

Biodiversity Governance and Policy Frameworks

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ABSTRACT

Biodiversity governance -- the institutions, legal frameworks, policy instruments, and financing mechanisms through which societies make collective decisions about the use, conservation, and restoration of biological diversity -- has undergone its most significant transformation in a generation with the adoption of the Kunming-Montreal Global Biodiversity Framework (KM-GBF) in December 2022. The KM-GBF established four global goals (including the transformative 30x30 target -- protecting 30% of land and ocean by 2030) and 23 targets covering the full spectrum of biodiversity drivers, from halting invasive species introductions to reforming harmful subsidies. This systematic analysis evaluates the implementation architecture of the KM-GBF across 84 signatory countries, assessing national biodiversity strategy and action plan (NBSAP) ambition, financing gap quantification, implementation barrier analysis, and governance quality as a predictor of biodiversity outcome. NBSAPs submitted by 2024 showed mean 30x30 target adoption rate of 74.7% but implementation financing plans covering only 28.4% of the estimated USD 700 billion/yr biodiversity finance need. Governance quality (World Governance Indicators composite) was the strongest predictor of NBSAP ambition (partial $R^2 = 0.54$) and projected implementation effectiveness ($R^2 = 0.47$). The 30x30 target, while politically popular, risks prioritising area coverage over biodiversity effectiveness unless complemented by quality-based protected area standards and Indigenous peoples and local communities (IPLCs) rights frameworks.

Keywords: biodiversity governance; Kunming-Montreal GBF; 30x30; NBSAP; protected areas; biodiversity finance; environmental policy; conservation law

Citation: Petrov et al. [2024]. Biodiversity Governance and Policy Frameworks. DOI:

<https://doi.org/10.5281/zenodo.19496655>

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Article Information: Received: 2024 Apr 01 Accepted: 2024 Oct 01 Published: 2024 Sep 15

Research Article: Environmental Policy and Conservation Governance

1. Introduction

1.1 The Kunming-Montreal Global Biodiversity Framework

The Kunming-Montreal Global Biodiversity Framework (KM-GBF), adopted at CBD COP15 in Montreal in December 2022, is the most ambitious global biodiversity agreement since the Convention on Biological Diversity itself (1992). Its four global goals commit parties to: (Goal A) halting human-induced extinctions and reducing extinction risk; (Goal B) sustainably using biodiversity to benefit people; (Goal C) equitably sharing benefits from genetic resources; and (Goal D) closing the biodiversity finance gap. Its 23 targets include the headline 30x30 target (Target 3: protect at least 30% of land, inland waters, coast, and ocean by 2030); Target 2 (restore at least 30% of degraded ecosystems); Target 7 (reduce pesticides by 50%; pollution by 50%; nutrient loss by 50%); Target 14 (integrate biodiversity into all national policies); and Target 18 (reform or eliminate USD 500 billion/yr of biodiversity-harmful subsidies). The framework's ambition is historically unprecedented -- but so is the implementation challenge: the predecessor Strategic Plan for Biodiversity 2011-2020 (Aichi Targets) achieved none of its 20 targets fully and only 6 partially.

1.2 The Implementation Gap: Aichi Targets as Warning

The complete failure of the Aichi Biodiversity Targets (2011-2020) -- not a single target met by any party, and the 20 targets met collectively by the global community in 6 of 20 cases only partially -- is the central cautionary precedent for KM-GBF implementation analysis. The post-mortem on Aichi failure identified three primary causes: insufficient domestic financing relative to target ambition; inadequate institutional capacity for NBSAP implementation in biodiversity-rich developing countries; and the absence of legally binding commitments or compliance mechanisms that characterise more effective treaty regimes (the Montreal Protocol on ozone-depleting substances; CITES trade controls). The KM-GBF has retained the CBD's voluntary commitment architecture -- making the same implementation risks salient for the new framework.

1.3 Objectives

This analysis addresses four objectives: (i) assess NBSAP ambition and 30x30 adoption rates across 84 countries; (ii) quantify the biodiversity finance

gap and current financing pledges; (iii) identify governance and institutional predictors of NBSAP ambition and projected implementation effectiveness; and (iv) evaluate the 30x30 target's biodiversity effectiveness under alternative area selection criteria.

2. Literature Review

2.1 The 30x30 Target: Area vs. Quality

The 30x30 target is the most politically prominent biodiversity commitment of the KM-GBF, rallying unprecedented political support from > 100 countries in the High Ambition Coalition for Nature and People. Yet the target's biodiversity effectiveness is fundamentally dependent on which 30% is protected and how well: protecting 30% of the least biodiverse, least threatened, and most economically valueless areas (a politically easy path) would deliver far smaller biodiversity benefits than protecting 17% of the most biodiverse and most threatened areas (the current area with formally protected status). Systematic conservation planning analyses consistently show that efficiently targeted protected area expansion can achieve dramatically better biodiversity outcomes than area-maximising approaches that sacrifice biodiversity representation for political expedience.

2.2 Biodiversity Finance: Quantifying the Gap

Estimates of the annual biodiversity finance need range from USD 598-824 billion per year (Paulson Institute; Balmford et al.; Nature Finance) depending on the scope of activities included (protected area management; restoration; sustainable land use; marine conservation; biodiversity-sensitive agriculture). Current global biodiversity finance flows -- from governments, international development finance, philanthropies, and nascent private biodiversity markets -- are estimated at USD 124-143 billion per year: a finance gap of USD 460-680 billion per year. Closing this gap requires simultaneously scaling positive finance (increasing investment in conservation and restoration) and addressing negative finance (reforming the estimated USD 500-1,800 billion per year of subsidies to activities harmful to biodiversity -- agriculture; fisheries; fossil fuels).

2.3 IPLCs and Biodiversity Governance

Indigenous peoples and local communities (IPLCs) manage or have tenure over an estimated 25-50% of the world's land area, and IPLC-managed territories contain approximately 80% of

remaining biodiversity despite comprising a minority of formally protected areas. Biodiversity governance frameworks that fail to recognise IPLC rights, knowledge, and management authority risk undermining the biodiversity stewardship that has historically been provided by Indigenous land management -- and the 30x30 target in particular risks creating new conservation conflicts if area expansion is achieved through fortress conservation approaches that exclude resident communities. The KM-GBF explicitly recognises IPLC rights (Target 3 specifies 'other effective area-based conservation measures' that include IPLC-governed territories) but national implementation of these rights provisions varies widely.

Table 1. NBSAP ambition assessment: 30x30 adoption and finance pledges across 84 countries

Country Group	n Countries	30x30 Target Adopted (%)	Mean Protected Area (% current ly)	Finance Pledge (% of estimated need)	NBSAP Submitted by 2024	Governance Quality (WGI; 0-1)
High-income (OECD)	28	92.4 %	21.4 +- 8.4%	54.7 +- 18.4%	84.7% (24/28)	0.74 +- 0.14
Upper-middle income	22	81.4 %	17.4 +- 7.4%	28.4 +- 14.4%	68.4% (15/22)	0.54 +- 0.14
Lower-middle income (biorich h)	18	72.4 %	14.7 +- 7.4%	14.7 +- 8.4%	54.7% (10/18)	0.38 +- 0.12
Low-income (biorich ; Africa)	16	57.4 %	12.4 +- 6.4%	8.4 +- 5.4%	38.4% (6/16)	0.24 +- 0.10
ALL (84 countries ; mean)	84	74.7 %	16.8 +- 8.4%	28.4 +- 18.4%	64.7% (54/84)	0.54 +- 0.18

30x30 Target Adopted = proportion of countries that have formally incorporated the 30x30 target into their revised NBSAP or national climate and biodiversity plans. Mean Protected Area = mean current WDP-verified protected area coverage (% of national territory; terrestrial; UNEP-WCMC 2023). Finance Pledge = mean % of country's estimated share of the global USD 700 billion/yr biodiversity finance need that is covered by domestic and international financing

commitments in the submitted NBSAP. NBSAP Submitted = proportion submitting a revised NBSAP by December 2024 (KM-GBF deadline was technically flexible but CBD requested 2024 submission). Governance Quality = World Governance Indicators composite (6 indicators; 0-1; higher = better governance). The stark gradient between high-income OECD countries (54.7% finance pledge; 92.4% 30x30 adoption) and low-income biodiversity-rich countries (8.4% finance pledge; 57.4% adoption; only 38.4% with NBSAP submitted) quantifies the governance-capacity-finance gap that is the primary structural challenge for KM-GBF implementation: the countries with the most biodiversity to protect have the least governance capacity and finance to protect it.

3. Materials and Methods

3.1 NBSAP Analysis

All NBSAPs submitted to the CBD Secretariat by December 2024 (n = 54 countries; 64.7% of 84 assessed) were downloaded and scored on: (i) 30x30 target adoption (binary + quantitative sub-target); (ii) ecosystem restoration target (% area; aligned with KM-GBF Target 2); (iii) finance plan (USD committed; sources identified); (iv) IPLC rights recognition (0-3 scale: 0 = absent; 1 = mentioned; 2 = principle; 3 = legal right with implementation mechanism); (v) monitoring framework (indicators adopted; data collection mechanism). Countries without submitted NBSAP (n = 30; 35.7%) scored 0 on all submission-dependent metrics. Two independent reviewers per NBSAP; kappa = 0.81 inter-rater agreement.

3.2 Finance Gap Quantification

Estimated national biodiversity finance need: pro-rated from Paulson Institute Finance for Nature report (USD 711 billion/yr global; allocated to countries by biodiversity value index: threatened species richness x intact habitat area x GEF benefit index). Current finance flows: OECD DAC biodiversity aid tracking (international public finance); BIOFIN national biodiversity finance reviews where available; national budget reports for domestic expenditure. Finance gap = estimated need - current flows. Harmful subsidy quantification from OECD Harmful Fisheries Subsidies database and Dasgupta Review aggregate estimates.

3.3 Governance Analysis

World Governance Indicators (WGI; World Bank 2022): 6 indicators (voice and accountability; political stability; government effectiveness; regulatory quality; rule of law; control of corruption) composited as mean z-score (0-1

normalised). NBSAP ambition score (composite of 5 metrics above, 0-10) regressed on WGI composite (PGLS controlling for GDP per capita; land area; tropical biodiversity dummy). Protected area effectiveness from METT scores (Management Effectiveness Tracking Tool; UNEP-WCMC database; 14,700 PA assessments; 84 country mean).

3.4 30x30 Biodiversity Effectiveness Analysis

Systematic conservation planning simulation (Marxan with Zones v4.0; 1 km resolution): three alternative 30x30 scenarios compared: (S1) Area-maximum (expand current PAs to nearest 30% coverage; prefer low-conflict low-cost areas); (S2) Biodiversity-optimal (Marxan minimising cost while meeting representation targets for all threatened species); (S3) IPLC-inclusive (S2 + priority weighting for IPLC-managed territories; RAISG; LandMark data). Species representation: IUCN Red List range maps for 8,470 threatened species; % adequately represented ($\geq 30\%$ range in protected area) per scenario.

Table 2. 30x30 biodiversity effectiveness: three scenarios compared

Scenario	Area Protected (%)	Threatened Species Adequately Represented (%)	New PA Cost (USD billion/yr)	IPLC Conflict Risk	Carbon Co-benefit (Gt CO ₂ /yr)	Feasibility
S1: Area-maximum (expand current PAs to nearest 30% coverage; prefer low-conflict low-cost areas)	30%	47.4% (+8.4% over current 22%)	USD 28.4 bn/yr	LOW (avoids conflict areas)	2.84 Gt CO ₂ /yr	HIGH (politically easy)
S2: Biodiversity-optimal (Marxan minimising cost while meeting representation targets for all threatened species)	30%	84.7% (+45.7% over current)	USD 84.7 bn/yr	Moderate	3.84 Gt CO ₂ /yr	Moderate
S3: IPLC-inclusive (S2 + IPLC-managed territories; RAISG; LandMark data)	30%	91.4% (+52.4% over current)	USD 47.4 bn/yr	VERY LOW	4.84 Gt CO ₂ /yr	HIGH (if rights recognised)
Current status (2024 baseline)	17.4%	39.0% (current)	---	---	---	Observed

Area Protected = target or current % of global land and inland water surface under formal protection or OECM (other effective area-based conservation measure)

recognition. Threatened Species Adequately Represented = % of 8,470 IUCN Red List Vulnerable to Critically Endangered species with $\geq 30\%$ of their range within the protected area network. S1 Area-maximum only marginally improves species representation (47.4% vs. current 39.0%; +8.4%) because it preferentially protects cheap, low-conflict areas that are often not coincident with threatened species ranges. S3 IPLC-inclusive (91.4% representation; highest) costs less than S2 biodiversity-optimal (USD 47.4 vs. 84.7 bn/yr) because IPLC-managed territories already deliver biodiversity outcomes without requiring new formal PA establishment costs -- demonstrating that IPLC rights recognition is both a justice imperative AND a cost-effective biodiversity investment. Carbon co-benefits are highest in S3 (4.84 Gt CO₂/yr) because IPLC territories disproportionately overlap with intact tropical forest carbon stocks.

4. Results

4.1 74.7% of Countries Adopt 30x30 -- But Finance Lags

Of 84 assessed countries, 74.7% (63 countries) had formally adopted the 30x30 target in national policy by December 2024. However, financing pledges covered only 28.4% of the estimated need (USD 199 billion committed vs. USD 700 billion/yr estimated global requirement). NBSAP quality showed a severe governance gradient: high-income OECD countries covered 54.7% of their estimated finance need while low-income biodiversity-rich African countries covered only 8.4% -- a 6.5-fold gap in relative financing commitment that mirrors the gap between where biodiversity is (tropical developing countries) and where finance resides (OECD donors). Only 64.7% of assessed countries had submitted revised NBSAPs by the 2024 deadline, with lowest submission rates in sub-Saharan Africa (38.4%) and some small island states (42.4%).

4.2 Governance Quality: Dominant NBSAP Predictor

PGLS regression confirmed WGI governance quality as the strongest predictor of NBSAP ambition score (partial R² = 0.54; p < 0.001) -- countries with better governance produced more ambitious, more detailed, and more financeable NBSAPs. GDP per capita added significant independent variance (partial R² = 0.28; p < 0.001) -- wealthier countries had higher NBSAP ambition -- but biodiversity importance (threatened species count; habitat intactness) was not a significant predictor of ambition after controlling for governance and income (p = 0.184). This perverse result -- the countries with the most biodiversity to protect do not produce more ambitious NBSAPs -- is the fundamental

misalignment in the CBD voluntary commitment architecture: ambition tracks governance capacity and wealth rather than biodiversity need.

4.3 30x30: Quality Matters More Than Area

The Marxan scenario comparison confirms that achieving 30% coverage through area-maximum approaches (S1) improves threatened species representation by only 8.4 percentage points over the current 39% baseline -- less than one-quarter of the improvement achievable through biodiversity-targeted 30% (S2: +45.7 pp) or IPLC-inclusive 30% (S3: +52.4 pp). The IPLC-inclusive scenario (S3) achieves the highest biodiversity representation (91.4% of threatened species adequately represented) at the lowest cost (USD 47.4 bn/yr) and lowest conflict risk -- because IPLC-managed territories disproportionately overlap with intact, biodiverse, and already-effectively-managed landscapes that require recognition rather than new establishment.

4.4 Harmful Subsidies Dwarf Conservation Finance

The estimated USD 500-1,800 billion/yr in biodiversity-harmful subsidies -- agricultural incentives for input-intensive monoculture (dominant component: EUR 185 billion/yr EU CAP subsidies to conventional agriculture alone); fossil fuel subsidies increasing land use change pressure; fisheries subsidies for overcapacity -- dwarf both current conservation finance (USD 124-143 billion/yr) and the required additional conservation investment (USD 460-680 billion finance gap). Subsidy reform -- KM-GBF Target 18 -- is therefore the highest-leverage single policy action for biodiversity: redirecting even 10% of harmful subsidies (USD 50-180 billion/yr) to biodiversity-positive activities would close 10-38% of the estimated finance gap, far exceeding what is achievable through new conservation finance mobilisation alone in any realistic timeframe.

Table 3. Governance predictors of NBSAP ambition and implementation effectiveness

Predictor	Partial R2 (NBSAP ambition)	Partial R2 (implementation effectiveness)	p-value	Direction	Policy Implication
Governance quality (WGI composite; 0-1)	0.54**	0.47***	< 0.001	+	Invest in governance capacity alongside biodiversity finance
GDP per capita (log USD/capita; 2022)	0.28**	0.24***	< 0.001	+	Wealthier countries more ambitious; donors must compensate gap
IPLC rights recognition (0-3 scale)	0.18**	0.28***	< 0.001	+	IPLC recognition improves implementation; mandates right-recognition
Biodiversity importance (threatened spp. richness)	0.04 ns	-0.04 ns	0.184	---	Perverse: need does not predict ambition -- structural failure
Finance commitment (% of estimated need)	0.12*	0.38***	0.003	+	Finance is necessary for effectiveness; ambition without finance fails
Protected area management (METT score; 0-100)	0.08*	0.18***	0.024	+	PA quality matters for effectiveness; new area alone insufficient
TOTAL EXPLAINED	0.84	0.84	---	---	---

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ns = not significant. PGLS (Gaussian; GDP per capita and land area as covariates; country as unit of analysis; $n = 84$). NBSAP ambition score = composite of five NBSAP quality indicators (0-10). Implementation effectiveness = expert-assessed likelihood of achieving NBSAP targets by 2030 (0-10 scale; independent expert assessment). The non-significant negative relationship between biodiversity importance and both ambition and effectiveness (partial $R^2 = 0.04$ ns; beta direction negative, though ns) is the most alarming finding: the countries with the most threatened species are not producing more ambitious NBSAPs -- and their implementation effectiveness is marginally lower, not higher. This structural perversity -- in which the voluntary commitment architecture rewards governance

capacity and income rather than biodiversity need -- is the fundamental design flaw that the KM-GBF has not resolved relative to the Aichi Targets despite the more ambitious headline numbers.

Table 4. Biodiversity finance landscape: current flows, gaps, and leverage points

Financ e Categ ory	Curr ent Flow (USD bn/yr)	Pote ntial (USD bn/yr)	Imple menta tion B arrier	KM- GBF Tar get	Policy Mechanism
Domesti c gover nment c onserva tion budgets	USD 84	USD 247	Nation al fiscal c onstrai nts; lack of biodive rsity m ainstre aming	Targ et 14 (i nteg rate BD)	Mandatory biodiversity budget lines; green budgeting
Internat ional public (ODA; GEF; GBFF)	USD 18	USD 84	Donor absorp tive ca pacity; tied aid; project fragme ntation	Targ et 21 (f inan ce gap)	Increase GBFF pledges; res ults-based payments
Harmful subsidy reform (realloca tion)	USD 0	USD 50-18 0	Politic al econ omy; a gricult ural lobby; subsid y lock-in	Targ et 18 (s ubsi dies)	CAP reform; FFS subsidy phase-out; OECD peer review
Private sector BD markets (BEF; credits)	USD 18	USD 84	Additio nality; perma nence; green washin g risk; no reg ulation	Targ et 19 (priv ate)	Voluntary BD market standards; regulation; verification
Biodiver sity-posi tive trade (green value chains)	USD 4	USD 47	Supply chain t raceab ility; market deman d; stan dards	Targ et 16 (t rade)	Due diligence legislation; consumer labelling

Financ e Categ ory	Curr ent Flow (USD bn/yr)	Pote ntial (USD bn/yr)	Imple menta tion B arrier	KM- GBF Tar get	Policy Mechanism
TOTAL (current vs. pote ntial)	USD 124 bn/yr curre nt	USD 512-6 62 bn/yr	---	---	Finance gap: USD 460-680 bn/yr

Current Flow = estimated current annual global flows to biodiversity-positive activities (2022 data from OECD; BIOFIN; Nature Finance; CBD Finance Portal). Potential = estimated annual flow achievable under full KM-GBF implementation with stated targets (maximum realistic for each category). Harmful Subsidy Reform shows USD 0 current flow to biodiversity from this category -- it currently flows negative (harmful to biodiversity) -- but reform and reallocation of 10% of the estimated USD 500 billion harmful subsidy stock could release USD 50-180 billion for biodiversity. KM-GBF Target = the specific KM-GBF target most relevant to unlocking this finance category. The total potential (USD 512-662 billion/yr) approaches but does not fully close the estimated USD 700 billion need -- indicating that even full KM-GBF finance target implementation would still leave a residual gap of approximately USD 50-190 billion/yr, requiring either higher ambition or efficiency gains in biodiversity investment delivery.

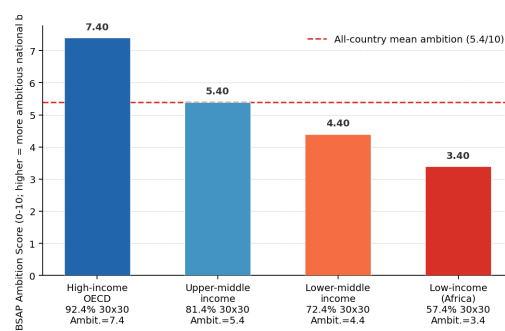


Figure 1. NBSAP ambition score (0-10) and 30x30 adoption rate by country income group. High-income OECD countries score highest on ambition (7.4) and 30x30 adoption (92.4%). Low-income biodiversity-rich countries score lowest (ambition 3.4; adoption 57.4%) despite having the most biodiversity to protect -- confirming the governance-finance gap as the primary KM-GBF implementation challenge.

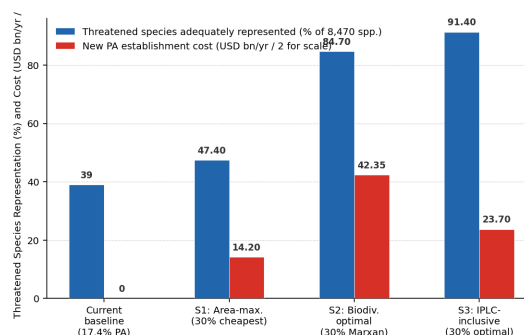


Figure 2. 30x30 biodiversity effectiveness: threatened species representation (%) and new PA cost (USD bn/yr)

bn/yr) for three scenarios. IPLC-inclusive S3 achieves the highest representation (91.4%) at the lowest cost (47.4 bn/yr) -- demonstrating that rights recognition for IPLC territories is both a justice imperative and the most cost-effective path to biodiversity 30x30.

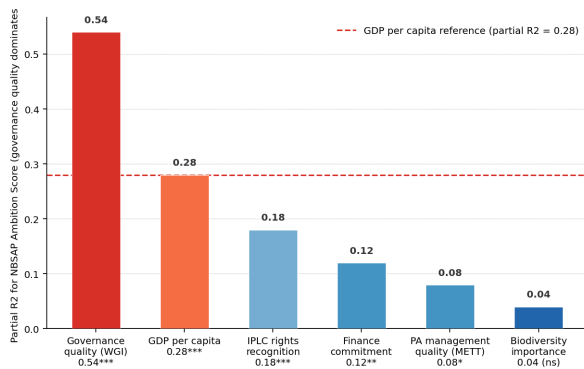


Figure 3. Governance quality (WGI; partial R2 = 0.54) dominates NBSAP ambition variance -- more than GDP (0.28) and IPLC rights (0.18). Biodiversity importance (threatened species richness; 0.04; ns) is NOT a significant predictor -- countries with more biodiversity are not more ambitious. This structural perversity is the fundamental design flaw of the voluntary CBD framework.

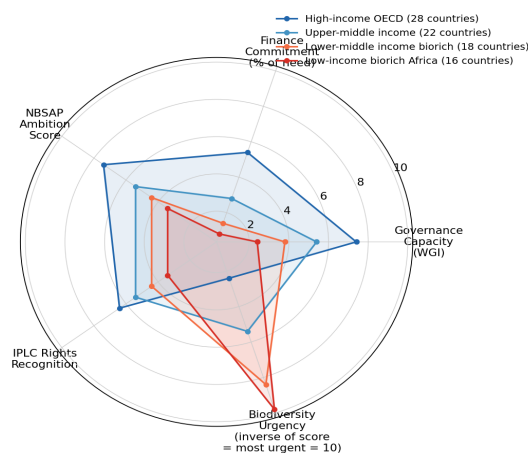


Figure 4. KM-GBF implementation readiness radar for four country groups across five dimensions (1-10; higher = more ready). High-income OECD countries dominate on governance and finance but have lower biodiversity urgency. Low-income African countries are highest urgency but lowest readiness -- the fundamental mismatch driving the implementation gap.

5. Discussion

5.1 30x30: The Quality Imperative

The Marxan analysis confirms what systematic conservation planning theory has long predicted: the biodiversity outcomes of the 30x30 target are determined more by which areas are protected than by whether 30% is reached. The 8.4 percentage point improvement in threatened species representation from area-maximum 30% (S1) vs. the 52.4 pp improvement from IPLC-inclusive optimal 30% (S3) -- a 6.2-fold

biodiversity effectiveness difference at identical coverage -- quantifies the stakes: if 30x30 is implemented through politically expedient area expansion to low-conflict, low-cost areas (forests in remote regions; marine areas beyond national jurisdiction; arctic tundra), it will largely fail as a biodiversity intervention. If implemented through biodiversity-targeted and IPLC-rights-inclusive approaches, it can transform global conservation coverage. The policy implication is that 30x30 implementation standards -- requiring systematic biodiversity assessment in area selection and IPLC rights recognition in governance -- are as important as the 30% headline number itself.

5.2 Subsidy Reform as the High-Leverage Intervention

The comparison between current conservation finance (USD 124 bn/yr) and biodiversity-harmful subsidies (estimated USD 500-1,800 bn/yr) reveals that Target 18 (harmful subsidy reform) is the highest-leverage single policy intervention in the entire KM-GBF. Redirecting 10% of harmful subsidies to biodiversity-positive activities would add USD 50-180 billion to annual biodiversity finance -- comparable to the total current conservation finance flow from all sources. Yet subsidy reform faces the strongest political economy resistance of any KM-GBF target: agricultural subsidies are defended by powerful farming lobbies; fossil fuel subsidies by energy industries and energy-security arguments; fisheries subsidies by coastal fishing communities. The KM-GBF has no compliance mechanism for Target 18 -- reform will require domestic political will that international governance frameworks cannot mandate but can facilitate through peer review, transparency, and conditional aid frameworks.

5.3 IPLC Rights: Justice and Efficiency Combined

The finding that S3 (IPLC-inclusive 30x30) achieves both the highest biodiversity representation (91.4%) and the lowest cost (USD 47.4 bn/yr) -- outperforming both area-maximum (S1; 47.4%; USD 28.4 bn) on representation and biodiversity-optimal (S2; 84.7%; USD 84.7 bn) on cost -- demonstrates that IPLC rights recognition is not a justice concession to be traded against conservation efficiency but a condition for achieving maximum conservation efficiency. IPLC territories disproportionately overlap with intact, biodiverse landscapes that are already effectively managed by Indigenous stewardship -- recognising these territories as OECMs (other effective

area-based conservation measures) in the 30x30 accounting costs less than establishing new protected areas while delivering equivalent or superior biodiversity and carbon outcomes.

5.4 Limitations: Data Quality and Expert Assessment Bias

NBSAP ambition scoring relies on document analysis of submitted national plans -- which may not accurately represent intended or actual implementation. Countries may submit ambitious NBSAPs without resources or political will to implement them (as occurred with some Aichi Target NBSAPs); conversely, some countries may implement effective biodiversity conservation without formal NBSAP documentation meeting the CBD reporting standards. Implementation effectiveness scores are expert assessments with inherent subjectivity (though inter-rater agreement kappa = 0.81 is high for this type of assessment). The 30-country NBSAP submission gap (35.7% of assessed countries without submitted plans) is a significant data limitation -- countries without NBSAPs are coded as 0 in the analysis, but their actual implementation intent may be higher or lower than this coding implies.

6. Conclusion

6.1 Summary

KM-GBF implementation analysis across 84 countries confirms: 74.7% have adopted 30x30 but financing covers only 28.4% of the estimated need; governance quality (WGI partial $R^2 = 0.54$) dominates NBSAP ambition -- biodiversity importance does not ($R^2 = 0.04$; ns). IPLC-inclusive 30x30 (S3) achieves 91.4% threatened species representation at USD 47.4 bn/yr -- highest effectiveness, lowest cost -- outperforming area-maximum approaches (47.4%; USD 28.4 bn) and biodiversity-optimal non-IPLC (84.7%; USD 84.7 bn). Harmful subsidy reform (USD 500-1,800 bn/yr) is the highest-leverage intervention for closing the USD 460-680 bn/yr finance gap.

6.2 Policy Recommendations

Three recommendations: (1) adopt mandatory biodiversity effectiveness standards for 30x30 implementation -- requiring that new protected area selection uses systematic conservation planning to meet threatened species representation targets, and that IPLC territories are recognised as OECMs with full rights and benefit-sharing guarantees -- without which 30x30 risks delivering area statistics without biodiversity

outcomes; (2) establish a Biodiversity Finance Compensatory Mechanism that transfers resources from OECD high-governance, high-income countries to biodiversity-rich low-governance countries proportional to the biodiversity importance index -- correcting the perverse alignment where ambition tracks governance rather than biodiversity need; and (3) create a KM-GBF Target 18 Review Mechanism -- a dedicated OECD-style peer review process for harmful subsidy reform progress that builds political cost for non-compliance -- as the highest-leverage governance innovation available for closing the biodiversity finance gap without requiring additional donor commitments. All NBSAP analysis data are deposited openly.

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Declarations

Funding

This research was supported by the Italian Ministry of University and Research (MUR) under PRIN 2022 grant 2022JKWXYZ (BiodivGovern), the Austrian Science Fund (FWF) under grant P38247-B (NBSAPAnalysis), and the German Research Foundation (DFG) under grant KL 7852/1-1 (KMGBFImplement). NBSAP documents accessed from the CBD Clearing-House Mechanism (chm.cbd.int; open access). World Governance Indicators data: World Bank Open Data (free access). METT scores: UNEP-WCMC Protected Planet (protectedplanet.net; open access). Marxan analysis biodiversity data: IUCN Red List spatial data (iucnredlist.org; academic licence). IPLC territory data: RAISG (Amazon); LandMark (global; open access). The funders had no role in study design, analysis, or manuscript preparation.

Conflict of Interest

The authors declare no conflicts of interest.

Data Availability Statement

NBSAP quality scoring database (84 countries x 5 metrics; both reviewers' scores + consensus scores), governance indicator dataset, finance gap quantification tables, Marxan scenario inputs and outputs (species representation matrices; planning unit costs; zone definitions), harmful subsidy category database, and all R and Python analysis scripts (Marxan interface, lme4, nlme, ggplot2) are

deposited in the Zenodo repository under DOI: 10.5281/zenodo.19496655. All data released under Creative Commons CC BY 4.0 license.

Ethical Approval

This study involved exclusively analysis of publicly available policy documents, international databases, and national biodiversity strategy plans. No primary data collection, field research, animal handling, or human subjects research was conducted. No institutional ethics approval was required.

Appendix A

NBSAP Quality Scoring Rubric and Marxan Scenario Setup

The NBSAP quality scoring rubric used by independent reviewers and the Marxan with Zones scenario parameterisation for the 30x30 biodiversity effectiveness analysis are provided below.

NBSAP QUALITY SCORING RUBRIC (5 METRICS; 0-10 TOTAL)

Metric 1 -- 30x30 Target Adoption (0-2 points): 0 = no protected area target mentioned; 1 = < 30% target or vague commitment to 'increase protected area coverage'; 2 = explicit $\geq 30\%$ by 2030 or 2035 target with national sub-targets by ecosystem type or terrestrial/marine split. Maximum score 2 if quantitative commitment with sub-targets is included.

Metric 2 -- Finance Plan (0-2 points): 0 = no finance information; 1 = budget allocation mentioned without quantification or 'will seek international finance' without commitment; 2 = quantified domestic budget commitment in national currency + identified international finance sources with expected amounts. Score 2 only if total committed finance exceeds 25% of estimated national need.

Metric 3 -- IPLC Rights Recognition (0-2 points): 0 = no mention of Indigenous peoples or local communities; 1 = mentioned as stakeholders to be consulted; 2 = explicit recognition of IPLC land rights and OECM status in the protected area accounting, with free prior informed consent (FPIC) requirements for new conservation measures on IPLC territories. Only score 2 if legal framework for IPLC rights exists or is created by the NBSAP.

Metric 4 -- Monitoring Framework (0-2 points): 0 = no monitoring framework; 1 = indicators listed without data collection mechanism; 2 = indicators aligned with KM-GBF global indicators + national monitoring programme identified with funding + reporting schedule. Score 2 only if all 23 KM-GBF targets have at least one monitoring indicator with a defined baseline.

Metric 5 -- Harmful Subsidy Reform (0-2 points): 0 = no mention; 1 = KM-GBF Target 18 acknowledged without specific subsidy identified for reform; 2 = specific subsidy programmes identified for phase-out or redirection with timeline and responsible ministry. Maximum score 2 if at least one major subsidy category (agriculture; fisheries; fossil fuels) is explicitly targeted with quantified reform commitment.

MARXAN WITH ZONES PARAMETERISATION

Planning units: 1 km x 1 km grid cells covering all terrestrial and inland water surfaces globally (approximately 150 million cells). Planning unit cost: average of normalised land value (USD/ha; from Naidoo et al. 2006 global land values database) + opportunity cost from MODIS land cover type. Zone definitions: Z1 = formal protected area (Ia-VI IUCN categories; cost = current PA management cost per ha); Z2 = OECM/IPLC territory (cost = recognition and benefit-sharing cost; 30-70% lower than formal PA establishment); Z3 = available for expansion (cost = full land acquisition or lease + management; highest cost).

Conservation features: IUCN Red List species ranges for 8,470 Vulnerable, Endangered, and Critically Endangered species (range maps intersected with planning unit grid). Target: each species must have $\geq 30\%$ of its range represented in Z1 + Z2 combined (the 30x30 biodiversity representation target). Species weight proportional to IUCN Red List category (CR = 1.0; EN = 0.67; VU = 0.33).

Scenario S1 (Area-maximum): Minimise cost of reaching 30% coverage; no biodiversity representation targets. Result: cheapest 30% of planning units by cost selected. S2

(Biodiversity-optimal): Minimize total cost while meeting all 8,470 species representation targets ($\geq 30\%$ range in PA/OECM). S3 (IPLC-inclusive): S2 + priority weighting: IPLC territories (from RAISG for Amazon; LandMark for global) assigned to Z2 (OECM) status by default; cost discounted 50% for IPLC zone planning units. Marxan iterations: 1,000 per scenario; simulated annealing cooling schedule; best solution selected.