated debates over the last ten years. Academic dialogue about the meaning of rewilding during the last decade has been productive, generating several complementary and contested definitions. The ambiguity implied by multiple definitions makes rewilding a useful concept in varied contexts but presents a challenge for the development of broad principles for rewilding practice that can be applied in different contexts. Nonetheless, such principles are crucial if we are to improve the effectiveness of this approach in achieving global conservation targets.

EVOLUTION OF REWILDING SINCE 2015

The number of papers appearing in the scientific literature has increased since the 1990s. A search of Web of Science for all papers with "rewild*" in the title returns 462 results published through September 2024, as well as 1,092 results including "rewild*" in either the abstract or keywords. **Figure 1** depicts the number of articles published with "rewild*" in the title and their cumulative total since 1999. **Figure 2** shows the geographical origin of these publications. The top ten Web of Science discipline categories are dominated by the ecological and environmental sciences as follows: Ecology ($n = 131$; 28.355%), Biodiversity Conservation ($n = 97$; 20.996%), Environmental Sciences ($n = 86$; 18.615%), Environmental Studies ($n = 58$; 12.554%), Multidisciplinary Sciences ($n = 49$; 10.606%), Biology ($n = 33$; 7.143%), Geography ($n = 25$; 5.411%), Evolutionary Biology ($n = 12$; 2.597%), Green Sustainable Science Technology ($n = 11$; 2.381%), and History ($n = 11$; 2.381%).

In the context of increased international awareness of biodiversity loss and sustainability challenges, engagement with rewilding has expanded to most continents, supported by increased coverage in public media tapping into growing public interest (7–9). This trend has also influenced the appeal of rewilding among policymakers and environmental organizations, especially in Europe (10). This geographic expansion has made it even more challenging to define rewilding or establish a consistent approach, limiting the relevance of theories suggested in the literature. For example, Galetti et al. (11) note that the focus on wilderness in North America, and its alignment with the neoliberal conservation goals promoted by some in Europe, can conflict with

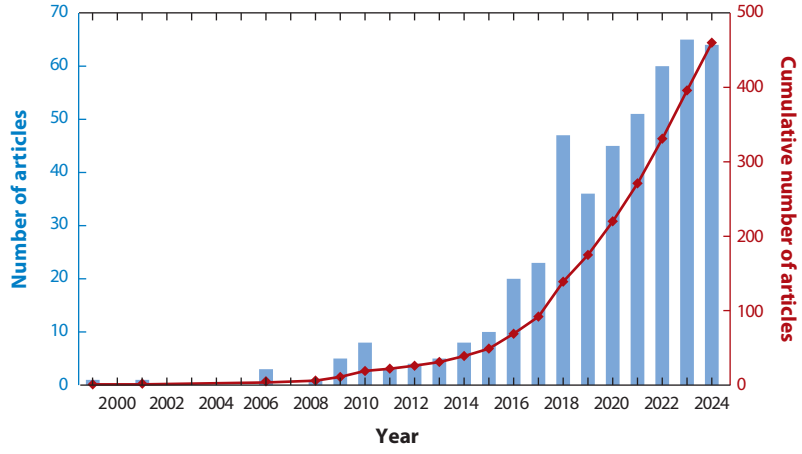

Figure 1

Articles containing "rewild*" in their titles by year published (since 1999).

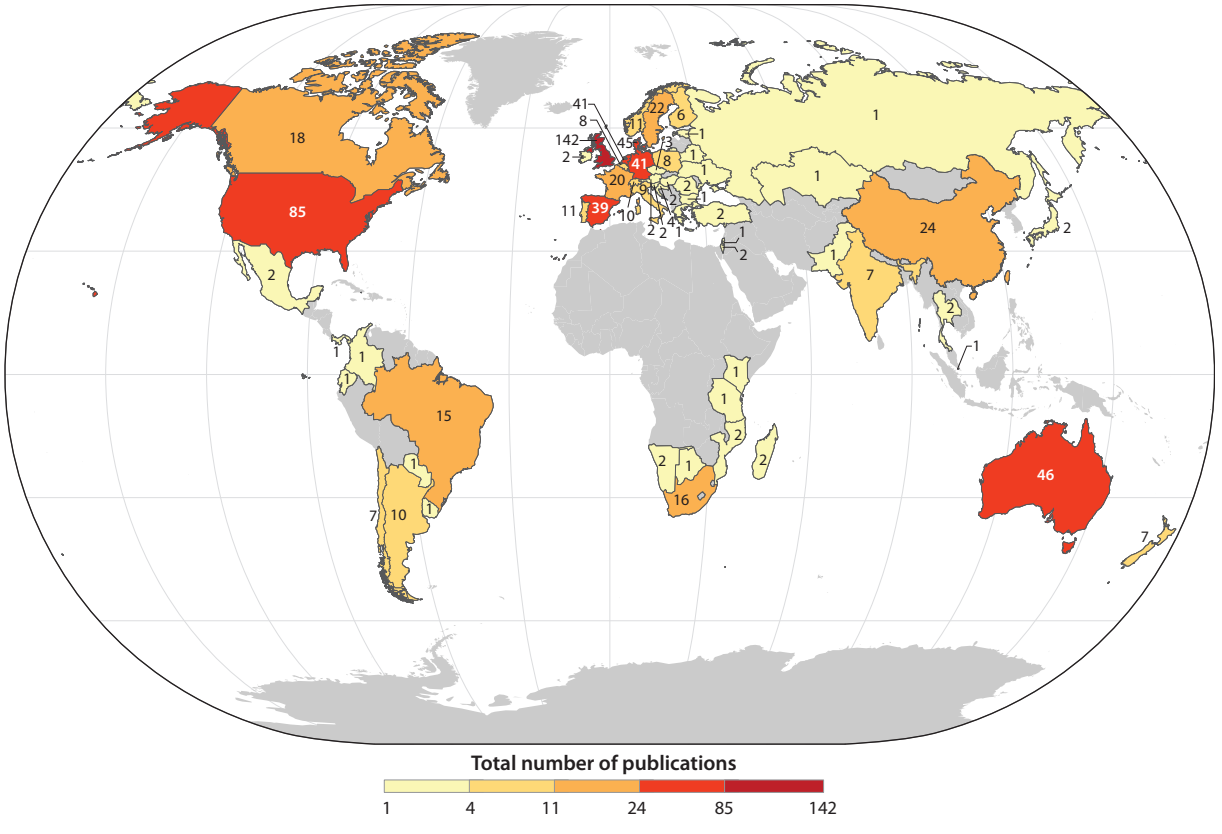

Figure 2

Geographical origin of published articles, with country counts.

colonial legacies and Indigenous values and land use practices in South America. This conflict has prompted considerations of how rewilding is interpreted in different social-ecological contexts, such as Oceania (12, 13) or South America (11, 14).

The literature also reflects interdisciplinary engagement with the remaining uncertainties inherent in rewilding, which has driven further engagement with its human dimensions and considerations for how it is understood in different cultural, geographic, or disciplinary contexts (13–16). Such studies have been helpful in identifying areas of consensus and areas requiring further investigation. This is driven by a more holistic systems framing of rewilding, highlighting complex social-ecological interactions (17, 18) and wider engagement with the concept across different geographies and disciplines (8, 19). This trend has highlighted the multivalence of the concept and the need for it to remain adaptable to diverse contexts (5).

As such, rewilding has become highly contextual and diverse, echoing the plurality of the wider conservation movement. A more nuanced critical reflexivity is therefore required (20) so that rewilding does not become oversimplified, and so that definitions and principles capture its multivalence rather than being prescriptive of its methods and underlying values (21).

In the next section, we highlight emergent themes and areas of consensus in rewilding, noting links to emergent environmental policies. Thereafter, we describe key remaining debates and uncertainties in the rewilding literature. The areas of consensus and tension have implications for the governance and the science of rewilding, which we discuss further in the final sections of this article.

EMERGING THEMES AND AREAS OF CONSENSUS IN REWILDING

While Lorimer et al. (1) reviewed the emerging literature up to 2015 under the broad headings of ecological benchmarks, practice, and politics, rewilding has since developed as a key topic in conservation science. Histories of rewilding provide more nuanced and holistic views of rewilding as a concept, highlighting distinctions from traditional conservation and ecological restoration. Recent literature has paid more attention to rewilding goals, noting that rewilding interventions can vary but that its goals may provide a route to finding common ground among diverse approaches. As a result, the literature has moved away from associating rewilding with its interventions, such as species reintroduction and wilderness, and toward focusing instead on its goals (6, 22). These goals note that rewilding is more than the sum of its parts (23), highlighting a shift toward social-ecological systems (SES) framings of rewilding and a relational paradigm. Rewilding is characterized by this paradigm shift in conservation from compositional goals to functional restoration and by a shift in governance from command-and-control to place-based and SES framings. Studies highlight the ethics of rewilding, goals for landscape-scale coexistence, and for (re)connecting people with other species and natural processes (24, 25, 8). These histories reflect a transition toward a more relational paradigm and goals of coexistence at the landscape scale (22).

Functional Restoration Goals

The literature highlights several emergent themes under the rewilding banner. For example, the post-2015 literature on rewilding has increasingly focused on restoring ecological processes rather than on specific species reintroduction per se. For instance, Sandom et al. (26) emphasize the importance of reestablishing natural processes such as trophic cascades and disturbance regimes (e.g., fire, flooding) to restore self-regulating ecosystems. This approach aligns with that of Pettorelli et al. (27), who advocate for a dynamic, process-based view of rewilding that adapts to changing environmental conditions and human impacts. These functional restoration goals distinguish

rewilding from compositional goals of conservation and some forms of ecological restoration, shifting importance away from goals based on ecological benchmarks, which were a key point of discussion for Lorimer et al. (1), toward reference ecosystems providing evidence to inform functional restoration (23).

Human–Nature Relationships

How rewilding integrates human presence has been a matter of significant debate, driven by concerns related to the concept of wilderness perpetuating human–nature dualism (28) as well as by concerns over systemic anthropocentrism perpetuating human dominance and control over nature (19). As a result, the literature has increasingly addressed the role of humans in rewilding and has called for cultural or transformative change to address human–nature disconnection. Some researchers frame rewilding as a strategy to foster coexistence between humans and nature rather than remove human activity (22, 29, 30). In rewilding practice, the goal of coexistence is supported by actions to (re)connect people and culture with nature (31, 23).

Environmental Justice and Equity

Rewilding has sparked ethical debates around land use, governance, and the potential displacement of local communities, and the ongoing perception of rewilding as the removal of human influence is regarded as a barrier to wider acceptance (32). Carver et al. (5) and Hawkins et al. (23) explore these political dimensions, advocating for contextual, inclusive, and participatory approaches that balance ecological goals with human needs. However, Martin et al. (33) show that, despite aspirations and commitments for rewilding to be inclusive, genuine collaboration is limited by entrenched views of power, ownership, and tendencies to prioritize one's own interests.

The emphasis of rewilding on uninhabited places and hands-off approaches has drawn criticism for decades, particularly from Indigenous communities and their advocates, and has rendered it largely irrelevant to these communities' needs (34, 35). Indigenous voices are notably absent from much of the rewilding literature, and despite several examples of Indigenous communities reintroducing large animals to restore ecological and cultural functions, few of these projects have been identified as rewilding. While there is potential for rewilding to align with the aspirations of Indigenous communities, such as in land care, health, and governance, this potential has yet to be realized.

Indigenous communities manage, or have the right to manage, vast areas of land with high conservation value (36). As with conservation more broadly, if rewilding is to support both social justice and ecological restoration on traditional lands, it must decolonize its theories and practices (28, 37). To garner broader support from local communities, rewilding must also continue to align itself with the more general aims of environmental justice (19, 38).

Pleistocene Rewilding and Deextinction

Pleistocene rewilding, which is the reintroduction of megafauna to restore ancient ecosystems, continues to be explored, though often critically. For example, Berti & Svenning (39) investigate the ecological functions of extinct megafauna and discuss the potential for introducing analogous species; they conclude that rewilding with extant megafauna could help restore biotic connectivity and reverse some of the negative consequences of past extinctions for ecosystem functioning. However, skepticism about the practicality and ethics of deextinction and Pleistocene rewilding is growing, with many calling for a focus on restoring more recent, human-altered ecosystems (40). The potential for taxon replacement has prompted questions about the indigeneity of flora and fauna in the modern context and supports the concept of novel ecosystems in conceptualizations

of rewilding, aligning with a shift away from ecological benchmarks (40). However, the concept of novel ecosystems does not have wide support, as there are concerns that it could perpetuate anthropocentrism and limit functional restoration goals (41).

Urban and Periurban Rewilding

A newer development is the application of rewilding principles in urban contexts. Pettorelli et al. (42) highlight the potential benefits of rewilding in cities, including improved biodiversity, carbon sequestration, and enhanced well-being for urban residents. These studies broaden the scope of rewilding from remote wild areas to human-dominated landscapes, suggesting that rewilding can play a critical role in urban sustainability.

Rewilding as a Climate Change Mitigation Tool

Recent literature positions rewilding as a potential climate change mitigation strategy. Cromsigt et al. (43) explore how restoring large herbivores and predators within the wider landscape can influence carbon cycling and help ecosystems become more resilient to climate change. Similarly, Bell et al. (44) assess the carbon sequestration potential of rewilding projects in Europe, finding significant opportunities for climate mitigation through ecosystem restoration. Schmitz et al. (45) argue that trophic rewilding can enhance natural climate solutions (NCS) by improving carbon storage, reducing greenhouse gas emissions, and fostering climate resilience. These authors emphasize that integrating trophic rewilding with current NCS strategies can amplify the effectiveness of these approaches and call for the inclusion of wildlife-driven ecosystem processes in climate policy frameworks. An example of such an approach is provided by Jones & Jones (18), who discuss rewilding and beaver reintroduction as a nature-based solution.

EMERGING CONSENSUS

In 2017, the International Union for Conservation of Nature (IUCN) Commission on Ecosystem Management set up a Rewilding Task Force (now called the Rewilding Thematic Group) to develop a unifying global definition for rewilding that captures its essential elements and that could be adapted or modified to suit local conditions and sociocultural/sociopolitical settings. In their paper titled "Guiding Principles for Rewilding," Carver et al. (5) develop both a definition and a set of guiding principles based on a multistep, collaborative approach that integrates scientific research, expert opinions, and stakeholder input. While one might argue (7) that rewilding remains a "plastic" term, making a one-size-fits-all definition almost impossible to achieve, Carver et al. tried to ensure that the definition and principles would be generic and applicable across different geographic regions and ecological contexts. Doing so involved considering various case studies and experiences from different parts of the world, as rewilding practices can vary on the basis of local ecological conditions and sociopolitical realities.

Carver et al. (5, p. 1888) defined rewilding as

> the process of rebuilding, following major human disturbance, a natural ecosystem by restoring natural processes and the complete or near complete food web at all trophic levels as a self-sustaining and resilient ecosystem with biota that would have been present had the disturbance not occurred. This will involve a paradigm shift in the relationship between humans and nature.

The ten agreed-upon guiding principles, paraphrased for brevity, are as follows:

1. Rewilding involves restoring trophic interactions to improve ecological integrity.
2. Rewilding involves landscape-scale planning, acknowledging the need for coexistence among more-than-human nature.

3. Rewilding focuses on the recovery of ecological processes, interactions, and conditions based on reference ecosystems.
4. Rewilding recognizes that ecosystems are dynamic and constantly changing.
5. Rewilding anticipates and mitigates the effects of climate change.
6. Rewilding requires local engagement and support.
7. Rewilding is informed by science, traditional ecological knowledge, and local knowledge.
8. Rewilding is adaptive and dependent on monitoring and feedback.
9. Rewilding recognizes the intrinsic value of all species and ecosystems; it is primarily ecocentric and not anthropocentric and involves the removal or reduction of human control.
10. Rewilding requires a paradigm shift in the coexistence of humans and nature with related institutional paradigm shifts. It is transformative and optimistic, delivering the best outcomes for nature and people.

Taken together, the Rewilding Thematic Group guiding principles and the literature reviewed here reflect a growing and emerging consensus on rewilding. First, rewilding aspires to enhance ecological processes and related natural dynamism, giving nature greater autonomy (15, 32, 46–49). Second, the literature reflects multidisciplinary engagement with the concept of rewilding, along with consensus regarding the need to integrate sociocultural factors into rewilding research, theories, and application (13, 15, 32, 46, 50, 51). There is also some consensus that the process of rewilding will be more effective and sustainable with the use of a place-based approach to governance (17, 50, 52). Increasing consideration of sociocultural factors, alongside ecological goals, has driven SES framings of rewilding in the literature (17, 49, 52, 53) and the development of governance frameworks based on adaptive, collaborative approaches (17, 23, 49). However, these frameworks are perhaps difficult to realize in practice, and a propensity for command-and-control governance is evident (33, 53, 54).

NEW POLICY DEVELOPMENTS

Growing consensus has supported the increasing legitimacy of rewilding as a policy approach at the national and international levels. Since 2015, several global policy mechanisms and initiatives have supported ecological restoration as part of a broader effort to combat biodiversity loss, climate change, and land degradation. These policies and initiatives are increasingly interlinked with international environmental goals and include the 2015 Paris Agreement, which encourages nature-based solutions as strategies for carbon sequestration and biodiversity conservation; the 2015 Sustainable Development Goals (SDGs), particularly SDGs 14 and 15, which call for restoration of marine and land ecosystems; the United Nations Decade on Ecosystem Restoration (2021–2030), which encourages countries to develop restoration projects to restore degraded ecosystems; and the Kunming-Montreal Global Biodiversity Framework, which sets new targets to halt and reverse biodiversity loss through conservation measures including restoration. This framework commits signatories to protecting at least 30% of terrestrial and marine ecosystems by 2030 and to restoring at least 30% of degraded ecosystems, while recognizing the importance of Indigenous peoples and local communities in conservation efforts. The extent to which such policy mechanisms expand restoration to including rewilding is uncertain, but if we are to accept that all rewilding is restoration, then we can safely assume that to be the case even if rewilding is not mentioned explicitly.

Many of these global policy mechanisms are supported and reinforced through a series of regional and national initiatives, such as the EU Biodiversity Strategy for 2030, the extension to the Bonn Challenge, the Nature Needs Half initiative and the Half-Earth Project, the 2016 Trillion

Tree Campaign, and the 2021 Glasgow Leaders' Declaration on Forests and Land Use. **Table 2** summarizes key global and regional efforts that support restoration and rewilding.

Collectively, these initiatives underscore the growing global recognition of ecological restoration and rewilding as critical tools for addressing biodiversity loss, climate change, and land degradation. Since 2015, the integration of restoration and rewilding into major international frameworks has helped to mobilize financial resources, foster cross-border collaboration, and support large-scale ecosystem recovery efforts. However, given the ambitious targets that have been set, the failure to meet previous binding targets, and the short time frames involved, whether any of these initiatives and policy mechanisms will have the desired effect remains to be determined (55).

CONTROVERSY AND DEBATE

Ever since rewilding emerged as a theme in conservation thinking, it has attracted both support and criticism in roughly equal measure. While some of the debates highlighted by Lorimer et al. (1) are reaching consensus as a result of the developments highlighted above (e.g., shifting perceptions of the role of ecological baselines), others stem from tensions among the diversity of interests, worldviews, and priorities of those involved in rewilding practice and theory (15). These tensions demonstrate that conflict remains a barrier to creativity and collaboration, reflecting concerns raised by Holmes et al. (15) that conflicts based on personalities, politics, or ethical principles remain barriers to cross-collaboration and consensus in rewilding, which in turn negatively affect the flow of ideas and resources. In this context, it remains difficult to identify ways to develop a rewilding concept that focuses on common ground while allowing for plurality.

Four key uncertainties that are evident in the literature are discussed below. Although some of them are closely related, they have different implications for principles, practicalities, or underlying ethical debates and are therefore described separately.

Perceptions of Rewilding in Relation to Ecological Restoration

How rewilding is perceived in relation to ecological restoration is an ongoing debate, which has spurred related debates on, for example, the role of ecological baselines in rewilding. Hayward et al. (56) argue that rewilding is simply an extension of traditional conservation and restoration efforts, with a focus on species reintroduction. They emphasize the importance of restoring ecosystems to their predisturbance states and advocate for scientifically grounded conservation. Hayward et al. therefore warn against rewilding, suggesting that it is unpredictable and may undermine proven restoration principles by prioritizing experimental ecosystems over established historical baselines.

In a response to Hayward et al., Anderson et al. (57) argue that rewilding should be integrated into ecological restoration, as it emphasizes the restoration of ecological processes and promotes self-sustaining ecosystems. Anderson et al. contend that rewilding complements restoration by broadening conservation approaches, focusing on adaptability to future environmental changes rather than strictly recreating historical conditions. They support a synergistic relationship between rewilding and restoration to enhance conservation outcomes through a balance of historical fidelity and ecological adaptability.

Recent studies, such as those by Pettorelli & Bullock (58), Nelson (59), and Mutillod et al. (60), emphasize the complementary goals of rewilding and restoration, advocating for collaboration between the two approaches. They posit that rewilding focuses more on functional goals, such as ecosystem processes, whereas restoration traditionally focuses on compositional goals. However, both goals share a common purpose of protecting and restoring biodiversity, with collaboration offering stronger resilience and adaptability to future challenges.

Table 2 Global policy mechanisms and support for restoration and rewilding

Initiative	Objective	Links to rewilding	Potential impact
Paris Agreement (2015)	Global framework to limit global warming to below 2°C and pursue efforts to limit it to 1.5°C	Encourages nature-based solutions, including rewilding and restoration, as essential strategies for sequestering carbon, enhancing ecosystem resilience, and supporting biodiversity conservation	Promotes investment in large-scale restoration projects and afforestation as part of countries' NDCs
SDGs (2015)	A set of 17 goals to end poverty, protect the planet, and ensure prosperity for all by 2030	Call for the restoration of degraded land/seas and the conservation of ecosystems, including through restoration and rewilding	Establish ecological restoration as a tool for achieving multiple global development targets
United Nations Decade on Ecosystem Restoration (2021–2030)	Aims to prevent, halt, and reverse ecosystem degradation on every continent and in every ocean	Encourages countries to implement restoration and rewilding projects to restore degraded ecosystems, with the goal of restoring 350 million hectares of land by 2030	Mobilizes global resources and attention toward large-scale ecological restoration initiatives, with a focus on biodiversity recovery and enhancing ecosystem services
Bonn Challenge (2011; extended in 2020)	A global effort to bring 350 million hectares of deforested and degraded land into restoration by 2030	Promotes forest landscape restoration, which can include rewilding approaches, such as the reintroduction of species and natural regeneration	More than 60 countries have made pledges, emphasizing restoration as a key mechanism for biodiversity recovery, climate mitigation, and sustainable development
Post-2020 Global Biodiversity Framework (drafted under the CBD)	Sets new global biodiversity targets post-2020 to halt and reverse biodiversity loss	Includes targets for restoring ecosystems, conserving biodiversity, and maintaining ecosystem services, with rewilding playing a role in reestablishing ecological processes and species populations	Shapes national policies and financial investments for restoration, potentially scaling up rewilding projects globally
EU Biodiversity Strategy for 2030 (2020)	Aims to protect and restore Europe's biodiversity by extending protected areas and restoring degraded ecosystems	Promotes rewilding as a key strategy to restore nature across Europe, with commitments to restore at least 30% of degraded habitats	Rewilding is embedded in the European Union's approach to biodiversity conservation, providing support for reintroducing key species and enhancing ecosystem connectivity
LDN targets (under UNCCD)	Aim to achieve neutrality by avoiding degradation and restoring land	Rewilding is considered an effective strategy for reversing land degradation, particularly through natural regeneration and species reintroduction	More than 120 countries have committed to LDN targets, with many incorporating rewilding into their land restoration efforts.
Trillion Tree Campaign (launched 2016)	Aims to restore forest ecosystems through planting and natural regeneration to address climate change and biodiversity loss	Emphasizes natural regeneration and forest restoration, which are key components of rewilding, particularly in allowing ecosystems to recover naturally without human intervention	Global collaborations are driving large-scale rewilding projects focused on restoring forest ecosystems.

(*Continued*)

Table 2 (*Continued*)

Initiative	Objective	Links to rewilding	Potential impact
Glasgow Leaders' Declaration on Forests and Land Use (COP26, 2021)	Commits to halting and reversing deforestation and land degradation by 2030	Supports large-scale forest and land restoration, with rewilding approaches increasingly recognized as part of the solution to restore ecosystems and biodiversity	Gathers commitments from more than 140 countries, enhancing support for rewilding and restoration projects globally
NCS initiatives	Promote conservation, restoration, and improved land management to increase carbon storage and reduce greenhouse gas emissions	Rewilding is one of the approaches promoted under NCS, especially in restoring carbon-rich ecosystems like wetlands, forests, and grasslands	Private sector entities, NGOs, and governments are investing in NCS, contributing to global rewilding efforts
Nature Needs Half	Advocates for protecting at least half of the planet's land and seas to sustain biodiversity and natural ecosystems	Highlights the need for protected areas, wilderness preservation, and landscape-level conservation strategies to maintain ecological integrity	Aligns with the 30×30 goal and broader biodiversity frameworks by encouraging ambitious protection targets that go beyond current conservation efforts
HEP	Proposed by biologist E.O. Wilson, HEP calls for setting aside half the planet's surface for nature to protect biodiversity and preserve ecosystems	Argues that allocating half of the Earth to nature would allow species and ecosystems to thrive, addressing the biodiversity crisis; is backed by research on species–area relationships, suggesting that protecting 50% of the planet could save 85% of species	HEP supports the mapping of global biodiversity hot spots and advocating for stronger conservation measures; closely aligns with the CBD's targets and with other rewilding and ecological restoration initiatives

Abbreviations: CBD, Convention on Biological Diversity; COP26, 26th Conference of the Parties to the United Nations Framework Convention on Climate Change; HEP, Half-Earth Project; LDN, land degradation neutrality; NCS, natural climate solutions; NDCs, Nationally Determined Contributions; NGOs, nongovernmental organizations; SDGs, Sustainable Development Goals; UNCCD, United Nations Convention to Combat Desertification.

A key distinction between the two lies in their sociopolitical dimensions. Maffey & Arts (31) note that rewilding is more concerned with addressing the root causes of ecological degradation, requiring a paradigm shift in how humans relate to nature. Rewilding is viewed as nature-led, giving ecosystems autonomy to develop, while restoration is human-led, focusing on achieving predefined ecological outcomes (23). This difference is reflected in the rewilding movement's broader social-ecological goals, including human–nature reconnection and systemic transformation (5, 19, 22). Ultimately, while rewilding and restoration share commonalities, their approaches to achieving ecological recovery differ; rewilding offers a more experimental, nature-driven trajectory.

Conflicting Perceptions of Nature and Culture

Many debates surrounding rewilding emphasize the role of human influence and cultural values in relation to wildness and nonhuman autonomy (15, 61, 62). Tensions arise from contrasting value orientations: Some researchers advocate for a separation between nature and people, while others promote their integration (5). These differing views create uncertainty over the aims of rewilding, particularly whether it should focus on "pristine" wilderness free from human intervention or

landscapes that integrate nature and culture (15, 32, 63). These debates are critical because they shape rewilding policies and practices (22).

Much of this tension stems from perceptions of 3Cs (cores, corridors, and carnivores) rewilding, which, influenced by deep ecology and wilderness preservation, is often considered out of touch with modern conservation needs (7, 10, 64). As a result, there is an assumed ideological divide between European and North American rewilding. Europe lacks large wilderness "cores" and faces challenges related to carnivore conflicts and limited species dispersal (25, 65). Therefore, European rewilding embraces dynamic, mutualistic systems that blur nature–culture boundaries (66), leading to practices such as agricultural rewilding, where domestic animals maintain wood pasture ecosystems (67). Projects like Knepp Wildland in the United Kingdom exemplify this approach through a transition from cattle farming to a rewilding business (68, 69).

While efforts to bridge ideological divides continue (23), multiple interpretations of rewilding fuel ongoing tension. Some researchers advocate a focus on ecological integrity through the withdrawal of human influence (70, 47), while others promote human participation and presence, including urban rewilding (61, 62).

Calls for value pluralism reflect diverse sociocultural priorities (63), yet tensions persist between rewilding advocates and critics, particularly in regions where rewilding is regarded as reducing human presence and threatening rural livelihoods, especially through predator reintroduction (71, 72). Sociopolitical tensions also persist; rural communities view rewilding as top-down, exogenous, and disruptive to local traditions (73, 74), reflecting broader conflicts between ecological restoration and cultural preservation (75).

Perceived Paradox Between Rewilding Interventions and Nonhuman Autonomy

A paradox in rewilding practice arises from ambiguity around rewilding interventions and nonhuman autonomy (15, 32, 46, 50, 63). While rewilding is often framed as human withdrawal, a more holistic view suggests that it can incorporate human involvement to enhance nonhuman agency in cultural landscapes (48, 62).

The literature agrees that total human withdrawal is impractical, but ambiguity persists regarding how to balance intervention with nonhuman autonomy (5, 48, 50). Some propose a gradient from human management to ecosystem self-management, suggesting that intervention may be necessary initially but should decrease over time (48, 61).

This complexity is compounded by conflicting conservation philosophies: While rewilding advocates for natural processes, traditional conservation often prioritizes active management to maintain species and habitats (63, 76). These differing views lead to policy challenges, especially in agricultural landscapes (77). Alternative frameworks like environmental pragmatism, collaborative rewilding, and compassionate conservation aim to integrate human and nonhuman agency (61, 77, 78). A relational approach is needed to clarify the definitions of nonhuman autonomy and balance intervention and wildlife freedom, promoting human–nature connections and justice in rewilding practices (22, 32, 79).

Pragmatism and Transformation

The literature highlights a perceived paradox between how rewilding is practiced or understood within current paradigms and its aims to create paradigm shifts, leading to conflicts and concerns that the transformative potential of rewilding is being compromised (5, 15, 33). These concerns and conflicts echo many of the conflicts in wider conservation literature, namely regarding the commodification of natural resources (13), anthropocentrism (32), and command-and-control

governance approaches (33). Desirable qualities include more holistic views that expand notions of well-being and interests to more-than-human nature (13, 32, 33, 50); improved adaptiveness and tolerance for uncertainty and dynamism inherent in wilder systems (15, 23, 50); and genuine collaboration, trust, and empowerment among stakeholders (33, 52).

This tension echoes conflicts between environmental pragmatism and transformation in the wider conservation literature. Some authors advocate for aligning rewilding with policy or seeking opportunities to enhance ecosystem services or economic development, such as through ecotourism (10, 75), while advocates for transformation criticize these approaches for being anthropocentric, highlighting the potential for "greenwashing" (25, 80) or for compromising the transformative potential of rewilding (15).

While the above conflicts show that concerns about compromise are legitimate, the literature demonstrates that there is potential for rewilding to be both pragmatic and visionary. To this end, Hawkins et al. (23) developed a theory of change and rewilding guidelines to address this paradox, promoting systems thinking and place-based, collaborative practice that balances transformative vision with place-based pragmatism.

IMPLICATIONS FOR REWILDING SCIENCE AND GOVERNANCE

Beyond these wider conceptual debates, the field of rewilding has had to create systems of governance and monitoring based on ecological process knowledge. Approaches to mapping opportunities for rewilding have also been developed to help target and connect areas for rewilding projects at landscape scales.

Rewilding Governance

The literature reflects a growing consensus on the need to consider governance and human dimensions of rewilding (5, 54). This consensus is supported by studies that seek to clarify the benefits of rewilding to humans, or the human-centered goals of rewilding, to further promote rewilding, address the tensions described above, and link to wider environmental policy (10). Studies of benefits include considerations for well-being, ecosystem services, and livelihoods. However, studies show that these benefits are contextual, influenced by existing values, land uses, worldviews, and so forth. So, there is a trend toward place-based rewilding governance that acknowledges the subjectivities and complexities associated with achieving rewilding goals and scaling up rewilding practice. Guidance is moving away from associating rewilding with specific interventions (e.g., wilderness, species reintroduction) and seeing rewilding as an adaptive process toward rewilding goals and a vision that incorporates functional restoration goals with systemic and sociocultural change (22, 23). Case studies reflect ecocultural or holistic approaches that integrate ecological restoration with cultural (re)connection (81).

However, while the guidelines outlined by Carver et al. (5) are aspirational, there is a tendency in the wider literature to gravitate toward compositional goals of traditional conservation, providing manageable and measurable objectives (23). A key conflict persists between the indeterminacy of rewilding (i.e., its lack of fixed compositional goals) and the focus of traditional conservation on community composition. This tension reflects a broader paradigm shift in some sectors from traditional conservation to rewilding, highlighting the challenges of putting this shift into practice.

Rewilding remains driven largely by human decisions, accompanied by challenges in applying its transformative vision while working within existing values and assumptions. Projects seek to avoid these complexities by limiting their scale, which presents a barrier to scaling up rewilding. Other barriers, like inflexible and short-term funding mechanisms, hinder the implementation

of these principles. Long-term case studies are needed to evaluate the progression of rewilding projects and governance, particularly governance implications of scaling up rewilding.

Further research in different social-ecological contexts and guidance will be required to build on the rewilding frameworks already proposed in the literature, particularly the following:

1. The development of adaptable monitoring guidelines to improve place-based assessments and knowledge sharing.
2. Understanding rewilding economics and integrating systems thinking into rewilding theory.
3. Longitudinal studies to assess whether human preferences and habitat-focused goals hinder rewilding aims.
4. Practical guidelines for collaboration, inclusion, and addressing institutional biases.
5. Consideration of diverse social-ecological contexts and the role of stewardship in promoting sustainable, ecocentric practices.

Monitoring

Robust approaches to monitoring are increasingly recognized as essential in rewilding efforts. The need for empirical evidence to assess whether rewilding restores ecosystem integrity and promotes self-sustaining, resilient ecosystems has been widely acknowledged (5). Achieving the vision of rewilding requires long-term monitoring, which could span several decades.

A key challenge in rewilding research is the limited study of ecosystem responses following megafauna reintroduction (82). Megafauna, as keystone species, affect ecosystems through complex factors such as trophic interactions, landscape features, and human influences. However, comprehensive research on trophic rewilding remains sparse and geographically biased (83). Despite the increase in monitoring studies on rewilding outcomes in the past decade, significant gaps in understanding persist.

Monitoring plans must establish clear goals and objectives, with a focus on specific outcomes like the impact of keystone species reintroduction. This process should address both ecological and socioeconomic components to ensure measurable and achievable outcomes (84). Many rewilding projects, however, fail to define short-term goals, making it difficult to measure their success or failure (85), whereas others embrace an open-ended approach, viewing rewilding as a journey rather than a destination (86). Large-scale initiatives, or those without reference systems, often require long-term, adaptive methods due to unpredictable outcomes and the need for stakeholder engagement.

Effective ecosystem response monitoring requires before/after designs with control or reference systems (84). Unfortunately, controls are often missing. Studies utilizing exclosures as controls include investigations of giant tortoises' effects on vegetation in the Galápagos Islands (82) and studies on large mammals limiting shrub encroachment in Mozambique (87). Despite the importance of reference systems, simultaneous monitoring of both the rewilded site and a reference system is rare.

Understanding species interactions in trophic webs is critical for rewilding success (88). For example, lynx reintroduction in Spain has benefited from such insights. Monitoring typically focuses on vegetation changes (89), species composition, trophic cascades (90), and invasive species (87). Rewilding also affects soil life, as demonstrated by Kaštovská et al. (91), who found changes in soil nutrient availability following herbivore reintroduction. The influence of large mammals on the carbon cycle is a potential nature-based climate solution (92). Various tools, including remote sensing and DNA metabarcoding, have been employed to monitor rewilding progress (87, 89).

Again, as with other forms of restoration, rewilding outcomes depend on context and setting, including reintroduced species and ecosystem characteristics. Hart et al. (93) argue against uniform

standards for success, suggesting country-specific networks to monitor rewilding and restoration outcomes.

Ecological Processes

Rewilding plays a crucial role in restoring ecological processes, enhancing biodiversity, and building ecosystem resilience, particularly by reinstating trophic cascades. Ecological resilience, or the ability of ecosystems to recover from disturbances, is central to most rewilding efforts. By promoting natural species interactions and disturbances, rewilding strengthens the capacity of ecosystems to withstand climate-induced challenges, such as droughts and wildfires. Rewilded landscapes often have greater biodiversity and microhabitat diversity than managed forests or monocultures, aiding faster recovery from environmental stress (94). Large herbivores are key to this process because they influence plant populations and promote regeneration through seed dispersal and selective grazing (95).

Herbivores contribute to ecosystem resilience by maintaining habitat heterogeneity, preventing the encroachment of woody species, and promoting plant diversity (96). Their activities, like trampling, also reduce wildfire risks by lowering vegetation density, particularly in tundra ecosystems, where they help prevent permafrost thaw (94). However, challenges remain in rewilding with herbivores, including conflicts with agriculture and the need for adequate habitat and resources, which have direct implications for animal health and well-being. These challenges are often ignored in rewilding, as has also been the case in conservation more widely. A good example is the public outcry over starving animals in the Oostvaardersplassen nature reserve in the Netherlands (97). Given its focus on animal agency, autonomy, and freedom, rewilding is well-placed to lead conservation toward a more thorough accounting of animal well-being.

Trophic cascades, in which apex predators regulate herbivore populations and indirectly shape ecosystems, are central to rewilding. Again, however, evidence for their effects is context specific. The reintroduction of apex predators, like wolves in Yellowstone National Park in the United States, can trigger ecological shifts, such as reduced herbivory and altered vegetation dynamics. However, these effects are complex, and factors like beaver activity and broader ecosystem interactions also play significant roles (98, 99). Much of the evidence for trophic cascades is correlational, leading to ongoing debates about their extent (100, 101).

Trophic cascades have been observed beyond Yellowstone, such as sea otter–urchin interactions in the Pacific (102). However, they are more pronounced in intact ecosystems, whereas in degraded or human-altered landscapes, top predators' influence may be diminished, complicating generalizations (103, 104). Thus, apex predator reintroduction is context dependent, and more robust research is needed to understand its full ecological impact.

Opportunity Mapping

Much of the above discussion highlights the context-specific nature of rewilding in terms of both social governance and ecological processes. Geographical knowledge regarding the ecological as well as the sociocultural and political setting is essential for successful projects. Several recent articles emphasize the need for spatial information systems such as GIS and remote sensing in understanding the multidimensionality of rewilding and in highlighting opportunities within a wider landscape setting, since deciding where rewilding is the most appropriate and acceptable approach is key to longer-term success.

Carver (105) demonstrates the need for spatial mapping tools to identify areas suitable for rewilding, emphasizing the importance of integrating ecological, social, and cultural factors. Various ways to map wildness exist, and spatial frameworks can enhance our understanding of

ecosystem dynamics and community engagement. The findings underscore the potential for mapping to facilitate effective rewilding strategies and promote biodiversity conservation while addressing local stakeholder interests.

Fayet & Verburg (106) assess the potential of abandoned farmland in Europe to meet environmental policy targets through spatial modeling approaches. They show that repurposing these lands could significantly enhance biodiversity, carbon sequestration, and ecosystem services while supporting sustainable land management. Their study emphasizes that strategic prioritization of areas for restoration can optimize ecological benefits and advocate for integrating socioeconomic factors in policy frameworks to ensure successful implementation and long-term sustainability of initiatives aimed at utilizing abandoned farmland.

Zoderer et al. (107) examine the distinction between protecting wilderness and rewilding through an ecoregion-based framework. Their study identifies priority areas for conserving and restoring natural processes crucial for biodiversity. The findings emphasize the importance of a nuanced approach that balances wilderness protection with rewilding efforts, highlighting specific regions where restoration can enhance ecological resilience. By integrating ecological data and sociopolitical considerations, the authors advocate for targeted conservation strategies that address both biodiversity preservation and the restoration of natural processes, ultimately supporting effective nature conservation practices.

Brown et al. (108) evaluate the future potential for rewilding in the United Kingdom. They identify key areas with high rewilding potential, highlighting the importance of ecological connectivity and landscape heterogeneity. The authors identify sociopolitical factors that may influence rewilding initiatives, including public acceptance and land use policies. Similar to Carver's (105) results, these findings suggest that successful rewilding will require integrating ecological assessments with stakeholder engagement and governance frameworks to balance conservation goals with socioeconomic needs. Ultimately, Brown et al. advocate for a strategic approach to enhance rewilding opportunities while addressing local community concerns.

Bergin et al. (109) present a systematic approach to identifying and prioritizing areas for rewilding in human-dominated regions. Their study integrates spatial data on biodiversity, land use intensity, and ecosystem resilience to map rewilding potential. It emphasizes areas where rewilding could provide significant ecological benefits while minimizing conflicts with human activities. The approach supports decision-making for conservation planning, focusing on regions with the highest rewilding potential. The findings highlight the importance of strategic rewilding in enhancing biodiversity, ecosystem services, and landscape resilience, especially in regions heavily influenced by human land use.

Araújo & Alagador (110) recently explored the potential for rewilding as a strategy to expand protected areas in Europe. They estimate that around 117 million hectares, or 25% of the continent, are suitable for rewilding. They distinguish between passive rewilding, where natural processes are allowed to take over, and active rewilding, which requires human intervention such as species reintroduction. The areas they identify as most viable for rewilding are located mainly in northern and mountainous regions of Europe, including Scandinavia and the Iberian Peninsula. However, densely populated countries like England and the Netherlands may struggle to meet conservation goals without alternative strategies, despite the popularity of rewilding.

Ecological connectivity is another vital aspect of opportunity mapping because ecological corridors allow species to move freely across landscapes, ensuring genetic diversity, species survival, and ecosystem resilience, per the original 3Cs model. Connectivity links fragmented habitats, enabling animals to migrate, find resources, and adapt to environmental changes, all of which is crucial in the face of climate change (111). By facilitating natural processes like dispersal and

migration, connectivity supports trophic interactions and the restoration of ecosystem functions (83).

Without connected habitats, isolated populations can suffer from inbreeding, reduced genetic diversity, and increased vulnerability to local extinctions (112). Rewilding efforts often focus on creating wildlife corridors and restoring natural landscapes to enhance connectivity, allowing species to reestablish their ecological roles. Maintaining and restoring ecological connectivity are thus essential for achieving the long-term goals of rewilding and fostering resilient ecosystems (113). To this end, Cao et al. (114) present a framework for integrating opportunity mapping and connectivity modeling to guide wildland network planning in China. They combine spatial analysis techniques to identify wilderness areas and model ecological connectivity, which is essential for maintaining biodiversity and ecosystem functions. By linking these two approaches, the framework helps plan more effective wildland networks that promote ecological resilience, species dispersal, and habitat connectivity.

OVERVIEW AND CONCLUSIONS

Since the publication of the first review article on rewilding in this journal (1), interest in rewilding has increased and the concept has developed, expanding beyond its initial focus on North America and wilderness areas. It has increasingly been applied in diverse ecological and sociopolitical contexts, leading to a greater understanding of its complexities and the need for adaptable, place-based approaches. This review notes areas of consensus and remaining tensions, and it explores the emergence of themes like functional restoration, human–nature relationships, and environmental justice, emphasizing the move away from compositional goals toward a focus on ecological processes and coexistence.

While there is growing consensus on the core principles of rewilding, uncertainties remain, particularly regarding its relationship with ecological restoration, competing perceptions of nature and culture, and the balancing act between interventions (i.e., managed demanaging) and nonhuman autonomy (i.e., self-willed land). These tensions highlight the need for nuanced approaches that consider diverse values, cultural contexts, and local communities.

Our review identifies the importance of rewilding governance and monitoring, emphasizing the need for place-based frameworks that integrate ecological, social, and cultural factors. Opportunity mapping, along with connectivity modeling, is a crucial tool for identifying and prioritizing rewilding areas.

Rewilding continues to evolve as a complex and multifaceted approach to conservation. The research highlighted in this review offers a nuanced understanding of its potential benefits, challenges, and areas for further exploration. As the concept matures, addressing the remaining uncertainties and developing effective governance mechanisms will be crucial for ensuring the successful implementation of rewilding and for contributing to a more resilient and sustainable future. Moving forward, a more nuanced framework that embraces plurality and focuses on practical applications will be needed to bridge existing divides and realize the transformative potential of rewilding. Such a framework should acknowledge the context-specific nature of rewilding, emphasizing the need for adaptable monitoring guidelines, a deeper understanding of the economics of rewilding, and the development of practical guidelines for collaboration and inclusion.

FUTURE DIRECTIONS

The rewilding literature has grown significantly since 2015. It has increasingly focused on ecological processes, rather than species reintroduction, and is exploring the integration of human presence within rewilding efforts. This focus is reflected in the development of a global

definition and guiding principles for rewilding by the IUCN Commission on Ecosystem Management. The definition emphasizes restoring ecological processes, food webs, and ecosystems to a self-sustaining state, while recognizing the need for a paradigm shift in the human–nature relationship. Further research is needed to address uncertainties and debates in the field.

SUMMARY POINTS

1. Rewilding has matured into a mainstream conservation strategy, evolving from a focus on wilderness and species reintroduction to an emphasis on restoring ecological processes, trophic complexity, and fostering human–nature coexistence.
2. A growing body of literature reflects a paradigm shift in conservation from static, compositional goals to dynamic, functional restoration, increasingly framed through social-ecological systems and relational perspectives.
3. Rewilding is increasingly viewed as a tool for climate change mitigation, particularly through trophic rewilding and the restoration of large herbivores and predators that influence carbon cycling and enhance ecosystem resilience.
4. Guiding principles for rewilding have been developed, emphasizing ecological integrity, landscape-scale planning, local engagement, and a shift toward ecocentric and adaptive governance.
5. Rewilding raises complex debates and tensions, including its relationship to ecological restoration, the role of human intervention versus nonhuman autonomy, and concerns over social justice and inclusion, especially regarding Indigenous perspectives.
6. Emerging forms of rewilding—such as urban, periurban, and agricultural rewilding—expand the concept's scope, demonstrating its adaptability but also necessitating new frameworks for governance and practice.
7. Effective rewilding requires robust monitoring and long-term studies, yet many projects lack clear success criteria or control sites, limiting the ability to measure ecological and social outcomes reliably.
8. Policy recognition of rewilding is growing, with global frameworks like the Paris Agreement and the United Nations Decade on Ecosystem Restoration increasingly supporting nature-based solutions that align with rewilding goals, despite continued implementation challenges.

FUTURE ISSUES

1. Developing adaptable monitoring guidelines to improve place-based assessments and knowledge sharing.
2. Understanding rewilding economics and integrating systems thinking into rewilding theory.
3. Longitudinal studies to assess whether human preferences and habitat-focused goals hinder rewilding aims.
4. Practical guidelines for collaboration, inclusion, and addressing institutional biases.

5. Consideration of diverse social-ecological contexts and the role of stewardship in promoting sustainable, ecocentric practices.

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AUTHOR CONTRIBUTIONS

S.C. was responsible for overall leadership and the main article content. S.H. and T.D. wrote the sections on social-ecological systems. I.C. and R.B. wrote the sections on monitoring and ecological processes. Y.C. was responsible for the figures and overview.

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