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Decision-Useful Nature-Related Reporting: Biological Asset Accounting, Biodiversity Disclosure and ESG Accountability

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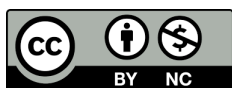
Abstract. Nature-related information is increasingly reported through financial statements, sustainability and integrated reports, ESG datasets, biodiversity-finance instruments, and conservation disclosures. This reflects the growing recognition that biological assets, ecosystem dependencies, biodiversity loss, and nature-related risks can affect valuation, stewardship, regulation, capital allocation, and cash-flow stability. However, greater reporting visibility does not necessarily produce decision-useful information. Biological assets may be measured without transparent valuation assumptions, biodiversity disclosed without ecological baselines or measurable outcomes, and ESG metrics presented as comparable despite weak links to the entity's specific ecological exposure. This article develops a conceptual framework for determining when nature-related reporting becomes decision-useful across biological asset accounting, biodiversity disclosure, and ESG accountability. It adopts a qualitative, interpretive design based on thematic synthesis of 155 published and institutional sources. Peer-reviewed journal articles formed the analytical core, supported, where relevant, by methodological literature, standards, frameworks, working papers, and reports. The analysis integrated research on IAS 41, biological asset valuation, biodiversity and conservation disclosure, ecological measurement, ESG and integrated reporting, biodiversity finance, governance, assurance, and disclosure analytics. The findings identify four mutually reinforcing conditions for decision usefulness. First, measurement credibility is required when reported values depend on biological transformation, fair-value judgment, inactive markets, valuation models, or biodiversity-risk estimates. Second, ecological validity is necessary where disclosures claim to represent biodiversity impacts, dependencies, conservation activities, or restoration outcomes. Third, governance, assurance, and regulatory anchoring are required to address managerial incentives, uncertain reporting boundaries, scientific complexity, and verification constraints. Fourth, analytical accessibility and stakeholder-use alignment are necessary to ensure that information is comparable, interpretable, and connected to actual decision needs. The article reframes nature-related reporting as a decision-usefulness conversion problem. Nature-related information becomes useful not merely when it is disclosed, measured, or standardized, but when biological and ecological phenomena are translated into credible, ecologically grounded, governed, and accessible knowledge. The framework supports future empirical research, reporting-quality assessment, assurance-readiness evaluation, and standard-setting.

Keywords: biological assets, biodiversity disclosure, decision-usefulness, ESG accountability, IAS 41, nature-related reporting, sustainability reporting.

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Корисність звітності пов'язаної з природою для прийняття рішень: облік біологічних активів, розкриття інформації про біорізноманіття та ESG-підзвітність

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Анотація. Інформація, пов'язана з природою, все частіше відображається у фінансовій звітності, звітах про сталий розвиток та інтегрованих звітах, наборах даних ESG та інструментах фінансування біорізноманіття. Це відображає зростаюче визнання того, що біологічні активи, залежності від екосистем, втрата біорізноманіття та ризики, пов'язані з природою, можуть впливати на оцінку, управління, регулювання, розподіл капіталу та стабільність грошових потоків. Однак, більша прозорість звітності не обов'язково забезпечує корисну для прийняття рішень інформацію. Метою цієї статті є розробка концептуальної основи для визначення того, коли звітність, пов'язана з природою, стає корисною для прийняття рішень в обліку біологічних активів, розкритті інформації про біорізноманіття та ESG підзвітності. Дослідження має якісний, інтерпретаційний дизайн, заснований на тематичному синтезі 155 опублікованих та інституційних джерел. Рецензовані статті з журналів сформували аналітичне ядро, яке, де це доречно, було підкріплено методологічною літературою, стандартами, регуляторними рамками, робочими документами та звітами. Результати дослідження визначають чотири взаємопідсилювальні умови корисності рішень. По-перше, достовірність вимірювань необхідна там, де звітні значення залежать від біологічної трансформації, оцінки справедливої вартості, неактивних ринків, моделей оцінки або оцінок ризику для біорізноманіття. По-друге, екологічна валідність необхідна там, де розкриття інформації відображають вплив на біорізноманіття, залежності, природоохоронну діяльність або результати відновлення. По-третє, для вирішення проблем управлінських стимулів, меж звітування, наукової складності та практичних обмежень перевірки необхідне належне управління, гарантування та регуляторне закріплення. По-четверте, аналітична доступність та узгодженість використання зацікавленими сторонами звітних даних необхідні для забезпечення порівнянності, інтерпретації та зв'язку інформації з фактичними потребами прийняття рішень. Стаття переосмислює звітність, пов'язану з природою, як проблему перетворення корисності рішень. Інформація, пов'язана з природою, стає корисною не лише тоді, коли вона розкривається, вимірюється або стандартизується, але й тоді, коли біологічні та екологічні явища перетворюються на достовірні, екологічно обґрунтовані, керовані та доступні знання.

Ключові слова: біологічні активи, розкриття інформації про біорізноманіття, корисність рішень, ESG підзвітність, МСБО 41, звітність, пов'язана з природою, звітність про сталий розвиток.

1. INTRODUCTION

Nature-related reporting has become increasingly prominent across financial statements, sustainability and integrated reports, ESG datasets, biodiversity-finance instruments, and conservation disclosures. Organizations now report biological assets, biodiversity impacts, ecosystem dependencies, land-use effects, restoration commitments, and nature-related risks through multiple accounting and accountability mechanisms.

A developing institutional architecture supports this expansion. IAS 41 Agriculture governs the accounting treatment of biological assets, while GRI 101: Biodiversity 2024 strengthens impact-oriented biodiversity disclosure. TNFD-style reporting promotes disclosure of nature-related dependencies, impacts, risks, and opportunities. European sustainability reporting requirements and IFRS-related work on biodiversity, ecosystems, and ecosystem services have further increased the visibility of nature within financial and non-financial reporting.

Greater visibility, however, does not necessarily produce decision-useful information. Biological asset

measurements may appear relevant yet remain unreliable when markets are inactive, valuation assumptions are opaque, or biological transformation is difficult to observe. Biodiversity disclosures may communicate policies and commitments without identifying affected ecosystems, species, locations, ecological baselines, pressures, or measurable outcomes. Conservation reports may describe activities without demonstrating ecological improvement. At the same time, ESG biodiversity scores may create an impression of comparability despite being broad, inconsistent, or weakly connected to site-specific ecological evidence.

The central problem is therefore not merely insufficient disclosure, but the failure to convert nature-related reporting into usable knowledge. Information may satisfy formal reporting expectations while remaining fragmented, symbolic, unverifiable, or disconnected from valuation, risk assessment, stewardship, board oversight, assurance, regulation, conservation management, and stakeholder accountability. Accordingly, the presence of nature-related information cannot be treated as evidence of its usefulness.

This problem is increasingly material because biodiversity loss and ecosystem degradation can affect organizational performance and accountability. Soil depletion, water stress, deforestation, habitat conversion, invasive species, pollution, and regulatory intervention may affect production capacity, supply chain resilience, land access, operating licenses, insurance costs, litigation exposure, reputation, financing costs, and cash flow stability. Biodiversity-finance research consequently examines whether capital markets price biodiversity risks, affect firm value or default risk, influence investor behavior, or are reduced through green finance mechanisms (Bassen et al., 2024; Coqueret et al., 2025; Cosma et al., 2025; Dong et al., 2026; Garel et al., 2024; Lang et al., 2025; Visentin, 2026; Wang et al., 2025; Wu et al., 2026; Zhou et al., 2025). However, research on ESG biodiversity ratings and finance metrics cautions that many indicators remain noisy, inconsistent, and insufficiently grounded in ecological substance (Christiansen et al., 2025; Clement & Grenon, 2025; Xin et al., 2025).

Against this background, the article addresses the following research question:

Under what conditions does nature-related reporting become decision-useful rather than merely compliant, symbolic, or legitimacy-oriented?

The article develops a conceptual framework explaining when nature-related reporting becomes decision-useful across biological asset accounting, biodiversity disclosure, and ESG accountability. Rather than testing statistical relationships or measuring disclosure frequency, it interprets and synthesizes published literature to identify the conditions through which biological and ecological information is converted into decision-relevant accounting and accountability knowledge.

The article makes three contributions. First, it integrates literature that is commonly examined separately, including biological asset accounting, biodiversity disclosure, conservation accountability, ESG reporting, and biodiversity finance. Second, it extends the usefulness of decisions beyond investor and creditor decisions to include stewardship, ecological accountability, assurance, regulation, board oversight, and stakeholder use. Third, it develops a decision-usefulness conversion framework applicable to corporate reporting, IAS 41 disclosures, biodiversity reports, ESG datasets, assurance engagements, and nature-related reporting standards.

2. LITERATURE REVIEW

The literature review is organized around three questions: what is established, what remains unresolved, and how these limitations define the research gap. It critically evaluates whether existing research explains how nature-related information becomes decision-useful, rather than assuming that increased reporting improves accountability.

2.1 Biological asset accounting: what exists and what remains unresolved

Biological assets present distinctive accounting challenges because growth, degeneration, production, and procreation continuously alter their condition and value. Therefore, IAS 41 generally requires biological assets, excluding bearer plants, to be measured at fair value less costs to sell where fair value is reliably measurable. Research across agriculture, livestock, aquaculture, plantations, forestry and agritourism shows that this treatment affects valuation, disclosure, auditability and financial-statement interpretation (Arbidane & Mietule, 2018; Bispo & Lopes, 2022; Bohušová & Svoboda, 2016, 2017; Campos-Llerena et al., 2025a, 2025b; Cavalheiro et al., 2019; Doorasamy et al., 2022; Hinke & Stárová, 2014; Hlaváčková et al., 2025; Kljajić et al., 2025; Kurniawan et al., 2014; Miranda-Quibot & Ohe, 2024a, 2024b; Norizan et al., 2022; Silva & Nardi, 2023; Tanaka Nakasone & Castillo, 2023).

Fair value may better reflect biological transformation than historical cost, and biological asset reporting has been associated with firm value, performance, reporting quality, cost of debt, and audit effort (Adeniran et al., 2026; Alfariysi et al., 2022; Almas et al., 2025; Ika et al., 2022, 2024; Toušek et al., 2025; Warsini et al., 2024; Wu et al., 2023). Decision usefulness, however, weakens where markets are inactive, transformation is difficult to observe, valuation expertise is limited, or assumptions are opaque. Credible measurement may also require asset-specific and interdisciplinary evidence, particularly in complex activities such as aquaculture (Bohušová & Svoboda, 2016, 2017; Cavalheiro et al., 2019; Hinke & Stárová, 2014; Norizan et al., 2022; Silva & Nardi, 2023).

Disclosure quality is further shaped by organizational capacity and incentives, including asset intensity, profitability, firm size, ownership, auditor type, and executive or board characteristics (Abdullah et al., 2023; Ika et al., 2022). Therefore, compliance with IAS 41 does not, by itself, ensure useful information.

The literature remains focused on valuation, implementation, disclosure determinants, and market effects, with limited integration of biodiversity impacts, ecosystem dependencies, and stakeholder accountability. A biological asset may be recognized and measured even when its ecological consequences remain undisclosed, whereas material biodiversity impacts may fall outside financial recognition criteria. Biological asset accounting provides measurement discipline, but only a partial basis for decision-useful nature-related reporting.

2.2 Biodiversity disclosure and conservation accountability: what exists and what is missing

Biodiversity extends beyond entity-controlled assets to include species, habitats, ecosystems, ecological dependencies, affected communities, and conservation responsibilities that often fall outside financial recognition boundaries.

Early research shows that biodiversity reporting may increase visibility without producing coherent accountability. Narrative disclosure can serve legitimization, while reporting remains fragmented, uneven, and difficult to compare (Samkin & Schneider, 2010; Schneider & Samkin, 2012; Samkin et al., 2014; Schneider et al., 2014). Conservation studies similarly show that reporting is shaped by public pressure and social, political, and ecological conditions, and that activity reporting does not establish ecological effectiveness without evidence of resource use, ecological effects, and management responses (Ackers, 2019; Samkin & Wingard, 2021; Van Wilgen et al., 2013; Vermeulen et al., 2019).

Recent corporate research confirms persistent weaknesses in the extent, readability, materiality, specificity, and comparability of biodiversity disclosure (Bassen et al., 2025; Dutta & Dutta, 2024; Kashyap et al., 2025; Maroun & Ecim, 2024; Roberts et al., 2023; Senanayake et al., 2024). Organizations may report policies, partnerships, and restoration commitments without ecological baselines, affected species and habitats, spatial boundaries, pressure pathways, monitoring methods, outcomes, or trade-offs. Such reporting may support legitimacy while offering limited decision value.

Therefore, the literature distinguishes biodiversity visibility from ecological accountability but does not explain how biodiversity information becomes decision-useful across accounting, ESG metrics, assurance, and financial materiality. This constitutes the second research gap.

2.3 ESG, governance, and integrated reporting: what exists and what remains underdeveloped

Governance structures, ownership, investor pressure, and regulatory frameworks shape ESG and integrated reporting. Board characteristics, institutional ownership, and reporting practices influence ESG and integrated reporting quality, including agricultural and biological asset disclosure (Abdelmoneim & El-Deeb, 2024; Abdullah et al., 2023; Lestari et al., 2020; Moikwatthai et al., 2019; Scholtz & Kieviet, 2018; Smit et al., 2018; Warsini et al., 2024).

Broader research positions ESG reporting as an infrastructure for organizing and comparing sustainability information, with attention to environmental performance, digitization, eco-efficiency, earnings management, and links between GRI 13 and IAS 41 (Gedam et al., 2026; He & Jiang, 2026; Hoinaru et al., 2023; Sklavos et al., 2025; Zhao et al., 2024).

Generic ESG frameworks, however, may not capture biodiversity's spatial, species-specific, ecosystem-dependent, and long-term characteristics. Kopnina et al. (2024) call for stronger integration of biodiversity, while Elliot et al. (2024) emphasize issue-specific standardization, materiality, and assurance. Governance may improve reporting discipline without ensuring ecological validity: boards may oversee disclosure without credible ecological evidence, integrated reports may omit baselines, and ESG ratings may obscure site-

specific exposure. The third research gap is therefore that ESG and governance research explains reporting infrastructure, but not how it produces credible, assured, and ecologically meaningful nature-related information.

2.4 Biodiversity finance and financial materiality: what exists and what remains contested

Biodiversity finance has expanded as biodiversity loss is increasingly recognized as a source of financial risk, valuation uncertainty, and investment opportunity. The literature now examines biodiversity premia, firm-level exposure, default risk, audit pricing, market responses, biodiversity-linked instruments, and cross-asset connectedness.

A growing body of evidence supports the financial relevance of biodiversity information. Studies link biodiversity exposure and management to investor behavior, firm value, corporate performance, stock-price crash risk, stock-price synchronicity, market attention, and audit pricing (Bassen et al., 2024; Coqueret et al., 2025; Cosma et al., 2025; Di Tommaso et al., 2025; Dong et al., 2026; Garel et al., 2024; Zhang et al., 2025; Zhou et al., 2025). Collectively, these findings indicate that biodiversity information can influence investors, auditors, and other capital-market participants.

A related literature positions biodiversity loss as a broader financial-system risk. Research examines corporate default, agricultural futures, risk spillovers, asset-market connectedness, banking activity, and the capacity of green finance to mitigate biodiversity exposure (Hao et al., 2026; Kalhor & Ahmed, 2025; Lang et al., 2025; Naifar, 2025; Patel, 2026; Visentin, 2026; Wang et al., 2025; Wu et al., 2026). This work extends the scope of biodiversity beyond firm-level disclosure by demonstrating its potential relevance to financial stability and market interdependence.

Research on biodiversity-finance instruments further explores investor preferences, conservation financing, and product design. Studies examine sustainability bonds, biodiversity-linked bonds, biodiversity and ecosystem-service finance, biodiversity investing, and the relationship between green finance and urban biodiversity (Appio et al., 2025; Aruga, 2026; Chan-Lau, 2026; Gao et al., 2025; Seidl et al., 2024; Willis, 2026).

Financial relevance, however, does not ensure decision usefulness. Biodiversity ratings may be noisy, provider methodologies may produce inconsistent risk measures, and rapid growth in biodiversity finance may outpace the quality of the underlying ecological evidence (Christiansen et al., 2025; Clement & Grenon, 2025; Xin et al., 2025). Biodiversity may therefore be financially material while the metrics used to represent it remain weakly grounded, difficult to compare, or poorly understood.

The literature establishes the potential financial materiality of biodiversity but does not adequately explain when biodiversity-finance information becomes credible and usable. Finance studies often focus on pricing, performance, and risk, without evaluating ecological validity, disclosure quality, assurance readiness, or stakeholder accountability. Accounting

research, in turn, rarely integrates this financial evidence into broader nature-related reporting. This forms the fourth component of the research gap: biodiversity finance demonstrates that nature-related information may affect financial decisions, but not how that information is converted into reliable, ecologically meaningful, and decision-useful knowledge.

2.5 Ecological asset measurement and natural capital: what exists and why accounting needs it

Ecological asset research is essential because biodiversity is spatial, dynamic, and difficult to represent through conventional accounting measures. Therefore, decision-useful reporting depends on credible ecological evidence.

Ecological assessment requires biophysical indicators, defined boundaries, baselines, and ongoing monitoring. Studies examine ecological asset quality, land-resource assets and liabilities, overlapping conservation responsibilities, unintended invasion risks from nature-based solutions, and the integration of ecosystem services into accounting (Grunewald et al., 2024; Potgieter et al., 2026; Sun et al., 2026; Liu et al., 2025b; Yang et al., 2024).

However, this literature remains weakly connected to accounting debates on governance, assurance, materiality, and user decisions. Accounting requires ecological evidence to avoid superficial reporting, while ecological evidence requires accounting mechanisms to become governed, assured, and usable. Ecological validity is therefore necessary, but insufficient, for decision-useful nature-related reporting.

2.6 Synthesis of the research gap

Nature-related reporting remains fragmented across partially connected fields. Biological asset accounting provides measurement discipline but focuses mainly on controlled assets and financial valuation. Biodiversity disclosure highlights ecological accountability yet often remains generic or legitimacy-oriented. ESG and governance research explain reporting infrastructure without ensuring ecological substance, while biodiversity finance demonstrates financial relevance despite inconsistent metrics. Ecological asset studies clarify ecological validity but remain weakly integrated with accounting decision-usefulness.

The central gap is therefore the absence of an integrated framework that explains how nature-related information becomes credible, ecologically grounded, governed, assured, and usable.

This article addresses that gap by developing a decision-usefulness framework spanning biological asset accounting, biodiversity disclosure, and ESG accountability.

3. RESEARCH OBJECTIVE

This article develops a conceptual framework explaining when nature-related reporting becomes decision-useful across biological asset accounting, biodiversity disclosure, and ESG accountability.

Decision usefulness is conditional. Information is not useful merely because it is disclosed, measured, standardized, assured, or translated into an ESG score; it must support judgment or action by identifiable users.

The article proposes that nature-related reporting becomes decision-useful when four conditions operate jointly: measurement credibility, ecological validity, governance, assurance and regulatory anchoring, and analytical accessibility. Together, these conditions convert symbolic or compliance-driven reporting into knowledge that supports valuation, risk assessment, stewardship, oversight, assurance, regulation, and stakeholder accountability. The proposition structures the literature synthesis and guides future empirical research.

4. RESEARCH METHODOLOGY

4.1 Research design

This study adopts a qualitative, interpretive research design focused on analyzing and interpreting published peer-reviewed journal articles. The purpose of the study is to develop conceptual understanding rather than to test statistical associations. A qualitative approach is appropriate because the research question concerns meaning, conditions, interpretation, and the conversion of reporting information into decision-useful knowledge.

The study follows a thematic synthesis approach. Thematic synthesis is suitable when a body of literature is conceptually fragmented, and the aim is to identify, interpret, and integrate recurring patterns across studies. In this article, the reviewed literature was treated as qualitative documentary evidence. The analysis examined how prior studies conceptualize, support, challenge, or limit the decision-usefulness of nature-related information.

Conceptual review methods are appropriate in fields where knowledge is dispersed across related but partially disconnected research streams. Nature-related reporting is such a field. It crosses biological asset accounting, biodiversity disclosure, conservation accountability, ESG reporting, integrated reporting, biodiversity finance, ecological asset measurement, governance, assurance, and disclosure analytics.

4.2 Evidence base and source treatment

This study adopts a qualitative, interpretive design to develop conceptual understanding rather than test statistical relationships. The approach is appropriate because the research question concerns how nature-related information acquires meaning and becomes decision-useful.

Published peer-reviewed journal articles were analyzed through thematic synthesis. The literature was treated as qualitative documentary evidence to identify recurring patterns, tensions, and conditions affecting decision usefulness.

This method is suited to a fragmented field spanning biological asset accounting, biodiversity disclosure, conservation accountability, ESG and integrated reporting, biodiversity finance, ecological measurement, governance, assurance, and disclosure analytics.

4.3 Inclusion logic

Articles were included where they addressed at least one of the following:

- biological asset recognition, measurement, valuation, disclosure, or auditability;
- IAS 41 implementation and reporting quality;
- biodiversity disclosure, accounting, or conservation accountability;
- nature-related ESG reporting, integrated reporting, governance, or assurance;
- biodiversity finance, risk, metrics, or capital-market relevance;
- ecological assets, natural capital, or ecosystem-service valuation relevant to reporting; or
- disclosure readability, comparability, analytics, or user accessibility.

Sources were excluded from the core synthesis if they addressed sustainability, finance, governance, climate, infrastructure, nutrition, or policy without a clear connection to biological assets, biodiversity, reporting, or nature-related decision usefulness.

4.4 Thematic synthesis procedure

The synthesis followed five stages. First, the source inventory was screened for relevance and publication type, with directly relevant peer-reviewed articles forming the analytical core. Second, the literature was grouped into six streams: biological asset accounting; biodiversity disclosure and conservation accountability; ESG, governance, and integrated reporting; biodiversity finance; ecological asset and natural-capital measurement; and disclosure analytics.

Third, articles were coded for their contribution to decision usefulness, including measurement reliability, ecological specificity, governance, financial materiality, assurance, readability, comparability, and user application. Fourth, contradictory findings were retained, such as the tension between fair-value relevance and reliability; disclosure visibility and accountability; financial materiality and metric quality; and governance discipline and ecological performance.

Finally, the findings were synthesized into four themes: measurement credibility; ecological validity; governance, assurance, and regulatory anchoring; and analytical accessibility linked to stakeholder use.

4.5 Trustworthiness and limitations

Trustworthiness was supported through transparent source selection, explicit inclusion criteria, separation of core and contextual evidence, cross-domain comparison, and retention of contradictory findings. The study seeks analytical, not statistical, generalization.

The framework was not tested against primary reports, interviews, assurance records, market data, or regulatory cases and depends on the accuracy of the source inventory. Recent working papers, preprints, and forthcoming publications should therefore be verified before submission. These limitations identify priorities for empirical testing.

5. RESULTS AND DISCUSSION

5.1 Overview of results

The synthesis identified four conditions for decision-useful nature-related reporting:

Measurement credibility: transparent methods, assumptions, boundaries, uncertainty, and evidence.

Ecological validity: accurate representation of biodiversity impacts, dependencies, and outcomes.

Governance, assurance, and regulatory anchoring: effective oversight, controls, monitoring, and independent challenge.

Analytical accessibility and stakeholder-use linkage: information that is understandable, comparable, and applicable to specific decisions.

Therefore, decision usefulness is a conversion process through which nature-related information becomes credible, ecologically grounded, governed, and usable.

5.2 Finding 1: Measurement credibility determines whether nature-related numbers can be relied upon

The first theme is measurement credibility. Biological asset accounting shows that measurement is essential but inherently vulnerable. Fair value may improve relevance by reflecting biological transformation and current economic conditions, yet reliability weakens where markets are inactive, assumptions are opaque, or change is difficult to observe.

Research across SMEs, bearer plants, aquaculture, forests, livestock, and agricultural firms confirms that credibility depends on asset type and context (Bohušová & Svoboda, 2016, 2017; Doorasamy et al., 2022; Hlaváčková et al., 2025; Kljajić et al., 2025; Norizan et al., 2022). Fair value may also require interdisciplinary evidence, whereas information under IAS 41 is not consistently useful in practice and may increase audit complexity (Cavalheiro et al., 2019; Silva & Nardi, 2023; Wu et al., 2023). Therefore, a reported value does not establish the credibility of the measurement.

The same limitation applies to biodiversity finance. Biodiversity footprints, ESG scores, risk metrics, and linked instruments depend on modeling choices, data boundaries, and assumptions. Although biodiversity exposure and management may be financially relevant, ratings and risk measures can remain noisy or inconsistent (Bassen et al., 2024; Coqueret et al., 2025; Cosma et al., 2025; Di Tommaso et al., 2025; Garel et al., 2024; Clement & Grenon, 2025; Xin et al., 2025).

Nature-related measures become decision-useful only when their methods, assumptions, boundaries, uncertainty, and evidence are transparent and open to scrutiny.

5.3 Interpretation of Finding 1

This finding addresses the research gap by identifying a shared problem across biological asset accounting and biodiversity finance: measurement does not become useful merely because a value or metric is reported. Decision usefulness depends on whether users can assess the measured object, method, assumptions, boundaries, uncertainty, and the reviewability of the estimate.

The theoretical contribution is to position measurement credibility as a condition for conversion within decision-usefulness theory. In nature-related reporting, relevance and faithful representation depend not only on the valuation technique but also on the definition of ecological boundaries, uncertainty disclosure, and assurance readiness. A biological asset value may be relevant yet unreliable, while a biodiversity-risk score may be comparable yet ecologically weak. Therefore, measurement credibility links financial reporting theory with nature-related accountability.

The finding also has implications for standard setting. Recognition and measurement requirements cannot ensure usefulness unless reporting explains underlying assumptions, boundaries, sensitivities, and uncertainty. Future qualitative research should examine how preparers, auditors, and users interpret biological asset valuations in the absence of active markets.

5.4 Finding 2: Ecological validity distinguishes biodiversity accountability from biodiversity visibility

The second theme is ecological validity. Biodiversity information may be visible in reporting without adequately representing ecological conditions. Existing studies show that disclosure is often fragmented, generic, difficult to interpret, or shaped by legitimacy concerns rather than substantive accountability.

Early research identifies incomplete and dispersed reporting of biodiversity (Samkin & Schneider, 2010; Schneider & Samkin, 2012; Samkin et al., 2014; Schneider et al., 2014). Conservation-accountability studies further show that reporting is influenced by social pressure, legitimacy, and political context (Ackers, 2019; Samkin & Wingard, 2021). More recent corporate research confirms persistent limitations in content, readability, and consistency (Dutta & Dutta, 2024; Kashyap et al., 2025; Maroun & Ecim, 2024; Roberts et al., 2023; Senanayake et al., 2024).

The central limitation is that organizations often report activities and commitments rather than ecological effects. Conservation programs, restoration initiatives, and nature-positive ambitions may be disclosed without ecological baselines, spatial boundaries, affected species and habitats, pressure pathways, dependencies, monitoring methods, outcomes, or trade-offs.

Ecological asset research clarifies why these omissions matter. Ecological conditions are spatially specific, dynamic, and scientifically complex, requiring biophysical evidence, defined boundaries, and outcome monitoring (Grunewald et al., 2024; Liu et al., 2025b; Potgieter et al., 2026; Sun et al., 2026; Yang et al., 2024). Biodiversity reporting becomes decision-useful only when it reflects ecological substance rather than organizational intent.

5.5 Interpretation of Finding 2

This finding distinguishes biodiversity visibility from ecological validity. Disclosure is decision-useful only when users can assess ecological condition, pressures, responses, and change.

The theoretical contribution is to embed ecological validity in accounting decision usefulness. Relevance, faithful representation, comparability, and understandability require biodiversity-specific content, including affected species, habitats, baselines, and pressure pathways. Therefore, ecological validity extends decision-usefulness theory into ecological accountability.

The finding also challenges ESG practice. Biodiversity commitments, partnerships, and nature-positive targets are not useful unless their ecological basis and outcomes can be evaluated. Future qualitative research should examine how preparers, ecologists, investors, regulators, and affected communities interpret such disclosures.

5.6 Finding 3: Governance, assurance, and regulation convert nature-related disclosure into information capable of reliance

The third theme is governance, assurance, and regulatory anchoring. Reporting quality depends on board oversight, ownership structures, internal controls, institutional pressure, and reporting capacity. These factors influence ESG, integrated and biological asset disclosure (Abdelmoneim & El-Deeb, 2024; Abdullah et al., 2023; Lestari et al., 2020; Moikwatthai et al., 2019; Scholtz & Kieviet, 2018; Smit et al., 2018; Warsini et al., 2024). Broader ESG research further links reporting quality to organizational systems, digitization, green accounting, and earnings-management risk (Gedam et al., 2026; He & Jiang, 2026; Sklavos et al., 2025; Zhao et al., 2024).

Nature-related assurance is especially demanding. Biological asset values may require valuation, agricultural and audit expertise, while biodiversity disclosures may depend on ecological surveys, geospatial evidence, species data, and long-term monitoring. Biodiversity metrics also require methodological scrutiny and robust data governance. Elliot et al. (2024) identify standardization, materiality, and assurance as central challenges, while Zhang et al. (2025) show that biodiversity regulation can increase audit pricing and assurance risk.

Frameworks such as IAS 41, GRI 101, TNFD-style disclosure, and European sustainability standards provide structure, but cannot independently ensure credible data, ecological substance, or accessible reporting. Therefore, decision usefulness depends on effective governance, assurance capability, and regulatory implementation.

5.7 Interpretation of Finding 3

This finding shows that the usefulness of decisions depends on the institutional conditions under which nature-related information is produced. Information becomes more reliable when it is governed, controlled, monitored, challenged, and capable of assurance.

The theoretical contribution is to position governance and assurance as conversion mechanisms rather than background determinants. Governance does more than influence the extent of disclosure; it helps convert reporting into decision-useful information. Assurance similarly tests whether nature-related subject matter is

clearly defined, adequately evidenced, and supported by effective controls.

The finding also has implications for standard setters. Expanded disclosure requirements will not improve usefulness unless organizations can produce assurance-ready evidence. Future qualitative research should examine how boards oversee nature-related information systems and how assurance practitioners evaluate biodiversity evidence.

5.8 Finding 4: Analytical accessibility and stakeholder-use linkage determine whether information can be applied

The fourth theme is analytical accessibility. Nature-related information may be credible and ecologically valid yet remain unusable if it is fragmented, unreadable, inconsistent, or disconnected from specific decisions.

Biodiversity research identifies persistent problems of readability and fragmentation (Maroun & Ecim, 2024; Schneider & Samkin, 2012; Schneider et al., 2014). Although machine-learning methods can detect nature-related disclosure more effectively than keyword searches, classification does not establish usefulness (Schimanski et al., 2024). Identified content may still lack credible measurement, ecological substance, or user relevance.

Similar limitations arise in biodiversity finance. Evidence links biodiversity information to firm value, default risk, futures markets, stock-price synchronicity, and portfolio connectedness (Coqueret et al., 2025; Cosma et al., 2025; Dong et al., 2026; Lang et al., 2025; Wu et al., 2026). However, noisy ratings and opaque methodologies can limit practical use (Xin et al., 2025).

Therefore, decision usefulness requires explicit linkage to stakeholders. Investors require risk and valuation information; boards need strategic and oversight relevance; assurance providers need defined boundaries and evidence; regulators require comparability and enforceability; conservation managers need ecological outcomes; and communities require information on land, livelihoods, and environmental harm.

5.9 Interpretation of Finding 4

This finding shows that usability is intrinsic to decision usefulness, not merely a presentation concern. Information that cannot be located, compared, understood, or applied cannot support judgment or action.

The theoretical contribution is to extend understandability to include readability, structure, comparability, machine readability, methodological transparency, and user-specific decision pathways. This is critical where nature-related information is dispersed across annual reports, sustainability reports, ESG datasets, regulatory filings, websites, and assurance statements.

Future qualitative research should examine how investors, boards, auditors, regulators, and communities interpret and use the same nature-related disclosures.

5.10 Integrated framework: the decision-usefulness conversion framework

The four findings form an integrated framework (Figure 1) in which nature-related reporting becomes decision-useful only when it satisfies four conversion conditions: measurement credibility, ecological validity, governance, assurance and regulatory anchoring, and analytical accessibility.

The framework explains inconsistencies in prior research. Biological asset disclosures may differ in value relevance because the credibility of their measurements varies. Biodiversity reporting may expand without improving accountability where ecological validity is weak. Biodiversity risk may be financially material while ESG metrics remain unreliable. Reporting standards may increase the volume of disclosures without strengthening assurance or usability.

The framework also connects financial materiality with ecological accountability. Nature affects organizations through dependencies, risks, and opportunities, while organizations affect nature through land use, extraction, pollution, habitat change, restoration, and conservation. These relationships interact through regulation, litigation, market responses, community pressure, and ecological decline. Decision-useful reporting must therefore address both effects.

The framework is not a checklist. Each condition requires critical evaluation of the underlying evidence, methods, boundaries, and reporting context.

The framework conceptualizes decision usefulness as a conversion process that requires four interdependent conditions: measurement credibility; ecological validity; governance, assurance, and regulatory anchoring; and analytical accessibility linked to stakeholder use. Where any condition is weak, reporting may remain compliant, symbolic, fragmented, or unusable. Where they reinforce one another, biological asset accounting, biodiversity disclosure, and ESG accountability become decision-relevant information.

This explains why disclosure, measurement, standardization, or ESG quantification alone is insufficient. Biological asset accounting provides measurement discipline but may omit ecological consequences. Biodiversity disclosure improves visibility but may remain symbolic without baselines, species- and habitat-specific evidence, and monitored outcomes. ESG and biodiversity-finance metrics may inform markets only when their methods are transparent, comparable, and ecologically grounded.

Therefore, the framework provides a diagnostic basis for evaluating whether nature-related reporting supports valuation, risk assessment, stewardship, governance, assurance, regulation, and stakeholder accountability.



Decision usefulness is strengthened when credible measurement, ecological substance, governance discipline and stakeholder accessibility work together.

Figure 1. Decision-usefulness conversion framework for nature-related reporting

Source: Author's concept.

5.12 Explicit theoretical contribution

The article makes four theoretical contributions.

First, it extends decision-usefulness theory beyond investor and creditor decisions to include ecological stewardship, governance, assurance, regulation, and stakeholder accountability.

Second, it reframes biological asset accounting by shifting attention from the abstract superiority of fair value or cost to whether the measurement basis is credible for the asset, context, and intended use.

Third, it distinguishes biodiversity visibility from ecological validity. Biodiversity disclosure becomes useful only when it represents ecological substance.

Fourth, it connects biodiversity finance with accounting accountability by showing that financial materiality alone is insufficient. Biodiversity metrics must also be credible, ecologically grounded, and usable.

6. CONCLUSIONS

This article examined when nature-related reporting becomes decision-useful across biological asset accounting, biodiversity disclosure, and ESG accountability. It addresses a central problem: reporting is expanding, but greater disclosure does not necessarily yield credible, ecologically meaningful, or usable information.

The thematic synthesis identified four interdependent conditions. First, measurement credibility requires transparent methods, assumptions, boundaries, and a clear statement of uncertainty. Second, ecological validity requires disclosure of baselines, spatial boundaries, affected species and habitats, pressures, dependencies, outcomes, and trade-offs. Third, governance, assurance, and regulatory anchoring are necessary to address weak controls, selective reporting, scientific uncertainty, and verification risk. Fourth, analytical accessibility and stakeholder-use linkage determine whether information can support decisions by investors, boards, assurance providers, regulators, conservation managers, and communities.

The article's principal theoretical contribution is to conceptualize nature-related reporting as a decision-usefulness conversion problem. Information is not useful merely because it is disclosed, measured, standardized, assured, or translated into an ESG metric. It becomes useful when it is converted into credible, ecologically grounded, governed, and accessible knowledge. This extends decision-usefulness theory beyond financial materiality to include ecological accountability and stakeholder use.

The framework also provides a diagnostic tool for practice. Preparers should disclose valuation methods, ecological baselines, material assumptions, uncertainty, monitoring evidence, and outcomes. Boards should strengthen oversight, accountability, and internal controls. Assurance providers should assess whether nature-related information is sufficiently defined, evidenced, and controlled. Regulators and standard setters should prioritize ecological specificity, comparability, and usability rather than disclosure volume alone.

Future research should apply the framework to corporate reports, assurance engagements, ESG datasets, and regulatory practice. Case studies, interviews, and field research could examine how nature-related information is produced, governed, assured, and interpreted across stakeholder groups. Comparative studies could also assess IAS 41, GRI 101, TNFD-aligned, and biodiversity-finance reporting against the four conversion conditions.

Nature-related reporting is neither inherently useful nor inherently symbolic. Its usefulness depends on whether biological and ecological information is measured credibly, represented ecologically, governed and assured effectively, and made accessible for specific decisions.

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