How Percentage-Protected Targets Can Support Positive Biodiversity Outcomes

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ABSTRACT

Global targets for the percentage area of land protected, such as 30% by 2030, have gained increasing prominence, but both their scientific basis and likely effectiveness have been questioned. As with emissions-reduction targets based on desired climate outcomes, percentage-protected targets combine values and science by estimating the area over which conservation actions are required to help achieve desired biodiversity outcomes. Protected areas are essential for achieving many biodiversity targets, in part because many species cannot persist even at relatively low levels of human-associated disturbance. However, because the contribution of protected areas to biodiversity outcomes is contingent on their location, management, governance, threats, and what occurs across the broader landscape matrix, global percentage-protected targets are unavoidably empirical generalizations of ecological patterns and processes across diverse geographies. Percentage-protected targets are insufficient in isolation but can complement other actions and contribute to biodiversity outcome goals within a framework that balances accuracy and pragmatism in a global context characterized by imperfect biodiversity data. Ideally, percentage-protected targets serve as anchors that strengthen comprehensive national biodiversity strategies by communicating the level of ambition necessary to reverse current trends of biodiversity loss. If such targets are to fulfill this role within the complex societal process by which both values and science impel conservation actions, conservation scientists must clearly communicate the nature of the evidence base supporting percentage-protected targets and how protected areas can function within a broader landscape managed for sustainable coexistence between people and nature. A new paradigm for protected and conserved areas recognizes that national coordination, incentives, and monitoring should support rather than undermine diverse locally-led conservation initiatives. However, the definition of a conserved area must retain a strong focus on biodiversity to remain consistent with the evidence base from which percentage-protected targets were originally derived.

INTRODUCTION

Percentage targets for the area of land (or water) protected for biodiversity conservation have been a persistent but contentious feature of global conservation policy for several decades. Most recently, to address the accelerating loss of global biodiversity (IPBES, 2019), many national governments have endorsed calls to protect at least 30% of their respective nations by 2030 (UNEP, 2020). This “30x30” commitment will likely be a key element of a new set of biodiversity targets, the Global Biodiversity Framework (GBF), to be finalized at the upcoming 15th Conference of Parties to the Convention on Biological Diversity (CBD)(CBD, 2021).

Targets such as 30x30 (henceforth “percentage-protected targets”) have grown more ambitious over time. In 1987, the Brundtland Commission suggested that the world’s nations each protect at least 12% of their area (Brundtland, 1987). At its 2010 meeting, the CBD proposed that its parties (all nations except the US and the Vatican) protect at least 17% of their terrestrial area by 2020 (CBD, 2010). With about 16% of the Earth’s land area now formally protected, the areal component of this goal has nearly been achieved, representing a tripling of the global protected area network in the span of a few decades (UNEP-WCMC, 2021).

The motivation for advancing biodiversity conservation via a global target for the percentage of the landscape within protected areas lies in the essential role that protected areas play in sustaining biodiversity in the face of anthropogenic pressures, and the relative feasibility of tracking increases in protected area designations (Watson et al., 2014; Bhola et al., 2020). Global percentage-protected targets have demonstrably advanced conservation, not only by directly incentivizing expansion of protected area networks, but also by helping to raise awareness of biodiversity loss, build partnerships and promote investment in conservation, and develop tools for tracking the status of biodiversity (Doherty et al., 2018, Woodley et al., 2019).

Nevertheless, while percentage-protected targets appear effective in practice in part because they are simple to communicate and monitor, the difference they make to the conservation outcome of interest - retention or restoration of healthy and biologically diverse ecosystems that sustain human societies – is often unclear (Maron et al., 2021, Pressey et al. 2021). Several recent reviews have suggested that percentage-protected targets can have unanticipated negative effects on biodiversity outcomes if national governments focus solely on the areal extent of protection or implement new protected areas without regard to equity and rights of Indigenous communities (Maxwell et al., 2020, Pressey et al., 2021).

Are proposals such as 30x30 and “Nature Needs Half” (Locke, 2014) simply a means of communicating that nature needs more? Or do percentage-protected targets have value beyond stimulating conservation ambition? Is it possible to retain the practical value of a simple target while improving its relevance to biodiversity outcomes? Increasing the likelihood that percentage-protected targets contribute substantially to retention of biodiversity requires clarifying the social and ecological complexities of the linkage between protected areas and biodiversity outcomes across a diverse spectrum of land management and governance contexts.

In this paper, we clarify the link between percentage-protected and biodiversity-outcome-based targets, drawing parallels to analogous challenges in defining global emissions- reduction targets and linking these targets to global climate outcomes (Table 1). We connect the evidence base supporting percentage-protected targets with the standards necessary for defining protected and conserved areas (the latter term used here to refer to areas managed under “other effective area-based conservation measures" (OECM; CBD, 2010)) in a manner that is flexible but ensures that such areas contribute substantively to biodiversity outcome goals. We address how strictly-protected areas can be more effectively integrated into landscape-wide planning to enhance the biodiversity benefits received from areas under other types of management, and how national coordination, incentives, and monitoring can support locally-led conservation initiatives. Our goal in exploring these issues is a more nuanced understanding of the strengths and limitations of percentage-protected targets and their value within the broader framework of biodiversity outcomes and the sociopolitical process through which conservation progress occurs.

THE HISTORY OF AND EVIDENCE BASE FOR PERCENTAGE-PROTECTED TARGETS

Much existing literature addressing percentage-protected targets tends to conflate protected area establishment (an action) and biodiversity retention (an outcome)(Maron et al., 2018). Whenever percentage-protected targets are communicated, it is crucial that the assumptions underpinning them be made clear. Is this the required percentage of land under strict protection, such as national parks? Or is this an estimate of the total area of strict protection plus multiple-use management required to achieve desired biodiversity outcomes? And in either case, is it assumed that the remaining landscape will be eventually transformed and therefore contribute little or nothing to biodiversity outcomes?

Two main lines of evidence supporting identification of percentage-protected targets. First, thresholds sometimes can be directly identified in the response of biodiversity or ecosystem processes to varying levels of intact habitat or development intensity within a landscape. In an early example of a process-based approach based on systems ecology, Odum and Odum (1972) proposed that prudent planning would retain 50% of every region as natural area to ensure maintenance of what are now called ecosystem services. Species-area relationships have also been used to justify percentage-protected targets that would limit species extinctions to below a certain level (Wilson, 2016). Such proposals are implicitly agnostic as to the extent that the landscape outside protected areas will contribute to biodiversity or ecosystem function goals; taken to its extreme, this might imply that all biodiversity outside the protected areas will be lost (here termed a “30+0” (or “50+0”) approach).

A second, prioritization-based approach identifies conservation features that are deemed essential to capture within protected areas due to their irreplaceability or vulnerability, and calculates the total percentage of a landscape that is required to retain all such features (Noss & Cooperrider, 1994). Although typically based on static conservation features, prioritizations can also include output from spatially-explicit population or disturbance models (Noss et al., 2002). Global targets have been proposed based on a synthesis of systematic conservation plans from many regions, leading to estimates that retention of natural systems (via strict protection or other management strategies) across approximately 25-75% of an ecoregion is needed to meet well-accepted conservation goals such as representing all ecosystem types, maintaining viable populations of all native species, and sustaining ecological processes and resilience (Noss, 1996; Noss et al., 2012; Jung et al., 2021).

Many ecoregional plans also consider the contribution to conservation of lands outside strictly protected areas, and what management is consistent with sustaining this contribution in combination with human economic uses. This approach in its extreme might be termed a “30+70” approach in the context of the 30% target, in that it envisions a core network of protected areas embedded in a landscape managed for sustainable coexistence between humans and nature

(Watson et al., 2021). Positive biodiversity outcomes often require a combination of “land sparing” (areas with limited use) and “land sharing” (areas with more intensive human use that also support biodiversity)(Kremen, 2015).

These complexities can be obscured when scientific findings are translated into simple targets, leading critics to question whether percentage-protected targets are science-based (Wilhere, 2021). Three broad issues arise when translating data on biodiversity’s response to protected areas into global targets. First, such targets may be science-informed but unavoidably include a normative component. Proponents of percentage-protected targets acknowledge that such targets are based on a mix of science and values, arising from both the instrumental value of biodiversity to humans and the proposition that biodiversity has intrinsic value and ought to be conserved (Fearnside, 2021; Noss, 1996). Percentage-protected targets should reflect science-based estimates of the area over which actions are required to contribute to alternative biodiversity outcomes, the latter determined based on societal values.

An analogy to the international effort to halt anthropogenic climate change is illustrative (Table 1). The IPCC, an intergovernmental climate-focused scientific body, has synthesized science regarding the anticipated societal and ecological effects of climate change if various targets for limiting anthropogenic emissions and the consequent rise in global temperature are met (Teske, 2019). Global climate outcomes (e.g., limiting heating to no more than 1.5 or 2 degrees C) are endorsed via values-based societal choices that climate change effects beyond a certain level must be avoided. Then, the actions required to achieve these outcomes (a certain quantum of emissions reduction) are set based on scientific evidence.

Analogously, IPBES, an intergovernmental biodiversity science body, has sought to quantify the socioeconomic benefits from biodiversity and the costs of its loss (IPBES, 2019). As is the case with climate targets, CBD targets are informed by science but are inevitably negotiated political outcomes based on societal preferences regarding desired states of nature and tolerable risk (Table 1). Once such outcome goals are set, a science-based process of setting percentage-protected and other action targets occurs. Given imperfect information, such targets will need to be iteratively revised as new data become available.

Near-future targets such as 30x30, although likely inadequate over the long term, may be seen as the maximum feasible societal goal over the next decade. Many conservationists have advanced the values-based proposition that the 30x30 goal is a step toward an ultimate goal of protection (or retention as natural habitat, which could become equivalent in rapidly-developing landscapes) of at least half of Earth for nature (Dinerstein et al., 2019; Locke, 2014; Noss et al., 2012; Wilson, 2016).

Even where percentage-protected targets are framed as science-based estimates of what is required to help achieve particular outcomes, there are many reasons why the estimated percentage required might vary. For example, global targets are necessarily generalizations based on the diverse responses observed in multiple geographies and over multiple scales of biodiversity. Like the emissions reductions target required to meet the maximum global warming outcome of 2 degrees, which would be an inadequate target for low-lying island nations, percentage-protected targets that are adequate for some regions will be inadequate for others.

Research and planning at extents much smaller than global (e.g., ecoregions) are needed to determine empirically the extent of protection required to sustain biodiversity in specific geographies. Ecoregions that are more physically or biologically heterogeneous (i.e., higher beta diversity) or richer in range-restricted species will likely require a greater percentage of area protected or otherwise retained than more homogeneous or endemic-poor ecoregions (Noss, 1996). Because the processes that maintain biodiversity are not globally connected to the same extent as are climate systems, better data cannot entirely resolve the inherent contrast between global percentage-protected targets and regionally-specific recommendations.

Lastly, percentage-protected targets alone do not capture all factors that determine the contribution of protected areas to achieving biodiversity goals (Pressey et al., 2021). The conservation impact of a protected area – the difference it makes to biodiversity outcomes - is contingent not only on its extent and location with respect to key biodiversity features, but also on its location relative to threats that it can avert (Harfoot et al., 2021, Pressey et al., 2021), as well as its management and governance and their effectiveness in averting those threats. These contingent factors can be addressed via additional targets and indicators that complement the percentage-protected target (Table S1; UNEP-WCMC, 2020). Since even ambitious percentage-protected targets such as 30x30 encompass a minority of the landscape, these additional targets and indicators are essential in ensuring that protected and conserved areas be located where they can achieve the maximum impact on biodiversity outcomes (Dinerstein et al., 2019, Pressey et al. 2021).

ACHIEVING BETTER INTEGRATION OF PERCENTAGE-PROTECTED TARGETS AND OUTCOME GOALS

The overarching goals of the CBD are to reverse biodiversity loss and safeguard nature's contributions to people in an equitable manner (CBD, 2021). Due to the hierarchical nature of biodiversity, which is manifest at multiple levels of biological organization, there is no single index of the status of biodiversity akin to the IPCC's "apex target" based on global mean temperature increase (Díaz et al., 2020). The latest version of the GBF includes targets directly related to the desired outcome of halting or reversing loss of biodiversity at each of three levels: ecosystems, species, and genetic diversity within species (CBD, 2021; Díaz et al., 2020). Proposed outcome goals and milestones include net gain in the extent, connectivity, and integrity of ecosystems compared to a 2020 baseline, reduction in species extinction rates and extinction risk, and retention of existing genetic diversity within species (CBD, 2021; Díaz et al., 2020; Watson et al., 2020)(Table S1).

Management interventions can in principle be directly linked to biodiversity outcomes by measuring and forecasting the positive conservation impact of specific actions (Pressey et al., 2021). Estimating the additive impact of protected area designation as a function of anticipated threats, and the effectiveness of a protected area in mitigating them, requires comparison of the outcomes expected from designation of a protected area to those expected under a counterfactual scenario in which the area in question is not protected (Pressey et al., 2021). Quantitative impact targets can help guide where protected areas can be located to maximize their contribution to net gain outcomes.

Methods for assessing how varying percentages of protected area in a landscape are correlated with the extent of intact ecosystems, species extinction rate and risk, and levels of intraspecific diversity span a spectrum of complexity and ecological realism (Table S1). The most conceptually straightforward method of tracking the contribution of protected areas toward biodiversity outcome goals is via direct monitoring of the status of biodiversity, in comparison to counterfactual scenarios in which an area was not protected. This is most feasible for ecosystem-related goals. Remote sensing data can track many key attributes, such as fragmentation, that characterize intact vs. degraded ecosystems and thereby determine the extent and location of new protection necessary to achieve net gain targets (Watson et al., 2020). Comprehensively monitoring the rate of species extinction and the status of intraspecific diversity is essential but more challenging (Rounsevell et al., 2020).

In addition to direct monitoring, the two approaches (process-based and prioritization-based) described above as forming the evidence base for percentage-protected targets are also relevant in this context (Table S1). Process-based models can be used to evaluate the adequacy of current or proposed protected area networks to achieve outcomes, in a manner analogous to how models are used to assess the adequacy of proposed national climate mitigation commitments. Ecosystem modeling can project to what degree anticipated land-use patterns or alternative management regimes will meet outcomes goals related to net gain in intact ecosystems and sustain desired ecosystem states, processes, and services (Bestelmeyer et al., 2017). Spatially-explicit population models can be used to assess the adequacy of proposed networks of protected areas and the larger landscape for fulfilling outcomes related to reducing extinction risk and sustaining intraspecific diversity (Pierson et al., 2015).

In a prioritization-based approach, proposed protected areas can be assessed as to whether they encompass sites of high importance to biodiversity as identified in systematic conservation plans (Margules & Pressey, 2000; Moilanen et al., 2009)(Table S1). However, most of the world's ecoregions still lack such plans, and many older plans are out of date. The GBF proposes use of global datasets such as the Key Biodiversity Areas system to complement information from other sources (CBD, 2021), although such global datasets are still incomplete and may be biased towards well-studied regions. The GBF also proposes to augment species monitoring data with indirect indicators based on species distribution models (CBD, 2021; Pereira et al., 2013). However, global species occurrence databases and suitability models derived from such data have limitations (e.g., they may not distinguish seasonal ranges)(Pressey et al., 2021).

Percentage-protected targets can also be indirectly linked to biodiversity outcomes by monitoring newly-protected areas in terms of their representativeness, as measured by data or models of the distribution of ecosystems and species, and connectivity, as measured by structural connectivity metrics (CBD, 2021). Although these metrics are available as globally-consistent datasets, they have the disadvantage of not directly tracking ecological processes of interest. For example, the connectivity metrics included in the GBF are abstracted representations of functional population connectivity in real landscapes (Schumaker et al., 2014). Caution is also necessary in using coarse-scale units such as ecoregions (as whole units) to assess representation, due to their high levels of internal ecological heterogeneity (Pressey et al., 2021)(Table S1).

Given that the GBF will be applied globally, the data requirements associated with direct monitoring of species and populations, process-based models, and systematic conservation planning are formidable. Conversely, globally consistent indicators (e.g., as derived from remotely-sensed data) often have limited spatial and thematic resolution (Pressey et al., 2021). Given the strengths and limitations of each of these approaches, the GBF appropriately envisions use of a combination of methodologies for monitoring progress toward outcome goals and retains complementary action and outcome targets in an effort to balance accuracy and pragmatism in a global context characterized by imperfect biodiversity data.

ACHIEVING BETTER INTEGRATION OF CONSERVED AREAS INTO WIDER LANDSCAPES

A potentially larger source of uncertainty in linking percentage-protected targets and outcome goals involves what happens in the broader landscape: i.e., whether strictly protected areas will be surrounded by an increasingly developed matrix or instead complemented by other areas under conservation and sustainable resource management (Maxwell et al., 2020; Watson et al., 2021). The conclusion that protected area designation should go hand-in-hand with conservation across the broader landscape has been recognized for decades, and formed the impetus for the Man and the Biosphere (MAB) program's concept of biosphere reserves (Batisse, 1982) and other conservation zoning approaches such as multiple-use modules (Noss & Harris, 1986).

Such planning approaches situate core protected areas within a matrix of buffer and transition zones and other lands used for sustainable resource production (Noss & Harris, 1986). The strictest level of protection is appropriate for nodes in every landscape that are inherently more irreplaceable or vulnerable, with a gradient of decreasing protection that parallels gradients in decreasing irreplaceability. Under this approach, the outcome of biodiversity retention is achieved by a combination of strictly protected areas and other management mechanisms that retain nature in the wider landscape (i.e., the "30+70" approach). Essentially, landscape-wide planning complements designation of protected areas to achieve desired biodiversity outcomes.

The GBF recognizes that protected areas function within the context of a broader landscape and supports management of the entire landscape for sustainable coexistence between people and nature (CBD, 2021). For example, the condition of the broader landscape is fundamental in fulfilling certain targets such as maintaining adequate connectivity between protected areas and allowing ecological processes that operate on large spatial scales to continue functioning. However, this recognition has not always been retained when global percentage-protected targets are implemented at national extents. For example, initial statements from the US federal 30x30 initiative emphasize landscape-wide planning (e.g., enhanced focus on biodiversity on multiple-use public lands plus incentivizing such focus on private lands) as an alternative to protected area designation (Yachnin, 2021), despite the substantial research indicating that protected areas are elements of landscape-level planning that are essential for achieving many biodiversity outcomes, in part because many species cannot persist even at relatively low levels of human-associated disturbance (Pacifici et al., 2020; Watson et al., 2014).

A DEFINITION OF "CONSERVED AREA" THAT SUPPORTS POSITIVE BIODIVERSITY OUTCOMES

Early percentage-protected targets, such as the 12% goal proposed by the Brundtland commission, implicitly referenced the traditional model of a park or protected area established and managed by a central government authority. Beginning with the CBD's 2010 17% target, the land management categories that counted toward the target were expanded to also include OECM (CBD, 2010). This shift was motivated by concerns that the standard park model was inappropriate in certain sociopolitical contexts (Jonas et al., 2021). The standard for what constitutes an OECM, developed by international organizations including CBD and IUCN, focuses on whether an area provides positive and sustained benefits to biodiversity and has an approved management plan that explicitly provides for these benefits (CBD, 2021). The IUCN Green List of Protected and Conserved Areas Standard defines such areas based on four necessary components: good governance, sound design and planning, effective management, and successful conservation outcomes (Hockings et al., 2019).

Given the incentive for national governments to report substantial (and perhaps inflated) progress toward percentage-protected targets, it is challenging to define OECM in a manner that is flexible yet substantive. This is analogous to the challenge in ensuring that Nationally Determined

Contributions (NDC) and national climate policies actually align with the emissions reduction targets endorsed by parties to global agreements (Liu & Raftery, 2021).

National governments can distort implementation of percentage-protected targets by siting conservation areas opportunistically without regard to the distribution of biodiversity features (e.g., on lands with low economic value), or by “counting” areas towards the target even though their existing land use is incompatible with biodiversity outcomes. Goodhart’s law states that when a metric becomes a target, it ceases to be an accurate metric, because it can be manipulated (i.e., further disconnected from biodiversity outcomes)(Newton, 2011). Effective target implementation may require a rigorous global system to track achievement, similar to that used to track achievement of Nationally Determined Commitments to climate mitigation (Table 1)(Xu et al., 2021). Creating a meaningful definition of what land uses are compatible with a “conserved area” hinges on the issue of defining thresholds along a continuum of biodiversity response to varying types and intensities of land use and management. Although we do not discuss marine conservation here, terrestrial conservation planners can learn from existing frameworks developed to classify marine reserves along a gradient from fully to minimally protected (Grorud-Colvert et al., 2021).

Integration of action targets and outcome goals can be furthered by an effective expanded definition of a “conserved area” (OECM) or could be hindered by a definition that lacks a substantive connection to biodiversity outcomes. If OECM are to be counted toward the currently proposed targets (e.g., 30x30), this would require a strong focus on biodiversity in the definition of OECM in order to remain consistent with the evidence base from which the percentage-protected target was originally derived (Noss et al., 2012). Effects of human-associated disturbance on biodiversity are a function of both disturbance area and disturbance intensity (Suraci et al., 2021). The core questions are what pattern and intensity of human land use is compatible with desired biodiversity outcomes, and what are equitable societal pathways for achieving this pattern and intensity. Potentially, to achieve an outcome equivalent to that achieved by strictly protecting 30% of the landscape, planners could retain a proportion >30% under an OECM definition that allowed a greater range of land uses (but maintaining a minimum area, e.g., >10-20%, under strict protection). The validity of this approach would depend on the extent to which the conservation features of concern (e.g., imperiled species) are dependent on strictly-protected areas (Pacifici et al., 2020).

The Gap Analysis Program's (GAP) Protected Status categories are often used to estimate the total protected area within the US (Scott et al., 1993). GAP categories 1 and 2 correspond to what are typically categorized as strictly protected areas. Most US public lands are categorized as GAP category 3, which indicates that they are managed for multiple uses but protect federally listed species and do not result in permanent conversion of natural to anthropogenic habitat (Scott et al., 1993). In practice. however, different GAP3 lands experience widely varying land uses and management regimes and therefore show contrasting levels of intactness and contribution to biodiversity.

A workable OECM definition would need to distinguish GAP3 lands for which the sum effects of all existing land uses and management actions in an area substantially contribute to positive biodiversity outcomes from those that do not, for example due to the lack of management effectiveness or ongoing uses (e.g., intensive resource production) that contribute to degradation (Maron et al., 2020). Ultimately, given the overarching goal of sustaining biodiversity in the face of a global extinction crisis, any specific definition of land uses compatible with OECM must respect the precautionary principle embodied in OECM standards by placing the burden on managers and policymakers to demonstrate compatibility of land management with positive biodiversity outcomes (CBD, 2021). A comprehensive OECM standard would need to address both biodiversity status and trends in a particular area. Does ongoing restoration of already-degraded lands place them in the OECM category despite a modest current ability to sustain biodiversity? A key question is whether inclusion of such areas within the OECM category enhances or compromises the adequacy of the percentage-protected target to support outcome goals.

A NEW SOCIETAL PARADIGM FOR CONSERVED AREAS

Much of the impetus for developing a definition of OECM originated from critiques of percentage-protected targets as being based on an outdated paradigm for establishment and management of protected areas that has historically often led to loss of rights and sovereignty of Indigenous and local inhabitants (Jonas et al., 2021; Maxwell et al., 2020). What we have termed the "30+0" perspective (i.e., the assumption that strictly protected areas are the primary strategy for biodiversity retention) arises in part from the reality of conservation in rapidly developing landscapes, where the landscape matrix is being radically transformed from historic landcover with consequent loss of ability to support many native species (Terborgh, 2020). However, this approach has been criticized as a "fortress conservation" strategy that, if interpreted as a landscape rigidly divided between areas for people and for wildlife, can result in eviction and loss of rights of Indigenous and local communities (Brockington, 2002).

Although historical examples exist of Indigenous dispossession during protected area establishment worldwide, this critique has most resonance in nations of Africa and Asia whose colonial period overlapped with the development of the national park concept. In other contexts, establishment of Indigenous-managed protected areas may serve as an effective means of defense for Indigenous communities fighting dispossession by local elites and global extractive industries. For example, Indigenous organizations recently secured support from the International Union for Conservation of Nature for a proposal to protect 80% of the Amazon basin (IUCN, 2021). Recent reviews documenting the global extent of Indigenous cultural landscapes (Fletcher et al., 2021) demonstrate that the concept of “wilderness” must encompass areas that can support subsistence and management practices of Indigenous communities and also support the full complement of native species and ecological processes, sustaining biodiversity over evolutionary time-scales (Watson & Venter, 2021).

Efforts to overcome historical limitations of the protected area concept have led to development of a new paradigm for protected and conserved areas in which national coordination, incentives, and monitoring support rather than usurp control from Indigenous and local community conservation initiatives (Jonas et al., 2021). This new paradigm recognizes that both equitable and effective governance (with a range of potential governance models), and effective management, reporting, and monitoring are preconditions for positive conservation outcomes in protected and conserved areas.

An example of the new paradigm is provided by recent establishment of Indigenous Protected and Conserved Areas (IPCA) in Yukon, Canada. The federal government committed to meeting CBD targets through reconciliation with First Nations within regional land-use planning processes. The land-use plan for the Peel Watershed, ratified in 2019 as part of this process, confers some level of protected status on 83% of the watershed. Planning was co-led by First Nations and subnational governments, with federal support complementing locally-led planning processes that integrated Western science with Traditional Ecological Knowledge (PWPC, 2019).

Many questions remain about how to achieve effective biodiversity outcomes within the context of the new protected areas paradigm. What do goals of equity and respect for land rights imply in a context where local sentiment over the need for establishment of a conserved area is polarized? Representative democracy does not assume that the public has a unified perspective, but rather provides a framework for acting in the face of diverse perspectives. For example, to meet commitments for reducing climate-heating emissions, national governments have created alternative employment opportunities in coal mining regions rather than protect existing mining jobs.

To sustain biodiversity in the face of a global extinction crisis, ecocentric values and objectives (Taylor et al., 2020) may need to similarly take precedence over potential short-term economic opportunities. Designation of the Bear Ears National Monument in the western US, an area encompassing Indigenous cultural landscapes as well as sought-after mineral deposits, provides an example in which the national government acted in the face of divided local sentiment by privileging the rights of Indigenous residents over those economically tied to extractive industries (Creadon & Bergren, 2019). However, to an even greater extent than in the case for climate policy, the best governance process will be place-specific and require transformational change in societal structures (Grumbine & Xu, 2021). Successful implementation of the Global Biodiversity Framework will require financial support from the global North for conserved areas in less-developed nations, analogous to the role of the Paris Agreement's Green Climate Fund (UNFCCC, 2015).

CONCLUSION

The transformative change that is required to respond effectively to the biodiversity and climate crises is a complex societal process through which both values and science impel targets and resultant actions (Grumbine & Xu, 2021). The societal debate over biodiversity targets such as 30x30 and Nature Needs Half is in many ways analogous to the debate over the degree of ambition necessary to limit anthropogenic global heating. Action targets such as 30x30 are a necessary complement to biodiversity outcome goals because they play a fundamental role in informing the societal process by which national conservation goals are proposed and implemented.

Nevertheless, the societal debate concerning the appropriate level of conservation ambition should not obscure scientific understanding of the complex relationship between conservation actions and biodiversity outcomes. The contribution of protected areas to biodiversity outcomes is contingent on their location, management, governance, and existing threats, as well as what is occurring in the broader landscape. Percentage-protected targets are therefore unavoidably empirical generalizations, which are insufficient in isolation but can be evidence-based if applied as part of a comprehensive suite of targets such as the proposed Global Biodiversity Framework (CBD, 2021). Achievement of any percentage-protected target must not overshadow the overarching biodiversity outcomes to which this achievement is meant to contribute. A primary focus must remain on the outcomes of net gain in biodiversity at all scales and levels of organization, recognizing that sustainability of society requires a healthy biosphere as the context for all life, including humans (Locke, 2021).

Global targets need to be supplemented by ecoregion-specific conservation plans that determine “how much is enough” in each ecoregion to achieve predetermined biodiversity conservation goals. What is possible to achieve for conservation in an ecoregion with abundant remaining wild area is quite different from what can be achieved in an ecoregion dominated by intensive agricultural or urban land uses. Conversely, substantial restoration may be required in highly-depleted ecoregions if they are to sustain their existing biodiversity, due to time lags in biodiversity response to land-cover change (i.e., extinction debt)(Maron et al., 2021). Until such ecoregional plans become available, it is appropriate to proceed on the basis of the best available information, including empirical generalizations, given the current extreme rate of habitat loss in many ecoregions (Noss et al., 2012).

If percentage-protected targets such as 30x30 are implemented within the context of broader frameworks such as the GBF, they can serve as anchors that strengthen more comprehensive national biodiversity strategies, helping to communicate the level of ambition necessary to reverse current trends of biodiversity loss and support previously neglected conservation targets via a variety of existing and new conservation policies. As in the case of the climate crisis, there is a need to encourage individual and local actions in response to the biodiversity crisis yet recognize that the enormity of the challenge requires ambitious coordinated national efforts that complement local efforts.

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SUPPORTING INFORMATION

Table S1. Data and model-based approaches for monitoring achievement of biodiversity outcome goals in relation to percentage-protected targets.

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Table 1. Stages of development and implementation process for biodiversity conservation and climate mitigation targets, and associated science and policy questions at each stage.

Stages of target	**Steps in climate**	**Steps in biodiversity**	**Challenges in**

development and implementation process	change target development and implementation	target development and implementation	biodiversity target development and implementation process
Field observations and simulations	Observations and simulations of global climate systems. Quantification of observational and model-based uncertainty.	Observations of impacts on biodiversity outcomes of past protected area designations. Simulations of species and ecosystem response to habitat loss. Systematic conservation planning.	Variation in protected area contribution to outcomes due to location, management, governance, threat level of protected area, and condition of landscape matrix.
Empirical generalizations	Summarize and generalize regional and global climate and earth systems response to various global temperature thresholds (i.e., alternative values for	Summarize above data over range of ecoregions, including via use of species-area and other models (IPBES). Describe strengths and limitations of	Observational and model-based uncertainty. Multi-scale nature of biodiversity and outcome targets. Generalization from regional observations

	climate apex target)(IPCC).	generalizations.	to global biodiversity target difficult when compared with global climate systems.
Negotiated choice of preferred outcome	Discuss relative value and urgency of climate mitigation versus other societal goals. Establish desired outcome (e.g., maximum 1.5, 2 degree heating)(UNFCC).	Discuss relative value of biodiversity versus (or as complementary to) other societal goals. Describe complementary nature of various targets and goals. Propose and negotiate action and outcome targets in Global Biodiversity Framework (CBD).	Place-specific nature of appropriate governance model for conserved areas.
Politically-informed interpretation of target	Determine what actions count toward Nationally Determined Contributions (NDC), how remaining carbon	Establish definition of areas managed under other effective conservation measures (OECM). Develop	Difficulty in characterizing the degree to which different management categories contribute

	budget can be fairly allocated between historical polluters and new sources, develop funding to support adaptation in global south. Establish NDC.	National Biodiversity Strategies and Action Plans (NBSAP).	to outcomes and thus should count towards percentage target. Variation in protected area resources, governance, and effectiveness.
Implementation actions	Establish national/subnational policies on climate mitigation. Clarify respective roles of local initiative versus national policy.	Establish protected areas and OECM. Ensure effective management and governance. Overcome barriers to cross-jurisdictional coordination.	National-local coordination more complex than for climate policy.
Monitoring and adaptive management	Track national commitments versus actual achievements. Track response of climate system.	Link protected-area-related actions to impacts and outcomes.	Monitoring challenges, especially for species and intraspecific diversity. Time lag between actions and biodiversity response

	Update simulations.	complicate adaptive management.