


Opinion

The Future of Access and Benefit-Sharing: What Next after the Adoption of the Global Biodiversity Framework and Decision on Digital Sequence Information?

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Abstract: Recent decisions at the Convention on Biological Diversity's (CBD) 15th Conference of the Parties (COP15) on access and benefit-sharing (ABS) fundamentally shift how ABS will work in the future. The key ABS challenges that now lie ahead will be to integrate digital sequence information into a functioning benefit-sharing mechanism compatible with the Nagoya Protocol, to address the difficult task of measuring benefit-sharing now required by the Global Biodiversity Framework, and ultimately to address the long-term challenges of the Nagoya Protocol's bilateral ABS approach. The relevant COP15 decisions do not provide simple and quick answers to these challenges. However, they do lay the groundwork for change and could form the basis for the further development of effective access and benefit-sharing.

Keywords: access and benefit-sharing; digital sequence information; Nagoya Protocol; convention on biological diversity; global biodiversity framework; indicators



Citation: Scholz, A.H.; Nunez-Vega, G.; Weissgold, L.; Wussmann, K. The Future of Access and Benefit-Sharing: What Next after the Adoption of the Global Biodiversity Framework and Decision on Digital Sequence Information? *Diversity* **2023**, *16*, 27. <https://doi.org/10.3390/d16010027>

Academic Editor: Michael Wink

Received: 16 October 2023

Revised: 28 November 2023

Accepted: 29 November 2023

Published: 31 December 2023



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1. Introduction

When the spotlight is on at the Convention on Biological Diversity (CBD) Conference of the Parties (COP), it does not usually shine on the complex issue of regulating access to genetic resources and the sharing of benefits arising from their use—widely known under the term access and benefit-sharing (ABS). Despite being one of the three main objectives of the 1992 CBD, ABS is often overshadowed by the other objectives—the conservation and sustainable use of biological diversity. However, at COP15 in December 2022, increasing benefit-sharing was one of four major goals of the new international agreement on nature conservation, known as the Kunming-Montreal Global Biodiversity Framework (GBF), and part of the political “package deal” in which agreeing to benefit-sharing from digital sequence information (DSI) was integral to achieving political consensus.

ABS in the CBD is perhaps most prominent in its 2010 Nagoya Protocol, which created a legally binding instrument for genetic resources (GRs, any nonhuman biological material containing functional units of heredity). However, whether the data derived from GRs, including digital sequence information (DSI), a placeholder term that could cover many types of biological data ranging from nucleotide sequences to proteins or metabolites, should also require benefit-sharing was an outstanding and unresolved question at the international level until COP15. The low amount of benefits shared through the Nagoya Protocol was and is a source of frustration for ratifying parties, and the increasing reliance on DSI for research and development raised concerns that open access to DSI was further eroding benefit-sharing outcomes.

1.1. ABS as a Major Building Block of the GBF

The GBF is structured around 4 long-term goals and 23 action-oriented targets. Both ABS markers in the GBF commit to a “significant” increase (by 2030 under Target 13) or “substantial” increase (by 2050 in Goal C) in benefits shared and extend the scope for benefit-sharing beyond the utilization of GRs and traditional knowledge to now include benefit-sharing from DSI [1]. The inclusion of DSI in Goal C and Target 13 and as part of the GBF package deal was a demand from low- and middle-income parties and represents a shift away from the previous more narrow interpretation of the CBD and Nagoya Protocol (NP) by parties from high-income countries. Because the current ABS model has been slow to demonstrate an increase in benefits (which we explore below), the inclusion of DSI is seen as essential to achieving the promised increases in benefit-sharing by 2030 and 2050.

1.2. DSI at COP15

Following the inclusion of DSI in the GBF and COP Decision 15/9, many open questions regarding benefit-sharing from DSI remain to be resolved. In theory, the DSI decisions at COP15 will implicitly cause an increase in monetary and non-monetary benefits shared because the baseline for benefit-sharing from DSI is near zero. However, predictions on the amount and type of benefit-sharing from DSI are still unclear. In Montreal, CBD Parties were unable to agree on any of the previously elaborated policy options for the future handling of DSI, and negotiations stretched deep into the final days of COP15 and were ultimately taken up by the high-level segment. In the end, the DSI agreement is in large part a “process decision”, postponing the final conclusion to COP16. Decision 15/9 [2] on DSI contains three core elements. The first element is the criterion that future solutions to DSI must be met. These include, among others, sufficient practicability, legal certainty, and efficiency, as well as compatibility with open access to data and no hindrance to research and development. The second element is an agreement to establish a (to-be-determined) multilateral mechanism for benefit-sharing from the use of DSI, including a global fund. The third element of the COP15 decision on DSI describes the further process toward an implementable mechanism for DSI benefit-sharing.

1.3. ABS Remains a “Construction Site”

Finding a solution to DSI will not entirely solve the political problem of committing to an increase in benefit-sharing. The discussions at COP15, both on the ABS targets of the GBF and on DSI, have repeatedly made one thing clear: there is widespread frustration on both sides on the issue of ABS. The NP was supposed to pave the way for greater legal certainty for both the providers and users of GRs when accessing GRs and, in turn, facilitate fair and equitable benefit-sharing. Neither the hopes of the users nor providers have been fulfilled [3]. The users of genetic resources from noncommercial and commercial scientific research are frustrated by the lack of information and predictability when complying with national ABS rules. They note opaque, slow, and unrealistic procedures for obtaining the necessary ABS permits, which, in turn, discourage international collaborations. At the same time, there are also unmet expectations on the part of the provider countries, especially regarding the amount of monetary benefits conferred from the NP [4]. Providers also note their limited capacity and the relatively high volume of requests from academic users.

The source of the frustration ultimately can be traced back to a central and essential tenet of the CBD and its Nagoya Protocol: states have sovereign rights over their genetic resources. This has led to an immense variety of national ABS regulations that function differently, as well as ensuing divergences in the expectations of what the NP can actually deliver. For those looking to comply, there is often little information available on how any given national law works. At the same time, the provider countries often put in place complex systems to ensure control and oversight. Increasing the difficulty of an ABS system ultimately decreases the number of users who are willing to work through that specific ABS system, thereby decreasing the benefits shared. A major challenge for the CBD until 2030 and beyond will be to reconcile the guarantee of sovereign rights over biological diversity

with the benefit-sharing needed to support the conservation of biodiversity. Opportunities for improvement might lie in the standardization of ABS processes either for particular sectors, such as academia, particular taxonomic groups with cosmopolitan distributions like microbes, or regional efforts to harmonize ABS procedures, including the implementation of Article 10 of the Nagoya Protocol, which could be carried out at the regional level. While DSI will likely play a major role in this reconciliation, fundamental inefficiencies and unfulfilled assumptions will ultimately need to be addressed if Parties to the CBD want to fulfill the convention's third objective.

2. The DSI Void and How Other UN Fora Deal with It

Benefit-sharing from DSI is a controversial issue under the international fora beyond the CBD. Due to the complex situation arising from the efforts to extend benefit-sharing to DSI and the incompatibility of the current ABS systems with DSI, different international fora are dealing intensively with this topic with many upcoming decisions in the next two years (see Figure 1) and beyond. This includes, among others, the UN High Seas Treaty on Biodiversity Beyond National Jurisdictions (BBNJ) under the United Nations Convention on the Law of the Sea (UNCLOS) [5], the still-to-be-negotiated Pandemic Preparedness CA+ agreement of the World Health Organization (WHO) [6], and the Food and Agriculture Organization's (FAO) International Treaty on Genetic Resources for Food and Agriculture (ITPGRFA). In the run-up to the CBD COP15, most fora were informally "waiting" for the expected CBD decision on DSI to negotiate their own decisions. These instruments intend to create or expand alternative multilateral mechanisms to the CBD and NP. As a final decision on DSI under the CBD is now expected at the end of 2024 at COP16 (at the earliest), these fora are starting to push ahead with their processes for creating or expanding benefit-sharing from GRs and the resulting DSI.

2.1. ABS for Areas beyond National Jurisdiction

The High Seas Treaty, which still needs to be formally ratified, addresses the special challenge of ABS with respect to BBNJ, in which no benefit-sharing from the utilization of marine genetic resources in international waters has previously been required. In this context, a key measure is the establishment of a clearing-house mechanism, which is intended to collect information on utilization activities on BBNJ marine genetic resources and any resulting DSI. The clearinghouse mechanism requires a notification when BBNJ GRs or DSI have been utilized, such as at the point of publication or commercialization. However, the treaty does not indicate whether or how benefit-sharing is tied to these notifications. The benefit-sharing mechanism will be determined during future BBNJ meetings by an Access and Benefit-Sharing Committee. The notification system could yield a high level of transparency on BBNJ utilization but a low level of legal certainty on the benefit-sharing compliance. The BBNJ Treaty makes a clear distinction between non-monetary and monetary benefit-sharing. For now, monetary benefit-sharing is to be provided by an annual contribution from the developed state parties. This will be a method of collecting monetary benefit until and if the Parties decide otherwise. Interestingly, open access to DSI is explicitly noted as a non-monetary benefit, a step not (yet) taken by the CBD. Finally, it is explicitly noted that future modalities should be mutually supportive of and adaptable to other ABS instruments, understood by many as a clear reference to parallel processes under the CBD.

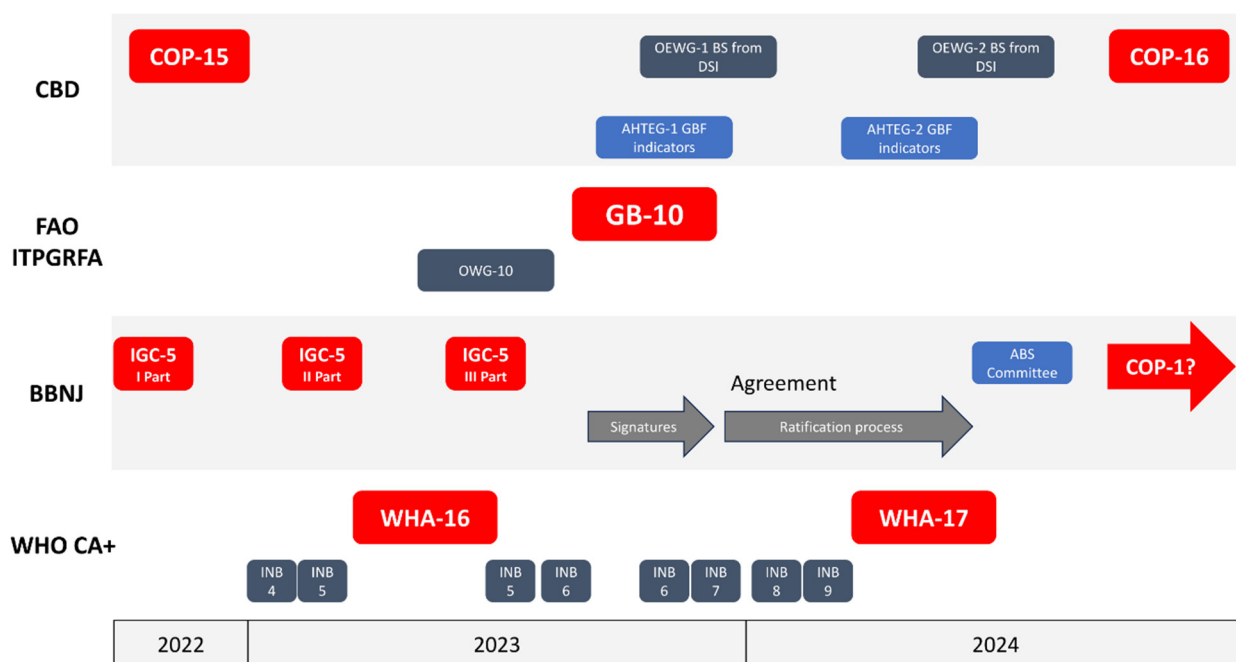


Figure 1. ABS developments in the COP15–16 biannual inter-sessional period 2023–2024 in the Convention on Biological Diversity (CBD) and other international fora, Food and Agriculture Organization’s (FAO) International Treaty on Genetic Resources for Food and Agriculture (ITPGRFA), the UN High Seas Treaty on Biodiversity Beyond National Jurisdictions (BBNJ), and the World Health Organization (WHO) convention, agreement or other international instrument on pandemic prevention, preparedness and response (WHO CA+). In red are the main conferences and general assemblies for the convention members: Conference of the Parties (COP), Governing Body (GB), Intergovernmental Conference (IGC), and World Health Assembly (WHA). In dark blue, working groups and negotiation bodies: Open-Ended Working Group (OEWG and OWG) on benefit-sharing (BS) from the use of Digital Sequence Information (DSI), and Intergovernmental Negotiating Body (INB). In light blue, sub-meetings: Ad Hoc Technical Expert Group (AHTEG) on Global Biodiversity Framework (GBF) Indicators and Access and Benefit Sharing (ABS) Committee. The ratification process of the BBNJ agreement is indicated by the gray arrow. The agreement will be open for the state’s signatures and will enter into force 120 days after the 60th ratification. However, the signature period still has to be defined. The arrows mean that dates are not clear; therefore, they could change with previous meeting outcomes.

2.2. The WHO and Its Agreement on Pandemic Preparedness

The WHO is currently working on a new pandemic preparedness agreement—the WHO CA+. In its zero draft, Article 10 provides a WHO Pathogen Access and Benefit-Sharing System (PABS System). The scope of the PABS System covers pathogens with pandemic potential and explicitly includes their genomic sequences. The PABS System is designed to provide rapid and open access to pathogens with pandemic potential. Therefore, the genomic sequences would have to be uploaded to one or more publicly accessible databases within a number of hours after the identification of a pathogen with pandemic potential. The benefit-sharing is handled through a Standard Material Transfer Agreement that contains the available benefit-sharing options. These options are not yet further defined, with one exception that must be included in any case: provide and facilitate access to 20 percent of pandemic-related products (e.g., vaccines) to the WHO for equitable distribution, particularly to developing countries. Finally, it should be noted that the WHO wants the PABS System to be recognized as a specialized international ABS instrument under the Nagoya Protocol. However, this very recognition of future specialized international ABS instruments was a key point of contention on which the Parties to the Nagoya Protocol were unable to agree recently at the Meeting of the Parties in Montreal.

2.3. International Treaty for Plant Genetic Resources for Food and Agriculture

The International Treaty on Plant Genetic Resources for Food and Agriculture, adopted by the FAO Conference in 2001, was set up as a specialized multilateral instrument with the objectives of the conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising out of their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security [7]. The ITPGRFA, unlike the CBD, has had a multilateral benefit-sharing system for GRs from its inception, and views of the treaty's benefit-sharing fund are favorable, despite its small size. In 2019, at the eighth Governing Body session, contracting parties were unable to come to an agreement on enhancement measures in part because they could not decide on how to treat DSI within the treaty context. In 2022, the contracting parties re-established a working group with the goal of agreeing on an enhancement package for the multilateral system [8]. Similar to the desire to retain bilateral systems in the CBD context, parties are reticent to expand the list of crops within the MLS because of the lack of benefits to date. Given the CBD's decision on DSI at COP15, if benefits from the use of DSI are not shared within the treaty, they will likely be shared in the CBD MLS. As mentioned in the treaty's objectives, the instrument was created to work in harmony with the CBD, meaning that the parties will keep the CBD's systems in mind when enhancing their own.

2.4. What Collective Trend Is Emerging from New and Extant ABS Systems?

The CBD's intensive work on DSI has had "ripple effects" on other UN instruments, for example, in the emphasis on open access to DSI and improving efficiency. However, each instrument has also signaled some differences, such as possible trigger points for DSI benefit-sharing and potential compliance mechanisms. All these fora will hopefully cross-pollinate each other and the negotiated texts will reflect new and emerging ideas. This would be a positive outcome, as the CBD also stated in its decision on DSI that a solution should be mutually supportive of and adaptable to other instruments and fora. Furthermore, from the user perspective, in which the entire DSI dataset is often used in an integrative manner, drawing on DSI from all these UN fora simultaneously, the issue of harmonization could become the next front for scientific engagement.

3. The Challenge of ABS Indicators in the GBF

The GBF, the Strategic Plan for the CBD for the next three decades, also sets goals and targets for ABS. While many of the science-based, biodiversity-focused indicators have well-established indicators with deep institutional support behind them, the indicators for ABS are underdeveloped. There are two main reasons for this. First, there has been no policy need to date to measure ABS. The GBF now creates this political motivation. Second, and perhaps most importantly, because of the bilateral approach to ABS under the CBD and NP, ABS transactions and the resulting benefits are broadly invisible at the international level. ABS under the NP results in a contract between a provider (often a country) and a user. These documents should be reflected in the publication of an internationally recognized certificate of compliance (IRCC) on the ABS-Clearinghouse, but many countries do not issue IRCCs and, if they do, the benefit-sharing arrangements are usually confidential. Thus, only the provider and user, but not the public or a reporting body at the international level, know the occurrence and extent of ABS transactions.

3.1. Should We Measure ABS Laws Created? Can We Measure the Benefits Shared?

One central challenge to measuring ABS is that the presence of an ABS permit or contract and even an IRCC does not provide a measurement of benefits shared. Rather, it is a measurement of a legal transaction and does not indicate what positive (monetary or non-monetary) outcomes arose. Although the Annex to the NP lists several exemplary monetary and non-monetary benefits, none of them is readily measurable. Over the past year, attempts have been made to develop methodologies to quantify the most "easy" types of benefits listed in the Annex, such as the research results shared, international

collaborations, and access to scientific infrastructures, which can be partially captured in the open science ecosystem (see Box 1).

Box 1. Developing new methods to attempt to quantify non-monetary benefit-sharing.

The Kunming-Montreal Global Biodiversity Framework (GBF) calls for an increase in monetary and non-monetary benefit-sharing over the next decade (Goal C). The Science Policy and Internationalisation (SPI) department at the Leibniz Institute DSMZ is leading a project entitled *Examining trends in non-monetary benefit sharing* (ET-NMBS), funded by the German Federal Agency for Nature Conservation (BfN), which will develop pilot methods and tools to quantify and assess some forms of non-monetary benefit sharing (NMBS). The 3-year-plus project began in 2022 with the main objectives to (1) quantify NMBS for documentable ABS cases in research infrastructures, (2) indirectly measure NMBS at the global scale, and (3) translate the significance of NMBS into tangible results. Countries like Germany invest significant resources in research, international cooperation, joint publications, and other activities related to the utilization of genetic resources that result in non-monetary benefits. However, these benefits are hard to see and measure under the CBD and NP. As a first step toward increasing visibility, the ET-NMBS project has created a database of potential non-monetary benefit-sharing by identifying scientific papers that cite ABS permits.

The ABS permit database was created by searching within the 4,729,721 open access research articles in the European PMC web service (EPMC) for the Internationally Recognized Certificate of Compliance (IRCC) codes. Subsequently, any mention of an ABS permit code, which is more difficult to identify due to variations in the permit code structure at the national level, was sought. Additional articles were obtained from EPMC using a combination of keyword searches. Relevant metadata fields, including the country issuing the permit, the article section where the permit was cited, and the author's affiliation, among others, were then annotated. The number of records in the database continues to increase as more types of ABS permit codes are identified. The ET-NMBS project has currently connected 476 research articles with a corresponding 698 ABS permits from 24 different countries (see Figure 2). To our knowledge, this is a one-of-a-kind database that represents a novel and first attempt to connect ABS permits with real-world outcomes, in particular, to scientific results and new knowledge generated.

By comparison, more than 4000 IRCCs have been issued by the ABS-CH since 2014, but only 18 (0.6%) of them were mentioned in the research articles in the ET-NMBS database. This could suggest that national ABS permit codes (rather than the internationally standardized IRCC numbers) are more frequently used to refer to benefit-sharing permits in scientific papers compared to IRCC codes. The data from the ET-NMBS project indicate that the current practice of citing ABS permits is heterogeneous. Identifying the national ABS permit code patterns was more effective when linking research results to ABS permits than looking for IRCC codes because the latter are rarely cited in scientific articles. Similarly, researchers usually reference the ABS national authority instead of the permit code. Furthermore, there is no consistency in the section in the scientific publication where an ABS permit is cited. It was found that 45.5% of articles used Material and Methods, followed by Acknowledgments (25.5%), Notes (15.9%), and Additional Information and Declarations (6.5%), but across the articles, there were twenty-two different sections used for citing a permit.

Empirical data are being used by the ET-NMBS project to give visibility to non-monetary benefit-sharing and develop possible new methods for a future GBF ABS indicator. Consistent reporting practices on benefit-sharing should be developed and used in scientific papers to provide better visibility of NMBS to the scientific community. New best practices should guide scientists on procedures for obtaining ABS permits, sharing benefits, and how and where in scientific articles they should mention benefits shared, including the citation of IRCC codes.

Ultimately, the existing compliance and reporting mechanisms available from the NP and CBD do not yield many clear-cut opportunities for readily measuring benefits shared at the national or global levels. New practices and procedures will ultimately be needed to achieve the GBF goal C and Target 13. In the absence of off-the-shelf indicators, the CBD and GBF policy process has two complementary approaches in place.

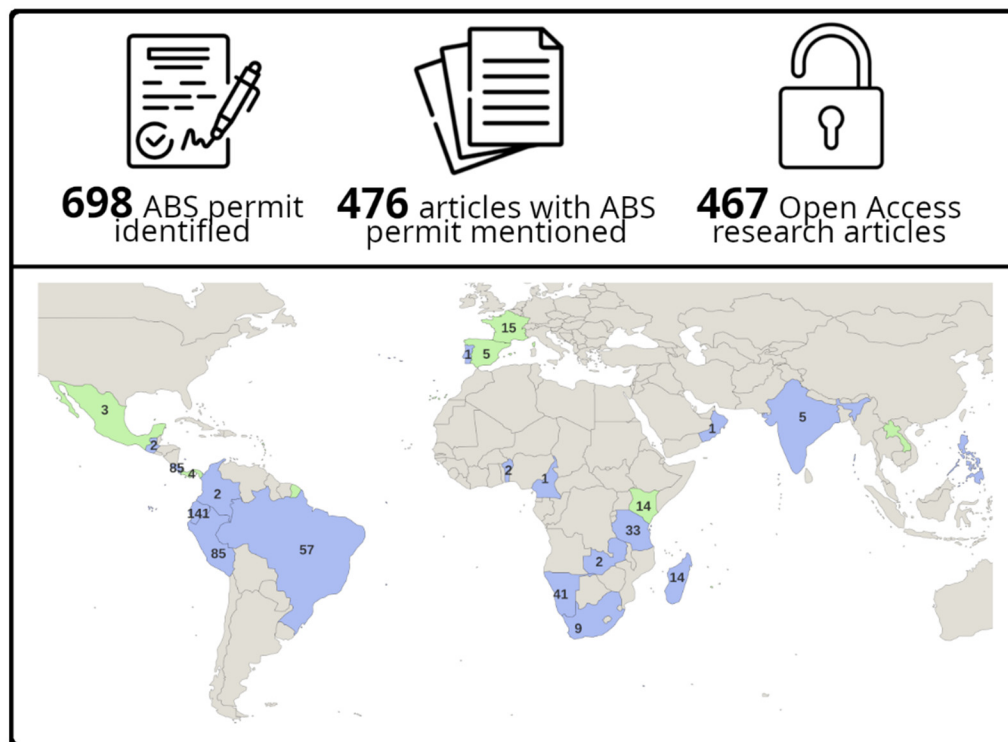


Figure 2. Composition and geographical distribution of the ABS permit database created as part of the ET-NMBS project. Green represents countries where at least one IRCC code was mentioned in the scientific articles in our database, purple represents countries where ABS permit codes were mentioned in the scientific articles in our database, and gray represents countries with missing information in our database. The number of articles per country in the database is shown inside the polygons. Three articles identify both IRCC and national ABS permit codes together in the same article.

3.2. The Current State-of-Play for ABS Indicators in the GBF

First, the GBF text has placeholder headline indicators in place for both Goal C and Target 13, i.e., these indicators will be replaced by future to-be-proposed text. These and other headline indicators will be discussed by an Ad Hoc Technical Expert Group (AHTEG), which has the mandate to suggest methodologies to collect data for headline indicators (if missing) and to improve headline indicators using COP16. The CBD Secretariat has also commissioned a study to analyze the feasibility and practicability of the available and hypothetical ABS indicators or other related indicators. The study will be made available as a public document by late spring 2024 and will be taken up for consideration by the AHTEG. The full implementation of ABS indicators is likely to be a multi-year process.

Despite the unknowns and limitations described above, the GBF does contain a number of noteworthy complementary ABS indicators analyzed in Table 1. Most of the indicators are either a measure of legal (trans)action, such as the existence of ABS laws themselves, or they propose to measure benefit-sharing directly, but no methodology exists to generate the data needed for the indicator. While legal transaction indicators could show an increase over time (more ABS laws made), actual benefits may either flat-line or decrease because some benefit-sharing regimes are quite restrictive and thus do not result in increases in benefit-sharing. This will also pose challenges when interpreting the data once collected, as a lack of increase in benefits could have multiple causes.

Table 1. The GBF complementary indicators for Goal C and Target 13 and initial observations on their feasibility and utility in measuring benefits shared.

	Complementary Indicators	Observations
Goal C	-Number of users that have provided information relevant to the utilization of genetic resources to designated checkpoints	-Unclear if distinct from checkpoint communiques Who will collect this? From which source? EU DECLARE system?
Goal C & Target 13	-Total number of internationally recognized certificates published in the ABS Clearing-House (Goal C only) -Number of internationally recognized certificates of compliance for non-commercial purposes (Goal C and Target 13)	-Easy to measure globally from ABS-CH but not measuring benefits shared -Leaves out countries that do not publish IRCCs (majority to-date) but could encourage more countries to do so -IRCCs not always clear whether commercial or non-commercial
Goal C	-Number of checkpoint communiques published in the ABS Clearing-House	-Easy to measure but very few so far; not a measure of benefits shared
Goal C	-Integration of biodiversity into national accounting and reporting systems, defined as implementation of the System of Environmental-Economic Accounting	-Unclear how/if related to ABS agreements
Target 13	-Total number of transfers of crop material from the Multilateral System of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) received in a country	-Useful to include other ABS instruments in the GBF -Is crop material transfer equivalent to benefit shared?
Target 13	-Total number of permits, or their equivalent, granted for access to genetic resources	-Data cannot be collected globally but providers and users could report at national/individual level including on benefits shared to ABS Clearing-House
Target 13	-Number of countries that require prior informed consent that have published legislative, administrative or policy measures on access and benefit-sharing in the ABS Clearing-House	-Quantifies legal measures but not benefits shared -May require manual curation to assess -Very similar to below indicator; potentially duplicative -Purely quantitative indicators on ABS regulations in place ignore the fact that restrictive and complex regulations are often a key hurdle for an effective ABS process and thus the generation of shareable benefits
Target 13	-Number of countries that require prior informed consent that have published information on access and benefit-sharing procedures in the ABS Clearing-House	-Likely to provide both providers and users with increased clarity -Would access measures and compliance measures be counted equally?
Target 13	-Number of countries that have adopted legislative, administrative and policy frameworks to ensure fair and equitable sharing of benefits	-Are ABS compliance measures implied here? -Measures laws not benefits shared
Target 13	-Estimated percentage of monetary and non-monetary benefits directed towards conservation and sustainable use of biodiversity	-Would capture benefits shared but no methodology exists to-date -National level reporting needed but methods for estimating would vary

The GBF brings together all three objectives of the CBD under one integrated plan. Tied tightly to the implementation of the GBF is updating the National Biodiversity Strategic Action Plans (NBSAPs), which are national reporting tools used by countries to assess their progress on GBF implementation. Because ABS is part of the GBF, countries will also need to report on progress on Goal C and Target 13, but the mechanism, ontology, and information reported are undefined. Because NBSAPs are the central tool to collect information on the GBF progress, this is also a valuable and as yet unutilized opportunity to capture benefit-sharing information at the national level.

4. Outlook: An Opportunity to Improve ABS

The Global Biodiversity Framework brings not only the promise of quantifying and tracking improvements in the achievement of the three objectives of the CBD, but it also contains the opportunity to objectively look at ABS issues and the future development of benefit-sharing principles. The DSI decision on benefit-sharing represents the potential for both the simplification of benefit-sharing procedures via a multilateral approach relative to the bilateral approach from the NP and for a significant increase in benefit-sharing if the mechanism truly generates more benefits than costs as outlined in paragraph 9 of Decision 15/9. Based on the above analysis, we observe three emerging trends for the broader field of benefit-sharing.

First, the push to monitor and quantify benefit-sharing outcomes will likely influence scientific best practices in the near term. What remains unclear is whether new policy measures at the national or international levels will be needed, which will also create additional compliance requirements, *or* whether the scientific community will propose bottom-up ideas for demonstrating benefit-sharing outcomes. One underexplored opportunity could be to “digitize” ABS outcomes to create more transparency and accountability and interconnect ABS to existing scientific outcomes, such as publications, databases, and infrastructure access. This “digitization” could, for example, allow users to report benefits shared in international databases, such as the ABS-clearinghouse, or to report on benefits shared in journal publications as part of the methods or acknowledgments section of a publication.

Second, the DSI decision lays the initial groundwork for the potential simplification of benefit-sharing procedures via the multilateral benefit-sharing mechanism. The DSI decision potentially opens the door for multilateral handling (on a voluntary basis) of GRs under the scope of the CBD. Taken together, the developments around DSI could result in a “policy experiment” in which parties can see the results of the new multilateral system and compare them with the results of the existing national (NP) systems. If, over time, the former outperforms the latter, parties might gradually shift more GRs into the MLS system and push for greater harmonization among the various UN fora.

Finally, a robust benefit-sharing system and accompanying indicators might also lead to the mainstream and increased visibility of benefit-sharing in environmental policy circles and beyond (e.g., health policy or human ethics). This could have “ripple effects” in the scientific, private sector, and policymaking communities in which these communities apply the basic principles of benefit-sharing to many more disciplines and interactions globally. Eventually, benefit-sharing might come full circle from a contentious topic negotiated on the perimeter to a central ethical principle that guides and governs international transactions that sustainably use the biodiversity of our planet.

Author Contributions: A.H.S. and K.W. designed and drafted the first draft of the manuscript. G.N.-V. wrote Box 1 and conducted the research contained therein. L.W. contributed to revisions and DSI sections of the manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: A.H.S. and G.N.-V. were supported by the BfN project Examining Trends in Non-Monetary Benefit-sharing (3521800500). A.H.S. was additionally supported by the BMBF WiLDSI-VorweRts project (16LW0062K).

Data Availability Statement: The data presented in this study are available in this article.

Acknowledgments: The authors submitted a German-language version of this article on 19 June 2023 to the journal *Natur und Landschaft* as part of a special issue on the 10-year anniversary of the Nagoya Protocol. The article was accepted on 11 December 2023 for publication on 1 March 2024 (Scholz et al., 2024) [9].

Conflicts of Interest: The authors declare no conflict of interest.

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