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Biodiversity reporting: standardization, materiality, and assurance

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This paper examines the evolving landscape of biodiversity reporting standards, describes their underlying rationale and anticipated effects, and highlights unresolved issues that impede the provision of 'good' information to markets and other report users. While a variety of reporting regulations exist, they do not point to a common ground for reporting. They address different aspects of corporate biodiversity impact and adopt different conceptions of assurance and materiality. Given the early stage of this field, further research is needed on what best practice informational governance may entail.

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Introduction

The planet is undergoing transformation, driven by human activities that threaten biodiversity, with profound consequences for ecosystems and human well-being [19]. In response, international efforts have sought to instigate transformation across all sectors of society, emphasizing sustainable and responsible practices. This includes an expectation for corporations to play a pivotal role in mitigating the adverse effects of their operations on biodiversity and nature [51]. In this context, corporate biodiversity reporting emerges as an instrument for enhancing transparency, encouraging responsible behavior, and fostering environmental stewardship [13,34,39]. This paper examines the evolving landscape of biodiversity reporting standards, describes their underlying rationale and anticipated effects, and highlights unresolved issues that impede the provision of 'good' information to markets and other report users.

Corporate engagement with environmental preservation has gained prominence in the last decade as the ramifications of biodiversity loss have become apparent [18,28,41]. International agreements, such as the Convention on Biological Diversity (CBD), underscore the importance of biodiversity in global sustainability agendas and highlight the expected role of corporations. As a result, the corporate sector faces growing expectations to contribute to biodiversity preservation and to provide relevant information on their actions and outcomes [36]. Numerous initiatives and standards aim to guide corporate biodiversity reporting [44]. Prominent among these are the European Sustainability Reporting Standards (ESRS) under the European Union's Corporate Sustainability Reporting Directive (CSRD),[1] the Global Reporting Initiative (GRI), the International Sustainability Standards Board (ISSB), ISO/TC 331, and the Task Force on Nature-related Financial Disclosures (TNFD). These standards (some are still under development) reflect a growing recognition of the need for systematic, transparent, and comparable disclosure of corporate dependencies and impacts on biodiversity.

The rationale underlying these standards is multifaceted [42]. In the first instance, the materiality of biodiversity issues drives the demand for standardized and reliable information [2,3,8,27]. Furthermore, the alignment with international frameworks, such as the CBD, provides a powerful norm for corporations to adhere to. Anticipated effects are equally manifold. Enhanced biodiversity reporting can stimulate corporate accountability, influence investment decisions, facilitate stakeholder engagement, and promote a culture of environmental stewardship within organizations.

Despite this, several challenges persist [26,4]. The measurement and quantification of corporate biodiversity impact remain complex, often involving the identification and characterization of ecological interactions over a long period

[1] Directive (EU) 2022/2464.

of time. Determining materiality, a cornerstone of reporting, is challenging due to varying perspectives on what is material [9,11,18,26,28,30,37]. Moreover, ensuring the accuracy, reliability, and comparability of reported data poses significant hurdles, demanding rigorous methodologies and data validation. Without confidence in the data presented, biodiversity information cannot be assured, and without assurance, its credibility is undermined.

We contribute within this context by providing an analysis of emerging standards, probing into their rationale, and delineating their expected effects on corporate behavior and market dynamics. Additionally, we examine the unresolved issues that undermine the provision of 'good' information through corporate reporting. By examining the complexities and challenges associated with reporting on biodiversity, this study aims to offer insights that inform the development of robust biodiversity reporting standards that cater to the needs of markets and other report users.

The remainder of the paper is organized thus. First, the fundamental principles underlying corporate biodiversity reporting standards are presented. Second, we review the literature on materiality and characterize the approach to materiality adopted by each of these standards. Third, the significance of assurance is examined along with a discussion of how assurance varies depending on different types of assurance providers (e.g. traditional accounting firms[2] that audit financial reports or other more technically oriented assurance providers[3]) and the level of assurance sought (which includes assurance of full reports or a limited number of data points) [29,5].

Evolving biodiversity standards and related policies

While the GRI has had existing reporting requirements on biodiversity, it revised and issued a new standard in this area in January 2024. At the same time, other reporting initiatives have emerged. Table 1 outlines the five most relevant corporate biodiversity standards, categorized by their (i) application area and target audience, (ii) focus areas and objectives, (iii) measurement approach, (iv) reporting requirements, and (v) voluntary or mandatory nature.

These standards exhibit variation across all dimensions (i–v) and address diverse aspects of biodiversity reporting, encompassing impacts and dependencies, risks and opportunities, management approach, and governance. The measurement approaches employed range from primary and secondary biodiversity data collection to the assessment of financial exposure. While some of the standards entail specific reporting requirements, others adopt a more flexible 'comply or explain' approach.[4] The intended audience for these standards comprises internal and external company stakeholders including auditors, shareholders, governments, banks and other investors, and financial analysts.

A frequently reported problem associated with these frameworks is the lack of standardized metrics and consistent ways to measure biodiversity interactions [43]. If one takes this perspective, the heterogeneous approaches recommended by these standards are likely to generate diversity in reporting practices, making it challenging for the companies' stakeholders to interpret and assess the quality of biodiversity reporting. At the same time, given the heterogeneity of the operating contexts within which companies are seeking to act, it is hard to imagine that any single standard could enumerate all the possible disclosures of relevance, nor the methods that should be used to achieve these outcomes. Moreover, each standard adopts a particular perspective on corporate–biosphere connections. Creating a framework that demonstrates each standard's focus and role is likely to be more valuable. Such a framework would offer greater clarity of what is being reported, highlight if comparisons are possible, and enhance transparency of the reporting landscape. Relatedly, the 'Align'[5] project seeks to integrate and harmonize reporting initiatives on broader sustainability issues with nature- and biodiversity-focused reporting standards. A higher level framing of reporting requirements is essential for achieving a more cohesive reporting landscape that supports the collective goals of sustainability and biodiversity.

To further this goal, the next subsection examines materiality, which is treated differently in these standards. Materiality approaches will determine the scope of an account, determining what aspects of biodiversity firms analyze and report on including dependencies, impacts, risks, and opportunities. Given that corporate biodiversity reporting is intended to portray material actions, this is the basis from which all other judgments are made.

[2] For instance, PwC, KPMG, Deloitte, E&Y, etc.

[3] For instance, British Standards Institute, Carbon Verification Service LLC, Earthcon, etc.

[4] The 'comply or explain' approach allows companies to either comply with a set of guidelines or, if they choose not to comply, to provide a detailed explanation for their non-compliance. This approach is commonly used in areas like corporate governance codes, sustainability reporting, and sometimes financial reporting.

[5] The Aligning accounting approaches for nature (Align) project. https://knowledge4policy.ec.europa.eu/publication/align-project-recommendations-standard-corporate-biodiversity-measurement-valuation_en.

Table 1

Overview of five key environmental reporting standards.

Framework/Standard/Org	Application area and/or audience	Focus areas and objectives	Measurement approach	Reporting requirements	Voluntary/mandatory
ESRS under CSRD	Companies operating in the EU. Audience: primary users of general financial reporting as well as other users, including business partners, trade unions and social partners, civil society and nongovernmental organizations, governments, analysts, and academics.	Specify what should be disclosed as material. Impacts, risks, and opportunities in relation to environmental, social, and governance. Sustainability matters, including the impact related to biodiversity. The objective is to enable users to understand: (a) how the undertaking affects *biodiversity* and *ecosystems*, in terms of material positive and negative, actual and potential impacts, including the extent to which it contributes to the drivers of biodiversity and ecosystem loss and degradation (b) any *actions* taken, and the result of such actions, to prevent or mitigate material negative actual or potential impacts and to protect and restore biodiversity and ecosystems, and to address risks and opportunities; (c) the plans and capacity of the undertaking to adapt its strategy and business model in line with Regional and Global biodiversity goals (d) the nature, type, and extent of the undertaking's material risks, dependencies, and opportunities related to biodiversity and ecosystems, and how the undertaking manages them; and (e) the *financial effects* on the undertaking over the short-, medium-, and long-term time horizons of material risks and opportunities arising.	Three main characteristics: magnitude (e.g. amount of contaminant, noise intensity), spatial extent (e.g. area of land contaminated), and temporal extent (duration of persistence of contaminant). Notably, requires disclosures of targets over time set in relation to EU goals. Primary data: collected *in situ*. Secondary data: including geospatial data layers that are overlaid with geographic location data of business activities. Modeled biodiversity state data	Identified actual and potential impacts on *biodiversity* and *ecosystems* at own *site* locations and in the value chain, including assessment criteria applied. Identified and assessed *dependencies* on biodiversity and ecosystems and their services at own site locations and in the value chain, including assessment criteria applied, and, if this assessment includes *ecosystem services* that are disrupted or likely to be. Identified and assessed *transition* and *physical risks* and opportunities related to biodiversity and ecosystems, including assessment criteria applied based on its impacts and dependencies. Considered *systemic risks.* Anticipated financial effects of material biodiversity- and ecosystem-related risks and opportunities	Mandatory for publicly traded firms as well as non-publicly traded larger European firms.

Table 1 (*continued*)

Framework/Standard/Org	Application area and/or audience	Focus areas and objectives	Measurement approach	Reporting requirements	Voluntary/mandatory
GRI	Global; Companies and organizations of all sizes and industries, including public and private sectors. Audience: internal and external stakeholders such as shareholders, customers, employees, communities, and governments	To assess and report on the impact of an organization's operations on biodiversity and ecosystems.	The GRI requires material impacts (determined using GRI 3) to be identified and managed, including aspects of their disclosure requirements, supply chain impacts, and a company's direct impacts. GRI 101 (2024) contains extensive guidance on tools and approaches that may underpin the disclosure items mandated.	Organizations are encouraged to report on their impacts on biodiversity using the GRI 101 (2024): including disclosures on: policies to halt and reverse biodiversity loss, management of biodiversity impacts, access and benefit-sharing, identification of biodiversity impacts, locations with biodiversity impacts, direct drivers of biodiversity loss, changes to the state of biodiversity, and ecosystem services.	Voluntary, but some countries and regions have incorporated GRI Standards into their regulatory frameworks. GRI is based on the comply or explain approach.
IFRS under ISSB	Companies and organizations. Audience: primary users of general financial reporting as well as other stakeholders	Sets our general requirements for sustainability- and climate-related disclosures useful to users of general-purpose financial reports. Including impact related to biodiversity. The objective is to reduce complexity related to sustainability disclosure frameworks and standards, address the reporting burden for companies, and improve reporting efficiency.	Financial exposures related to sustainability and climate-related exposure. Cross-industry metric categories such as: proportional value of climate-related transition risks, physical risks, and transition opportunities. Capital deployment toward climate-related risks and opportunities, internal carbon prices, and remuneration linked to climate-related considerations.	Disclosure about sustainability- and climate-related risks and opportunities that could affect enterprise cash flows, access to financing, and cost of capital.	Currently voluntary. Can be made mandatory in individual jurisdictions.

Table 1 (*continued*)

Framework/Standard/Org	Application area and/or audience	Focus areas and objectives	Measurement approach	Reporting requirements	Voluntary/mandatory
ISO/TC 331 ISO/CD 17298 Biodiversity – Strategic and operational approach for organizations. – Requirements and guidelines	Companies and organizations. Audience: any type of organization (private, public, NGO, any size).	Identifying and prioritizing actions in favor of biodiversity conservation, restoration, and sustainable use, while considering the equitable sharing of benefits. The objective is to give a biodiversity approach aiming to integrate biodiversity issues into strategy and improve environmental, social, and economic performance.	For each planned action, the organization shall associate performance indicators applying the Pressure-State Response. The organization shall record the biodiversity indicator results at regular intervals. The intervals shall be specific to each indicator and relevant for: – the specific time scale of the indicator and its specific cyclic variations; – the deadlines for achieving the objectives identified in 7.2; – the time scale of the approach and the action concerned by the indicator.	No reporting requirements.	Voluntary.
TNFD consists of 40 individual Taskforce Members representing financial institutions, corporates, and market service providers with over US$20trn in assets. The TNFD Co-Chairs, David Craig and Elizabeth Mrema, lead the Taskforce.	Companies and financial sector.	Risk management Integration of biodiversity and strategies Development of economic indicators and models. Provide a risk management and disclosure framework to support a shift in global financial flows away from nature-negative outcomes and toward nature-positive outcomes.	Financial exposures related to biodiversity. Develop models to assess financial risks and opportunities to support investment and financing of nature-related projects. Implement carbon reduction initiatives and track emission reduction progress.	Identification of financial risks and opportunities related to biodiversity. Reporting data on biodiversity-related impacts and dependency of company operations and financial risks and opportunities.	Voluntary for all firms and based on loosely held comply or explain approach.

Materiality

Materiality is widely discussed in the literature [3,7,8,10,14,16,17,24,27,35,38,40,46,48,52], and two types of materiality have been identified [17,45], namely:

- *Financial* materiality — which relates to implications of sustainability on financial performance from the perspective of owners' and creditors' decision-making.
- *Impact* materiality — which relates to social and environmental impacts created by corporate activities on stakeholders and the natural environment.

In addition, existing and forthcoming frameworks (such as the ESRS and the TNFD) use the idea of double materiality. For example, the ESRS offers guidance for evaluating materiality across various domains and levels (e.g. type of stakeholder, type of materiality [financial or impact], and level of disaggregation [country, site, or individual asset]). On the other hand, the TNFD framework implicitly applies the concept of double materiality by recommending disclosures pertaining to nature-related dependencies, impacts, risks, and opportunities. These standards different from the ISSB and the GRI actively embrace a more dynamic approach to materiality. Although GRI recognizes impact materiality as a foundational principle, both ISSB and GRI's standards on materiality demonstrate a focus on entity-specific financial considerations. ISSB's materiality threshold is customized to each entity, with materiality judgments influenced by the impact on the decision-making of financial stakeholders, leaning toward a single financial materiality perspective ([2]; International Financial Reporting Standards Sustainability [1]. Conversely, the ESRS, similarly to the GRI, employs a stakeholder-focused materiality model as opposed to the ISSB's entity-specific materiality model more centered on the entity's decision-making of specific stakeholders.

The materiality approach embraced by the ISSB provides continuation between financial and nonfinancial reporting with its focus on matters that affect investors' and creditors' willingness to invest/lend money in the reporting enterprise, with the interests of society not being comprehensively addressed [32].[6] Adopting the materiality approach proposed in the ESRS encompasses the broader societal implications arising from environmental damage. However, it introduces challenges in determining the extent of disclosure requirements. For instance, the ESRS materiality model includes adverse environmental impacts beyond normal enterprise contractual relationships. This might be conceptually robust (after all there is a shared responsibility for environmental harm) but it is operationally difficult to enact (and may result in different companies reporting on the same impacts). This also has the problem of raising uncertainty about who might have responsibility to act to address the impact. It is likely that both approaches to materiality will be present in corporate reporting, making navigating what the reporting means and what actions should follow the reporting difficult to specify clearly.

Assurance

The incidence of independent assurance of sustainability information produced by the world's biggest companies (N100) has increased from 30% in 2005 to 63% in 2015.[7] The current sustainability assurance market is dominated by the Big-4[8] accounting firms, engineering firms, and consulting firms [4,6]. The Big-4 firms provide global networks and extensive experience in financial auditing, the engineering firms are renowned for their technical expertise and comprehension of complex processes, and consulting firms offer subject-matter expertise in assuring sustainability reports [4,6]. Alsahali and Malagueño (2022) argued that despite being a sizeable and rapidly growing market, assurance of corporate biodiversity reporting is still in its infancy, and in contrast to broader sustainability assurance, biodiversity reporting assurance is dominated by Non-governmental organizations (NGO) funded by EU. More research is needed to understand the evolving market dynamics for corporate biodiversity reporting, in order to understand which actors will dominate this market in the future.

Assurance of sustainability information seeks to enhance reporting credibility [15,29] in the face of criticisms that sustainability reports project a more sustainable image than reality (greenwashing — see Refs. [25,49]). At the same time, there are also concerns that companies are failing to disclose all their activities (greenhushing — see Ref. [22]). Moreover, some companies deliberately highlight trivial sustainability efforts in their reports, while conveniently ignoring major environmental concerns (so-called green spotlighting). All of these omissions create false perceptions [50].

Assurance of sustainability reporting seeks to ensure greater reliability, as stakeholders perceive assured reports as more dependable [20,47]. Nevertheless, concerns have been raised regarding the reliability of sustainability assurance [23,31]. One concern pertains to

[6] An illustrative case example of this problem is provided in Appendix A.

[7] The N100 refers to a global sample of 4900 firms constituting the top 100 companies by revenue in 49 countries.

[8] Big-4 refers to the globally largest accounting firms PwC, KPMG, Deloitte, and E&Y.

the reliance of assurance providers on their professional judgment to determine materiality [33], with differences between assurance providers' definitions of materiality [21]. Moreover, Boiral and Heras-Saizarbitoria [12] conducted an analysis of 337 assured sustainability reports from the mining and energy sectors and concluded that assurance opinions often lack a meaningful and credible verification process. Instead, they characterize assurance as superficial exercises detached from sustainability and stakeholder concerns. Thus, trustworthy assurance mechanisms, including third-party audits and verification processes, are a pivotal part of the informational governance surrounding biodiversity disclosures. These measures evaluate the methodologies, data sources, and reporting processes employed by organizations, verifying that they align with established standards and best practices. Such assurance might not only foster transparency but also build trust among stakeholders, investors, and the wider public, ultimately driving greater corporate accountability and commitment to preserving biodiversity.

Concluding remarks

Using corporate disclosure as a way of governing behavior is commonplace, with demands for corporate biodiversity reporting becoming prevalent. The challenge is how to ensure robust data collection on management action that is useful to a broad group of stakeholders and supports changes in biodiversity impacts. Ideally, reporting (appropriately verified) should enhance transparency and cultivate trust among stakeholders and investors. Moreover, it could empower companies to make informed decisions, set meaningful biodiversity goals, and contribute to global efforts to address biodiversity loss.

While a variety of reporting regulations exist, they do not point to a common ground for reporting. Rather, they address different aspects of corporate biodiversity impact and adopt different conceptions of what is material to report. Given the early stage of this field, further research is needed on what best practice informational governance may entail. It is our firm belief that the establishment of a framework that ensures clarity as to what notion of materiality informs reporting alongside robust assurance is part of the solution. However, empirical work illustrating challenges and success stories are much needed in this field.

Data Availability

No data were used for the research described in the article.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

Case study: Forico's materiality approach to sustainability reporting

To elucidate the complexities of sustainability reporting, let's consider a real-world case study of Forico, a forest management company operating in Tasmania.

Financial materiality approach

In a financial materiality approach, Forico might primarily focus on disclosing financial metrics such as profitability margins and the increased shareholder value that comes from the efficient utilization of forest resources. They could also highlight their compliance with local and international regulations that protect certain tree species and natural habitats. While this approach aligns with Forico's globally certified forests and their prestigious Banksia Foundation National Sustainability Award, it could potentially overlook broader impacts on the ecosystem.

Impact materiality approach

Contrast this with an impact materiality approach that also considers societal implications. In this scenario, Forico would go beyond financial metrics and regulatory compliance. They would disclose the potential or actual impact of their logging activities on local biodiversity, perhaps even detailing how they monitor and report on affected species or ecological indicators like soil and water quality. Given their existing Natural Capital Report, Forico might also disclose efforts to engage with Aboriginal communities, who have been custodians of the natural environment for generations, as part of their broader sustainability initiatives.

By comparing these two approaches through the lens of Forico, it becomes apparent that entity-specific materiality may not capture the full scope of a company's impact on biodiversity and societal well-being. A more comprehensive materiality approach would consider the broader environmental and societal implications, advocating for a more inclusive reporting framework that accounts for various stakeholder interests.

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