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Priorities for protected area expansion so nations can meet their Kunming-Montreal Global Biodiversity Framework commitments

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Abstract

As part of the Kunming-Montreal Global Biodiversity Framework (K-M GBF), signatory nations of the Convention on Biological Diversity (CBD) aim to protect at least 30% of the planet by 2030 (Target 3). This bold ambition has been widely celebrated and its implementation seen as pivotal for the overall success of K-M GBF. However, given that many CBD signatory nations prioritised quantity (e.g., area) over quality (e.g., important areas for biodiversity) when attempting to meet their 2010 CBD Aichi protected area commitments, it is critical that nations focus on protecting those terrestrial, inland waters and marine areas that have the best chance of halting and reversing biodiversity loss and thus contribute to Goal A of the K-M GBF. Here we provide a review on the type of areas that nations need to prioritise when implementing Target 3 that relates to area 'quality': *areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems*. We show that data is available for 12 distinct biodiversity conservation and ecosystem service elements that can be mapped and, if conserved, will (with appropriate management) help meet the broad intention of Target 3. We highlight examples of the planning methods available that can be utilized so these areas can be targeted for protection. We discuss issues related to trade-offs regarding how to prioritise amongst them as well as to operationalise some of the vaguer concepts like 'representation' and 'ecosystem functions and services' so that they achieve the best outcomes for biodiversity.

KEYWORDS

biodiversity, connectivity, conservation planning, effectiveness, protected areas, quality, representation

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1 | INTRODUCTION

Parties to the Convention on Biological Diversity (CBD) recently adopted the Kunming-Montreal Global Biodiversity Framework (K-M GBF), which included four goals that are supported by 23 targets to be completed by 2030 (CBD, 2022). The Framework states that it 'is action- and results-oriented and aims to guide and promote, at all levels, the revision, development, updating, and implementation of policies, goals, targets, and national biodiversity strategies and action plans, and to facilitate the monitoring and review of progress at all levels in a more transparent and responsible manner'. The Framework's ratification was hailed as a major success for nature conservation by some nations (Gilbert, 2022) and considered as a foundational shift in recognising human rights as critical in the response to the biodiversity crisis. Statements from the CBD Secretariat and the 15th Conference of the Parties (COP 15) leadership go further, portraying the new K-M GBF as a 'historic' blueprint that will 'galvanize urgent and transformative action' to reduce biodiversity loss (CBD, 2022).

Some assessments of the new global framework argue that it should be viewed as a mixed success (Hughes, 2023). Parties did reach an agreement on several contentious issues at COP 15 and some individual targets have been strengthened, especially those associated with ecosystems and ensuring quality (of protected areas) was a focus (Maxwell et al., 2020; Watson et al., 2020). There are significant improvements over previous agreements, with parties agreeing to increase protection of terrestrial, inland waters and marine areas to at least 30% from the former 17% terrestrial and 10% for marine (Target 3); restoring 30% of the Earth's degraded terrestrial, inland water and marine and coastal ecosystems (Target 2); encouraging efforts by private businesses to track their biodiversity impacts (Target 15); recognizing the rights of Indigenous Peoples and local communities to their traditional lands (Target 22) and infusing gender equality and responsiveness into CBD decision-making (Target 23). But it is also clear that some of the new targets are not an improvement on those agreed upon in 2010. For example, the target on species extinction (Target 4) has been diluted and its timeline shifted 30 years into the future, despite warnings during the final years of negotiations that the draft target was weak (Williams et al., 2021). Moreover, despite agreement that target wording was a major weakness with the 20 CBD Aichi targets (only six of its 20 targets contained quantitative language useful to track implementation success (Butchart et al., 2016)), and considered one of the main reasons no Aichi Targets were fully implemented, only eight (Targets 1, 2, 6, 7, 18, 21, 22 and 23) of the 23 K-M GBF targets incorporate coherent, quantitative wording that can be measured and reported on. It is therefore timely to consider core lessons for how nations implemented the Aichi Targets, to ensure better implementation of the targets in the K-M GBF.

Practitioner points

- The Protected and Conserved Area (PCA) Target in the Post-2020 Global Biodiversity Framework provides impetus for nations to significantly expand the extent of terrestrial, inland waters and marine areas under formal protection.
- Nations must focus on protecting sites that have the best chance of halting and reversing biodiversity loss.
- There are data and methods available to ensure important biodiversity conservation sites can be proactively identified, mapped and conserved.

Here we provide a perspective on Target 3 (hereafter T3) of the K-M GBF, the area-based conservation target, and in particular, how nations can identify areas for prioritisation when considering the area expansion agenda it outlines (see Table 1 for full text). It is well established that protected areas are a critical tool for halting biodiversity loss (Pacifici et al., 2020; Watson et al., 2014); 'other effective conservation measures' (OECMs) now offer the opportunity for recognition of a wider range of area-based conservation approaches to be added to the conservation estate (Dudley et al., 2018). The success of protected areas and OECMs [hereafter 'protected and conserved areas' (PCAs)] in the new '30% by 2030' agenda, in terms of where new PCAs are located and how they are managed, will likely be a cornerstone for conservation efforts aimed to bend the curve for biodiversity (Visconti et al., 2019) and achievement of the K-M GBF's 2050 Goals. In July 2023 Protected Planet (protectedplanet.net) reports that PCAs cover 17.19% of terrestrial and inland waters, and 8.26% of marine areas. Thus, in less than 7 years the increase in area needed to achieve 30% of protection on land will be almost as much as the total area that has been protected since 1872 when Yellowstone was declared a National Park—the first formal terrestrial protected area in the world (Watson et al., 2014). In coastal and marine areas, that increase in area needs to be triple of what has been achieved since 1935 when the first formal Marine Protected Area was declared (Gubbay et al., 1995). This expansion agenda that CBD signatory nations have committed to is thus undoubtedly a major challenge, but also a unique opportunity to rapidly extend conservation efforts globally in an equitable and representative manner.

Significant conservation opportunities will be realized only if the wording in T3 around 'areas of particular importance for biodiversity and ecosystem functions and services, are effectively

TABLE 1 A comparison of area-based conservation targets in 2010 convention on biological diversity strategic plan and 2022 Kunming-Montreal Global Biodiversity Framework highlighting the specific language around priority areas (in bold).

Aichi Target 11	Kunming-Montreal Global Biodiversity Framework Target 3
By 2020, at least 17% of terrestrial and inland water, and 10% of coastal and marine areas, **especially areas of particular importance for biodiversity and ecosystem services**, 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.	Ensure and enable that by 2030 at least 30% of terrestrial and inland water areas, and of marine and coastal areas, **especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems** of protected areas and other effective area-based conservation measures, recognizing indigenous and traditional territories, where applicable, and integrated into wider landscapes, seascapes and the ocean, while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognizing and respecting the rights of Indigenous peoples and local communities, including over their traditional territories.

conserved and managed through ecologically representative, well-connected and equitably governed systems' is defined, understood and prioritised by nations and other important stakeholders, such as the mining sector, that have made commitments to safeguard biodiversity (ICCM, 2023). Yet, this type of wording is not unique to the current K-M GBF framework, with the 2010 Aichi Target 11 (the area-based conservation target for the 2010-2020 CBD strategic plan), having similar qualifier language 'especially areas of particular importance for biodiversity and ecosystem services…through effectively and equitably managed, ecologically representative and well-connected systems of protected areas…' to the K-M GBF's T3 (Table 1). Despite the presence of this language in the 2010 Aichi Targets, and clear guidance provided by CBD (e.g., CBD, 2018), and various publications (Barnes et al., 2018; Watson et al., 2014, 2016), nations for the most part ignored it with independent assessments showing that while there was significant areal expansion of PCAs during the 2010–2020 period, the specific gains when considering biodiversity coverage were incremental and piecemeal (Devillers et al., 2015; Kuempel et al., 2019; Maxwell et al., 2020; Relano & Pauly, 2023; Ward et al., 2020).

We argue that humanity cannot risk a repeat of the past decade where great gains were made in the overall area under recognised protection but in locations that were often not priorities for biodiversity conservation outcomes. There is an urgent need to correctly place (and then effectively govern and manage) the network of PCAs given the amount of land, water and sea available for significant conservation gain is rapidly decreasing (Halpern et al., 2008; Williams et al., 2020, 2022). While T3 and the overall K-M GBF must be seen as interim goals and targets when considering the 2050 Vision of the CBD, how PCA growth is implemented by nations over the next 7 years will likely determine the options for future post-2030 frameworks and their specific targets.

Here we review key considerations for nations when they set priorities for PCA expansion that address 'areas of particular importance for biodiversity and ecosystem functions and services … ecologically representative and well-connected'. We first identify specific biodiversity and ecosystem service elements that can be mapped against each of the core terms and show examples of where they can be included in planning exercises (Table 2). We then discuss ways to overcome the vaguer components of the target (including those associated with 'representation', 'well connected' and 'ecosystem functions and services') and discuss priorities when considering all these objectives, to ensure nations achieve biodiversity outcomes consistent with the CBD's 2050 Vision, and indeed other multilateral agreements. As this review deals solely with the issue of identifying the best places for PCAs to reduce biodiversity loss, we do not attempt to cover important issues such as PCA effectiveness, their governance, and issues associated with inclusivity, rights, and equity. These are critical elements of T3 that need attention and guidance and there are separate best practice efforts underway to do these issues justice (WWF and IUCN WCPA, 2023).

2 | PRIORITIES FOR PROTECTED AND CONSERVED AREA EXPANSION

To ensure PCAs are placed in areas of importance for biodiversity, specific objectives need to be articulated based on the components of T3 surrounding biodiversity. We, therefore, break down the components in 'areas of particular importance for biodiversity and ecosystem functions and services … ecologically representative and well-connected' into 12 related biodiversity elements that have been widely identified in the protected area planning literature (Table 2). We show how these elements meet the specific component terms in T3 and provide wider justification of their use based on evidence in the peer-reviewed literature. We then provide examples of how these elements can be made into clear objectives for spatial

TABLE 2 Twelve distinct biodiversity elements set against the core components of T3 of the K-M GBF to be considered when identifying priorities for PCA establishment.

Components of T3	Specific biodiversity elements within components that should be targeted	Why they need to be targeted for PCA
....especially areas of particular importance for biodiversity...	Rare or threatened species and habitats, and the ecosystems that support them	PCAs are a core tool in halting species extinction and stabilizing the decline of threatened species (Watson et al., 2014). There are current significant protection shortfalls on land, water and sea (Allan et al., 2022; Jones et al., 2020; Shen et al., 2023) which have been identified in global reviews (Maxwell et al., 2020) that need to be targeted for PCA expansion.
	Threatened and/or collapsing ecosystems	As with threatened species, threatened and collapsing ecosystems need to be protected from threats (Murray et al., 2020) and there are shortfalls in the current PCA estate that need to be targeted.
	Range-restricted species and ecosystems in natural settings	Range-restricted species and ecosystems are more at risk of stochastic events (Shrestha et al., 2019). Their strategic protection in the PCA estate lowers this risk.
	Globally significant ecosystems (e.g., significant wetlands, Gondwanan rainforests, coral reefs)	Globally significant ecosystems have been recognised through efforts like UNESCO natural World Heritage, Ramsar and other international assessments (Allan et al., 2018; Kormos et al., 2016; Mackey et al., 2015). They need to be proactively protected, especially those that are at risk of being degraded.
	Areas with a high level of ecological integrity	These places are critical for species and ecosystem conservation especially considering the impacts of climate change (Di Marco et al., 2019; Leclère et al., 2020; Mokany et al., 2020). Conserving the most intact components of ecosystems is considered a 'no-regrets' conservation approach (Watson et al., 2020). They are currently not well protected (Grantham et al., 2020; Hansen et al., 2020; Watson et al., 2009).
	Ecosystems especially important for species life stages, feeding, resting, moulting and breeding (IUCN, 2016b)	These areas are critical for safeguarding key ecological processes needed to sustain certain species populations (Eken et al., 2004).
	Important species aggregations, including during migration or spawning (IUCN, 2016b)	These areas are critical for safeguarding key ecological processes needed to sustain species populations (Eken et al., 2004).
	Climate refugia for species and ecosystems	Many species are moving (or retreating) due to changes in the climate (Chen et al., 2011). As a consequence, 'refugial' habitats will likely be key for sustaining many species, especially for those species already endangered or likely to become endangered in the future (Morelli et al., 2020).
....and ecosystem function and services...	Ecosystems containing high levels of carbon in either above ground, or below ground, biomass	Sequestering and storing carbon in native vegetation is a critical component of climate change mitigation strategies (Houghton, 2007; Maxwell et al., 2019). PCAs play an important role in safeguarding this carbon (Liang et al., 2023), especially those that are at risk of being degraded (Noon et al., 2022).
	Important waterbodies	Securing specific rivers, freshwater bodies, water catchments are critical for human well-being, especially those catchments near big population centres (Hole et al., 2022). PCAs can play an important role in safeguarding these water catchments, especially if those that are risk of being degraded (Acreman et al., 2020).

(Continues)

TABLE 2 (Continued)

Components of T3	Specific biodiversity elements within components that should be targeted	Why they need to be targeted for PCA
...ecologically representative...	Representative natural ecosystems	Achieving a representative sample of biodiversity is a fundamental principle of reserve planning (Margules and Pressey, 2000; Watson et al., 2011).
...well-connected...	Areas of importance for ecological connectivity or that are important to complete a conservation network within a landscape or seascape	It is accepted that gradients of ecological connectivity are critical especially in a time of climate change. This includes: altitudinal gradients in hilly and mountainous areas such as the coastal ranges (Groves et al., 2012); latitudinal gradients, to ensure that migratory pathways of many mobile species are protected; catchment connectivity, where waterways in relatively natural or restored condition are used as natural routes for migration and dispersal across shorter coastal (mountain to sea) gradients (Beger et al., 2010), and connectivity from moister to drier climates, allowing seasonal movement of fauna as well as longer-term species adaptation (Scheffers et al., 2016).

planning. We show there is data that can be used now to set targets against these objectives and published methodologies that can incorporate these targets into planning that national governments and other stakeholders (e.g., conservation NGOs, mining and forestry sectors) can undertake (Table 3).

We argue that these 12 biodiversity elements can be mapped, and planned for, by every CBD signatory nation using available data and as such can be considered in their national reporting immediately (Table 3). All of the elements can take advantage of publicly available input datasets that have been generated and made available over years of curation. For example, the International Union for Conservation of Nature Red List of Species and Red List of Ecosystems provide critical information around the locations and threat status of species and ecosystems across Earth (Keith et al., 2015; Mace et al., 2008) and the World Database on Key Biodiversity Areas (IUCN, 2016) provides large quantities of information that can help identify sites of global importance to biodiversity (Kullberg et al., 2019; Smith et al., 2019). Important surrogate datasets have been recently created, and are constantly being updated, that are freely available to allow for both the mapping of ecosystem integrity (Beyer et al., 2020; Grantham et al., 2020) and some key ecosystem services (e.g., water and carbon) (Chaplin-Kramer et al., 2023; Goldstein et al., 2020; Noon et al., 2022). It is important to state that previous limitations relating to mapping and planning for 'areas of particular importance for biodiversity and ecosystem functions and services … ecologically representative and well-connected' cannot be made anymore by national decision makers and other stakeholders given the wealth of data available.

3 | PRINCIPLES THAT CAN GUIDE PLANNING

While we argue these 12 distinct biodiversity elements could be used as a foundation to meet the broad intention of the wording 'areas of particular importance for biodiversity and ecosystem functions and services … ecologically representative and well-connected', we recognise they are not completely comprehensive and other elements will need to be identified as more data comes to hand, especially in the realms of ecosystem function and services. But given these twelve elements have been identified and in the most part, mapped, they can be used to guide area-based conservation as they clearly relate to the broader intentions around quality in T3 (see Table 2 and Figure 1) and are a logical first step to help prioritize areas that will lead to greater biodiversity gains than we have seen in the past.

Given that so many specific planning objectives can be identified, issues around which objectives to prioritise first when considering PCA designation, and what to do around trade-offs between elements, may arise. In this section, we identify six principles to help resolve potential prioritisation issues.

3.1 | Principle 1. Make 'areas of particular importance for biodiversity' the primary focus of PCA establishment

The main objective of T3 and a fundamental requirement of PCAs is to halt biodiversity loss and enable its recovery. The definitions of both protected areas and OECMs clearly focus on the conservation of biodiversity as the core reason why they should be established by nations (Dudley, 2008; Dudley

TABLE 3 Planning objectives and example methodologies and datasets for ensuring twelve biodiversity and ecosystem service elements can be captured in future protected area and conserved area (PCA) establishment.

Specific biodiversity elements	Example of a target objective that can be set in PCA planning efforts	Examples of methods for how to integrate these specific biodiversity elements into a PCA spatial plan	Example of global datasets (regional or local datasets should be used when available)
Rare or threatened species and habitats, and the ecosystems that support them.	'Adequate coverage of all threatened species in the PCA estate' where adequacy is defined as the minimum areas needed for species to persist and reach healthy and resilient levels.	Species on the IUCN Red List of Threatened Species, or national equivalents, have been used as the unit of interest when planning for PCA identification (Watson et al., 2010). Targets have been set based on species' range when it comes to PCA coverage with a weighting applied to plans (e.g., Venter et al., 2014) or on minimum viable populations (e.g., Wilson et al., 2010). Sites have been identified via Key Biodiversity Areas (Harvey et al., 2021), Ecologically or Biologically Significant Marine Areas (EBSAs) (Clark et al., 2014), Important Marine Mammal Areas (Hoyt and Sciara, 2021; Tetley et al., 2022) and Alliance for Zero Extinction Sites (Conde et al., 2015; Ricketts et al., 2005) methodologies.	• KBAs (Birdlife International, 2023) • AZE sites (Conde et al., 2015; Ricketts et al., 2005). • IBAs (Birdlife International, 2023) • Global Safety Net Rare Species Sites (Dinerstein et al., 2020) • Areas of global significance for biodiversity conservation (Jung et al., 2021) • Threatened species richness (UNEP-WCMC, 2020a) • Rarity Weighted richness (UNEP-WCMC, 2020b) • Threatened species rarity-weighted richness (UNEP-WCMC, 2020c) • IUCN range maps (IUCN, 2022)
Threatened and/or collapsing ecosystems	'Adequate coverage of all threatened and collapsing ecosystems in the PCA estate' where adequacy is defined as the minimum areas needed for ecosystem persistence.	IUCN Red List of Ecosystems (Keith et al., 2015) have been used as the unit of interest when planning for the PCA estate (Botts et al., 2020). Targets have been set on the ecosystems risk of collapse (Venegas-Li et al., 2023).	• Global Seagrass distribution (UNEP-WCMC, 2018) • Global distribution of tropical dry forest (Miles et al., 2006) • Maps of national red list of ecosystem assessments, e.g, Myanmar (Murray et al., 2020)
Range-restricted species and ecosystems in natural settings	'Complete coverage of range-restricted species and ecosystems in the PCA estate'.	High thresholds (e.g., 100%) of coverage can be set for range-restricted species and ecosystems for protection (Pressey et al., 2003).	• AZE sites (Birdlife International, 2023) • Global Safety Net Rare Species Sites (Dinerstein et al., 2020) • Rarity Weighted richness (UNEP-WCMC, 2020) • Threatened species rarity-weighted richness (UNEP-WCMC, 2020)
Globally significant ecosystems (e.g., significant wetlands, Gondwanan rainforests, coral reefs)	'Complete coverage of globally significant ecosystems in the PCA estate'.	These ecosystems have been mapped and then high thresholds (e.g., 100%) of coverage then targeted for protection (Pressey et al., 2003).	• Coral Reefs (Allen Coral Atlas, 2020) • Mangroves (Bunting et al., 2018) • Seagrasses (UNEP-WCMC, 2018) • Salt marshes (Mcowen et al., 2017)
Ecosystem integrity	'Representative samples of all ecosystems that have high levels of ecological integrity in the PCA estate' where higher percentages set for those ecosystems that are more degraded and a minimum percentage is set as 50% protection per ecosystem.	Integrity is measured along a spectrum and thresholds can be set against the level of intactness using proxy data on ecosystems (Beyer et al., 2020; Grantham et al., 2020a). Those ecosystems that are identified as the most intact can then be targeted for protection (Venegas-Li et al., 2023).	• Forest Landscape Integrity Index (Grantham et al., 2020) • Beyer Intactness Index (Beyer et al., 2020) • Forest Structural Condition (Hansen et al., 2019) • Forest Structural Integrity Index (Hansen et al., 2019) • Biodiversity Intactness Index (Newbold et al., 2016)

(Continues)

TABLE 3 (Continued)

Specific biodiversity elements	Example of a target objective that can be set in PCA planning efforts	Examples of methods for how to integrate these specific biodiversity elements into a PCA spatial plan	Example of global datasets (regional or local datasets should be used when available)
		Sites can be identified using the IUCN's (2016) Key Biodiversity Area Standards (criteria C).	
Areas important for species life stages, feeding, resting, moulting, migrating, spawning, aggregating, and breeding	'Complete coverage of all areas that are important for species life stages are in the PCA estate'.	The IUCN's (2016) Key Biodiversity Area Standards have established guidelines on identifying these sites (IUCN, 2016b) then high thresholds (e.g., 100%) of coverage can be set for protection (Handley et al., 2023).	• Sea turtle nesting sites (Halpin et al., 2009; Kot et al., 2023) • KBAs (Birdlife International, 2023)
Important species aggregations, including during migration or spawning	'Complete coverage of all ecosystems that are especially important for species life stages are in the PCA estate'.	The IUCN's (2016) Key Biodiversity Area Standards have established guidelines on identifying these sites (IUCN, 2016b) then high thresholds (e.g., 100%) of coverage can be for protection (Harvey et al., 2021).	• KBAs (Birdlife International, 2023)
Climate refugia for species and ecosystems	'Adequate coverage of all identified climate refugia in the PCA estate' where adequacy is defined as the minimum areas needed for species to persist and reach healthy and resilient levels.	Targets have been set based on species' range climate refugia when it comes to PCA coverage (Cacciapaglia and van Woesik, 2015; Keppel et al., 2012; Maxwell, Reside, et al., 2019; Michalak et al., 2018). As we learn more about the direction and rate of climate change, new refugia will be identified suggesting continual evolution of the system (Arafeh-Dalmau et al., 2021; Beyer et al., 2018; Jones et al., 2016).	• There is increasing amount of data available that help map these habitats (e.g., Reside et al., 2013; Warren et al., 2013)
Ecosystems containing high levels of carbon in either above ground, or below ground, biomass.	'All ecosystems containing significant levels of carbon in either above ground, or below ground, biomass (and there are clear benefits to biodiversity) are in the PCA estate'.	There is an increasing amount of spatial data on carbon across ecosystems (Noon et al., 2022). There are a variety of methods of integrating important ecosystems with significant carbon qualities into PCA planning (Jung et al., 2021; Shen et al., 2023). Targets have been set around amounts of carbon wanting to be secured (Busch & Grantham, 2013).	• Irrecoverable, Manageable, and Vulnerable Carbon (Noon et al., 2022) • Above and Belowground biomass carbon density in the year 2010 (Spawn et al., 2020) • World Biomass Carbon (Soto-Navarro et al., 2020) • Global Patterns in Marine Sediment Carbon Stocks (Atwood et al., 2020)
Waterbodies important for biodiversity, ecosystems, or ecosystem services	'All important waterbodies which have clear benefits to biodiversity are in the PCA estate'.	There is hydrographic information available in a consistent and comprehensive format that can be used for regional and landscape applications (Chaplin-Kramer et al., 2023; Mulligan et al., 2020). There are a variety of methods of integrating important water bodies into PCA planning (Jung et al., 2021; Shen et al., 2023).	• Areas of global significance for biodiversity conservation and water provision (Jung et al., 2021) • Potential Clean Water Provision (Mulligan, 2019) • Realised Clean Water Provision (Mulligan, 2019) • Global Wetlands Tropical and Subtropical Wetlands Distribution (Gumbricht et al., 2017) • HydroSheds (Lehner et al., 2022)

TABLE 3 (Continued)

Specific biodiversity elements	Example of a target objective that can be set in PCA planning efforts	Examples of methods for how to integrate these specific biodiversity elements into a PCA spatial plan	Example of global datasets (regional or local datasets should be used when available)
Representative natural ecosystems	'Representative samples of all ecosystems in the PCA estate' with higher percentages set for those ecosystems that are more intact and a minimum percentage is set as 10% protection per ecosystem.	There is now a global ecosystem typology (Keith et al., 2022) that can be utilised. There are a variety of ways of achieving representative ecosystems across terrestrial, marine and freshwater ecosystem (Grantham et al., 2020b; Jung et al., 2021).	• Terrestrial Biomes and Ecoregions (Dinerstein et al., 2017) • Marine Ecosystems of the World (Spalding et al., 2007) • Maps of national red list of ecosystem assessments, e.g, Myanmar (Murray et al., 2020)
Areas of importance for ecological connectivity or that are important to complete a conservation network within a landscape or seascape.	'All areas required for functional and structural connectivity are captured in the PCA estate'.	Planning principles have been generated to ensure connectivity is captured across the gradients outlined (Hilty et al., 2020). There are a variety of ways and tools available for planning for connectivity (Game et al., 2010; Hilty et al., 2020; Theobald et al., 2022).	• Coral Reef Connectivity (Beyer et al., 2018) • Forest Connectivity (Jantz et al., 2014) • Global Safety Net Potential Wildlife Corridors (Dinerstein et al., 2020)

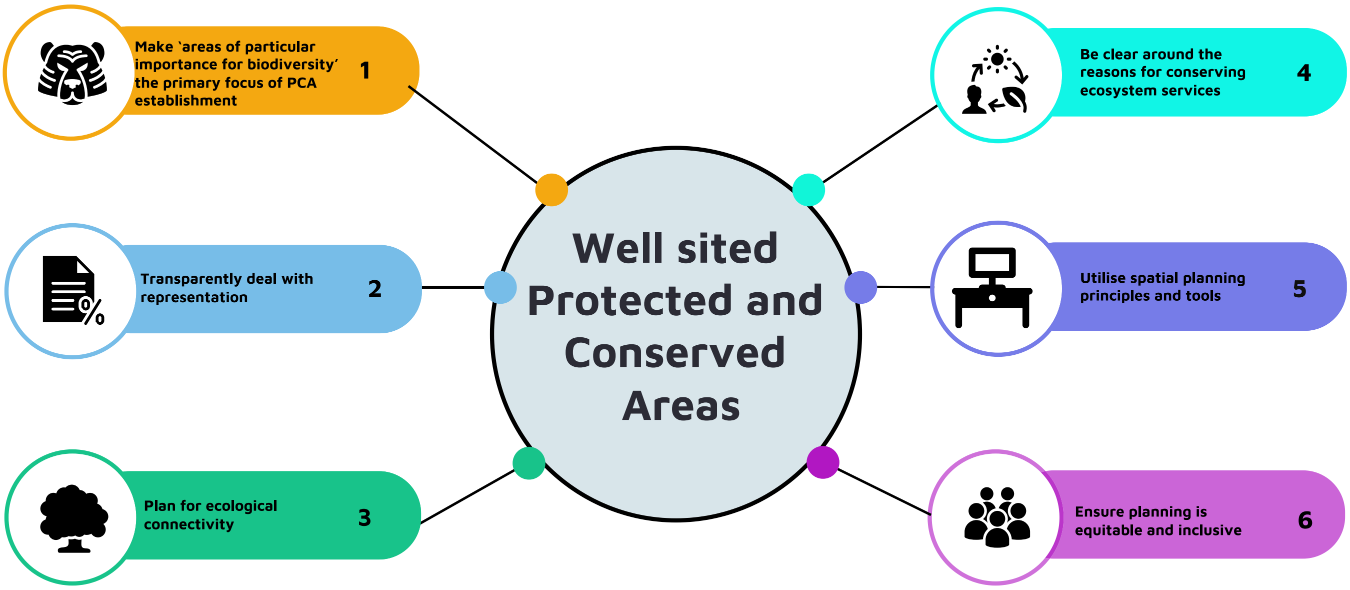

FIGURE 1 Six broad principles that can guide planning and ensure protected and conserved areas are well sited.

et al., 2018; Jonas et al., 2018). That means those places identified as 'especially areas of particular importance for biodiversity' as per the elements in Table 1 should be considered of the highest importance when it comes to planning and recognising new PCAs. Setting clear priorities around these biodiversity elements will mean that places that can be managed and enhanced to support the persistence and recovery of threatened species and ecosystems, key sites for maintaining biodiversity function (e.g., congregation sites, spawning sites), and the last samples of any ecosystem and other irreplaceable sites, such as those places that are still large, intact and functioning in ecologically and evolutionary natural ways, will be location priorities for area-based conservation. These are priorities that cannot be deprioritised or traded off against other factors within T3 or any other Target of the K-M GBF and there are numerous analyses that show the area of land and sea needed to safeguard the most endangered species and ecosystems is relatively small (Allan et al., 2022; Dinerstein et al., 2017; Jones et al., 2020).

3.2 | Principle 2. Transparently deal with representation

Achieving an ecologically representative conservation estate has been a foundational principle for reserve design for at least four decades (Cocks & Baird, 1989; Margules & Pressey, 2000). This was to ensure comprehensive coverage of ecosystems and species in the PCA estate. But, as with previous strategic plans, it is not clear what 'ecologically representative' actually encompasses in T3, especially around how much 'representation' is needed and of what. In the past, ecoregions have often become the proximate reporting unit (see, e.g., UNEP-WCMC and IUCN, 2021) and it has been assumed by many nations that there needs to be exact amount of 'representation' that aligns directly with the overall target (e.g., 17% representation is needed for all ecoregions given the Aichi Target protected area estate target is 17%), despite this clearly not being stated in the language of the target (Butchart et al., 2015; Woodley et al., 2012).

To overcome issues with vagueness around what is an ecologically representative PCA system, it is essential to be transparent about the types of representation nations are attempting to achieve when setting 'ecologically representative' targets. While ecoregions may be the best option in data poor regions, they are delineated based on large-scale biogeographical patterns (Olson et al., 2001). We suggest that ideally representation should be based on ecosystem types and many countries and regions now have fine-scale data sets on these (Comer et al., 2020). The recently published IUCN Ecosystem Typology (Keith et al., 2022), which comprises six hierarchical levels including three upper levels (realms, functional biomes and ecosystem functional groups), allow bottom-up classification of ecosystems based on their functional characteristics. While mapping of these functional groups is happening at a rapid pace (Keith et al., 2020); it will take some time to get a complete global picture of ecosystems at this level (fifth and sixth hierarchical levels). We therefore argue mapping biogeographic ecotypes (the fourth hierarchical level), which is currently being completed, and then setting targets of representation for their coverage. This uses the ecosystem functional group maps and divides these by biogeography (e.g., ecoregions), a step that overcomes the coarseness of just using ecoregions themselves.

We suggest representation targets need to reflect what is feasible and pragmatic, and recognise large representation targets are simply not possible for many ecosystems, given the amount of human industrial-level pressure they have faced (Kuempel et al., 2016; Mappin et al., 2019). A potentially pragmatic way through this is setting smaller, feasible representative targets for more degraded systems and prioritise restoration efforts outside protected and conserved areas in these systems, as per Target 2 of the K-M GBF. At the same time, larger targets can be set for those more intact ecosystems, where retaining high elements of ecosystem integrity is a priority (Locke et al., 2019; Watson et al., 2020).

Beyond issues of clarity around the unit of representation and targets set for its achievement, all efforts to achieve a representative reserve system must be complementary—and not in competition—to those efforts trying to identify '… areas of particular importance for biodiversity'. Evidence shows that if PCA expansion is based on the objectives identified as those 'especially areas of particular importance for biodiversity', high levels of ecosystem representation can be achieved at the same time (Polak et al., 2015, 2016; Venter et al., 2014). But these studies also clearly show the opposite is not true—targeting ecosystem representation by itself does not mean sites critical for sustaining 'areas of particular importance for biodiversity' are captured. Thus, we argue that the expansion of protected areas should be based primarily on the location of areas of importance for biodiversity regardless of distribution across biogeographical typologies, in particular prioritising the conservation of habitats for rare and threatened species and ecosystems. A parallel effort should be made to include at least some representation across ecosystems as discussed above.

3.3 | Principle 3. Plan for ecological connectivity

It is well established that ensuring ecological connectivity across landscapes and seascapes is critical in facilitating crucial ecological processes, including meta-population viability and successful species migration (Hilty et al., 2020; Tucker et al., 2018; Watson et al., 2018). Furthermore, intensive human activities like farming, urbanization, mining, fishing, and unsustainable forestry are disrupting these connections. Hence, maintaining and, if necessary, restoring landscape connectivity, especially between established PCAs and maintaining connectivity within and between ecosystems or specific species, is crucial for achieving the biodiversity goals laid out in the GBF, especially when considering intentions to secure ecosystem functions. Yet assessments show that PCAs connectivity did not improve during the Aichi period of implementation (UNEP-WCMC and IUCN, 2021).

At a foundational level, for PCA prioritisation, those areas that are more connected, or where connectivity can be re-established, should be given higher priority. This is especially true considering treating PCAs as 'systems' is a core component of T3. But connectivity will also be needed in fragmented landscapes given that climate change is also a factor, with predicted changes in temperature, precipitation, and other variables that will lead to changes in habitat extent and condition. There are an increasing array of methods that can ensure connectivity is considered in the assessment phase for future PCA designation (Buenafe et al., 2023; Keeley et al., 2021; Theobald et al., 2022) but an important consideration is that connectivity should not be prioritised over other objectives aimed at achieving either representation or those identified as 'especially areas of particular importance for biodiversity'—it is important additional factor for successful biodiversity outcomes, not a direct priority for PCA establishment. Indeed, the extent to which connectivity might 'weight' decisions about PCA siting should reflect the context of the proposed PCA—namely, the specific biota it is seeking to protect and enhance, and the land-and seascape context (i.e., use, threats, degree of climate change it will experience) in which it occurs.

3.4 | Principle 4. Be clear around the reasons for conserving ecosystem services

Functioning ecosystems sustain the ecological processes that drive the services upon which humanity depends (Díaz et al., 2018; Fedele et al., 2021; Pascual et al., 2017) and it is well established that PCAs provide an enormous range of ecosystem services to humanity (Stolton & Dudley, 2010). It is therefore not surprising that T3 contains the words 'ecosystem functions and services' when considering where to target PCAs. But not all ecosystem services are compatible with the core values of T3 and management for ecosystem services should not undermine biodiversity conservation objectives. Indeed, many of the drivers that create ecosystem services humanity depends on (e.g., human demand for the 'provisioning services' of fiber, energy, and food) are the very drivers of the extinction crisis and biodiversity collapse being experienced around the world (Maxwell et al., 2016).

It is therefore important for nations to outline specifically what ecosystem services are being targeted and how they are associated with positive biodiversity conservation outcomes (Grantham et al., 2016). Given the overall priorities of the CBD when it comes to PCAs (i.e., to conserve biodiversity [Dudley et al., 2018]), ecosystem services should not become the main reason for establishment of a protected area or recognition of an OECM until a clear positive link with biodiversity conservation is provided. This is because PCAs must ensure that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognizing and respecting the rights of Indigenous Peoples and local communities, including over their traditional territories.

We identify two services—carbon sequestration and storage, and water provisioning—as examples that could be used to guide PCA expansion (Table 2). For the most part, these ecosystem services are positively linked to biodiversity (though the relationship is complex and landscape and vegetation-specific [Cardinale et al., 2012; Di Marco et al., 2018]), and there is increasingly data and methods available for how they can be mapped and incorporated in planning efforts (Table 3). But we recognise there are other services that have positive biodiversity associations that could be added (e.g., disaster risk reduction, spiritual and aesthetic benefits; Chaplin-Kramer et al., 2023; Simmonds et al., 2023).

3.5 | Principle 5. Utilise spatial planning principles and tools

Central to Target 1 of the K-M GBF is that spatial planning efforts that set clear objectives and targets will have a crucial role in informing the design of future PCA networks and other conservation activities. This is because there is substantial evidence which shows that when regional and systematic spatial planning is undertaken, the overall design of PCA networks is more efficient in achieving conservation outcomes (Groves & Game, 2015; Moilanen et al., 2009), and allows for greater transparency and accountability for areas targeted (or not) for conservation (Grantham et al., 2020; McDonald-Madden et al., 2009; Watson et al., 2011).

There are a variety of freely available spatial priorisitisation software such as *Marxan*, *Zonation*, and *PrioritizR* that use models and algorithms to identify areas that integrate and maximize various types of objectives. They all consider the spatial distribution of biodiversity and certain aspects of biodiversity (e.g., species threat status, or how intact an ecosystem is), and can identify appropriate levels of PCA coverage for areas of particular importance for biodiversity while at the same time considering other planning objectives like ecological representation and connectivity (Beger et al., 2022; Grantham et al., 2020). These tools often not only account for ecological factors but also socioeconomic considerations, including land ownership, land use conflicts, and human population density (Carwardine et al., 2008; Wilson et al., 2009). By considering these factors, decision-makers can ensure that proposed PCAs are not only ecologically valuable but also socially acceptable and feasible (Knight et al., 2006; Sinclair et al., 2018).

3.6 | Principle 6. Ensure planning is equitable and inclusive

It is important to recognise that PCAs must safeguard human rights when implemented, as outlined in the CBD. Therefore the 12 elements (and associated planning objectives) suggested here can only be successfully implemented at local scales where planning is equitable, inclusive and agreed upon by local rightsholders and stakeholders following the principles of Free, Prior and Informed Consent (FPIC). Biodiversity outcomes in the 30 × 30 agenda can only be achieved through fair and equitable means (Sandbrook et al., 2023). We recognise that social equity in the context of PCAs has multiple dimensions, including distributional equity (e.g., people agree on a scheme for sharing benefits and burdens), procedural equity (e.g., decision-making, i.e., transparent, accountable and participatory) and recognition (e.g., respect for cultural identities, customary rights and traditional management practices) (Franks et al., 2018).

While the CBD, from its inception in 1992, has specifically recognized the role of Indigenous Peoples through two articles—8(j) and 10(c)—Indigenous Peoples have historically been marginalized in the planning and implementation of CBD targets. This must change if the K-M GBF is to be successful, as significant portions of unprotected lands identified as particularly important for biodiversity overlap with Indigenous territories (Dinerstein et al., 2020; Garnett et al., 2018). Many civil society organisations have called for the adoption of a 'rights-based approach' to scaling conservation efforts globally, going beyond FPIC by centering the autonomous decision-making processes of Indigenous Peoples and Local Communities (Rights and Resources, 2021), while reducing overall costs for implementation (Tauli-Corpuz et al., 2020). When considering the equitable allocation of new PCAs under the GBF, it should be restated that the 30% global goal is neither a floor nor a ceiling for national or regional area-based target-setting efforts. Some jurisdictions may seek much higher regional targets, and other jurisdictions with highly converted rural lands should not be expected to significantly expand their PCA networks. It should also be noted that the target can be implemented, at least in part, by formalising the rights of Indigenous Peoples and Local Communities to the lands and waters they conserve, rather than exclusively through the designation of new, government-governed, PCAs. This differentiated approach will go a long way in allaying fears about 'land grabs' that may challenge the rollout of new area-based targets under the GBF in the future.

4 | ENSURE THE INDICATORS REFLECT THE ELEMENTS OF TARGET 3

Beyond getting the planning principles right, it is critical that the very indicators set to report progress reflect what is needed for successful biodiversity outcomes (Nicholson et al., 2021; Stevenson et al., 2021). The CBD offers a monitoring framework outlining indicators which countries can use to report progress on the K-M GBF, but there is little guidance provided to parties around the specific objectives of 'areas of particular importance for biodiversity and ecosystem services'. The recognition of the need of a monitoring framework is an advance as it is considered poor implementation of the Aichi targets by parties was partially due to a weak or non-existent set of indicators. However, the current CBD headline indicator for T3 of the K-M GBF is 'Coverage of Protected areas and OECMS (by effectiveness)' and as such only focused on areal coverage of PCAs, rather than one that speaks to the qualitative elements of the target, especially the needs of biodiversity (i.e., those components listed in Table 2) (CBD, 2021). Developing and promoting a wider range of indicators, and refining current proposed indicators, at subsequent CBD Conference of Parties is therefore an urgent priority. We note an Ad Hoc Technical Advisory Group has been established under the CBD to refine the headline indicators and identify how they should be disaggregated and the priority must be to ensure they link directly to biodiversity outcomes.

5 | CONCLUSION

Given the areal commitments made by nations in the K-M GBF, area-based conservation should remain the cornerstone of biodiversity conservation efforts long into the 21st century. But to ensure they are effective at abating the catastrophic biodiversity loss we are witnessing, PCAs that make up the 30% must be planned in ways that capture the needs of biodiversity, and best contribute to the broader 2050 Goals and Vision of the CBD. This review is intended to provide information around different elements of biodiversity and ecosystem services nations can target that meet the intentions of T3, in particular, to ensure that they can better achieve the quality outcomes for conserving biodiversity. If PCA expansion undertaken by nations follows the planning principles we identify, many of the needs of biodiversity will be met, if these areas are effectively managed for conservation.

AUTHOR CONTRIBUTIONS

James E. M. Watson: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; resources; software; supervision; validation; visualization; writing—original draft; writing—review and editing. **Ruben Venegas-Li**: Investigation; resources; software; supervision; validation; visualization; writing—original draft; writing—review and editing. **Hedley Grantham**: Writing—original draft; writing—review and editing. **Nigel Dudley**: Writing—original draft; writing—review and editing. **Sue Stolton**: Writing—original draft; writing—review and editing. **Madhu Rao**: Writing—original draft; writing—review and editing. **Stephen Woodley**: Writing—original draft; writing—review and editing. **Marc Hockings**: Writing—original draft; writing—review and editing. **Karl Burkart**: Writing—original draft; writing—review and editing. **Jeremy S. Simmonds**: Writing—original draft; writing—review and editing. **Laura J. Sonter**: Writing—original draft; writing—review and editing. **Rachakonda Sreekar**: Writing—original draft; writing—review and editing. **Hugh P. Possingham**: Writing—original draft; writing—review and editing. **Michelle Ward**: Writing—original draft; writing—review and editing.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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REFERENCES

Acreman, M., Hughes, K.A., Arthington, A.H., Tickner, D. & Dueñas, M.A. (2020) Protected areas and freshwater biodiversity: a novel systematic review distils eight lessons for effective conservation. *Conservation Letters*, 13, e12684. Available from: https://doi.org/10.1111/CONL.12684

Allan, J.R., Kormos, C., Jaeger, T., Venter, O., Bertzky, B., Shi, Y. et al. (2018) Gaps and opportunities for the World Heritage Convention to contribute to global wilderness conservation. *Conservation Biology*, 32, 116–126. Available from: https://doi.org/10.1111/cobi.12976

Allan, J.R., Possingham, H.P., Atkinson, S.C., Waldron, A., Di Marco, M., Butchart, S.H.M. et al. (2022) The minimum land area requiring conservation attention to safeguard biodiversity. *Science*, 376, 1094–1101. Available from: https://doi.org/10.1126/SCIENCE.ABL9127

Allen Coral Atlas. (2020) Imagery, maps and monitoring of the world's tropical coral reefs. *Zenodo*. Available from: https://doi.org/10.5281/zenodo.3833242

Arafeh-Dalmau, N., Brito-Morales, I., Schoeman, D.S., Possingham, H.P., Klein, C.J. & Richardson, A.J. (2021) Incorporating climate velocity into the design of climate-smart networks of marine protected areas. *Methods in Ecology and Evolution*, 12, 1969–1983. Available from: https://doi.org/10.1111/2041-210X.13675

Atwood, T.B., Witt, A., Mayorga, J., Hammill, E. & Sala, E. (2020) Global patterns in marine sediment carbon stocks. *Frontiers in Marine Science*, 7, 514487.

Barnes, M.D., Glew, L., Wyborn, C. & Craigie, I.D. (2018) Prevent perverse outcomes from global protected area policy. *Nature Ecology & Evolution*, 2, 759–762. Available from: https://doi.org/10.1038/s41559-018-0501-y

Beger, M., Grantham, H.S., Pressey, R.L., Wilson, K.A., Peterson, E.L., Dorfman, D. et al. (2010) Conservation planning for connectivity across marine, freshwater, and terrestrial realms. *Biological Conservation*, 143, 565–575. Available from: https://doi.org/10.1016/j.biocon.2009.11.006

Beger, M., Metaxas, A., Balbar, A.C., McGowan, J.A., Daigle, R., Kuempel, C.D. et al. (2022) Demystifying ecological connectivity for actionable spatial conservation planning. *Trends in Ecology & Evolution*, 37, 1079–1091. Available from: https://doi.org/10.1016/J.TREE.2022.09.002

Beyer, H.L., Kennedy, E.V., Beger, M., Chen, C.A., Cinner, J.E., Darling, E.S. et al. (2018) Risk-sensitive planning for conserving coral reefs under rapid climate change. *Conservation Letters*, 11, e12587. Available from: https://doi.org/10.1111/conl.12587

Beyer, H.L., Venter, O., Grantham, H.S. & Watson, J.E.M. (2020) Substantial losses in ecoregion intactness highlight urgency of globally coordinated action. *Conservation Letters*, 13, e12692. Available from: https://doi.org/10.1111/CONL.12692

Birdlife International. (2023) World Database of Key Biodiversity Areas. Managed by BirdLife International on behalf of the KBA Partnership: BirdLife International, International Union for the Conservation of Nature, American Bird Conservancy, Amphibian Survival Alliance, Conservation.

Botts, E.A., Skowno, A., Driver, A., Holness, S., Maze, K., Smith, T. et al. (2020) More than just a (red) list: over a decade of using South Africa's threatened ecosystems in policy and practice. *Biological Conservation*, 246, 108559. Available from: https://doi.org/10.1016/j.biocon.2020.108559

Buenafe, K.C.V., Dunn, D.C., Everett, J.D., Brito-Morales, I., Schoeman, D.S., Hanson, J.O. et al. (2023) A metric-based framework for climate-smart conservation planning. *Ecological Applications*, 33, e2852. Available from: https://doi.org/10.1002/EAP.2852

Bunting, P., Rosenqvist, A., Lucas, R., Rebelo, L.M., Hilarides, L., Thomas, N. et al. (2018) The global mangrove watch—a new 2010 global baseline of mangrove extent. *Remote Sensing*, 10, 1669.

Busch, J. & Grantham, H.S. (2013) Parks versus payments: reconciling divergent policy responses to biodiversity loss and climate change from tropical deforestation. *Environmental Research Letters*, 8, 034028. Available from: https://doi.org/10.1088/1748-9326/8/3/034028

Butchart, S.H.M., Clarke, M., Smith, R.J., Sykes, R.E., Scharlemann, J.P.W., Harfoot, M. et al. (2015) Shortfalls and solutions for meeting national and global conservation area targets. *Conservation Letters*, 8, 329–337.

Butchart, S.H.M., Di Marco, M. & Watson, J.E.M. (2016) Formulating smart commitments on biodiversity: lessons from the Aichi targets. *Conservation Letters*, 9, 457–468. Available from: https://doi.org/10.1111/conl.12278

Cacciapaglia, C. & van Woesik, R. (2015) Reef-coral refugia in a rapidly changing ocean. *Global Change Biology*, 21, 2272–2282. Available from: https://doi.org/10.1111/gcb.12851

Cardinale, B.J., Duffy, J.E., Gonzalez, A., Hooper, D.U., Perrings, C., Venail, P. et al. (2012) Biodiversity loss and its impact on humanity. *Nature*, 486, 59–67.

Carwardine, J., Wilson, K.A., Watts, M., Etter, A., Klein, C.J. & Possingham, H.P. (2008) Avoiding costly conservation mistakes: the importance of defining actions and costs in spatial priority setting. *PLoS One*, 3, e2586.

CBD. (2018) Protected areas and other effective area-based conservation measures. Montreal: Convention on Biological Diversity. 19. Available from: https://www.cbd.int/doc/decisions/cop-14/cop-14-dec-08-en.pdf

CBD. (2021) Proposed headline indicators of the monitoring framework for the post-2020 Global Biodiversity Framework. CBD/WG2020/3/3/Add1. 15 Available from: https://www.cbd.int/doc/c/d716/da69/5e81c8e0faca1db1dd145a59/wg2020-03-03-add1-en.pdf

CBD. (2022) Kunming-Montreal Global Biodiversity Framework. CBD/COP/DEC/15/4. Montreal: Convention on Biological Diversity. 14. Available from: https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf.

Chaplin-Kramer, R., Neugarten, R.A., Sharp, R.P., Collins, P.M., Polasky, S., Hole, D. et al. (2023) Mapping the planet's critical natural assets. *Nature Ecology & Evolution*, 7, 51–61. Available from: https://doi.org/10.1038/S41559-022-01934-5

Chen, I.C., Hill, J.K., Ohlemüller, R., Roy, D.B. & Thomas, C.D. (2011) Rapid range shifts of species associated with high levels of climate warming. *Science (New York, N.Y.)*, 333, 1024–1026. Available from: https://doi.org/10.1126/SCIENCE.1206432

Clark, M.R., Rowden, A.A., Schlacher, T.A., Guinotte, J., Dunstan, P.K., Williams, A. et al. (2014) Identifying ecologically or biologically significant areas (EBSA): a systematic method and its application to seamounts in the South Pacific Ocean. *Ocean & Coastal Management*, 91, 65–79. Available from: https://doi.org/10.1016/J.OCECOAMAN.2014.01.016

Cocks, K.D. & Baird, I.A. (1989) Using mathematical programming to address the multiple reserve selection problem: an example from the Eyre Peninsula, South Australia.

Biological Conservation, 49, 113–130. Available from: https://doi.org/10.1016/0006-3207(89)90083-9

Comer, P.J., Hak, J.C., Josse, C. & Smyth, R. (2020) Long-term loss in extent and current protection of terrestrial ecosystem diversity in the temperate and tropical Americas. *PLoS One*, 15, e0234960. Available from: https://doi.org/10.1371/JOURNAL.PONE.0234960

Conde, D.A., Colchero, F., Güneralp, B., Gusset, M., Skolnik, B., Parr, M. et al. (2015) Opportunities and costs for preventing vertebrate extinctions. *Current Biology*, 25, R219–R221. Available from: https://doi.org/10.1016/J.CUB.2015.01.048

Devillers, R., Pressey, R.L., Grech, A., Kittinger, J.N., Edgar, G.J., Ward, T. et al. (2015) Reinventing residual reserves in the sea: are we favouring ease of establishment over need for protection? *Aquatic Conservation: Marine and Freshwater Ecosystems*, 25, 480–504. Available from: https://doi.org/10.1002/AQC.2445

Díaz, S., Pascual, U., Stenseke, M., Martín-López, B., Watson, R.T., Molnár, Z. et al. (2018) Assessing nature's contributions to people. *Science (New York, N.Y.)*, 359, 270–272. Available from: https://doi.org/10.1126/science.aap8826

Di Marco, M., Ferrier, S., Harwood, T.D., Hoskins, A.J. & Watson, J.E.M. (2019) Wilderness areas halve the extinction risk of terrestrial biodiversity. *Nature*, 573, 582–585. Available from: https://doi.org/10.1038/s41586-019-1567-7

Di Marco, M., Watson, J.E.M., Currie, D.J., Possingham, H.P. & Venter, O. (2018) The extent and predictability of the biodiversity-carbon correlation. *Ecology Letters*, 21, 365–375. Available from: https://doi.org/10.1111/ele.12903

Dinerstein, E., Joshi, A.R., Vynne, C., Lee, A.T.L., Pharand-Deschênes, F., França, M. et al. (2020) A 'global safety net' to reverse biodiversity loss and stabilize Earth's climate. *Science Advances*, 6, eabb2824. Available from: https://doi.org/10.1126/sciadv.abb2824

Dinerstein, E., Olson, D., Joshi, A., Vynne, C., Burgess, N.D., Wikramanayake, E. et al. (2017) An ecoregion-based approach to protecting half the terrestrial realm. *BioScience*, 67, 534–545.

Dudley, N., Jonas, H., Nelson, F., Parrish, J., Pyhälä, A., Stolton, S. et al. (2018) The essential role of other effective area-based conservation measures in achieving big bold conservation targets. *Global Ecology and Conservation*, 15, e00424.

Dudley, N. (Ed.) (2008) *Guidelines for applying protected area management categories*. Iucn.

Eken, G., Bennun, L., Brooks, T.M., Darwall, W., Fishpool, L.D.C., Foster, M. et al. (2004) Key biodiversity areas as site conservation targets. *BioScience*, 54, 1110–1118.

Fedele, G., Donatti, C.I., Bornacelly, I. & Hole, D.G. (2021) Nature-dependent people: mapping human direct use of nature for basic needs across the tropics. *Global Environmental Change*, 71, 102368. Available from: https://doi.org/10.1016/J.GLOENVCHA.2021.102368

Franks, P., Booker, F. & Roe, D. (2018) Understanding and assessing equity in protected area conservation: a matter of governance, rights, social impacts and human wellbeing. IIED, London.

Game, E.T., Groves, C., Andersen, M., Cross, M., Enquist, C., Ferdaña, Z. et al. (2010) Incorporating climate change adaptation into regional conservation assessments. The Nature Conservancy, Arlington, Virginia.

Garnett, S.T., Burgess, N.D., Fa, J.E., Fernández-Llamazares, Á., Molnár, Z., Robinson, C.J. et al. (2018) A spatial overview of the global importance of indigenous lands for conservation. *Nature Sustainability*, 1, 369–374.

Gilbert, N. (2022) Nations forge historic deal to save species: what's in it and what's missing. *Nature*. Available from: https://doi.org/10.1038/D41586-022-04503-9

Goldstein, A., Turner, W.R., Spawn, S.A., Anderson-Teixeira, K.J., Cook-Patton, S., Fargione, J. et al. (2020) Protecting irrecoverable carbon in Earth's ecosystems. *Nature Climate Change*, 10, 287–295. Available from: https://doi.org/10.1038/s41558-020-0738-8

Grantham, H.S., Duncan, A., Evans, T.D., Jones, K.R., Beyer, H.L., Schuster, R. et al. (2020) Anthropogenic modification of forests means only 40% of remaining forests have high ecosystem integrity. *Nature Communications*, 11, 5978. Available from: https://doi.org/10.1038/s41467-020-19493-3

Grantham, H.S., Portela, R., Alam, M., Juhn, D. & Connell, L. (2016) Maximizing biodiversity and ecosystem service benefits in conservation decision-making. *Routledge Handbook of Ecosystem Services*, 554–563. Available from: https://doi.org/10.4324/9781315775302-49

Grantham, H.S., Shapiro, A., Bonfils, D., Gond, V., Goldman, E., Maisels, F. et al. (2020) Spatial priorities for conserving the most intact biodiverse forests within Central Africa. *Environmental Research Letters*, 15, 0940b5. Available from: https://doi.org/10.1088/1748-9326/ab9fae

Groves, C.R., Game, E.T., Anderson, M.G., Cross, M., Enquist, C., Ferdaña, Z. et al. (2012) Incorporating climate change into systematic conservation planning. *Biodiversity and Conservation*, 21, 1651–1671.

Groves, C.R. & Game, E.T. (2015) *Conservation planning: Informed decisions for a healthier planet*, 1st edition. Greenwood Village, Colorado: Roberts and Company Publishers.

Gubbay, S. (1995) Marine protected areas—past, present and future. In: Gubbay, S. (Ed.) *Marine protected areas: principles and techniques for management*. Netherlands, Dordrecht: Springer. pp. 1–14.

Gumbricht, T., Roman-Cuesta, R.M., Verchot, L., Herold, M., Wittmann, F., Householder, E. et al. (2017) An expert system model for mapping tropical wetlands and peatlands reveals South America as the largest contributor. *Global Change Biology*, 23, 3581–3599. Available from: https://doi.org/10.1111/gcb.13689

Halpin, P., Read, A., Fujioka, E., Best, B., Donnelly, B., Hazen, L. et al. (2009) OBIS-SEAMAP: the world data center for marine mammal, sea bird, and sea turtle distributions. *Oceanography*, 22, 104–115.

Halpern, B.S., Walbridge, S., Selkoe, K.A., Kappel, C.V., Micheli, F., D'agrosa, C. et al. (2008) A global map of human impact on marine ecosystems. *Science (New York, N.Y.)*, 319, 948–952. Available from: https://doi.org/10.1126/SCIENCE.1149345

Handley, J.M., Harte, E., Stanworth, A., Poncet, S., Catry, P., Cleminson, S. et al. (2023) Progressing delineations of key biodiversity areas for seabirds, and their application to management of coastal seas. *Diversity and Distributions*, 29, 123–142. Available from: https://doi.org/10.1111/DDI.13651

Hansen, A.J., Burns, P., Ervin, J., Goetz, S.J., Hansen, M., Venter, O. et al. (2020) A policy-driven framework for conserving the best of Earth's remaining moist tropical forests. *Nature Ecology & Evolution*, 4, 1377–1384. Available from: https://doi.org/10.1038/s41559-020-1274-7

Hansen, A., Barnett, K., Jantz, P., Phillips, L., Goetz, S.J., Hansen, M. et al. (2019) Global humid tropics forest structural condition and forest structural integrity maps. *Scientific Data*, 6, 232. Available from: https://doi.org/10.1038/s41597-019-0214-3

Harvey, M.S., Ralph, G.M., Polidoro, B.A., Maxwell, S.M. & Carpenter, K.E. (2021) Identifying key biodiversity areas as marine conservation priorities in the greater Caribbean. *Biodiversity and Conservation*, 30, 4039–4059. Available from: https://link.springer.com/article/10.1007/s10531-021-02291-8

Hilty, J., Worboys, G.L., Keeley, A., Woodley, S., Lausche, B.J., Locke, H. et al. (2020) Guidelines for conserving connectivity through ecological networks and corridors. Guidelines for conserving connectivity through ecological networks and corridors. Available from: https://doi.org/10.2305/IUCN.CH.2020.PAG.30.EN

Hole, D.G., Collins, P., Tesfaw, A., Barrera, L., Mascia, M.B. & Turner, W.R. (2022) Make nature's role visible to achieve the SDGs. *Global Sustainability*, 5, e8. Available from: https://doi.org/10.1017/SUS.2022.5

Houghton, R.A. (2007) Balancing the global carbon budget. *Annual Review of Earth and Planetary Sciences*, 35, 313–347. Available from: https://doi.org/10.1146/annurev.earth.35.031306.140057

Hoyt, E. & Notarbartolo di Sciara, G. (2021) Important marine mammal areas: a spatial tool for marine mammal conservation. *Oryx*, 55, 330. Available from: https://doi.org/10.1017/S0030605321000272

Hughes, A.C. (2023) The Post-2020 global biodiversity framework: how did we get here, and where do we go next? *Integrative Conservation*, 2, 1–9. Available from: https://doi.org/10.1002/INC3.16

ICCM. (2023) Mining and Metals: The Opportunity to Contribute to the Global Biodiversity Framework. London, United Kingdom. Available from: https://www.icmm.com/website/publications/pdfs/environmental-stewardship/2023/factsheet_nature-gbf.pdf

IUCN. (2016) A Global Standard for the Identification of Key Biodiversity Areas, Version 1.0, 1st edition. IUCN, Gland, Switzerland.

IUCN. (2022) The IUCN Red List of Threatened Species. Version 2022-2. Available from: https://www.iucnredlist.org.

Jantz, P., Goetz, S. & Laporte, N. (2014) Carbon stock corridors to mitigate climate change and promote biodiversity in the tropics. *Nature Climate Change*, 4, 138–142.

Jones, K.R., Watson, J.E.M., Possingham, H.P. & Klein, C.J. (2016) Incorporating climate change into spatial conservation prioritisation: a review. *Biological Conservation*, 194, 121–130.

Jones, K.R., Klein, C.J., Grantham, H.S., Possingham, H.P., Halpern, B.S., Burgess, N.D. et al. (2020) Area requirements to safeguard Earth's marine species. *One Earth*, 2, 188–196. Available from: https://doi.org/10.1016/j.oneear.2020.01.010

Jonas, H., MacKinnon, K., Dudley, N., Hockings, M., Jensen, S., Laffoley, D. et al. (2018) Editorial essay. *Parks*, 24, 9–16. Available from: https://parksjournal.com/wp-content/uploads/2018/06/PARKS-24-SI-Low-ResWeb.pdf

Jung, M., Arnell, A., de Lamo, X., García-Rangel, S., Lewis, M., Mark, J. et al. (2021) Areas of global importance for conserving terrestrial biodiversity, carbon and water. *Nature Ecology & Evolution*, 5, 1499–1509. Available from: https://doi.org/10.1038/S41559-021-01528-7

Keeley, A.T.H., Beier, P. & Jenness, J.S. (2021) Connectivity metrics for conservation planning and monitoring. *Biological Conservation*, 255, 109008. Available from: https://doi.org/10.1016/J.BIOCON.2021.109008

Keith, D.A., Ferrer-Paris, J.R., Nicholson, E., Bishop, M.J., Polidoro, B.A., Ramirez-Llodra, E. et al. (2020) Indicative distribution maps for Ecosystem Functional Groups-Level 3 of IUCN Global Ecosystem Typology. Available from: https://doi.org/10.5281/ZENODO.4018314

Keith, D.A., Ferrer-Paris, J.R., Nicholson, E., Bishop, M.J., Polidoro, B.A., Ramirez-Llodra, E. et al. (2022) A function-based typology for Earth's ecosystems. *Nature*, 610, 513–518. Available from: https://doi.org/10.1038/s41586-022-05318-4

Keith, D.A., Rodríguez, J.P., Brooks, T.M., Burgman, M.A., Barrow, E.G., Bland, L. et al. (2015) The IUCN red list of ecosystems: motivations, challenges, and applications. *Conservation Letters*, 8, 214–226. Available from: https://doi.org/10.1111/CONL.12167

Keppel, G., Van Niel, K.P., Wardell-Johnson, G.W., Yates, C.J., Byrne, M., Mucina, L. et al. (2012) Refugia: identifying and understanding safe havens for biodiversity under climate change. *Global Ecology and Biogeography*, 21, 393–404. Available from: https://doi.org/10.1111/J.1466-8238.2011.00686.X

Knight, A.T., Driver, A., Cowling, R.M., Maze, K., Desmet, P.G., Lombard, A.T. et al. (2006) Designing systematic conservation assessments that promote effective implementation: best practice from South Africa. *Conservation Biology*, 20, 739–750.

Kormos, C.F., Bertzky, B., Jaeger, T., Shi, Y., Badman, T., Hilty, J.A. et al. (2016) A wilderness approach under the world heritage convention. *Conservation Letters*, 9, 228–235.

Kot, C.Y., Fujioka, E., DiMatteo, A., Bandimere, A., Wallace, B., Hutchinson, B. et al. (2023) The State of the World's Sea Turtles Online Database: Data provided by the SWOT Team and hosted on OBIS-SEAMAP. Oceanic Society, IUCN Marine Turtle Specialist Group (MTSG), and Marine Geospatial Ecology Lab, Duke University.

Kuempel, C.D., Jones, K.R., Watson, J.E.M. & Possingham, H.P. (2019) Quantifying biases in marine-protected-area placement relative to abatable threats. *Conservation Biology*, 33, 1350–1359. Available from: https://doi.org/10.1111/COBI.13340

Kuempel, C.D., Chauvenet, A.L.M. & Possingham, H.P. (2016) Equitable representation of ecoregions is slowly improving despite strategic planning shortfalls. *Conservation Letters*, 9, 422–428. Available from: https://doi.org/10.1111/CONL.12298

Kullberg, P., Di Minin, E. & Moilanen, A. (2019) Using key biodiversity areas to guide effective expansion of the global protected area network. *Global Ecology and Conservation*, 20, e00768. Available from: https://doi.org/10.1016/J.GECCO.2019.E00768

Leclère, D., Obersteiner, M., Barrett, M., Butchart, S.H.M., Chaudhary, A., De Palma, A. et al. (2020) Bending the curve of terrestrial biodiversity needs an integrated strategy. *Nature*, 585, 551–556. Available from: https://doi.org/10.1038/S41586-020-2705-Y

Lehner, B., Messager, M.L., Korver, M.C. & Linke, S. (2022) Global hydro-environmental lake characteristics at high spatial resolution. *Scientific Data*, 9, 351. Available from: https://doi.org/10.1038/S41597-022-01425-Z

Liang, M., González-Roglich, M., Roehrdanz, P., Tabor, K., Zvoleff, A., Leitold, V. et al. (2023) Assessing protected area's carbon stocks and ecological structure at regional-scale using GEDI lidar. *Global Environmental Change*, 78, 102621. Available from: https://doi.org/10.1016/J.GLOENVCHA.2022.102621

Locke, H., Ellis, E.C., Venter, O., Schuster, R., Ma, K., Shen, X. et al. (2019) Three global conditions for biodiversity conservation and sustainable use: an implementation framework. *National Science Review*, 6, 1080–1082. Available from: https://doi.org/10.1093/NSR/NWZ136

Mace, G.M., Collar, N.J., Gaston, K.J., Hilton-Taylor, C., Akçakaya, H.R., Leader-Williams, N. et al. (2008) Quantification of extinction risk: IUCN's system for classifying threatened species. *Conservation Biology*, 22, 1424–1442.

Mackey, B., DellaSala, D.A., Kormos, C., Lindenmayer, D., Kumpel, N., Zimmerman, B. et al. (2015) Policy options for the world's primary forests in multilateral environmental agreements. *Conservation Letters*, 8, 139–147.

Mappin, B., Chauvenet, A.L.M., Adams, V.M., Di Marco, M., Beyer, H.L., Venter, O. et al. (2019) Restoration priorities to achieve the global protected area target. *Conservation Letters*, 12, e12646. Available from: https://doi.org/10.1111/CONL.12646

Margules, C.R. & Pressey, R.L. (2000) Systematic conservation planning. *Nature*, 405, 243–253. Available from: https://doi.org/10.1038/35012251

Maxwell, S.L., Cazalis, V., Dudley, N., Hoffmann, M., Rodrigues, A.S.L., Stolton, S. et al. (2020) Area-based conservation in the twenty-first century. *Nature*, 586, 217–227. Available from: https://doi.org/10.1038/S41586-020-2773-Z

Maxwell, S.L., Evans, T., Watson, J.E.M., Morel, A., Grantham, H., Duncan, A. et al. (2019) Degradation and forgone removals increase the carbon impact of intact forest loss by 626%. *Science Advances*, 5, eaax2546.

Maxwell, S.L., Fuller, R.A., Brooks, T.M. & Watson, J.E.M. (2016) Biodiversity: the ravages of guns, nets and bulldozers. *Nature*, 536, 143–145.

Maxwell, S.L., Reside, A., Trezise, J., McAlpine, C.A. & Watson, J.E. (2019) Retention and restoration priorities for climate adaptation in a multi-use landscape. *Global Ecology and Conservation*, 18, e00649. Available from: https://doi.org/10.1016/J.GECCO.2019.E00649

McDonald-Madden, E., Gordon, A., Wintle, B.A., Walker, S., Grantham, H., Carvalho, S. et al. (2009) Environment "true" conservation progress. *Science (New York, N.Y.)*, 323, 43–44.

Mcowen, C., Weatherdon, L., Bochove, J.-W., Sullivan, E., Blyth, S., Zockler, C. et al. (2017) A global map of saltmarshes. *Biodiversity Data Journal*, 5, e11764.

Michalak, J.L., Lawler, J.J., Roberts, D.R. & Carroll, C. (2018) Distribution and protection of climatic refugia in North

America. *Conservation Biology*, 32, 1414–1425. Available from: https://doi.org/10.1111/COBI.13130
Miles, L., Newton, A.C., DeFries, R.S., Ravilious, C., May, I., Blyth, S. et al. (2006) A global overview of the conservation status of tropical dry forests. *Journal of Biogeography*, 33, 491–505.
Moilanen, A., Wilson, K.A. & Possingham, H. (2009) *Spatial conservation prioritization: quantitative methods and computational tools*. Oxford, UK: Oxford University Press.
Mokany, K., Ferrier, S., Harwood, T.D., Ware, C., Di Marco, M., Grantham, H.S. et al. (2020) Reconciling global priorities for conserving biodiversity habitat. *Proceedings of the National Academy of Sciences*, 117, 9906–9911. Available from: https://doi.org/10.1073/pnas.1918373117
Morelli, T.L., Barrows, C.W., Ramirez, A.R., Cartwright, J.M., Ackerly, D.D., Eaves, T.D. et al. (2020) Climate-change refugia: biodiversity in the slow lane. *Frontiers in Ecology and the Environment*, 18, 228–234. Available from: https://doi.org/10.1002/FEE.2189
Mulligan, M. (2019) Potential Clean Water Provision. Model results from the Costingnature version 3 policy support system (noncommercial-use). http://www.policysupport.org/costingnature [prepared by user mark.mulligan_kcl.ac.uk].
Mulligan, M. (2019) Relative realised water provisioning services index. Model results from the Costingnature version 3 policy support system (noncommercial-use). http://www.policysupport.org/costingnature [prepared by user mark.mulligan_kcl.ac.uk].
Mulligan, M., van Soesbergen, A., Hole, D.G., Brooks, T.M., Burke, S. & Hutton, J. (2020) Mapping nature's contribution to SDG 6 and implications for other SDGs at policy relevant scales. *Remote Sensing of Environment*, 239, 111671. Available from: https://doi.org/10.1016/j.rse.2020.111671
Murray, N.J., Keith, D.A., Duncan, A., Tizard, R., Ferrer-Paris, J.R., Worthington, T.A. et al. (2020) Myanmar's terrestrial ecosystems: status, threats and conservation opportunities. *Biological Conservation*, 252, 108834. Available from: https://doi.org/10.1016/J.BIOCON.2020.108834
Newbold, T., Hudson, L.N., Arnell, A.P., Contu, S., De Palma, A., Ferrier, S. et al. (2016) Has land use pushed terrestrial biodiversity beyond the planetary boundary? A global assessment. *Science (New York, N.Y.)*, 353, 288–291. Available from: https://doi.org/10.1126/science.aaf2201
Nicholson, E., Watermeyer, K.E., Rowland, J.A., Sato, C.F., Stevenson, S.L., Andrade, A. et al. (2021) Scientific foundations for an ecosystem goal, milestones and indicators for the post-2020 global biodiversity framework. *Nature Ecology & Evolution*, 5(10), 1338–1349. Available from: https://doi.org/10.1038/s41559-021-01538-5
Noon, M.L., Goldstein, A., Ledezma, J.C., Roehrdanz, P.R., Cook-Patton, S.C., Spawn-Lee, S.A. et al. (2022) Mapping the irrecoverable carbon in Earth's ecosystems. *Nature Sustainability*, 5, 37–46. Available from: https://doi.org/10.1038/s41893-021-00803-6
Olson, D.M., Dinerstein, E., Wikramanayake, E.D., Burgess, N.D., Powell, G.V.N., Underwood, E.C. et al. (2001) Terrestrial ecoregions of the world: a new map of life on earth. *BioScience*, 51, 933–938.
Pacifici, M., Di Marco, M. & Watson, J.E.M. (2020) Protected areas are now the last strongholds for many imperiled mammal species. *Conservation Letters*, 13, e12748. Available from: https://doi.org/10.1111/CONL.12748
Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M. et al. (2017) Valuing nature's contributions to people: the IPBES approach. *Current Opinion in Environmental Sustainability*, 26–27, 7–16. Available from: https://doi.org/10.1016/J.COSUST.2016.12.006
Polak, T., Watson, J.E.M., Bennett, J.R., Possingham, H.P., Fuller, R.A. & Carwardine, J. (2016) Balancing ecosystem and threatened species representation in protected areas and implications for nations achieving global conservation goals. *Conservation Letters*, 9, 438–445. Available from: https://doi.org/10.1111/conl.12268
Polak, T., Watson, J.E.M., Fuller, R.A., Joseph, L.N., Martin, T.G., Possingham, H.P. et al. (2015) Efficient expansion of global protected areas requires simultaneous planning for species and ecosystems. *Royal Society Open Science*, 2, 150107. Available from: https://doi.org/10.1098/rsos.150107
Pressey, R.L., Cowling, R.M. & Rouget, M. (2003) Formulating conservation targets for biodiversity pattern and process in the Cape Floristic Region, South Africa. *Biological Conservation*, 112, 99–127.
Relano, V. & Pauly, D. (2023) The 'paper park index': evaluating marine protected area effectiveness through a global study of stakeholder perceptions. *Marine Policy*, 151, 105571. Available from: https://doi.org/10.1016/J.MARPOL.2023.105571
Reside, A.E., VanDerWal, J., Phillips, B., Shoo, L.P., Rosauer, D.F., Anderson, B.J. et al. (2013) Climate change refugia for terrestrial biodiversity. National Climate Change Adaptation Research Facility.
Ricketts, T.H., Dinerstein, E., Boucher, T., Brooks, T.M., Butchart, S.H.M., Hoffmann, M. et al. (2005) Pinpointing and preventing imminent extinctions. *Proceedings of the National Academy of Sciences*, 102, 18497–18501. Available from: https://doi.org/10.1073/PNAS.0509060102
Rights and Resources Initiative. (2021) Rights-based conservation: the path to preserving Earth's biological and cultural diversity? Washington, DC: Rights and Resources Initiative.
Sandbrook, C., Albury-Smith, S., Allan, J.R., Bhola, N., Bingham, H.C., Brockington, D. et al. (2023) Social considerations are crucial to success in implementing the 30 × 30 global conservation target. *Nature Ecology & Evolution*, 7, 784–785. Available from: https://doi.org/10.1038/S41559-023-02048-2
Scheffers, B.R., De Meester, L., Bridge, T.C.L., Hoffmann, A.A., Pandolfi, J.M. et al. (2016) The broad footprint of climate change from genes to biomes to people. *Science (1979)*, 354, aaf7671. Available from: https://doi.org/10.1126/science.aaf7671
Shen, X., Liu, M., Hanson, J.O., Wang, J., Locke, H., Watson, J.E.M. et al. (2023) Countries' differentiated responsibilities to fulfill area-based conservation targets of the Kunming-Montreal global biodiversity framework. *One Earth*, 6, 548–559. Available from: https://doi.org/10.1016/J.ONEEAR.2023.04.007
Shrestha, N., Shen, X. & Wang, Z. (2019) Biodiversity hotspots are insufficient in capturing range-restricted species. *Conservation Science and Practice*, 1, e103. Available from: https://doi.org/10.1111/CSP2.103
Simmonds, J.S., Suarez-Castro, A.F., Reside, A.E., Watson, J.E.M., Allan, J.R., Atkinson, S.C. et al. (2023) Retaining natural vegetation to safeguard biodiversity and humanity. *Conservation Biology*, 37, e14040. Available from: https://doi.org/10.1111/cobi.14040
Sinclair, S.P., Milner-Gulland, E.J., Smith, R.J., McIntosh, E.J., Possingham, H.P., Vercammen, A. et al. (2018) The use, and usefulness, of spatial conservation prioritizations. *Conservation Letters*, 11, e12459. Available from: https://doi.org/10.1111/conl.12459
Smith, R.J., Bennun, L., Brooks, T.M., Butchart, S.H.M., Cuttelod, A., Marco, M. et al. (2019) Synergies between the key biodiversity area and systematic conservation planning approaches. *Conservation Letters*, 12, e12625. Available from: https://doi.org/10.1111/conl.12625
Soto-Navarro, C., Ravilious, C., Arnell, A., de Lamo, X., Harfoot, M., Hill, S.L.L. et al. (2020) Mapping co-benefits for carbon storage and biodiversity to inform conservation policy and action. *Philosophical Transactions of the Royal Society, B: Biological Sciences*, 375, 20190128.
Spalding, M.D., Fox, H.E., Allen, G.R., Davidson, N., Ferdaña, Z.A., Finlayson, M. et al. (2007) Marine ecoregions of the world: a bioregionalization of coastal and shelf areas. *BioScience*, 57, 573–583.
Spawn, S.A., Sullivan, C.C., Lark, T.J. & Gibbs, H.K. (2020) Harmonized global maps of above and belowground biomass carbon density in the year 2010. *Scientific Data*, 7, 112. Available from: https://doi.org/10.1038/s41597-020-0444-4
Stevenson, S.L., Watermeyer, K., Caggiano, G., Fulton, E.A., Ferrier, S. & Nicholson, E. (2021) Matching biodiversity indicators to policy needs. *Conservation Biology*, 35, 522–532. Available from: https://doi.org/10.1111/cobi.13575

Stolton, S. & Dudley, N. (Eds.) (2010) *Arguments for protected areas*. London: Earthscan.
Tauli-Corpuz, V., Alcorn, J., Molnar, A., Healy, C. & Barrow, E. (2020) Cornered by PAs: adopting rights-based approaches to enable cost-effective conservation and climate action. *World Development*, 130, 104923. Available from: https://doi.org/10.1016/J.WORLDDEV.2020.104923
Tetley, M.J., Braulik, G.T., Lanfredi, C., Minton, G., Panigada, S., Politi, E. et al. (2022) The important marine mammal area network: a tool for systematic spatial planning in response to the marine mammal habitat conservation crisis. *Frontiers in Marine Science*, 9, 841789. Available from: https://doi.org/10.3389/FMARS.2022.841789
Theobald, D.M., Keeley, A.T.H., Laur, A. & Tabor, G. (2022) A simple and practical measure of the connectivity of protected area networks: the ProNet metric. *Conservation Science and Practice*, 4, e12823. Available from: https://doi.org/10.1111/CSP2.12823
Tucker, M.A., Böhning-Gaese, K., Fagan, W.F., Fryxell, J.M., Van Moorter, B., Alberts, S.C. et al. (2018) Moving in the anthropocene: global reductions in terrestrial mammalian movements. *Science (New York, N.Y.)*, 359, 466–469. Available from: https://doi.org/10.1126/science.aam9712
UNEP-WCMC, Short, F.T. (2018) Global distribution of seagrasses (version 7.1). Seventh update to the data layer used in Green and Short (2003).
UNEP-WCMC and IUCN. (2021) Protected Planet Report 2020. UNEP-WCMC and IUCN: Cambridge UK; Gland, Switzerland.
UNEP-WCMC. (2020a) Threatened species richness. Derived from Areas of Habitat maps created from data from the IUCN Red List, BirdLife International, the Global Assessment of Reptile Distributions (GARD), the Botanical Information and Ecology Network (BIEN) database and additional vascular plant species ranges were created from point data from the IUCN Red List, Botanic Gardens Conservation International (BGCI), the Global Biodiversity Information Facility (GBIF) and iNaturalist.
UNEP-WCMC. (2020b) Rarity-weighted species richness. Derived from Areas of Habitat maps created from data from the IUCN Red List, BirdLife International, the Global Assessment of Reptile Distributions (GARD), the Botanical Information and Ecology Network (BIEN) database and additional vascular plant species ranges were created from point data from the IUCN Red List, Botanic Gardens Conservation International (BGCI), the Global Biodiversity Information Facility (GBIF) and iNaturalist.
UNEP-WCMC. (2020c) Threatened rarity-weighted species richness refined by area of habitat.
Venegas-Li, R., Grantham, H.S., Rainey, H., Diment, A., Tizard, R. & Watson, J.E.M., 2023. An operational methodology to identify Critical Ecosystem Areas to help nations achieve the Kunming-Montreal Global Biodiversity Framework. *bioRxiv*.
Venter, O., Fuller, R.A., Segan, D.B., Carwardine, J., Brooks, T., Butchart, S.H.M. et al. (2014) Targeting global protected area expansion for imperiled biodiversity. *PLoS Biology*, 12, e1001891. Available from: https://doi.org/10.1371/JOURNAL.PBIO.1001891
Visconti, P., Butchart, S.H.M., Brooks, T.M., Langhammer, P.F., Marnewick, D., Vergara, S. et al. (2019) Protected area targets post-2020. *Science (New York, N.Y.)*, 364, 239–241. Available from: https://doi.org/10.1126/science.aav6886
Ward, M., Saura, S., Williams, B., Ramírez-Delgado, J.P., Arafeh-Dalmau, N., Allan, J.R. et al. (2020) Just ten percent of the global terrestrial protected area network is structurally connected via intact land. *Nature Communications*, 11(1), 4563. Available from: https://doi.org/10.1038/s41467-020-18457-x
Warren, R., Vanderwal, J., Price, J., Welbergen, J.A., Atkinson, I., Ramirez-Villegas, J. et al. (2013) Quantifying the benefit of early climate change mitigation in avoiding biodiversity loss. *Nature Climate Change*, 3, 678–682. Available from: https://doi.org/10.1038/NCLIMATE1887
Watson, J.E.M., Darling, E.S., Venter, O., Maron, M., Walston, J., Possingham, H.P. et al. (2016) Bolder science needed now for protected areas. *Conservation Biology*, 30, 243–248. Available from: https://doi.org/10.1111/COBI.12645
Watson, J.E.M., Dudley, N., Segan, D.B. & Hockings, M. (2014) The performance and potential of protected areas. *Nature*, 515, 67–73. Available from: https://doi.org/10.1038/NATURE13947
Watson, J.E., Evans, M.C., Carwardine, J., Fuller, R.A., Joseph, L.N., Segan, D.B. et al. (2011) The capacity of Australia's protected-area system to represent threatened species. *Conservation Biology*, 25, 324–332. Available from: https://doi.org/10.1111/j.1523-1739.2010.01587.x
Watson, J.E.M., Evans, T., Venter, O., Williams, B., Tulloch, A., Stewart, C. et al. (2018) The exceptional value of intact forest ecosystems. *Nature Ecology & Evolution*, 2, 599–610. Available from: https://doi.org/10.1038/s41559-018-0490-x
Watson, J.E.M., Fuller, R.A., Watson, A.W.T., Mackey, B.G., Wilson, K.A., Grantham, H.S. et al. (2009) Wilderness and future conservation priorities in Australia. *Diversity and Distributions*, 15, 1028–1036.
Watson, J.E.M., Grantham, H.S., Wilson, K.A. & Possingham, H.P. (2011) Systematic conservation planning: past, present and future. *Conservation Biogeography* 136–160. Available from: https://doi.org/10.1002/9781444390001.CH6
Watson, J.E.M., Keith, D.A., Strassburg, B.B.N., Venter, O., Williams, B. & Nicholson, E. (2020) Set a global target for ecosystems. *Nature*, 578, 360–362. Available from: https://doi.org/10.1038/d41586-020-00446-1
Williams, B.A., Venter, O., Allan, J.R., Atkinson, S.C., Rehbein, J.A., Ward, M. et al. (2020) Change in terrestrial human footprint drives continued loss of intact ecosystems. *One Earth*, 3, 371–382. Available from: https://doi.org/10.1016/j.oneear.2020.08.009
Williams, B.A., Watson, J.E.M., Beyer, H.L., Klein, C.J., Montgomery, J., Runting, R.K. et al. (2022) Global rarity of intact coastal regions. *Conservation Biology*, 36, e13874. Available from: https://doi.org/10.1111/COBI.13874
Williams, B.A., Watson, J.E.M., Butchart, S.H.M., Ward, M., Brooks, T.M., Butt, N. et al. (2021) A robust goal is needed for species in the Post-2020 global biodiversity framework. *Conservation Letters*, 14, e12778. Available from: https://doi.org/10.1111/CONL.12778
Wilson, K.A., Meijaard, E., Drummond, S., Grantham, H.S., Boitani, L., Catullo, G. et al. (2010) Conserving biodiversity in production landscapes. *Ecological Applications*, 20, 1721–1732. Available from: https://doi.org/10.1890/09-1051.1
Wilson, K.A., Carwardine, J. & Possingham, H.P. (2009) Setting conservation priorities. *Annals of the New York Academy of Sciences*, 1162, 237–264.
Woodley, S., Bertzky, B., Crawhall, N., Dudley, N., Londoño, J.M., MacKinnon, K. et al. (2012) Meeting Aichi target 11: what does success look like for protected area systems. *Parks*, 18, 23–36.
WWF and IUCN WCPA. (2023) A Guide to Inclusive, Equitable and Effective Implementation of Target 3 of the Kunming-Montreal Global Biodiversity Framework: Version 1, August 2023. Available from: https://www.iucn.org/resources/grey-literature/30x30-guide-inclusive-equitable-and-effective-implementation-target-3

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