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PERSPECTIVE

Biodiversity post-2020: Closing the gap between global targets and national-level implementation

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Abstract

National and local governments need to step up efforts to effectively implement the post-2020 global biodiversity framework of the Convention on Biological Diversity to halt and reverse worsening biodiversity trends. Drawing on recent advances in interdisciplinary biodiversity science, we propose a framework for improved implementation by national and subnational governments. First, the identification of actions and the promotion of ownership across stakeholders need to recognize the multiple values of biodiversity and account for remote responsibility. Second, cross-sectorial implementation and mainstreaming should adopt scalable and multifunctional ecosystem restoration approaches and target positive futures for nature and people. Third, assessment of progress and adaptive management can be informed by novel biodiversity monitoring and modeling approaches handling the multidimensionality of biodiversity change.

KEYWORDS
biodiversity change, global biodiversity framework, implementation, mainstreaming, monitoring, remote responsibility, restoration, scenario, values

1 | INTRODUCTION

While the signatory parties to the Convention on Biological Diversity (CBD) negotiate global biodiversity goals for coming decades, recent reports of the state of biodiversity paint a sobering picture (CBD, 2020a; IPBES, 2019; WWF, 2020). The world is not on track to meet the CBD 2050 vision of "living in harmony with nature." Our repeated failure to reach agreed global biodiversity targets is rooted in the lack of appropriate implementation and effective actions toward them on the national level (Hagerman & Pelai, 2016). While national biodiversity strategies and action plans (NBSAPs) have been revised in response to the 2011–2020 Strategic Plan (Pisupati & Prip, 2015), governments have not aligned national targets well enough with the Aichi targets (Xu et al., 2021). Many policy instruments lacked accountability due to imprecise definition of targeted actions and responsible actors, and systematic monitoring was missing. Uptake of NBSAPs across sectors such as agriculture, energy, or finance has been limited (Whitehorn et al., 2019), and previous frameworks lacked coordination between targets across regulatory agreements and agencies (Perrings et al., 2010).

The current draft of the post-2020 framework establishes a set of goals for 2050 and associated milestones for 2030 for the state of biodiversity and nature's contributions to people, as well as a set of action-oriented targets (CBD, 2021a; Table 1). This proposal considers some of the shortcomings of the past 10 years, with a set of goals and targets informed by science (SBSTTA, 2021). If, however, at the national and local level, implementation of the post-2020 framework is not significantly improved, the world risks missing future biodiversity targets again. Like its predecessors, the post-2020 framework in its current state lacks detail on effective mechanisms to translate global targets into national- or local-level action.

Several recent interdisciplinary advances in our understanding of biodiversity and people's relationship with nature can help to address the implementation gap across stakeholders. These scientific advances can help refine and translate the post-2020 targets to national and subnational scales, identify priority areas for action tailored to particular stakeholders, support assessment, and inform adaptive management (e.g., Leclère et al., 2020). Here, we review those scientific advances in six major topics: multiple values of biodiversity, remote responsibility, restoration, positive futures, multidimensional biodiversity change, and biodiversity monitoring and modeling (Figure 1). Building on those advances, we then propose a framework to support the national and subnational implementation of the post-2020 biodiversity agenda. Although our analysis and proposals are arguably biased toward a perspective of scientists from European countries, we believe they hold insights that can be useful in any region, and therefore we resort also to examples from outside Europe.

2 | BUILDING ON SCIENTIFIC ADVANCES

2.1 | Multiple values of biodiversity

Meeting biodiversity targets requires behavioral change by individuals and organizations (Leadley et al., 2014). Yet, conservation policies often fail to incorporate behavior change theory (Kidd et al, 2019). For example, often biodiversity targets have missed to link concrete target actions to the specific target audience—the individuals or groups whose behavior is to be changed (e.g., 40% of national pollinator initiatives fail to identify who needs to do what differently; Marselle et al., 2020). In order to do so, it is important to understand how people value biodiversity. People place multiple values on biodiversity which is important for physical, mental, and social health and well-being (Marselle et al., 2019). The different perceptions and values of biodiversity are often linked to the preferences of different stakeholder groups for particular bundles of ecosystem services (Martin-López et al., 2012).

Many of the original arguments to protect biodiversity were based on intrinsic and existence values of nature (Mace, 2014). Later, the concept of ecosystem services included more utilitarian views, including the insurance and option values of biodiversity, opening opportunities to align conservation with economic measures (Mace, 2014). The concept of ecosystem services was well suited to represent biodiversity facets appreciated by different economic sectors (Hiron et al., 2018), particularly those that have a market, incentivizing conservation to secure their provision. Nonetheless, values placed on biodiversity by individuals or local communities are often dependent on highly variable cultural and societal contexts, and frequently lack such markets (Adams, 2014). Policies need to consider the plurality of values to effectively prioritize actions (Hiron et al., 2018) and should strive to make hedonic and utilitarian goals compatible with normative or cultural values and goals (Steg et al., 2014). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has brought increased recognition of indigenous and local knowledge perspectives, leading to the concept of nature's contributions to people (Pascual et al., 2017). This concept encompasses diverse perspectives on values of nature, including relational values, and emphasizes how culture shapes our relationship with nature.

TABLE 1 Current draft of the goals and targets of the Convention on Biological Diversity (CBD) post-2020 framework (adapted from CBD, 2021a)

Goal A: The integrity of all ecosystems is enhanced, with an increase of at least 15% in the area, connectivity and integrity of natural ecosystems, supporting healthy and resilient populations of all species, the rate of extinctions has been reduced at least tenfold, and the risk of species extinctions across all taxonomic and functional groups, is halved, and genetic diversity of wild and domesticated species is safeguarded, with at least 90% of genetic diversity within all species maintained.
Goal B: Nature's contributions to people have been valued, maintained, or enhanced through conservation and sustainable use supporting the global development agenda for the benefit of all.
Goal C: The benefits from the utilization of genetic resources are shared fairly and equitably, with a substantial increase in both monetary and nonmonetary benefits shared, including for the conservation and sustainable use of biodiversity.
Goal D: The gap between available financial and other means of implementation, and those necessary to achieve the 2050 Vision, is closed.
Reducing threats to biodiversity
Target 1: Ensure that all land and sea areas globally are under integrated biodiversity-inclusive spatial planning addressing land- and sea-use change, retaining existing intact and wilderness areas.
Target 2: Ensure that at least 20% of degraded freshwater, marine and terrestrial ecosystems are under restoration, ensuring connectivity among them and focusing on priority ecosystems.
Target 3: Ensure that at least 30% globally of land areas and of sea areas, especially areas of particular importance for biodiversity and its contributions to people, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.
Target 4: Ensure active management actions to enable the recovery and conservation of species and the genetic diversity of wild and domesticated species, including through ex situ conservation, and effectively manage human-wildlife interactions to avoid or reduce human-wildlife conflict.
Target 5: Ensure that the harvesting, trade, and use of wild species is sustainable, legal, and safe for human health.
Target 6: Manage pathways for the introduction of invasive alien species, preventing, or reducing their rate of introduction and establishment by at least 50%, and control or eradicate invasive alien species to eliminate or reduce their impacts, focusing on priority species and priority sites.
Target 7: Reduce pollution from all sources to levels that are not harmful to biodiversity, ecosystem functions, or human health, including by reducing nutrients lost to the environment by at least half, and pesticides by at least two thirds and eliminating the discharge of plastic waste.
Target 8: Minimize the impact of climate change on biodiversity, contribute to mitigation and adaptation through ecosystem-based approaches, contributing at least 10 GtCO2e per year to global mitigation efforts, and ensure that all mitigation and adaptation efforts avoid negative impacts on biodiversity.
Meeting people's needs through sustainable use and benefit-sharing
Target 9: Ensure benefits, including nutrition, food security, medicines, and livelihoods for people especially for the most vulnerable through sustainable management of wild terrestrial, freshwater, and marine species and protecting customary sustainable use by indigenous people and local communities.
Target 10: Ensure all areas under agriculture, aquaculture, and forestry are managed sustainably, in particular through the conservation and sustainable use of biodiversity, increasing the productivity and resilience of these production systems.
Target 11: Maintain and enhance nature's contributions to regulation of air quality, quality and quantity of water, and protection from hazards and extreme events for all people.
Target 12: Increase the area of, access to, and benefits from green and blue spaces, for human health and well-being in urban areas and other densely populated areas.
Target 13: Implement measures at a global level and in all countries to facilitate access to genetic resources and to ensure the fair and equitable sharing of benefits arising from the use of genetic resources and, as relevant, of associated traditional knowledge, including through mutually agreed terms and prior and informed consent.
Tools and solutions for implementation and mainstreaming
Target 14: Fully integrate biodiversity values into policies, regulations, planning, development processes, poverty reduction strategies, accounts, and assessments of environmental impacts at all levels of government and across all sectors of the economy, ensuring that all activities and financial flows are aligned with biodiversity values.
Target 15: All businesses (public and private, large, medium, and small) assess and report on their dependencies and impacts on biodiversity, from local to global, and progressively reduce negative impacts, by at least half and increase positive impacts, reducing biodiversity-related risks to businesses and moving toward the full sustainability of extraction and production practices, sourcing and supply chains, and use and disposal.

(Continues)

TABLE 1 (Continued)

Target 16: Ensure that people are encouraged and enabled to make responsible choices and have access to relevant information and alternatives, taking into account cultural preferences, to reduce by at least half the waste and, where relevant the overconsumption, of food and other materials.
Target 17: Establish, strengthen capacity for, and implement measures in all countries to prevent, manage or control potential adverse impacts of biotechnology on biodiversity and human health, reducing the risk of these impacts.
Target 18: Redirect, repurpose, reform, or eliminate incentives harmful for biodiversity, in a just and equitable way, reducing them by at least 500 billion per year, including all of the most harmful subsidies, and ensure that incentives, including public and private economic and regulatory incentives, are either positive or neutral for biodiversity.
Target 19: Increase financial resources from all sources to at least 200 billion per year, including new, additional and effective financial resources, increasing by at least 10 billion per year international financial flows to developing countries, leveraging private finance, and increasing domestic resource mobilization, taking into account national biodiversity finance planning, and strengthen capacity building and technology transfer and scientific cooperation, to meet the needs for implementing the post-2020 global biodiversity framework implementation, commensurate with the ambition of the goals and targets of the framework.
Target 20: Ensure that relevant knowledge, including the traditional knowledge, innovations and practices of indigenous and local communities with their free, prior, and informed consent, guides decision making for the effective management of biodiversity, enabling monitoring, and by promoting awareness, education and research.
Target 21: Ensure equitable and effective participation in decision-making related to biodiversity by indigenous people and local communities, and respect their rights over lands, territories and resources, as well as by women, girls, and youth.

FIGURE 1 Scientific advances of the past 10 years inform a framework for implementation of the post-2020 goals and targets. The framework promotes ownership and mainstreaming, accountability and monitoring of biodiversity and is applicable across sectors and spatial scales

Although the proposed Target 21 (Table 1) recognizes the importance of equitable participation of local communities in decision-making, we argue that recognizing and fostering these different values systems needs to underpin the translation and implementation of the entire post-2020 set of goals and targets. This would increase acceptance, ownership and thus mainstreaming of biodiversity goals. For instance, proposed Targets 1 through 3 (Table 1) should recognize that priority areas for conservation and restoration need to be defined based on different values of biodiversity. At the national level, a general percentage target for protected areas may be meaningless without associated targets for different types of protected areas reflecting different conservation values.

Overall, global biodiversity targets need to be translated to national policy by clearly defining the practices and behaviors to be changed and the sectors or population groups that need to change their practices. This needs to be followed by an analysis of values as motivational influences for different target groups (A. Nilsson et al, 2016; Steg & Vlek, 2009). This identification of actions can build on ongoing initiatives on different sectors, such as impact investment on the finance sector which aims to address social and environmental challenges alongside achieving financial returns (Bauman et al., 2018) or the mitigation and off-set measures of the mining industry (Virah-Sawmy et al, 2014). Employment of the full range of effective behavioral intervention tools, beyond education and incentives (Byerly et al., 2018; Cinner, 2018; Marselle et al., 2020), for example, environmental restructuring, training, and social role models (Michie et al., 2014), can pave the road to more successful implementation of post-2020 targets.

2.2 | Remote responsibility

We live in an increasingly connected world. People benefit from biodiversity distant from their homes, through trade, travel, or information, and conversely, indirectly affect biodiversity in remote regions through land-use, resource exploitation, and consumption (Koellner et al, 2019; Liu et al., 2016; Moran & Kanemoto, 2017). Thirty percent of global species' threats are linked to internationally traded commodities (Lenzen et al., 2012), with 90% of the biodiversity impacts from consumption in high-income countries occurring elsewhere, particularly in tropical regions (Marques et al., 2019). Correspondingly, strategies to conserve and restore biodiversity could be substantially more effective if they were directly integrated into supply- and demand-side measures in the economic sectors responsible for biodiversity losses (Leclère et al., 2020). Many governments and companies have already committed to sustainable practices, for example, through zero-deforestation commitments, but often struggle to trace their impacts along their complex supply chains (Green et al., 2019).

Recently, more detailed attribution of regional biodiversity impacts to specific sectors and even individual actors has become possible through approaches such as life cycle analysis, multi-regional input-output analysis, and among others (Godar et al., 2016; Green et al., 2019; Marques et al., 2017), and a number of databases are being made available for end-users tapping also into earth observations and machine learning (Moran et al., 2020). In addition, with the emergence of internationally comprehensive and detailed environmental accounting tools such as the UN System of Environmental Economic Accounting (Hein et al., 2020), we can increasingly pinpoint which sectors impact ecosystems, what these impacts are, where they occur, and which actors in supply chains beyond producers and final consumers are involved. Together with the increasing scope and detail of global biodiversity monitoring, this opens opportunities for mainstreaming biodiversity with quantifiable contributions per sector and country to meet global targets.

The use of attribution approaches for remote impacts is particularly relevant for translating Target 15 on impacts of businesses on biodiversity and Target 16 on people's consumption patterns to national and sectoral targets (Table 1). In addition, with an increasing part of the population in urban centers, the indirect remote impacts of cities will continue to increase and exceed their direct impacts (McDonald et al., 2020). The importance of different levels of government is recognized in the renewed Plan of Action on Subnational Governments, Cities and Other Local Authorities of the CBD 2021–2030 (CBD, 2021b). However, significant work remains ahead to support local governments in translating the post-2020 global biodiversity framework with the most recent scientific advances on remote responsibility.

2.3 | Restoration

It is increasingly apparent that in order to bend the curve of biodiversity loss (Mace et al., 2018), we have to move from conserving the remaining biodiversity to restoring ecosystems (Leclère et al., 2020; Strassburg et al., 2020). The declaration of 2021–2030 as the Decade on Restoration by the United Nations recognizes the importance of restoration on environmental policy. Based on more than 2 decades of studies of biodiversity and ecosystem functioning (Eisenhauer et al., 2019), we are now increasingly able to design restoration projects that manage biodiversity to improve particular ecosystem services such as carbon sequestration while maintaining resilience to change (Kollmann et al., 2016), for instance by diversifying planted forests (Messier et al., 2021). This will increasingly enable our capacity to develop restoration projects that provide nature-based solutions to environmental problems (Griscom et al., 2017). The discipline of restoration research has also evolved from a strictly natural science discipline toward collaborative work between natural and social sciences. Restoration is now considered an important tool for spreading awareness about environmental issues and empowering communities (Druschke & Hychka, 2015).

Still, some of the most effective restoration approaches are based on natural ecological processes and passive restoration (Chazdon & Guariguata, 2016; Crouzeilles et al., 2017). Large-scale passive afforestation can both restore native biodiversity and place us on a path to the 1.5°C Paris goal (Lewis et al., 2019), in contrast to large scale monotonous exotic tree plantations which may neither be effective for carbon sequestration nor desirable for biodiversity conservation. The idea of promoting more space for nature to promote self-regulating and functional ecosystems is at the core of rewilding (Perino et al., 2019). Rewilding is a major shift in restoration away from static restoration goals, such as species composition, toward restoring interacting ecosystem processes (Toit & Pettorelli, 2019).

Actions to protect or restore natural ecosystems, including rewilding, have often been criticized for being top-down and for excluding people from land (Dove, 2006; Fox & Cundill, 2018; Ward, 2019). In particular, they have not always acknowledged indigenous cultural landscapes and have negated long-standing, multidimensional relationships of indigenous or traditional people with landscapes. While recent restoration frameworks, including rewilding, acknowledge the societal dimension of restoration (Perino et al., 2019), the role and rights of indigenous people and other local communities (IPLCs) need to be strengthened in restoration projects. This requires social-ecological thinking and the inclusion of relational values in the discussion of restoration goals (Fisher et al., 2021). Better inclusion of IPLCs in the development of new restoration actions could, for example, be supported through legislation that recognizes IPLC land tenure rights and includes their participation in the development and planning processes, going beyond observing "free, prior, and informed consent."

The post-2020 framework has revised the 2020 Aichi target on restoration to now aim at placing 20% of degraded ecosystems under restoration by 2030 (Target 2, Figure 1). This change reflects an increased ambition from the previous 15% target, and requires the recognition that these areas may not be restored by 2030 as there can be considerable time lags between policy actions and restoration outcomes (sometimes referred to as "restoration debt," Tittensor et al., 2014). This calls for the use of models to estimate the future impacts of policy actions (Ferrier et al., 2016). The restoration debt should be further considered in reporting and accountability measures, for example, by reporting on action-oriented as well as outcome-oriented indicators.

Systematic approaches to identify the priority areas for restoration and the modes of restoration (e.g., active restoration vs. passive rewilding) and ecosystem functions targeted at each area will be a key translation challenge for the governments on Target 1. In addition, connecting Target 1 with Target 3 on protected areas, Target 8 on climate mitigation, and Target 10 on sustainable agriculture will facilitate synergies and cobenefits of policy actions (Figure 1). For instance, the EU Biodiversity Strategy for 2030 (EC, 2020) proposes the development of legally binding EU nature restoration targets by 2021. It also recognizes the linkages between these targets, and the different types of protected areas, stating an ambitious target of 30% of protected areas and an even more ambitious target of 10% strict protected areas by 2030.

2.4 | Positive futures

One of the major results of the IPBES Global Assessment is the need for transformative change across economic, social, and political factors (IPBES, 2019). Scenario studies provide an important tool in understanding how transformative change can be achieved, and they can be used at different stages of the policy design cycle (Ferrier et al., 2016). For instance, Leclère et al. (2020) have explored how actions on conservation, on the demand side and on the supply side, or combination of those three types of actions can bend the curve of terrestrial biodiversity loss.

Recently, scenarios assessing positive futures for nature and people have started to be developed (Bennet et al., 2016; Rosa et al., 2017). Examining pathways to positive futures for biodiversity and people requires participatory approaches involving diverse stakeholders from different sectors—with indigenous, local, and expert knowledge—and quantitative models at different scales (Rosa et al., 2017). For instance, the nature futures framework, originally developed by the IPBES Expert Group on Scenarios and Models, aims at improving the state of nature by considering three perspectives: nature for nature (emphasizing existence and intrinsic values), nature for society (emphasizing utilitarian values), and nature as culture (emphasizing relational values) (L. M. Pereira et al., 2020).

Some of the values for the quantitative aspects of the post-2020 targets are already guided by scenarios (Diaz et al., 2020), but we advocate an even more concrete and broader use of scenarios in translating the targets to the national level. The action-oriented targets of the post-2020 need to be concretized into specific actions by different actors at the national level, and the exact mix of actions and their ambition needs to be assessed against the overall goals. Scenario analysis can help here by using models to assess the contribution of different mixes of actions to achieve the 2050 goals and 2030 milestones for biodiversity (Table 1).

2.5 | Multidimensional biodiversity change

Biodiversity change is complex. It is a result of both biodiversity alterations and biodiversity loss (H. M. Pereira et al., 2012). Research on previously hidden aspects of biodiversity has highlighted that patterns of biodiversity change vary across biomes (Cameron et al., 2019), within taxonomic groups (van Klink et al., 2020) and across scales (Keil et al., 2018). Global meta-analyses have not revealed consistently negative trends in local species richness, although there are significant alterations in community composition over time (Blowes et al., 2019). Yet, at global scales, extinction rates are elevated by orders of magnitude (IPBES, 2019). One explanation for this apparent paradox is that narrow-ranged species are more vulnerable to change and are being replaced by wide-ranged ones, leading to biodiversity homogenization around the world (Newbold et al., 2019; Staude et al., 2020). Some of these colonizing species are invasive species that are important drivers of biodiversity loss themselves (IPBES, 2019). It is now apparent that the distribution of species in their exotic ranges is becoming increasingly homogenous (Capinha et al., 2015).

Mounting evidence suggests that biomass and total abundance of several functional groups are declining, with some of the most abundant species exhibiting strong declines (Gregory et al., 2019; Rosenberg et al., 2019; Schipper et al., 2016). As abundant species play a key role in energy flows and nutrient cycling in ecosystems, the impacts of biodiversity change on ecosystem functioning may be greater than previously appreciated and ultimately affect the provision of ecosystem services (Felipe-Lucia et al., 2020). The explicit goals around multiple levels of biodiversity formulated in the current draft of the post-2020 strategy are a step toward acknowledging this complexity of biodiversity change. But how to define quantitative baselines and assess progress for the multiple dimensions of biodiversity change, particularly at the national and subnational scales, is not yet adequately covered in the post-2020 monitoring framework (CBD, 2020b). We suggest that multiple metrics of biodiversity change need to be incorporated, and limitations of indicators such as the Living Planet Index need to be addressed (e.g., Leung et al., 2020).

2.6 | Monitoring and modeling biodiversity

Effective, traceable, and accountable implementation of biodiversity policies requires evidence of change, that is, monitoring of biodiversity trends. This is a major challenge, however, given the conspicuous lack of coordinated national and global biodiversity observation systems (Navarro et al., 2017). National reports to the CBD often lack evidence-based indicators (Pisupati & Prip, 2015). This absence of tools to evaluate the effectiveness of measures and policy instruments for the implementation of biodiversity goals and targets across all sectors is at the core of policy failure.

New opportunities for assessing biodiversity status and trends have emerged in recent years. Novel biodiversity models integrate in situ observations with remote and other sensing methods, and approaches such as environmental DNA monitoring are coming of age (Navarro et al., 2017). Global data repositories such as the Global Biodiversity Information Facility (GBIF) and increased efforts in data sharing and standardization further fuel the potential of these approaches (Jetz et al., 2019; Kissling et al, 2018). These advances allow for more cost-effective and more spatio-temporal representative monitoring of biodiversity change, providing data for increasingly realistic models that can generate future projections and support decision-making (Ferrier et al., 2017). For instance, the Group on Earth Observations Biodiversity Observation Network (GEO BON) is developing open model-based workflows for Essential Biodiversity Variables (H. M. Pereira et al., 2013), that is, a set of complementary measurements needed to detect and document biodiversity change across all levels of biodiversity across space and time (Fernández et al., 2020).

Despite these advances, major data gaps remain as most countries lack national biodiversity monitoring systems. Unfortunately, the current draft of the post-2020 framework falls short of setting explicit targets for the establishment of national biodiversity monitoring systems, although monitoring is mentioned in Target 20. In order for countries to deploy cost-effective systems to monitor the post-2020 goals and targets, the integration of remote sensing with models will be essential. Remote sensing and modeling approaches can fill data gaps and facilitate transparency, together with the adoption of Findable, Accessible, Interoperable and Re-usable (FAIR) data principles. Promoting a culture of integration of different monitoring actors, including agencies across different sectors, research organizations, natural history museums, and societies can foster effective and resilient monitoring networks (Kühl et al., 2020). Participation of citizens in biodiversity monitoring and community-based monitoring projects (Farhan Ferrari et al., 2015; FAO, 2018) can complement professional monitoring efforts and foster societal awareness, capacity-building, environmental stewardship, and social license for biodiversity conservation (Kelly et al., 2019; Turrini et al., 2018), contributing to Target 21.

Tackling the challenges we are facing requires transformation at all levels of society. As a result, it is important to not only monitor biodiversity trends but also changes toward more biodiversity-friendly behavior. Studies on monitoring behavior change are scarce compared to studies focusing on changes in attitudes (D. Nilsson et al., 2020). This gap should be addressed as it has been shown that a change in attitude does not necessarily lead to a change in behavior. Studies monitoring behavior should clearly define the target group (i.e., the group whose behavior should be changed), should be designed to fit the targeted action (e.g., frequent behaviors should be monitored frequently), and should include an impact evaluation some years after the end of the intervention to assess its long-term success (D. Nilsson et al., 2020).

3 | IMPLEMENTING THE POST-2020 FRAMEWORK

We draw on these scientific advances to outline a framework for implementation of the post-2020 goals and targets. In our view, global goals and targets should define the scope of target and actions at the national and subnational scales. Based on this premise, we propose actions in three interlinked steps that address the challenges of ensuring ownership of the actions by multiple stakeholders, mainstreaming of the implementation across sectors, and accountability of the different actors (Figure 1). These three interlinked steps are not strictly sequential (e.g., the identification of actions can be combined with assessment of the impact of the actions) and can be refined cyclically with each implementation cycle being informed by the previous one, using an adaptive management approach.

3.1 | Identifying actions and enhancing ownership

Step one is the translation of global targets to national targets and the identification of sector-specific actions (Figure 1). These action plans should include the production sectors, such as agriculture and forestry, and other sectors such as public health, transport, infrastructure, energy, trade, and finance. The codesign of national and subnational biodiversity strategies and action plans for post-2020 by a wide range of stakeholders at the relevant scale is needed to create and enhance ownership of those plans and overcome responsibility gaps (Nunan et al., 2012; Sarkki et al., 2016). For this, the diversity of biodiversity values and preferences held by those stakeholders need to be recognized explicitly (Zinngrebe, 2018), and the different sectors need to identify actionable and accountable measures for their fields themselves. For instance, farmer associations may want to identify actions important for agrobiodiversity and for pollination services, hunters and fishermen associations should identify actions regarding sustainable harvest, indigenous and local communities may advocate for the formal recognition and maintenance of cultural landscapes, and finance and trade should identify and enact sustainable modes of business transactions. Spatial planning conflicts and solutions need to be identified that seek cobenefits across multiple values and preferences in stakeholder fora (Carvalho Ribeiro et al., 2013; Kim et al., 2021; Reed et al, 2013).

Impacts on biodiversity can now be traced, quantified, and mapped across scales, facilitating the identification of sector-specific responsibilities and needs for action (Marques et al., 2017; Moran et al., 2020). In addition, there is an increase in the perceived "reputational" risk by many stakeholders, particularly in the business sector, which can facilitate a more proactive attitude of those stakeholders on addressing their responsibilities in order to minimize future risk (van Toor et al, 2020; World Bank, 2020). Implementation plans need to include an inventory of actions to be carried out by each sector, and the projected contributions of each action to global and national biodiversity goals.

3.2 | Implementation and mainstreaming

Cross-sectoral implementation of actions is the second step (Figure 1). Policies and interventions should be facilitated by legal, economic, and other behavioral tools, targeting different stakeholders (IPBES, 2019). Scenario development and other participatory exercises to identify positive futures can function as leverage points and enable conditions for implementation (Karlsson-Vinkhuyzen et al., 2017; Reed et al., 2013; Runhaar et al., 2020; Zinngrebe, 2018). A major challenge is to adjust existing regulatory frameworks, finance flows, and network structures, which currently prioritize support for nonsustainable forms of production over those integrating biodiversity values (Zinngrebe et al., 2020). For instance, subsidies harmful to biodiversity need to be eliminated (Pe'er et al., 2019), and if new subsidies are implemented, governments need to ensure that they promote biodiversity-friendly economic choices in the long-term, by better accounting for negative externalities of agricultural production and the public good dimension of biodiversity (Deutz et al., 2020).

Detailed plans for both active restoration and passive rewilding will need to be developed together with all stakeholders and funded. Innovative conservation finance mechanisms could leverage funding from impact investors to support biodiversity-sound businesses and restoration interventions by nongovernmental organizations (Bos et al., 2015; Deutz et al., 2020; World Bank, 2020). Compliance of different stakeholders in each country could be fostered by rewarding those that implement commitments and penalizing those that have not. For instance, fiscal transfers to municipalities can depend on the level of implementation of protected areas and other biodiversity conservation measures (Brito, 2020; Tacconi et al., 2019), and governments should tax businesses for externality costs of biodiversity-adverse actions. Some countries, for example, Mexico, Portugal, and Brazil financially reward municipalities that designate land for ecosystem service provision or biodiversity protection (OECD, 2020; Ring, 2008; Santos et al., 2012).

3.3 | Assessment, accountability, and adaptive management

Finally, as step three, the systematic assessment of biodiversity and its response to management actions is needed to support accountability mechanisms and adjust further actions in an adaptive management cycle (Figure 1). To this end, countries need to implement national biodiversity observation systems. To fully capture the complexity of biodiversity change, multiple biodiversity metrics (e.g., Essential Biodiversity Variables) and issues of temporal and spatial scalability should be considered (Guerra et al., 2019). Importantly, monitoring systems should be able to traceback biodiversity change to various sectors and administrative units, including production and consumption impacts (Marques et al., 2019).

The data and knowledge from biodiversity monitoring systems, interpreted through scenarios and models, can then be used by regional and national agencies to evaluate policies and adjust actions as needed (Ferrier et al., 2016). For instance, retrospective policy evaluation can be carried out through impact evaluation methods, while policy design and policy setting can use models of the impacts of direct drivers on biodiversity and ecosystem services (Kim et al., 2021). In addition, the UN System of Environmental Economic Accounting (UNCEEA, 2021) can help assess social costs of biodiversity-adverse activities and guide the design of new policies (Hein et al., 2020).

Finally, to ensure accountability, signatory parties should regularly report on the implementation level of actions, and their effectiveness in mitigating and reversing biodiversity loss. The CBD could also consider linking the achievement of national commitments to particular Global Environment Fund lines, World Bank loans, or specially designated biodiversity funds. For example, countries could contribute to such global biodiversity funds based on their remote impacts on biodiversity (Marques et al., 2019), which is arguably an alternative criterion to the ones currently being used based on historical contributions or gross domestic product (GEF, 2021).

4 | ACHIEVING TRANSFORMATIONAL CHANGE

The next decade is crucial for bending the curve of biodiversity loss (Mace et al., 2018) and placing us on track to achieving the CBD 2050 vision of "living in harmony with nature." To achieve transformative change, effective implementation of the post-2020 framework requires increased stakeholder ownership through actionable measures with clearly assigned responsibilities, policy coherence through integration, and implementation across multiple sectors, as well as systematic monitoring to assess changes and effectively evaluate policy measures at the national and global scale.

A wealth of evidence is available to inform action toward transformative change already today. At the same time, continued monitoring is necessary to track success and failures on the path toward a transformed society and for data-driven decision making and adaptive management. The knowledge needed to support such transformative change is continuing to grow, particularly through the integration of scientific developments from multiple disciplines. Biodiversity values, remote responsibility, restoration science, scenarios of positive futures, the study of multidimensional biodiversity change, and the development of biodiversity monitoring and modeling are important fields that will help to translate global goals into national and local action for safeguarding the sustained health and well-being of the people and our planet.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Henrique M. Pereira, Aletta Bonn, and Andrea Perino developed the idea for the work and organized the workshop where the concepts and frameworks were created. Andrea Perino, Henrique M. Pereira and Aletta Bonn wrote the manuscript with special contributions from Maria Felipe-Lucia, HyeJin Kim, Hjalmar S. Kühl, Melissa

R. Marselle, Carsten Meyer, Jasper N. Meya, Laetitia M. Navarro, and Roel van Klink and contributions from all other authors.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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