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Perspective

An inclusive, empirically grounded inventory facilitates recognition of diverse area-based conservation of nature

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SUMMARY

As the international community strives to conserve 30% of Earth's lands and waters by 2030, the full extent of area-based conservation remains unclear. Official databases do not fully recognize and track the diversity of conservation-relevant governance systems, hindering conservation research, policy, planning, and action. Here, we describe and test an inclusive, empirically grounded approach to documenting area-based governance systems that potentially advance biodiversity conservation. Among Amazonian countries, we identify greater area coverage and diversity of conservation governance systems than official databases. We further illustrate the relevance of this approach using global examples of under-recognized conservation governance systems. Our findings highlight the need for an inclusive, empirically grounded inventory that reflects the full diversity of area-based conservation systems. We recommend researchers, governments, non-state actors, and donors to adopt similar inventories to increase feasibility, transparency, and inclusivity as a foundational component of global efforts to fulfill international commitments and create a nature-positive future.

INTRODUCTION

The conceptualization and spatial extent of conserved areas are foundational to goal setting and prioritized actions for biodiversity conservation,[1] climate solutions,[2] and sustainable development goals.[3] Scientists and decision makers have developed criteria regarding planetary protection,[4,5] guidelines for assessing conserved areas beyond protected areas,[6] and the importance of integrating conservation values in other area-based governance systems.[7,8]

Nations have agreed upon conserving 30% of global lands and water by 2030 (30-by-30), codified as Target 3 of the 2022 Kunming-Montreal Global Biodiversity Framework (GBF) agreed at the 15th Conference of the Parties (COP15) of the United Nations (UN) Convention on Biological Diversity (CBD).[1] Other proposals suggest that more ambitious targets, such as Half-Earth, are necessary to effectively safeguard biodiversity.[9] Debates are also intensifying around these proposals, given the magnitude of potential social impacts,[10] along with criticisms of the fortress conservation model, which separates people from nature.[11,12] Challenging questions have been raised about which conservation objectives matter, what types of areas count toward 30-by-30, who bears the cost, who decides, and what happens to the parts of the planet that are not reserved "for nature."[11,13] Alternative proposals advocate for shared landscapes instead of separate allocations for people and nature[5,7,8]; for instance, Indigenous groups recently led an International Union for Conservation of Nature (IUCN) Resolution urging the protection of 80% of the Amazon by 2025 to avoid a tipping point "in partnership with and recognizing the leadership of Indigenous peoples in the Amazon."[14]

Fundamental to these discussions is knowledge of the existing types and extents of conservation areas :how and where are lands and waters managed, and what is the coverage and diversity of approaches? Answering these questions has proved difficult, because the range of existing area-based conservation governance systems are more diverse than is currently recognized by policy discussion and tracking systems.[15,16] Many area-based governance systems are designed with conservation intentions, including conservation concessions, conservation agreements, and privately or community-owned conservation areas.[17–19] Many other area-based governance systems, although not necessarily intended for conservation, may foster positive biodiversity conservation outcomes. For example, Indigenous territories with secure land titles often have lower rates of deforestation and forest carbon emissions,[20–22] although effectiveness varies.[21] Community-based natural resources management (CBNRM), including community forestry, may also have a positive effect on reducing deforestation.[23] Sacred natural sites protected for their special spiritual values also contain high biodiversity.[24–26] Payments for ecosystem services (PES) programs can cost-effectively incentivize forest conservation.[27] Productive landscapes including eco-certified production (including areas set aside for protection) and state-required sustainable forestry areas can foster biodiversity conservation as they restrict some land clearing.[28–31] Military training areas, especially large, remote areas with restricted access, may provide habitat with high biodiversity.[32–34] Efforts to track area-based conservation have traditionally focused on state-designated protected areas (PAs). Expansions to PA coverage, according to global data, have brought approximately 16.64% of the world's lands and 7.74% of coastal and marine areas under protection,[15] although legal changes have reversed some protections.[35] Considered the cornerstone of conservation, PAs have received the most attention and funding,[36,37] and can often effectively protect species and ecosystems.[38–40] PAs also have wide-ranging and diverse impacts on people's livelihoods,[41,42] and they have also been criticized for violating people's rights, failing in the mission to conserve.[43] Focusing solely on PA coverage can lead to ineffective management ("paper parks")[44] and mislabeling of other types of area-based conservation governance systems as PAs,[45] while other conservation approaches struggle to advocate for proper recognition and support.[25,46,47]

Given the possibility of unintended negative consequences of proposals to expand PAs,[11,48,49] and their potential to advance climate and biodiversity conservation goals,[2,3,50] growing efforts have emerged to recognize, include, and promote other forms of area-based conservation.[16] Such reflections and efforts have successfully led to the inclusion of other effective area-based conservation measures (OECMs) and the recognition of Indigenous and traditional territories (when applicable) in Target 3 of the new GBF.[1] Several initiatives have begun to inventory a more diverse array of governance systems beyond state PAs. Particularly relevant are the World Database on Protected Areas (WDPA) and the World Database on Other Effective Conservation Measures (WD-OECM).[51] These databases are used officially for accounting toward 30-by-30,[52] and are widely used to guide policy, track progress, assess risks, and target funding.[53] The WDPA includes some PAs owned and managed by non-state actors (e.g., Indigenous peoples, private actors), and the WD-OECM tracks other geographically defined areas beyond PAs that achieve "… positive and sustained long term outcomes …."[6] While reporting to WDPA is primarily led by national governments and international secretariats, expert review rather than state review is also possible, and WD-OECM's data reporting and verification involves more diverse actors, such as non-government organizations, Indigenous peoples and local communities (IPLC) organizations, and individuals.[53] The Indigenous and Community Conserved Areas (ICCA) registry is another important effort that documents territories and areas conserved by Indigenous peoples and local communities. The reporting is done by "communities, Indigenous peoples and those who work with them."[54]

Despite these advances, significant knowledge gaps and challenges remain in three aspects: (1) current tracking systems exclude existing forms of area-based governance and management related to conservation, failing to reflect diverse perspectives regarding what counts as area-based conservation, specifically toward the 30-by-30 goal of the GBF; (2) the decision power still largely lies with national governments due to reporting structures, making it challenging for systems beyond state-protected or state-recognized areas to receive proper recognition; (3) there is still a surprising lack of data due to historical focus in PAs and lack of documentation of other area-based conservation governance systems, and because current tracking systems take a site-based reporting approach, which ensures site-level accuracy but can be time consuming and data intensive.

To address these challenges, we need an inclusive, empirically grounded approach to track PAs and other area-based conservation governance systems. Such an approach must employ a broader scope than OECMs and ICCAs, overcome some of the limitations of existing approaches, and meet the pressing policy demand of understanding how much of the planet is conserved, where, and how.

In this perspective, we propose an empirical framework to inclusively inventory area-based conservation governance systems to address these challenges. We highlight the usefulness of this approach in the Amazon region, where we comprehensively document the extent, types, and actors involved in area-based conservation. We show that our approach can help fill gaps in existing official databases. We further illustrate the importance of scaling up this approach globally with examples from Indigenous and community lands, certified forests, and biodiversity offsets. Our approach contributes to grounding policy discussions on the magnitude and governance approaches relevant to tracking area-based conservation targets. It also advances conservation science by providing the baseline for conservation planning and rigorous impact evaluation.

THE CHALLENGES IN RECOGNIZING AREA-BASED CONSERVATION

There is a clear need to recognize the full range of conservation-relevant governance systems in research, policy, and practice. In conservation research, recognizing areas beyond PAs involves understanding their contributions to protecting habitats or improving connectivity and considering them along with PAs in planning and priority setting.[55,56] For policy and practice, it is important to be aware of and acknowledge that conservation areas are managed by diverse actors under various governance schemes, all of which should be considered when setting targets, allocating resources, and designing safeguards.[57] As countries prepare National Biodiversity Strategies and Action Plans (NBSAPs) and donors decide where to allocate limited funding, there is an urgent need for a more rapid and inclusive assessment of existing area-based conservation governance systems to guide resource allocation effectively.

Given heterogeneity in objectives and governance types, properly recognizing and accounting for contributions of diverse governance systems to conservation poses fundamental questions: what counts as an area-based conservation system and who has the authority to decide? A narrow definition of area-based conservation risks discounting current progress and ignoring the contributions of widespread governance systems to nature conservation beyond state-designated PAs. Conversely, inventorying all geographies under area-based governance risks overestimating and obscuring critical conservation priorities. In either scenario, the potential for misaligned financial resources and human capacity on a global scale is considerable and potentially catastrophic for nature and humanity.

Yet, existing approaches fall short in meeting the pressing demand from policy and practice due to three major challenges. First, current tracking systems still exclude many area-based governance systems that could provide conservation benefits. Debates surrounding what should count toward global biodiversity targets, among those who advocate for strictly PAs and those who hold more inclusive views,[11,16] are reflected in the design of current tracking systems to monitor progress toward these targets. While the inclusion of OECMs has expanded what was traditionally counted as conservation, it still has requirements that can limit its scope. For example, one of the OECM criteria is that the site must be long term, which is interpreted as the site being likely to be protected in perpetuity.[6] Currently, despite their conservation potential, eco-certified production areas are not considered OECMs because they may be subject to limited time.[30] Another criterion for the screening of OECMs is site effectiveness.[6] While it is justified to assess outcomes of conservation sites to avoid over-reporting toward official databases, using effectiveness as a screening criterion is challenging. Validation of conservation effectiveness requires the collection of baseline data, long-term monitoring, and rigorous impact evaluation[58,59]; further, the delivery of conservation outcomes is often dependent on governance and management capacity and other related support, as even state-designated PAs may fail to deliver conservation outcomes when under-resourced.[60–62] However, the availability of funding and other resources often depends on site recognition as PAs or OECMs; for example, the Global Environmental Facilities prioritized supporting PAs and OECMs.[63,64] Since higher funding levels often give rise to biodiversity information, it will take years and a significant increase in funding before effectiveness data will be collected and adequately inform reporting, especially for those conserved areas that are not yet recognized by states.[65]

Second, the reporting processes for official datasets are still dominated by governments, in part due to UNEP-WCMC's reporting process that requires governments to approve submissions from non-state actors. These procedures are in place to ensure accuracy of submissions. While WD-OECM incorporates non-governmental reporting entities and expert review as a parallel process to government review, there is still inequality in the process. WD-OECM recognizes government-reported OECMs automatically and requires extra review for submissions from non-state actors,[66] yet these same non-state actors are the least likely to have the time and resources to fulfill these submission and reporting obligations. While the benefits of getting formal OECM recognition is clear for governments—they can fulfill their commitments to global biodiversity targets—it is not yet clear whether engagement brings adequate returns (e.g., funding, capacity support) to non-governmental entities, especially IPLCs.

Third, the speed of data collection in the current tracking systems does not match the pressing need from policy and science. Conservation beyond state-designated PAs has been overlooked, causing a lack of documentation of their spatial extent and other characteristics. In addition, current tracking systems take a site-based reporting approach; while this increases accuracy of data at the site level, it can be time consuming. Finally, obtaining official OECM status and being counted toward national biodiversity targets may not be appealing to all sites given their diverse objectives and management approaches, which can lead to under-reporting of OECMs. Since the establishment of the WD-OECM in 2019, the database has recorded 872 sites in 10 countries and territories,[67] covering 1% of the terrestrial and inland waters globally. Established in 2008, the ICCA registry recorded 310 sites in 24 countries and territories, covering 311,780 km^2, or about 0.24% of global land area.[68]

As a result of these three major constraints, the WDPA and WD-OECM databases may exclude systems with conservation intention or with potential to deliver conservation outcomes.[15,16,46] The limitations of the formal databases compromise the effectiveness of policy formulation, funding allocation, and scientific research, which highlights the necessity of complementary civil society data and tracking initiatives. Meanwhile, numerous local-level data collection efforts are underway (e.g., the civil society conserved area mapping project in Venezuela[69]). These local efforts present an important opportunity for

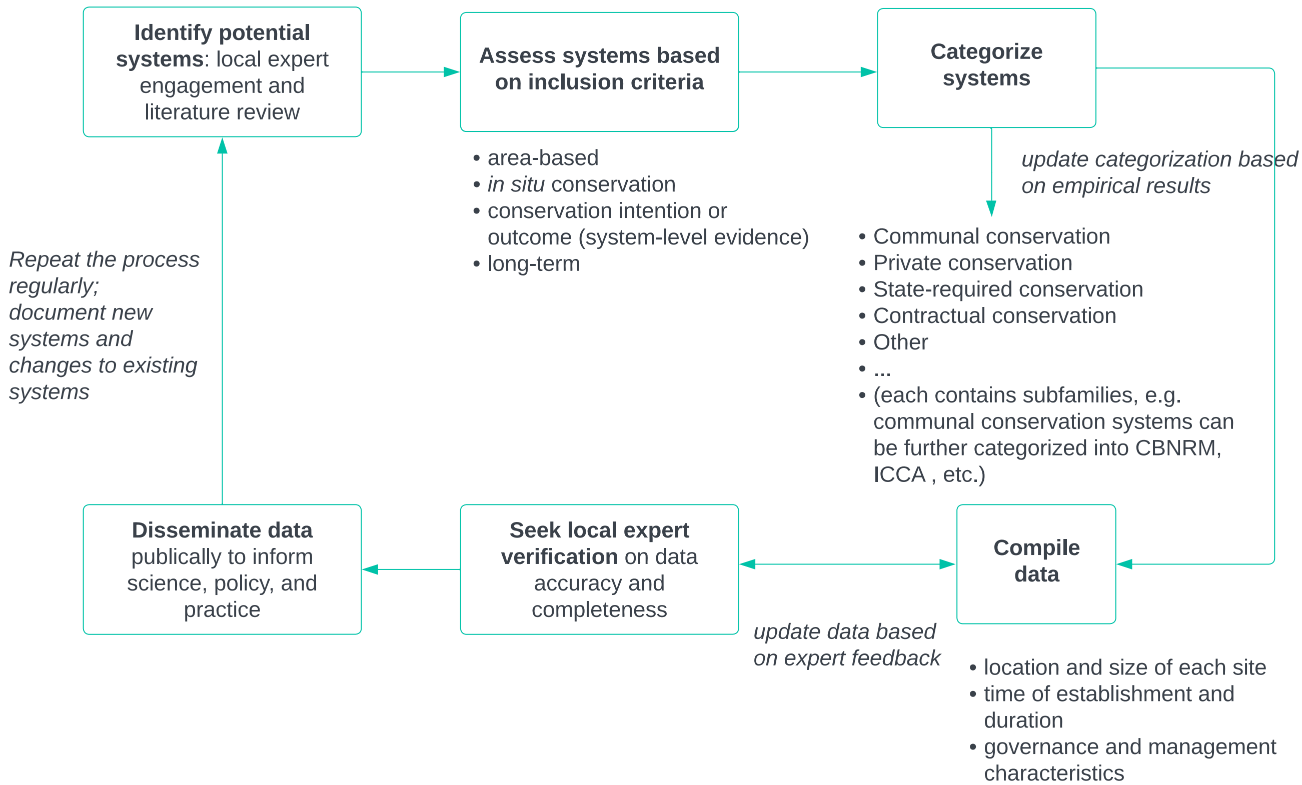

Figure 1. Overview of the proposed approach to inventory area-based conservation governance systems

knowledge co-production and synthesis to build more comprehensive datasets of area-based conservation.

AN INCLUSIVE, EMPIRICALLY GROUNDED INVENTORY TOWARD RECOGNIZING A DIVERSE AREA-BASED APPROACH TO CONSERVATION

To address the gaps and challenges with existing tracking systems, we propose an empirical and inclusive approach that begins with a spatially explicit, regularly repeated inventory of all area-based conservation governance systems globally. Such an inventory would answer the following questions: what are the existing forms of area-based governance that have conservation objectives or potential conservation outcomes? Who governs these areas and how? When were these governance systems established, when and how have they changed, and how long do or did they last? Inputs from diverse sources such as the scientific literature, local knowledge holders including IPLC communities, and other non-peer-reviewed sources are required for a holistic inventory.[70,71] Following the Findability, Accessibility, Interoperability, and Reusability (FAIR) and Collective benefit, Authority to control, Responsibility, and Ethics (CARE) principles for data governance, the data would be made public to the extent permissible by data owners, and necessary data anonymization and aggregation can be employed to address data privacy concerns.[72] Instead of reporting to pre-defined governance categories, an inclusive, empirically grounded approach can better capture the diversity and dynamics of existing governance systems and flexibly integrate emerging actors and arrangements, hence providing a more representative global picture of current conservation progress, gaps, and opportunities than is possible through current frameworks. Instead of site-by-site reporting, our approach compiles datasets at a system level, which reduces the reporting burden by managers of individual sites and yields a quicker overview. A holistic view will lay the foundation for knowledge production and informed policy debates, and it will further increase the transparency of policy and funding decisions, with respect to not only what is counted but also what is not and why.[73,74]

Our proposed approach (Figure 1) aims to capture qualitative, quantitative, and geospatial data on area-based conservation governance systems including and beyond state-designated PAs (i.e., PAs designated by a government authority; to see the distinction we make between state-designated PAs, national protected area systems, and areas recorded in the WDPA, please refer to supplemental information). By "area-based conservation governance system," we refer to the "set of regulatory processes, mechanisms, and organizations through which … actors influence … [conservation] actions and outcomes [in a defined geographic area]."[75] The inventory process starts with literature review and expert consultation to identify potential area-based conservation governance systems (referred to as "systems" hereafter). The next step is to assess whether to include each system based on the following criteria: (1) whether the system is area based; (2) whether the system potentially provides *in situ* conservation of biodiversity (as opposed to *ex situ*); (3) whether the system has either a conservation objective and/or provides potential conservation outcomes based on evidence

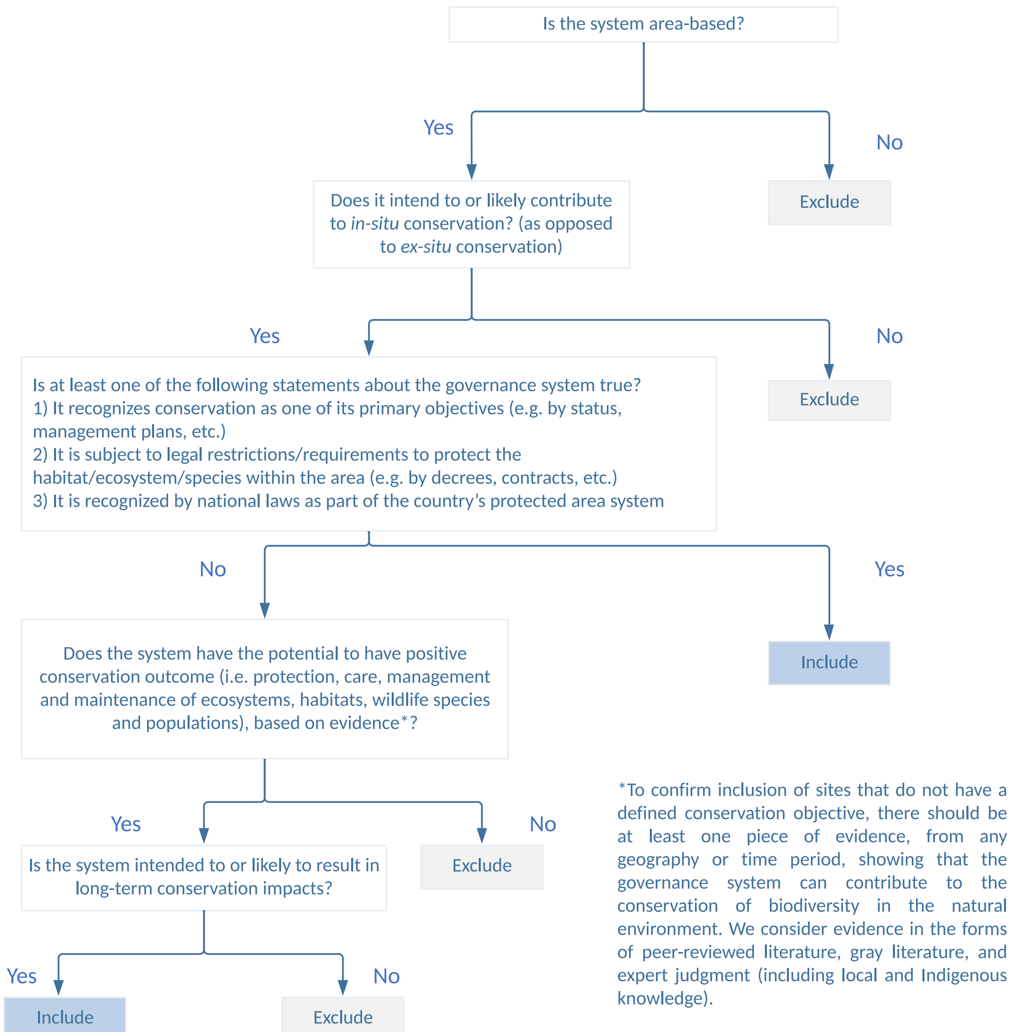

Figure 2. Decision tree for inclusion of candidate governance system in the conservation beyond PAs database

on that system from any geography; and (4) whether the system is intended or likely to result in long-term conservation impacts (Figure 2). The inclusion decision takes place at a system rather than site level. We avoid making *a priori* assumptions about the effectiveness of conservation governance systems. By including a system, we do not imply that the system guarantees conservation outcomes. Rather, we propose inclusively collecting baseline data of all sites with potential positive conservation impact.

Once an area-based conservation governance system is identified, spatial, statistical, and descriptive data are collected through literature review, web search, and expert solicitation. It is important to document and follow the use and sharing policy of the data owner. Prioritizing publicly shareable data over proprietary data can ensure the broadest utility, transparency, and reproducibility. The following types of data should be documented:

(1) Description of the type of conservation governance system, including its legal status.
(2) The location and size of each site of a given conservation governance system as a spatial polygon or point. In the cases where spatial data are not available or where sharing is prohibited, collect statistics and other descriptive data.
(3) Time of establishment and duration of each site.
(4) Governance and management characteristics of each site.

Detailed explanation of each field collected can be found in a separate Excel file: Data S1 (section "attributes collected").

Following data collection, the next step is to verify data with local experts familiar with the systems to ensure data accuracy, completeness, and correct categorization. The initial categorization can be suggested by the data provider or made by the synthesizing team based on laws, regulations, and literature. Further verification of the categorization should involve the inventory team (for consistency) and local experts (for accuracy), with the rationale and sources of information recorded (see Data S3 for example). We provide the step-by-step guidelines (supplemental information) with practical examples for resolving conflicts to help enable stakeholders to systematically apply our framework. While modification of the framework is needed to

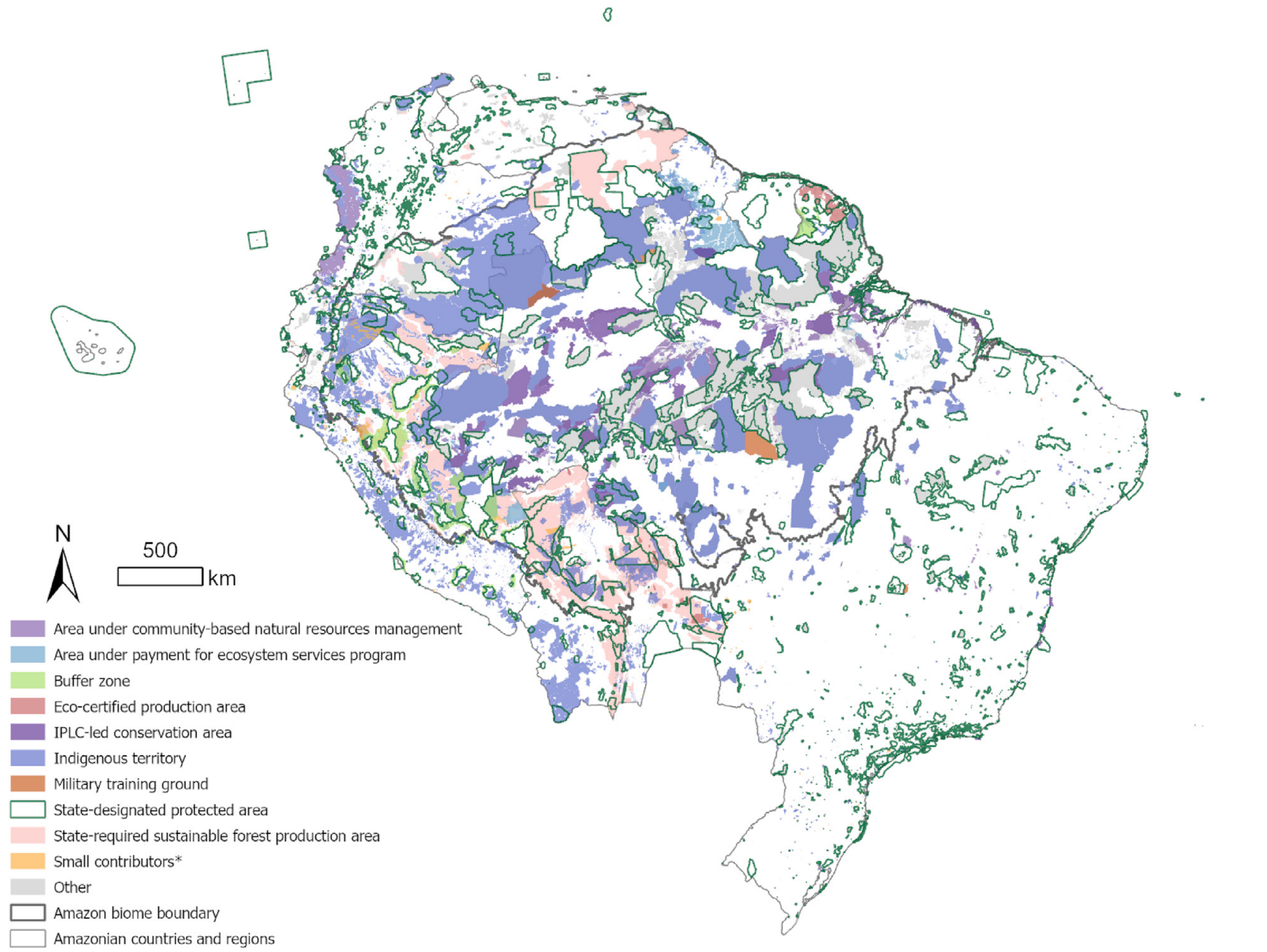

Figure 3. Map of area-based conservation governance systems in the Amazonian countries: Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, and Venezuela

The map contains all polygon data (i.e., excluding data represented by points or statistics) of area-based conservation governance systems, in 2016. Small contributors include private recreational areas, conservation concessions, conservation agreements, privately protected areas, and state-designated recreational areas; they collectively cover less than 1% of total area-based conservation governance systems in the Amazonian countries and regions. See supplemental information for detailed data collection and classification methods and data sources.

adapt to their goals and needs, we encourage maintaining consistency within their scope of work and transparency about the methodology.

Concurrently, spatial data permissions and terms of use should be documented. For categories where terms of use dictate that users cannot share the spatial data, we suggest case-by-case discussions with data owners and other parties (e.g., communities) to explore sharing the information in an alternative format (e.g., Data S2 and S5).

This inventory provides a baseline understanding of where area-based conservation is happening; who the actors and stakeholders are; and what the spatial, temporal, and governance characteristics are of the sites. It also identifies knowledge gaps for future research. During country-level assessments, we encounter systems lacking spatial or descriptive data, which indicates the necessity of resource-intensive primary data collection to create a more comprehensive picture of area-based conservation.

We illustrate our approach by comprehensively inventorying and categorizing area-based conservation in the Amazonian countries, inclusive of the total land area of Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, and Venezuela. We further show the relevance of this approach on a global scale. The empirical and inclusive inventory reveals a wide range of systems that potentially contribute to conservation.

Comprehensive assessment of area-based conservation in Amazonia

A closer look at conservation initiatives in Amazonia reveals the scientific and policy imperative for recognizing diverse approaches to area-based conservation of nature. We identified a diverse set of area-based systems with the intent and/or potential to contribute to conservation (see definitions in Table S1), including and beyond state-PAs, covering at least 5.57 million km^2 (40.95%) of the total terrestrial area of the nine Amazonian countries (Figure 3). State-designated PAs cover 2.23 million km^2 (16.41%), while other forms of area-based conservation cover 4.42 million km^2 (32.54%) (contains overlap with

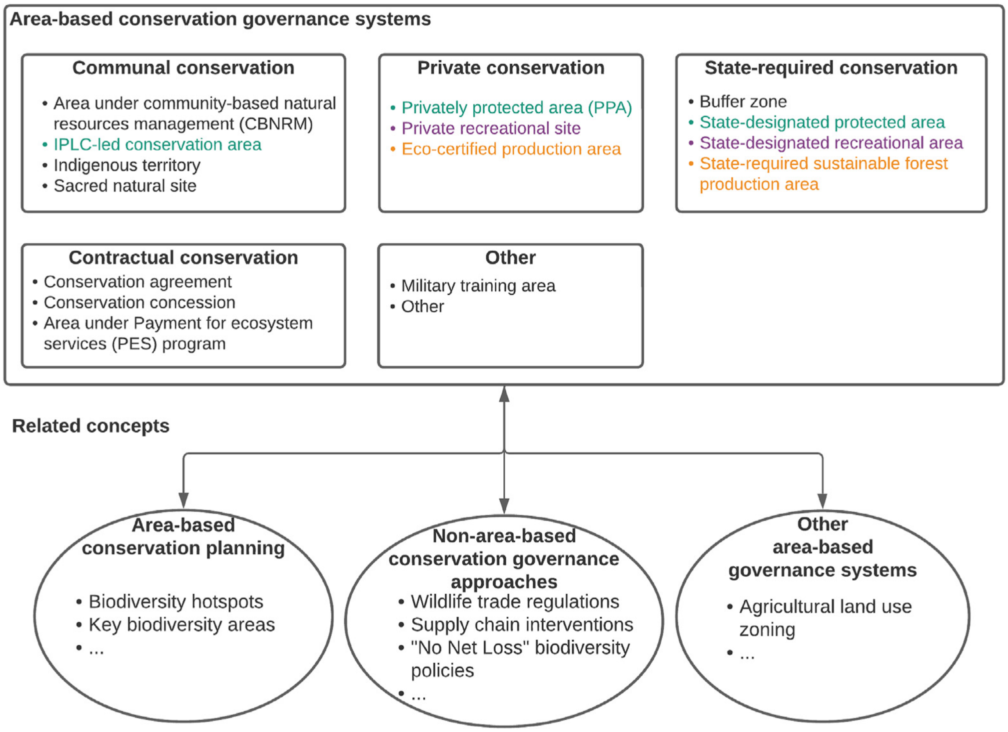

Figure 4. Categorization of area-based conservation governance systems by family and subfamily, and their relationship with other environmental governance approaches

Based on the inventory in Amazonia only; categories may be updated with future inventories in other regions. Throughout this figure, by "conservation," we refer to conservation objective or potential conservation benefits. We do not imply that these systems guarantee conservation outcomes regardless of the context. Subfamilies with the same color indicate that they are conceptually similar, but under different type of property rights regime.

state-designated PAs). The largest contribution to areas under some form of conservation beyond state-designated PAs in Amazonian countries is communal conservation, including state-recognized Indigenous lands (2.22 million km^2 16.3%), IPLC-led conservation areas (0.26 million km^2 1.91%), and community-based natural resource management systems (0.21 million km^2 1.6%) (see Table S4). In Brazil, Indigenous lands are recognized as part of the formal conservation estate; in other Amazonian countries, the level of recognition, tenure security, regulations, and objectives for Indigenous lands and other community-based natural resource management systems varies (see Data S3). Registered and reported privately protected areas cover only 13,659 km^2 (0.1%).

Beyond the commonly recognized and reported categories, area-based conservation governance systems in the Amazonian countries also include sustainable production areas, areas under conservation contracts and agreements, and other designations (Figures 3 and 4; Tables S1, and S7). There is 746,881 km^2 (5.5% of total terrestrial area) of land under legislative requirements for sustainable forest production, and 104,023 km^2 (0.77%) under forest certification schemes, with some forests under multiple schemes. Contract and agreement-based exchanges for conservation were introduced in the early 2000s; PES programs, conservation agreements, and conservation concessions cover at least 112,555 km^2 (0.83%), 15,108 km^2 (0.11%), and 12,816.64 km^2 (0.09%), respectively (Table S4). PA buffer zones comprise 153,169 km^2 (1.13%). Designated recreational areas represent 2,335 km^2 (0.02%). Other areas with access restrictions but that are not designated for conservation may also conserve nature. For instance, the military training areas in Brazil provide 36,382 km^2 (0.27%) of habitat for endangered species.[76] Additional private, state-required, and community-based conservation areas were yet to be recognized or mapped, some of which cover large areas (e.g., legal reserves established under the 2012 Brazilian Forest Code cover ~1.67 million km^2 [12.3%]) (Table S7). Notably, these areas may also include shared spaces in agricultural landscapes,[8] such as a rice field in French Guiana that supports migratory bird conservation.

In comparison, data in WDPA from the same period[77] indicate 3.76 million km^2 (27.7%) of land territories as protected. However, not all these areas are state-designated PAs. An assessment of the WDPA data shows a variety of sites beyond state PAs were reported by national governments, including Indigenous territories, IPLC-led conservation areas, privately protected areas, state-designated recreational areas, other area-based conservation governance systems, and in some cases sites that our framework does not consider area-based conservation governance systems (Figure 5). Still, our inventory shows that area-based conservation is much more diverse than is captured in WDPA. A comparison between our 2016 data and the combined WDPA and WD-OECM datasets in 2023 reveals that, despite improvements in the official databases in recent years, there are still many gaps that could be filled through our inventory approach (Table S9).

	BOL	BRA	COL	ECU	GUF	GUY	PER	SUR	VEN
Area under community-based natural resources management		Poly	Poly	Poly				Stat	
Area under payment for ecosystem services program	Poly	Poly &Pt	Poly	Poly		Poly	Poly & Pt		
Buffer zone					Poly		Poly		
Conservation agreement	Poly			Poly					Poly
Conservation concession						Poly	Poly		
Eco-certified production area	Poly	Stat	Stat	Stat	Poly	Stat	Stat	Stat	Stat
Indigenous territory	Poly	Poly	Poly	Poly	Poly	Poly	Poly		Poly
IPLC-led conservation area		Poly				Poly			
Military training ground		Poly							
Private recreational area							Poly		
Privately protected area	Poly	Poly &Stat	Poly	Poly			Poly		
State-designated protected area	Poly & St	Poly	Poly	Poly	Poly	Poly	Poly	Poly	Poly
State-designated recreational area			Poly				Poly		
State-required sustainable forest production area	Poly		Poly	Poly			Poly		Poly
Other	Poly	Poly	Poly	Poly	Poly		Poly		Poly
International designation	Pt	Pt	Pt	Pt			Pt		Pt
Not area-based conservation governance systems									

Legend

Poly	Polygon data covered in our inventory
Pt	Point data covered in our inventory
Stat	Statistics covered in our inventory
	Polygon reported to WDPA
	Points reported to WDPA

Figure 5. Comparison of data covered in our inventory and data reported to WDPA in 2016
"International designation" includes World Heritage Sites, Ramsar sites, and Biosphere Reserves.

Our inventory in Amazonia also reveals important knowledge gaps. Original data providers for several systems report data of total areas, but spatially explicit information was not aggregated or did not exist at the time of our data collection (see Table S7). For example, Forest Stewardship Council (FSC) reported the total area of certified production for each country in which they have issued certifications, but efforts are ongoing to compile spatial boundaries of production areas from each certified company. Similarly, spatial boundaries for several "reducing emissions from deforestation and forest degradation" (REDD+) projects in Brazil and Peru were not available. In Suriname, two forms of CBNRM, communal cutting licenses and community forests, reported total areas but not spatial data on the government website.[78] In Venezuela, there are ongoing efforts to document conservation areas,[69] but political instability and funding shortages pose challenges.

There are many cases where an area-based conservation governance system has not been recognized and therefore not captured in government databases. Many IPLC communities lack formal government recognition: for example, in Suriname, the legislative system has not recognized the land rights of Indigenous and Maroon communities. In other cases, even after legal recognition, the process for IPLCs to obtain land title is arduous. For example, while the land rights of Quilombos—remnants of settlements founded by formerly enslaved Afro-Brazilians—were assured by the Brazilian 1988 constitution, only 137 out of the total 2,819 certified Quilombo communities have obtained full title as of 2022.[79] As a result, our inventory does not capture the full range of *de facto* area-based conservation governance systems.

Despite these limitations, our Amazonia inventory provides a preliminary answer to fundamental, previously unanswered questions: which areas are protected, when, by whom, and how? Obtaining a baseline of the current conservation estate in Amazonia allows us to contextualize policy discussions on conservation target setting. At least 41.3% of total terrestrial area across the nine Amazonian countries are under various area-based conservation governance systems (Figures S1–S4). However, the Amazon is still under serious threat from deforestation, fire, and climate change, and it may reach a tipping point and drastically shift toward dry savanna, threatening both ecosystem health and human wellbeing.[80] To address these fundamental challenges, conservation policymakers should not only focus on more ambitious area targets (for example, by supporting the proposal to protect 80% of Amazon by Coordinator of Indigenous Organizations of the Amazon Basin [COICA] and other Indigenous organizations)[81] but should also support existing conservation systems, investing in evidence generation and ensuring adequate and equitable resource allocation to diverse stewards of nature.[47,64,82] This inventory can also improve future efforts to evaluate effectiveness of different conservation interventions systematically and comparatively. Existing impact evaluation studies in the Amazon have compared effectiveness among strict PAs, sustainable-use PAs, and IPLC lands with private or untitled lands.[83,84] Our inventory allows for more thorough comparative analyses, considering more diverse governance systems. It also improves how we select and interpret control areas, moving beyond the assumption in analyses that areas outside of PAs or Indigenous lands are untreated.

Examples of global assessments of area-based conservation beyond PAs

Globally, many area-based systems beyond state PAs govern large expanses of land and water, with significant implications

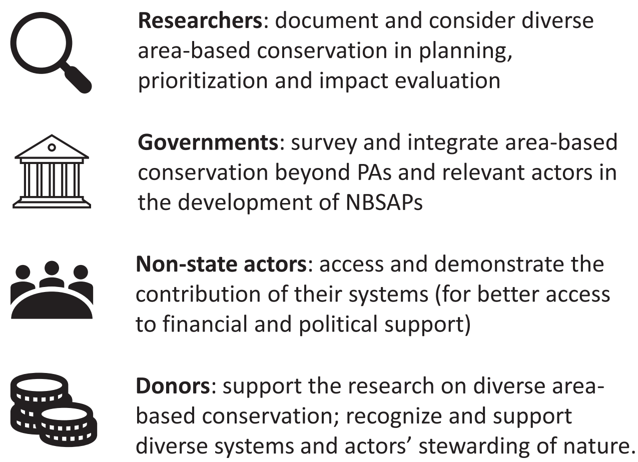

Figure 6. How different actors can apply this approach in research, practices, and policies to facilitate the recognition and integration of diverse area-based conservation

for biodiversity conservation, climate mitigation, and sustainable development, but they are currently under-recognized in official tracking systems. Here, we highlight three diverse types of area-based conservation governance systems beyond PAs—IPLC lands, certified forests, and biodiversity offsets—and review the available data globally on coverage and spatial distribution. These three systems illustrate the diversity of approaches to Earth governance relevant to conservation.

An estimated 45% or more of the world's lands (~60 million km^2) are customarily held by IPLCs (Figures S6–S7).[85,86] While not all IPLC-held lands are governed or managed with a conservation objective, research shows that Indigenous lands overlap with 36% of global intact forests and with over 40% of global lands with good ecological condition, and they host a similar amount of threatened species to PAs.[85,87–89] A pan-tropical analysis showed that Indigenous lands are as, if not more, effective as PAs in reducing deforestation and degradation.[90] Documented IPLC governance systems cover 24 million km^2 (12.4%) of global lands, among which only 14 million km^2 (58% of the 24 million km^2) are acknowledged by state governments.[86] The numbers reported above likely represent a lower bound of all IPLC lands, because customarily held IPLC lands that lack government recognition are less likely to be mapped.[86,91]

At a global level, we also examined certificated production schemes. For instance, the FSC has certified approximately 1,770 forestry production areas covering 2.2 million km^2 (1.1% of global lands) across 80 countries[92]; at least 10%, i.e., 220,000 km^2, are required to be set aside for conservation. There are several challenges associated with recognizing certified areas such as FSC. First, certificates are often voluntary and short term; while many certificate holders do renew them over time, they are still a very dynamic category. Second, because of the lack of publicly available boundary location data, we were not able to identify the spatial extent of plantation versus natural forests within the total 2.2 million km^2 of FSC-certified area. The mix of plantation and natural/semi-natural vegetation is a common challenge for recognizing the contribution of certified areas. Nevertheless, we believe the 220,000 km^2 set-aside areas are the lower limit of natural/semi-natural habitat under FSC, because many production forests are also natural forests. In addition, some of the FSC-certified areas have additional certification for ecosystem services.[93] While mixed results on the effectiveness of certificates are reported,[29,30,94,95] mapping and recognizing the potential of these areas will be the first step to systematically understand their extent and impacts and potentially help scale up good practices.

Biodiversity offsets, implemented to compensate for negative impacts on biodiversity that result from development activities, represent at least 12,983 documented projects in 37 countries extending over 153,679 km^2 (+25,013, −64,223 km^2) (0.08% of global lands),[96] many of which are located outside of state-designated PAs. The global biodiversity offset dataset provides statistics on lands used for offsetting, but we lack information on governance, precise spatial locations, and boundaries of effective offsets.[96] Further research is required to determine the extent to which these project areas contribute to area-based conservation. Given debates on offset effectiveness, greenwashing, and inequality, such data are crucial for assessing project effectiveness and developing standards for high-quality offsets.[97]

At a global scale, data regarding the extent and exact locations of sustainable production areas, recreational areas, and areas under communal or contract-based approaches remain sparse. Our inventory approach, implemented at a global scale, can help overcome this barrier to conducting policy-relevant science and evidence-based policy.

MOVING FORWARD

We propose an empirical and inclusive geospatial inventory of all areas globally that are relevant to—intended and/or with the potential to deliver benefits for—conservation, and illustrate the utility of such an inventory through Amazonian and global case studies. The existing official databases face challenges of under-reporting and exclusion of diverse conservation governance systems, tend to be primarily led by governments, and can be time consuming due to a site-based approach.[46] Our proposed inventory can begin to fill these gaps by using a system-based approach to inclusively aggregate data on conservation governance systems by diverse actors such as private actors and IPLCs. By leveraging diverse local and expert knowledge as well as unofficial data sources, this inventory can help address the data gap that often challenges existing tracking systems. An unofficial, civil-society effort, complementary to the official reporting process, will allow integration of any available data through a quicker assessment while limiting potential bias of existing reporting systems. The framework expands our vision of what constitutes area-based conservation, encouraging a more holistic approach to conservation prioritization, siting of new conservation areas, and resource allocation. Moving forward, various actors in conservation can apply this approach and the results of such inventory to better recognize and consider diverse area-based conservation in research, practices, and policies (Figure 6).

We recommend that researchers document the distribution of multiple area-based conservation systems beyond PAs and reflect them in prioritization and impact-evaluation studies. For conservation planning research, instead of treating all areas

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outside of PAs as "unprotected," we advocate for assessments of other types of potentially relevant areas and for using a range of protection levels instead of a binary protected vs. unprotected categorization. In addition, prioritization for allocation of PAs should also recognize other types of area-based conservation to avoid crowding out local regulations and displacement of local people and to better align conservation interventions with existing forms of governance. For impact evaluations, we recommend inclusion of other conservation areas to address false-control bias and expand comparative impact evaluation. Impact evaluations of PAs or Indigenous lands often assume that areas not directly targeted by the intervention of interest are "untreated." However, multiple concurrent conservation interventions may influence the outcomes of interest, leading to a complex landscape of policies and tenure systems. To eliminate this bias, information on all interventions in the study region is needed. When estimating impacts relative to no treatment, alternative treatment areas should be excluded from the pool of potential controls. Another avenue of future research is to comparatively assess the impacts of multiple conservation systems, as work has begun to explore in Brazil.[84,98] Expanding datasets of diverse area-based conservation to other regions will facilitate more comprehensive, rigorous, and nuanced analyses of their social and ecological impacts, informing policy decisions on the selection of conservation tools. Finally, inclusive identification and documentation of all potential conservation systems will enable scholars to better describe, explain, and predict their emergence and evolution[99–101] and whether sites face the threat of reductions or removals.[35,102,103]

As national governments are adapting global conservation targets to regional and country level for implementation,[104] a more accurate and inclusive understanding of the extent, diversity, and dynamics of area-based conservation governance systems can help inform the design of socially feasible targets and roadmaps in terms of quantity, location, and forms of conservation. Therefore, when developing NBSAPs to fulfill international commitments under the UN CBD, we recommend surveying and documenting the scope and locations of existing area-based environmental governance systems to assess whether and how they are related to conservation and what additional support can assist which systems to achieve their full conservation potential. Having such information will help better match conservation intent with capacity.[6,16] In addition, when planning or designating new PAs or OECMs, we recommend documenting the pre-existing area-based governance systems (e.g., sacred mountains, community forests) as a baseline for designating/recognizing PA/OECM; it is important to clarify how the designation of new PA/OECM is improving/affecting the pre-existing systems. Accounting for the full range of existing governance systems will reduce the risk of imposing new conservation designations onto lands and waters already governed by communal or private actors, which not only leads to the waste of limited resources but also raises environmental justice and equity concerns.[105,106]

For conservation donors/investors, applying this preliminary assessment of the existence, locations, and diversity of area-based systems will enable more effective allocation of resources to deliver desired outcomes. Although conservation funders have prioritized state-designated PAs,[36,37] donors can assess the relative advantages of various conservation tools in different contexts and allocate funding to diverse actors accordingly.[107] In addition, many Indigenous peoples and local communities reside and steward nature in areas beyond titled IPLC lands; applying this approach may help identify these informal area-based governance systems to help fulfill the promise of biodiversity and climate donors to directly support Indigenous peoples and local communities.[108] This more inclusive approach holds promise to improve conservation outcomes globally, toward support of the myriad governance systems and diverse actors' stewarding natures.

Lastly, non-state actors, including IPLCs and private land managers and stewards, and other civil society actors can use the criteria and process to assess the relevancy of their land to conservation, and, if so, to demonstrate their contribution. In parallel with the Multilateral Environmental Agreements-driven approach of designing and imposing (i.e., top down) certain types of area-based conservation, recognizing the contribution of local residents will help facilitate and utilize varied forms of local schemes to steward nature.[109] We recommend that processes such as the development of NBSAPs should be open to relevant non-state actors, including but not limited to IPLCs. This may include expanding formal recognition of Indigenous peoples' and local communities' customary ownership of resources and land upon which to root sustained conservation practices and culture. Such recognition is relevant not only for conservation policies but also for safeguarding policies when planning development projects as well as carbon-offsetting projects.[106]

The application of our framework complements official tracking systems such as the WDPA and WD-OECM. When national governments and non-state actors conduct system-level screening of existing area-based conservation using our framework, they can identify potential eligible sites to be eventually included in the official databases. For area-based conservation governance systems that are outside of the scope of official tracking systems (e.g., eco-certified production area or sites that the governance body do not wish to be considered as OECMs), our framework serves as an alternative civil society approach for their recognition in conservation policy and research.

When applying the approach, some caveats should be considered when interpreting the data and can be improved in future research. First, based on our inclusion criteria, we still exclude some conservation efforts, for example, non-area-based conservation approaches such as supply-chain interventions, informational campaigns, behavioral interventions, and capacity-building activities. Complementary efforts for non-area-based measures have begun to address this gap.[110,111] Second, our data cannot be used to infer the effectiveness of specific sites or their suitability for inclusion toward official biodiversity targets. However, it serves as a valuable baseline for further work, including rigorous impact evaluations and site-specific reporting. Third, our Amazonia dataset is limited to a snapshot rather than longitudinal data that reflect changes over time, and we identified many systems that lack spatial data. In connection, the subfamilies we identified in our Amazon inventory (Table S1) cannot be viewed as an exhaustive list, because area-based conservation continues to evolve and vary across regions. We further discuss these limitations in the supplemental information.

To fully realize the potential of existing area-based conservation, ongoing efforts in data inventory and investments in primary data collection—particularly in less-developed countries[112,113]—are essential. Building such understanding and a database of area-based conservation should be pursued in a way that is not extractive but facilitates knowledge co-production.[114] Local expertise, including from researchers; Indigenous peoples; and other local residents, civil society organizations, corporations, and government agencies, will be necessary to generate, analyze, and interpret these insights, identify context-based policy responses, and articulate evidence-based and collectively desired futures for all life on Earth.[115] The local data-driven inventory approach may also help improve data justice and equity in conservation target setting and conservation planning, especially when paired with FAIR and CARE data principles.[106,116–118] As many studies have documented specific types of potential area-based conservation in different regions,[119–121] a global inventory to compile scattered efforts and datasets could facilitate the recognition and integration of this area-based conservation in research and policymaking. Our proposed approach complements biophysical and economic prioritization strategies with socially feasible spatial priorities, enhancing the transparency and inclusivity of conservation practices.

EXPERIMENTAL PROCEDURES

Resource availability

Lead contact

For further information on the analysis, please contact the corresponding author, Yifan He (yifan_he@bren.ucsb.edu).

Materials availability

No new or unique materials have been generated in this study.

Data and code availability

Original data have been deposited to Harvard Dataverse: https://doi.org/10.7910/DVN/HHT0TN. Replication code has been stored in GitHub Repository: https://github.com/florayh/conservationinventory.git.

SUPPLEMENTAL INFORMATION

Supplemental information can be found online at https://doi.org/10.1016/j.oneear.2024.03.005.

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AUTHOR CONTRIBUTIONS

Conceptualization, S.Q., Y.H., R.E.G.K., and M.B.M.; methodology, S.Q., Y.H., R.E.G.K., S.S., and M.B.M.; data collection, S.Q., Y.H., B.C., M.K., J.C.L., C.M., V.M.-Z., R.U., E.Y., C.B., E.M., N.P., E.O., and M.B.M.; validation, B.C., M.K., J.C.L., C.M., V.M.-Z., R.U., E.Y., C.B., J.W.B., E.M., N.P., K.R., P.V., C.L.M.-T., and L.A.W.; formal analysis, S.Q. and Y.H.; writing – original draft, S.Q., Y.H., and M.B.M.; writing – review & editing, S.Q., Y.H., R.E.G.K., S.S., B.C., M.K., J.C.L., C.M., V.M.-Z., R.U., E.Y., C.B., J.W.B., E.M., N.P., K.R., P.V., E.O., C.L.M.-T., L.A.W., and M.B.M.; visualization, S.Q. and Y.H.; supervision, S.Q., Y.H., and M.B.M.; project administration, S.Q., Y.H., R.E.G.K., and S.S.; and funding acquisition, M.B.M.

DECLARATION OF INTERESTS

The authors declare no competing interests.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work the authors used ChatGPT 3.5 to shorten a few complex sentences to increase readability. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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