From science to policy: evolving marine biodiversity targets

Jan-Claas Dajka[1,2*†], Anne K Eilrich[3†], Andrea Franke[1,2], Benjamin S Halpern[4,5], Bernadette Snow[6,7], Amanda T Lombard[7], Ute Jacob[1,2], Silke Laakmann[1,2], Amelie Luhede[2,8,9], and Helmut Hillebrand[1,2,9]

The Montreal-Kunming Global Biodiversity Framework (GBF) substantially advances biodiversity protection. We systematically reviewed the scholarly literature published during the UN Decade on Biodiversity (2010–2020) to assess whether GBF targets align with scientific approaches and improve upon the Aichi Targets in recognizing the complexity of marine biodiversity. Our findings showed that the new targets have improved to address the full suite of essential biodiversity variable (EBV) classes, reducing the risk of changes in crucial aspects of biodiversity being overlooked. We observed a high degree of alignment between research and policy in EBVs and a relative increase in the reliance of the GBF on secondary variables such as ecosystem function. While this alignment mirrors that within other global frameworks, we caution against overemphasizing secondary variables at the expense of foundational variables such as community composition. Our analysis demonstrates that global policy targets align well with scientific understanding of marine biodiversity. Future efforts should focus on improving national-level implementation and refining indicators to foster transformative change in biodiversity conservation.

Front Ecol Environ 2025; e70000, doi:10.1002/fee.70000

Changes in biodiversity are occurring at an unprecedented pace across the planet, both on land and in the ocean. These changes, in turn, are altering the relations between people and the contributions they garner from nature (ie nature's contribution to people [NCP]) around the world (Daskalova *et al*. 2021). Such relations include the importance of marine protein resources for livelihoods or the regulation of air quality and climate (Cimatti *et al*. 2023; Fleming *et al*. 2023). Although the consequences of changes in marine biodiversity on material NCPs (eg food) are usually the main focus of policy and management, the most substantial impacts on human societies are likely to occur as a result of alterations in regulating (eg climate) and non-material (eg cultural) NCPs (Díaz *et al*. 2019).

In a nutshell:

- New international targets for protecting marine life, outlined in the Montreal-Kunming Global Biodiversity Framework, are more comprehensive than those of their predecessors
- These targets cover all major aspects of ocean biodiversity, from genetics to ecosystems, an improvement that will facilitate tracking changes in marine biodiversity and ensure that no important aspect of biodiversity is overlooked
- We observed a relative increase in secondary variables and advise caution against overemphasizing these at the expense of foundational variables
- Successful national implementation of these targets, along with ongoing development of measurement tools, are crucial for ensuring healthy oceans and continuation of the many benefits they provide

To mitigate the impacts of these changes, national and international policies set targets for management and conservation that aim to restore sustainable interactions between people and nature. However, a key challenge in defining and setting these targets is that "biodiversity" encompasses many diverse aspects of genes, species, and ecosystems (Pereira *et al*. 2013). Single "apex" target goals akin to the 1.5°C-target for climate change are often dismissed due to their inability to capture these aspects (Leclère *et al*. 2020; Purvis 2020; Hillebrand *et al*. 2023). If policy targets are to be successful in tackling biodiversity change, this complexity must be taken into account during formulation of actionable goals (Hillebrand *et al*. 2018, 2023).

The extent to which recent research and policy assessments sufficiently cover the inherent complexity of marine biodiversity is unclear. The UN Decade on Biodiversity (2010–2020) motivated considerable research on biodiversity and culminated in the Kunming-Montreal Global Biodiversity Framework (GBF). Before the adoption of the GBF, the Convention on Biological Diversity (CBD) developed the Aichi Biodiversity Targets (hereafter, Aichi Targets) in 2010—a set of 20 targets that aimed to halt the global loss of biodiversity by 2020. However, none of these

[1]Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany; [2]Helmholtz Institute for Functional Marine Biodiversity at the University of Oldenburg, Oldenburg, Germany [*](jan-claas.dajka@hifmb.de); [3]Kiel University, Kiel, Germany; [4]National Center for Ecological Analysis and Synthesis, University of California, Santa Barbara, Santa Barbara, CA; [5]Bren School of Environmental Science and Management, University of California, Santa Barbara, Santa Barbara, CA;

continued on last page

targets have been fully achieved (CBD 2020). In December 2022, the CBD adopted the GBF, with an update to the Aichi Targets that will guide biodiversity policy through four overarching goals to be achieved by 2050 and a set of 23 targets to be reached by 2030 (CBD 2022b). The period between the 2010 Aichi Targets and the update in 2022 following the Decade of Biodiversity thus created an opportunity to evaluate whether and how the intervening science may have influenced the policy targets.

Here, we evaluated the degree to which the complexity of biodiversity was recognized in research and policy, and if this was improved upon in the latest iteration of global biodiversity targets. We also discuss possible pathways to success.

Essential biodiversity variables to analyze the coverage of biodiversity

Essential biodiversity variables (EBVs) represent a core set of critical measurements designed to capture and monitor changes in biodiversity. Each of the 21 variables are allocated to one of six classes that provide a comprehensive view of biodiversity, spanning from genetic variation to species diversity and ecosystem complexity. As compared to other frameworks that display the levels to biodiversity as the "totality of genes, species and ecosystems of a region" (Larsson 2001) or as the "species, genes, evolution, functions and ecosystems" (Antonelli 2022), EBVs, in our opinion, offer the most comprehensive framework that is, through its categorization into classes, still operationalizable for policymakers. Focusing on this essential set of variable classes allows scientists and policymakers to efficiently track the multifaceted nature of biodiversity change across various scales and environments, and ensures that no major aspect of biodiversity is overlooked in monitoring and policy targets (Pereira *et al*. 2013; Fernández *et al*. 2020). As such, EBVs offer a useful framework for our systematic review.

We examined the extent to which these EBV classes are used in scientific literature pertaining to marine biodiversity during the recently completed UN Decade on Biodiversity and its corresponding marine biodiversity policy (UN 2011). We covered only primary research articles on marine biodiversity published between 2010 and 2020 to match the timing of the UN Decade. Reviews, summaries, and policy papers, such as overviews of management strategies, were excluded from our analysis (see Methods for more details).

To assess whether or how biodiversity indicators and targets changed over this same period, we considered the following six policy assessments: the Convention on Biological Diversity (CBD), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on the Conservation of Migratory Species (CMS), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), the Ramsar Convention on Wetlands (Ramsar), and the UN Sustainable Development Goals (SDGs). These policy assessments use indicators—quantifiable assessments of different biodiversity aspects in space and time—to determine whether their targets have been met. For these assessments, we reviewed publicly available indicator metadata in the Biodiversity Indicators Partnership (BIP) database and the GBF database. For the CBD assessments specifically, we reviewed the indicators of the pre-2020 Aichi Targets (using the BIP database) and the post-2020 GBF targets (using the Post-2020 Indicators database) and compared them by analyzing which EBVs feed into which indicator to assess how well they cover different variables of biodiversity.

Methods

Biodiversity indicators

We extracted data on the biodiversity indicators from the BIP (www.bipindicators.net) and the Post-2020 Indicators (www.post-2020indicators.org) websites, both of which are hosted by the UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) in Cambridge, UK. We retrieved more detailed information about policy matters, including Aichi Targets, the biodiversity assessments, the UN Decade of Biodiversity 2010–2020, and the Post-2020 Global Biodiversity Framework, from the CBD website (www.cbd.int), which is hosted by the Secretariat of the CBD in Montreal, Canada.

For the pre-2020 targets, we restricted our search on the BIP website to indicators that covered the themes "Marine & freshwater habitats" and "species", which resulted in 77 indicators that were further investigated to determine their methodology. We excluded 48 of 77 indicators because they (i) were derivatives of other indicators (eg Red List Index ["impacts of invasive alien species"]), (ii) did not provide a quantitative evaluation of the physical state of biodiversity (eg Biodiversity Engagement Indicator), or (iii) did not assess marine biodiversity (eg Wildlife Picture Index). We categorized the remaining 29 indicators into the EBV classes according to which biodiversity variable or variables that they directly measured (Appendix S1: Table S1). For instance, because the indicator of GBF's Target 4 "Proportion of populations within species within an effective population size > 500" directly measures effective population size within species, it was therefore categorized into the EBV classes "genetic composition" and "species population" (Appendix S1: Table S3). We then sorted the indicators according to their integration in the biodiversity assessments. In the same manner, we checked to see if the indicators were included in the Aichi Targets.

Many of the post-2020 indicators have yet to be fully developed, resulting in limited data availability and uncertainty about which EBV they were measuring. We therefore examined the general inclusion of EBVs in the indicators before focusing specifically on marine indicators. We excluded 13 of 34 single headline indicators from the EBV analysis for the abovementioned reasons and categorized the remaining 21 indicators into EBV classes, as well as into a "to be determined (tbd)" class (Appendix S1: Figure S1). Nine indicators that assess terrestrial habitats were also excluded given our focus on marine post-2020 indicators, resulting in a final count of 12 marine indicators. We sorted the marine headline indicators according to their integration in the post-2020 biodiversity targets.

Systematic review

For our systematic review of the inclusion of EBVs in research conducted during the UN Decade on Biodiversity (2010–2020), we searched the ISI Web of Science (WoS) on 28 Nov 2022, using the search string "marine OR coast* OR ocean* OR benth* OR plankton* and 'biodiversity' and 'assess* OR conserve* OR trend* OR status*'" and focused on the WoS category "Marine & Freshwater Biology". Only studies published between 2010 and 2020 were included. This search string ensured that the output record included only primary research that focused on biodiversity in the marine environment and considered conservation issues within the UN Decade on Biodiversity. This filtering excluded policy papers and studies of non-marine ecosystems, thereby reducing the number of records returned.

We retrieved 2615 records, of which 507 were screened for a random subset based on the title and abstract and then fed into the machine-learning tool ASReview (van de Schoot *et al*. 2021; ASReview LAB 2024). Of the subset of 507 initial papers, we manually filtered about half, leaving a total of 262 relevant papers (~10% of the original corpus). We created our ASReview project using the specifications listed in Appendix S1: Panel S1. Setting the query strategy to "random" disabled acceleration of the review by machine learning, thus presenting the records in random order without considering relevance scores of certain topics or keywords. We manually labeled the records as "relevant" if EBVs were measured and the study therefore involved quantitative assessment of the physical state of biodiversity. Manual sorting of the random subset enabled evaluation of the AI-algorithm performance, which was determined to be excellent, with only 0.5% wrongly labeled inclusions detected. We excluded models and reviews from further analyses (such records were labeled as "irrelevant") because our focus was on primary, empirical research and monitoring papers that were directly relevant to policy targets and indicators. The remaining (relevant) records were then sorted into EBV classes, for which inspection of the full text was sometimes necessary to ascertain the exact methodology used if this was not apparent from reading the abstract. The majority of the papers included in the EBV analysis considered biodiversity conservation, whereas irrelevant records mainly consisted of reviews, summaries, and overviews of management strategies.

The integration of the biodiversity indicators in research as well as in policy assessments and targets was visualized through Alluvial plots, which we created using the *networkD3* package in R (RStudio v2023.03.0+386 "Cherry Blossom"; R Core Team 2021). On the left side of Figure 1, the 262 research papers were sorted into the six EBV classes; for a research paper that investigated more than one of the 21 available EBVs, that paper would be counted once per each relevant EBV class. On the right side of Figure 1, the 29 marine indicators among the six policy assessments were sorted by EBV class; likewise, in Figure 2, the pre-2020 Aichi indicators (left) and the post-2020 GBF indicators (right) for marine targets were sorted by EBV class.

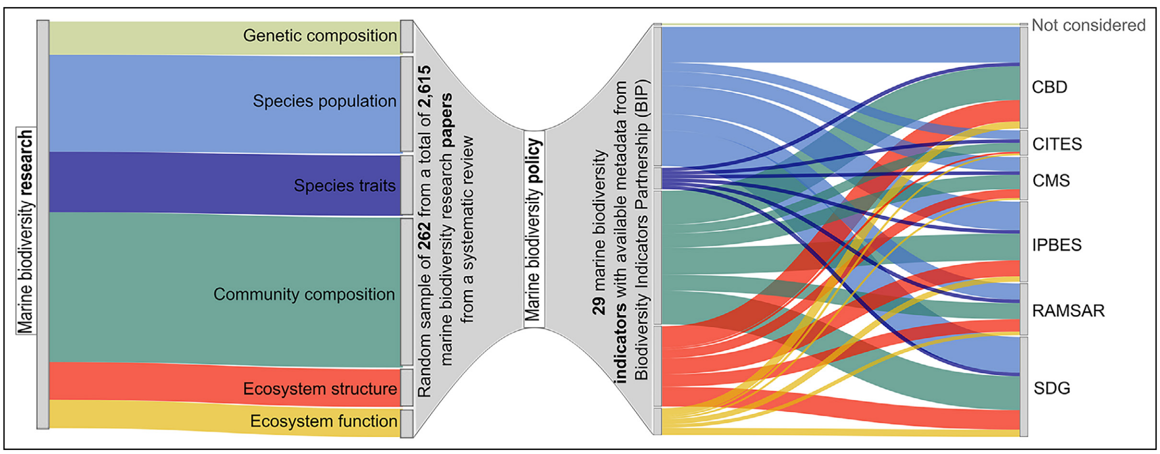

Figure 1. Alluvial plot showing the six classes of essential biodiversity variables (EBVs)—genetic composition, species population, species traits, community composition, ecosystem structure, and ecosystem function—found in the reviewed marine biodiversity research and policy assessments (2010–2020); for exact percentages, see Table 1. Only policy indicators relevant to marine biodiversity were included. Band thickness reflects how often each EBV is represented in research and indicators. CBD: Convention on Biological Diversity; CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora; CMS: Convention on the Conservation of Migratory Species; IPBES: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services; RAMSAR: Ramsar Convention on Wetlands; SDG: UN Sustainable Development Goals.

Table 1. Percentages of studies (research) and indicators (policy) from 2010 to 2020, sorted into six classes of essential biodiversity variables (EBVs).

	Marine biodiversity research		Marine biodiversity policy	
EBV class	Percentage of studies	Sum of class contributions	Percentage of indicators	Sum of class contributions
A: Genetic composition	8	8	0	0
B: Species population	24	76	35	73
B: Species traits	15		5	
B: Community composition	37		33	
C: Ecosystem structure	9	16	20	27
C: Ecosystem function	7		7	

Notes: categories A, B, and C correspond to gene-related variables, species-related variables, and ecosystem-related variables, respectively.

Results and discussion

Marine biodiversity research is well-integrated into global policy assessments

Our analysis shows that research focused primarily on species-related EBVs, followed by ecosystem-related and then gene-related EBVs (Figure 1; Table 1). However, when used as indicators in marine biodiversity assessments, ecosystem-related EBVs had a noticeably higher representation in policy documents (27%) than in research (16%).

The bulk of marine research and policy indicators (more than 60%) assessed community composition and species populations (Figure 1; Table 1). In marine research, species traits were included within 15% of the studies, whereas ecosystem structure, genetic composition, and ecosystem function each constituted fewer than 10%. In policy documents, indicators for ecosystem structure were more common (20%) than indicators of ecosystem function (7%) and species traits (5%). Genetic composition has yet to be considered in policy, and species traits are underrepresented as compared to what is available in marine research (Table 1). While less thoroughly studied than species diversity or ecosystem diversity (Caldwell *et al.* 2024), genetic diversity is nonexistent in policy assessments of the UN Decade on Biodiversity. This discrepancy is most likely due to the lack of generally policy-accepted indicators for species traits and genes (Hoban *et al.* 2020). Intraspecific genetic diversity comprises both the variation in DNA sequences among individuals of the same population and the divergence in genetic composition among different populations of the same species. Traits often reflect morphological or physiological attributes of organisms but can also comprise aspects of behavior and/or spatial mobility of organisms. Despite the plethora of metrics for genetic and functional (trait-based) diversity available for use in marine research, they have only rarely been implemented in assessments.

Therefore, development of relevant policy indicators for the EBV classes of genetic composition and species traits is a key area for improvement. More broadly, however, we observed that most biodiversity aspects are successfully integrated into policy assessments. All global assessments combine several indicators from multiple EBV classes, covering a respectable slice of marine biodiversity.

CBD assessments exhibited distinct changes from the pre-2020 to the post-2020 iteration

After the GBF negotiations in December 2022 (CBD 2022b), we chose to focus on the CBD assessments more closely by comparing pre-2020 and post-2020 indicators. Because global protection of terrestrial areas is far more extensive than for marine areas (Jenkins and Van Houtan 2016) and because marine habitats are historically considered "out of sight, out of mind", marine habitats are thought to be underappreciated in biodiversity negotiations. However, for the CBD assessments, we found that about one-third of pre-2020 and post-2020 indicators address marine habitats, which is a similar proportion to that for both terrestrial and freshwater habitats (Figure 2, top).

The GBF is split into headline, binary, component, and complementary indicators (CBD 2022a, 2024). Our analysis focused only on marine headline indicators because, for most other indicators, no metadata were available for the exact physical aspect of biodiversity being measured, and therefore we could not assess which EBV was involved. In addition, some complementary and component indicators may be modified at a later date (Appendix S1: Figure S1; CBD 2022a, 2024). For instance, while "Target 10 – Enhance Biodiversity and Sustainability in Agriculture, Aquaculture, Fisheries, and Forestry" aims to cover marine aspects, they are currently not covered by the two nominated headline indicators "10.1 Proportion of agricultural area under productive and sustainable agriculture" and "10.2 Progress towards sustainable forest management". Therefore, Target 10 is excluded from our analysis (Table 2; Figure 2).

The distribution of EBV classes across all marine Aichi Targets and GBF goals/targets, respectively, is similar overall

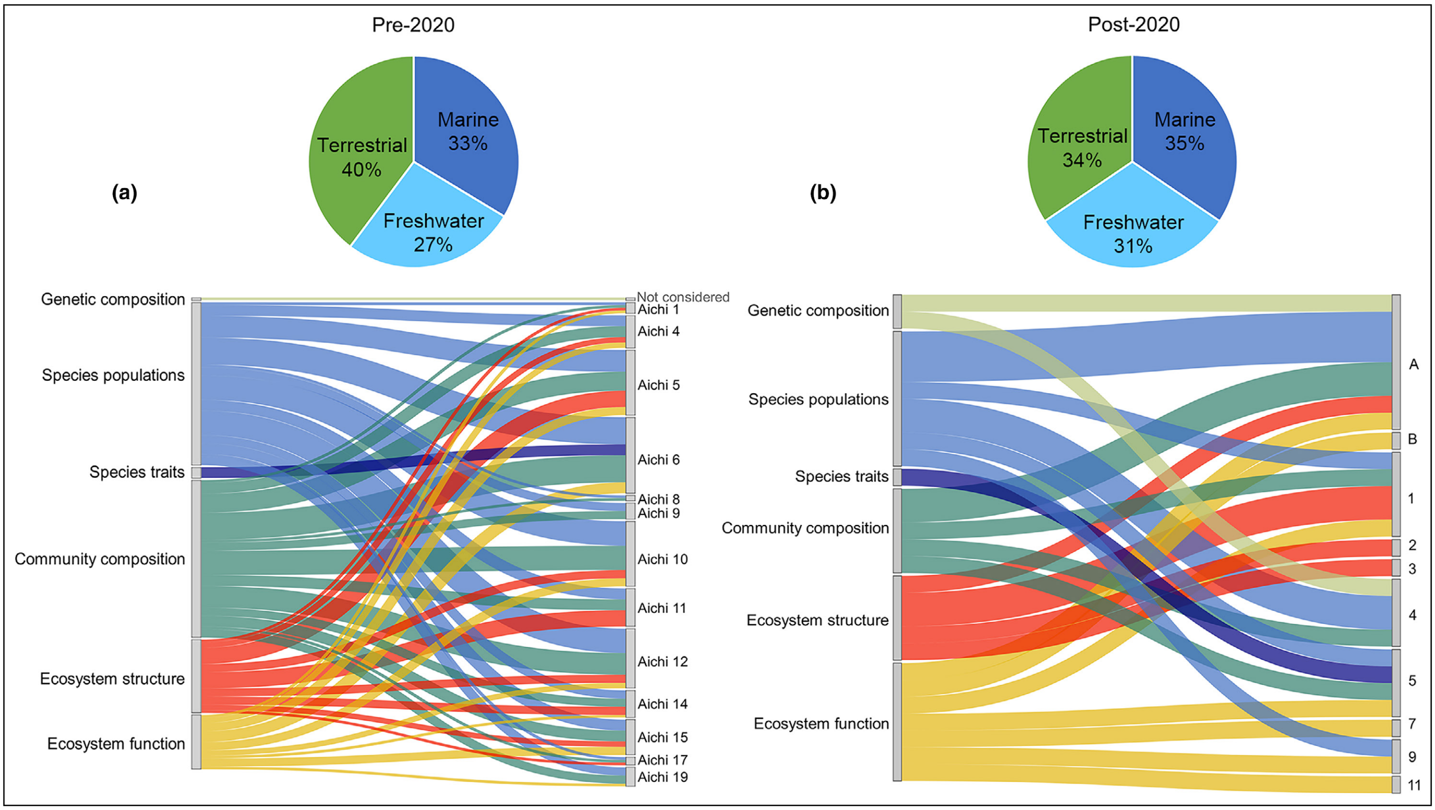

Figure 2. (top) Pie charts showing pre-2020 Aichi indicators and post-2020 Global Biodiversity Framework (GBF) indicators split into habitats. (bottom) Alluvial plots showing policy indicators relevant for marine biodiversity. (a) Pre-2020 Aichi indicators split into EBV classes. (b) Post-2020 GBF indicators for Goals (A and B) and Targets (1–5, 7, 9, and 11) split into EBV classes. For exact percentages of the EBV classes, see Table 2. Band thickness reflects how often each EBV is represented in indicators.

Table 2. Percentages of indicators employed by the Convention on Biological Diversity (CBD) in the pre-2020 Aichi indicators and the post-2020 Global Biodiversity Framework (GBF) indicators, sorted into six classes of essential biodiversity variables (EBVs).

	Marine pre-2020 Aichi indicators		Marine post-2020 GBF indicators	
EBV class	**Percentage of indicators**	**Sum of class contributions**	**Percentage of indicators**	**Sum of class contributions**
A: Genetic composition	0	0	7	7
B: Species population	36	72	29	50
B: Species traits	2		3	
B: Community composition	34		18	
C: Ecosystem structure	16	28	18	43
C: Ecosystem function	12		25	

Notes: categories A, B, and C correspond to gene-related variables, species-related variables, and ecosystem-related variables, respectively.

(Figures 1 and 2; Tables 1 and 2). However, all current GBF headline indicators relating to marine biodiversity exhibited changes as compared to the Aichi Targets (Figure 2b; Table 2). In terms of EBV classes, the GBF now includes indicators for genetic composition, which is a marked improvement. At the same time, however, species traits are still largely absent, likely due to the abovementioned lack of accepted indicators for measuring traits. Indicators associated with the measuring of species populations remain the most common, but indicators related to ecosystem function now rank second. This outcome is a result of the GBF including an ecosystem-specific reference under Goal A, whereas the Aichi Targets did not include a specific ecosystem goal. Notably, we detected a shift away from more foundational biodiversity variables (genetic composition, species population, species traits, and community composition) toward secondary variables (ecosystem function and ecosystem structure) that derive from foundational ones (Loreau *et al.* 2001).

Caution with putting ecosystems at the center of biodiversity management

The increased focus on ecosystem-related variable classes is intentional, as noted in the GBF ("ecosystems are central to meeting all three objectives of the CBD"; Nicholson *et al.* 2021). This is also reflected in other prominent examples of policy-relevant research, such as the more recent iterations of the Planetary Boundaries framework, which only assess natural ecosystem area and functional integrity of ecosystems as proxies for biodiversity (Rockström *et al.* 2023). We appreciate the utility of ecosystem structure and function in management practicability and communication. Functions like primary productivity, carbon sequestration, and coastal protection directly affect human well-being, and are therefore much easier concepts to communicate to decisionmakers than, for example, the importance of protecting one specific type of coral.

Although well situated at the center of the CBD objectives, ecosystems are not the central building block of biodiversity (Antonelli 2022). The variable classes "ecosystem structure" and "ecosystem function" indeed build on the other four classes and would not exist without them (Schuldt *et al.* 2018; Ramus *et al.* 2022). Genetic and species diversity contribute substantially to ecosystem multifunctionality. A diverse array of species supports a wide range of ecosystem functions, such as nutrient cycling and energy flow, which are essential for ecosystem health (Mori *et al.* 2023). A sizable portion of those species disproportionately support ecosystem functions, highlighting the necessity for holistic management of biodiversity.

The increasing relative representation of ecosystems, and therefore secondary variables, in biodiversity management is understandable but raises concerns. Overly focusing on secondary variables can lead to unintended outcomes, with individual species lost despite the maintenance of ecosystem function. We suggest that a balance between the four foundational variable classes (genetic composition, species population, species traits, and community composition) and the two secondary variable classes (ecosystem function and ecosystem structure) be maintained through biodiversity conservation management targets and indicators. All six variable classes are important for a holistic understanding of biodiversity change, and excessive focus on ecosystem-based biodiversity proxies will fall short.

We recognize that foundational and secondary variables can overlap, both with regard to their underlying processes and in the manner in which they are measured. Indeed, EBVs are versatile in their data sources and applications—a single data source often contributes to multiple EBV classes (Fernández *et al.* 2020). For instance, in ecosystem-based fisheries management, foundational indicators like the age and size structure of forage species can be incorporated into broader, secondary indicators of ecosystem function. This nested approach allows for the aggregation of data from multiple stocks, providing a more comprehensive view of the ecosystem in question (Shin *et al.* 2005; Scotti *et al.* 2022).

A potential limitation of our assessment is that every indicator is assumed to be of equal importance in policy and application, which might not necessarily be the case. Although we suggest there is overemphasis of the number of secondary variable indicators, in practice they may not weigh as heavily.

Conclusions

During the UN Decade on Biodiversity (2010–2020), research articles covered the complexity of marine biodiversity well and simultaneous policy assessments converted this knowledge into actionable targets reasonably well. With the adoption of the post-2020 GBF targets, the situation has improved, as the targets include all six classes of EBVs. Our main finding is that the targets and associated indicators of the GBF sufficiently cover the multifaceted, complex nature of marine biodiversity, reducing the risk of changes in biodiversity going unnoticed. Overall, the targets are well linked to meaningful headline indicators (CBD 2024). Yet despite this progress, we caution against moving too far in the direction of secondary variables, at the risk of losing focus on indicators that monitor foundational variables, especially in terms of the species traits and genetic composition variable classes.

For biodiversity to be monitored holistically, the foundational variable classes (genetic composition, species population, species traits, community composition) of biodiversity must be thoroughly covered before indicators of secondary roles (ecosystem structure, ecosystem function) are emphasized. When implementing these much-improved global targets of the GBF, we would advise national governments to be aware of this need and ensure that a balance is struck between indicators of foundational variables and secondary variables. If the goal is to protect biodiversity, then indicators that thoroughly assess its foundations must be developed. Investing in monitoring and evaluating ecosystem-related variables should not be made at the expense of their foundations.

In summary, global and national attention should focus on achieving the targets and implementing science-based policies for successful marine biodiversity conservation and restoration (Perino *et al.* 2022). Achieving this outcome will require paying attention to the functioning not only of marine biodiversity but also of governments and other decision-making organizations (eg nongovernmental organizations, corporations) as they are involved in policy efforts and lobbying of national and international target implementations. These efforts require ongoing facilitation and support of the science–policy interface resulting from the integration of marine social sciences (McKinley *et al.* 2020) with natural sciences (Franke *et al.* 2020). National science foundations and practitioners could especially assist in identifying more suitable national-level indicators that match the coverage in EBVs of the global indicators. Together, these efforts could provide evidence-based knowledge more effectively, to inform decision- and policymaking, and improve governance practices to safeguard marine biodiversity and its benefits to humankind.

Acknowledgements

This manuscript was inspired by recent discussions surrounding the Global Biodiversity Framework. *Funding*—J-CD, AKE, AF, UJ, SL, AL, and HH acknowledge funding by HIFMB, a collaboration between the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, and the Carl von Ossietzky University Oldenburg, initially funded by the Ministry for Science and Culture of Lower Saxony and the Volkswagen Foundation through the "Niedersächsisches Vorab" grant program (grant #ZN3285); J-CD, AKE, ATL, and HH acknowledge funding by the German Federal Ministry for Education and Research and the Belmont Forum for the MARISCO project (award 03F0836A). *Author contributions*—conceptualization: J-CD, AKE; methodology: J-CD, AKE, HH; investigation: J-CD, AKE; visualization: J-CD, AKE; funding acquisition: J-CD, HH; project administration: J-CD, HH; supervision: J-CD, HH; writing (original draft): J-CD, AKE, AF, HH; writing (review and editing): all authors. Open Access funding enabled and organized by Projekt DEAL.

Data Availability Statement

Biodiversity indicator data were extracted from the Biodiversity Indicators Partnership (www.bipindicators.net) and the Post-2020 Indicators (www.post-2020indicators.org) websites, both of which are hosted by the UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC). Data and code (Dajka 2025) necessary to replicate our work are available on Zenodo at https://doi.org/10.5281/zenodo.15275888.

References

Antonelli A. 2022. The hidden universe: adventures in biodiversity. Chicago, IL: University of Chicago Press.

ASReview LAB. 2024. ASReview LAB—a tool for AI-assisted systematic reviews (v1.6.3rc0). Zenodo. https://zenodo.org/records/11185216. Viewed 24 Jun 2025.

Caldwell IR, Hobbs JPA, Bowen BW, *et al*. 2024. Global trends and biases in biodiversity conservation research. *Cell Rep Sustain* **1**: 5.

CBD (Convention on Biological Diversity). 2020. Global biodiversity outlook 5. Montreal, Canada: CBD Secretariat.

CBD (Convention on Biological Diversity). 2022a. Monitoring framework for the Kunming-Montreal Global Biodiversity Framework. Conference of the Parties to the CBD – 15th Meeting, Decision 15/5. Montreal, Canada: CBD Secretariat.

CBD (Convention on Biological Diversity). 2022b. Kunming-Montreal Global Biodiversity Framework. 7–19 December. Montreal, Canada: CBD Secretariat.

CBD (Convention on Biological Diversity). 2024. Monitoring framework for the Kunming-Montreal Global Biodiversity Framework. Conference of the Parties to the CBD – 16th Meeting, Decision Working Group 1. Montreal, Canada: CBD Secretariat.

Cimatti M, Chaplin-Kramer R, and Di Marco M. 2023. The role of high-biodiversity regions in preserving nature's contributions to people. *Nat Sustain* **6**: 1385–93.

Dajka J-C. 2025. JanDajka/BiodivTargets: release to *Front Ecol Environ* paper "From science to policy: evolving marine biodiversity targets" (v3.5). Zenodo. 10.5281/zenodo.15275888. Viewed 24 Jun 2025.

Daskalova GN, Bowler D, Myers-Smith IH, and Dornelas M. 2021. Representation of global change drivers across biodiversity datasets. *EcoEvoRxiv*; 10.32942/osf.io/db4s7.

Díaz SM, Settele J, Brondízio E, *et al*. 2019. The global assessment report on biodiversity and ecosystem services: summary for policy makers. Bonn, Germany: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Fernández N, Ferrier S, Navarro LM, *et al*. 2020. Essential biodiversity variables: integrating in-situ observations and remote sensing through modelling. In: Cavender-Bares J, Gamon JA, and Townsend PA (Eds). Remote sensing of plant biodiversity. Cham, Switzerland: Springer.

Fleming LE, Rabbottini L, Depledge MH, *et al*. 2023. Overview of oceans and human health. In: Fleming LE, Alcantara Creencia LB, Gerwick WH, *et al*. (Eds). Oceans and human health (2nd edn). San Diego, CA: Academic Press.

Franke A, Blenckner T, Duarte CM, *et al*. 2020. Operationalizing ocean health: toward integrated research on ocean health and recovery to achieve ocean sustainability. *One Earth* **2**: 557–65.

Hillebrand H, Blasius B, Borer ET, *et al*. 2018. Biodiversity change is uncoupled from species richness trends: consequences for conservation and monitoring. *J Appl Ecol* **55**: 169–84.

Hillebrand H, Kuczynski L, Kunze C, *et al*. 2023. Thresholds and tipping points are tempting but not necessarily suitable concepts to address anthropogenic biodiversity change—an intervention. *Mar Biodivers* **53**: 43.

Hoban S, Bruford M, Jackson JD, *et al*. 2020. Genetic diversity targets and indicators in the CBD post-2020 Global Biodiversity Framework must be improved. *Biol Conserv* **248**: 108654.

Jenkins CN and Van Houtan KS. 2016. Global and regional priorities for marine biodiversity protection. *Biol Conserv* **204**: 333–39.

Larsson TB. 2001. Ecological bulletins: biodiversity evaluation tools for European forests. Copenhagen, Denmark: Munksgaard International.

Leclère D, Obersteiner M, Barrett M, *et al*. 2020. Bending the curve of terrestrial biodiversity needs an integrated strategy. *Nature* **585**: 551–56.

Loreau M, Naeem S, Inchausti P, *et al*. 2001. Biodiversity and ecosystem functioning: current knowledge and future challenges. *Science* **294**: 804–08.

McKinley E, Acott T, and Yates KL. 2020. Marine social sciences: looking towards a sustainable future. *Environ Sci Policy* **108**: 85–92.

Mori AS, Isbell F, and Cadotte MW. 2023. Assessing the importance of species and their assemblages for the biodiversity–ecosystem multifunctionality relationship. *Ecology* **104**: e4104.

Nicholson E, Watermeyer KE, Rowland JA, *et al*. 2021. Scientific foundations for an ecosystem goal, milestones and indicators for the post-2020 global biodiversity framework. *Nat Ecol Evol* **5**: 1338–49.

Pereira HM, Ferrier S, Walters M, *et al*. 2013. Essential biodiversity variables: a global system of harmonized observations is needed to inform scientists and policy-makers. *Science* **339**: 277–78.

Perino A, Pereira HM, Felipe-Lucia M, *et al*. 2022. Biodiversity post-2020: closing the gap between global targets and national-level implementation. *Conserv Lett* **15**: e12848.

Purvis A. 2020. A single apex target for biodiversity would be bad news for both nature and people. *Nat Ecol Evol* **4**: 768–69.

R Core Team. 2021. R: a language and environment for statistical computing (v4.0.3). Vienna, Austria: The R Foundation for Statistical Computing.

Ramus AP, Lefcheck JS, and Long ZT. 2022. Foundational biodiversity effects propagate through coastal food webs via multiple pathways. *Ecology* **103**: e3796.

Rockström J, Gupta J, Qin D, *et al*. 2023. Safe and just Earth system boundaries. *Nature* **619**: 102–11.

Schuldt A, Assmann T, Brezzi M, *et al*. 2018. Biodiversity across trophic levels drives multifunctionality in highly diverse forests. *Nat Commun* **9**: 2989.

Scotti M, Opitz S, MacNeil L, *et al*. 2022. Ecosystem-based fisheries management increases catch and carbon sequestration through recovery of exploited stocks: the western Baltic Sea case study. *Front Mar Sci* **9**: 879998.

Shin YJ, Rochet MJ, Jennings S, *et al*. 2005. Using size-based indicators to evaluate the ecosystem effects of fishing. *ICES J Mar Sci* **62**: 384–96.

UN (United Nations). 2011. Resolution adopted by the General Assembly. 65/161. New York, NY: UN.

van de Schoot R, de Bruin J, Schram R, *et al*. 2021. An open source machine learning framework for efficient and transparent systematic reviews. *Nat Mach Intel* **3**: 125–33.

Supporting Information

Additional material can be found online at http://onlinelibrary.wiley.com/doi/10.1002/fee.70000/suppinfo

[6]*Scottish Association for Marine Science, Oban, UK;* [7]*Institute for Coastal and Marine Research, Nelson Mandela University, Gqeberha, South Africa;* [8]*Bielefeld University Faculty of Business Administration and Economics, Bielefeld, Germany;* [9]*Institute for Chemistry and Biology of the Marine Environment, School of Mathematics and Science, Carl von Ossietzky University, Oldenburg, Germany*
[†]*these authors contributed equally to this work*