Corporate Social Responsibility and Environmental Management

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REVIEW ARTICLE OPEN ACCESS

A Scoping Review of Determinants of Business Engagement With Biodiversity

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Received: 15 November 2024 | **Revised:** 24 March 2025 | **Accepted:** 3 May 2025

Funding: This work was supported by EU Horizon 2020 project SUPERB (systemic solutions for upscaling of urgent ecosystem restoration for forest-related biodiversity and ecosystem services) (GA-101036849).

Keywords: biodiversity finance | biodiversity management | corporate biodiversity actions | financial instruments | motivations | PRISMA-ScR guidelines

ABSTRACT

Corporate biodiversity engagement is rising on the international agenda because companies not only face increasingly apparent biodiversity-related risks and dependencies, but also contribute to, and have the potential to mitigate biodiversity loss through their practices and investments. This scoping review maps the current literature on the determinants of business engagement with biodiversity, outlining motivations, barriers, actions, and financial instruments from 100 studies based on 26,096 records published between 2000 and 2023, following Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping reviews guidelines. Findings reveal that companies are driven by multifaceted factors, with economic motivations including operational management and profitability frequently recorded. Regulatory frameworks motivate corporate engagement through legislation compliance while posing challenges due to regulatory uncertainty and inconsistent policies. While various financial mechanisms exist, further research is needed to explore innovative funding structures to upscale business investment. We call for empirical, context-specific studies on biodiversity monetization mechanisms.

1 | Introduction

Global biodiversity[1] is continuing to decline (Díaz et al. 2019). Economic sectors drive biodiversity loss through land use changes, overexploitation of wildlife, pollution, and climate change, which threaten species and ecosystems, both directly and through their supply chains (Jaureguiberry et al. 2022; Lorente et al. 2023; Wilting and van Oorschot 2017). Meanwhile, several economic sectors rely on the resources and services provided by ecosystems (Panwar et al. 2022). Due to these impacts and dependencies, businesses[2] across different sectors are expected to play an important role to halt biodiversity loss and maintain the benefits that nature provides to both businesses and society at large (White et al. 2024; van Oorschot et al. 2020).

Furthermore, businesses are also gaining attention for their potential to help reverse the biodiversity decline by addressing the substantial financial gap needed for conservation efforts (Folke et al. 2019; White et al. 2024). A significant financial shortfall exists in meeting the demand to halt biodiversity loss, with an estimated USD 800 billion needed annually to close the financing gap and achieve the UN's 2050 biodiversity goals (Deutz et al. 2020). While public funding is predominant in current conservation funding, it remains insufficient

(Barbier 2022; Deutz et al. 2020; Tobin-de la Puente and Mitchell 2021). Consequently, there is growing focus in both recent research (Karolyi and Tobin-de la Puente 2023; Löfqvist and Ghazoul 2019) and global policy discussions on mobilizing new streams of finance from the private sector. For instance, the Kunming-Montreal Global Biodiversity Framework (GBF, Target 19) promotes leveraging private capital through innovative approaches such as green bonds, biodiversity credits and offsets, or payment for ecosystem services (PES) (CBD 2022). New regulations and voluntary initiatives including the Corporate Sustainability Reporting Directive (CSRD) and Taskforce for Nature-related Financial Disclosure (TNFD) framework are requiring businesses to assess their impacts on biodiversity and integrate it into their core strategies, while consumer demand for sustainability and investor expectations further push businesses to take action (White et al. 2024; Zu Ermgassen et al. 2025). An increasing number of companies are now setting targets and developing strategies to address their biodiversity impacts, whereas businesses previously gave little attention to biodiversity in their environmental, social, and governance (ESG) reporting (White et al. 2024; Addison et al. 2019).

However, mainstreaming biodiversity into business strategies remains a long-term challenge (Krause et al. 2021; Zu Ermgassen et al. 2025). Businesses face challenges in understanding their relationships with biodiversity, positioning themselves amid various shareholder pressures, and responding effectively (Panwar et al. 2022; White, Mukherjee, et al. 2023; White, Petrovan, et al. 2023). For governments, the challenge is to create the appropriate incentives to drive timely corporate action toward positive biodiversity outcomes. Therefore, understanding why companies act on biodiversity, what they do, the barriers they face, and the financial instruments that incentivize their involvement is essential for both governments and businesses to develop effective policies and strategies that promote biodiversity-positive actions and ensure sustainable practices.

Existing literature provides valuable insights into the role of businesses in protecting biodiversity, such as business and management (Krause et al. 2021; Meißner and Grote 2017), conservation biology (Addison et al. 2019; Cortina-Segarra et al. 2021), ecological economics (Brody et al. 2006; Houdet et al. 2012; Folke et al. 2019), finance (Flammer et al. 2025; Karolyi and Tobin-de la Puente 2023; Löfqvist and Ghazoul 2019), corporate accounting (Roberts et al. 2021), and political science (Varumo et al. 2022). Recent studies on the financial materiality of biodiversity risks show mixed results. Garel et al. (2024) and Giglio et al. (2023) found that stock markets already priced in biodiversity risks, while Xin et al. (2023) showed no effect on stock returns. Trinh (2023), Li et al. (2025), and Liang et al. (2024) found that biodiversity risks were linked to reduced investment, lower firm efficiency, and increased financial distress, respectively. Several review articles have mapped the literature on biodiversity finance[3] (Cosma et al. 2023; den Heijer and Coppens 2023; Hutchinson and Lucey 2024; Junge et al. 2023). However, to the best of our knowledge, no systematic review has yet attempted to provide an overview of the wider literature on business engagement with biodiversity (biodiversity finance being only a subset hereof), except for some attempts in the gray literature (Deutz et al. 2020; OECD 2020; Tobin-de la Puente and Mitchell 2021; UNDP 2018; Parker et al. 2012; Kumar 2010).

Therefore we aim to address this gap by using a scoping review methodology to conduct a formal, comprehensive assessment of existing research on the determinants of businesses' biodiversity engagement, including motivations, strategies and actions, barriers, and the financial instruments designed to incentivize their involvement in biodiversity-related activities.

Our scoping review contributes to the academic literature in several ways. First, we examine and structure key concepts in the literature on how businesses perceive, engage with, and contribute to biodiversity conservation, thereby adding to the biodiversity-related business literature (Houdet et al. 2012; Krause et al. 2021; White, Mukherjee, et al. 2023; White, Petrovan, et al. 2023; Panwar et al. 2022). Second, we are at a critical point where new regulations are attempting to entice businesses to further engage in biodiversity conservation while research on the subject continues to grow. Hence, a timely synthesis, mapping the current literature and its gaps, can lay the groundwork for a deeper understanding of biodiversity finance, as called for by Karolyi and Tobin-de la Puente (2023) and Flammer et al. (2025). This would also add perspective to the sustainable finance literature that has primarily focused on climate finance (Flammer 2021; Krueger et al. 2020; Starks 2023). In addition, our study provides entry points for governments to design tailored policies that create effective incentives for businesses to actively engage with biodiversity and stimulate market involvement. It also provides businesses with knowledge to understand the opportunities and risks associated with biodiversity, how they can contribute, and the current landscape of financial instruments available to support their efforts.

The remainder of the paper is organized as follows. Section 2 outlines the scoping review methodology and data collection. The results are presented in Section 3, summarizing businesses' motivations, barriers and activities, and financial instruments. Section 4 presents further discussion, limitations, and knowledge gaps for further research. Section 5 concludes.

2 | Methods

2.1 | Scoping Review Methodology

We conduct a scoping review to map the relevant literature on businesses engagement with biodiversity. This methodology is guided by a priori protocols and aims to be a transparent, replicable, and rigorous approach that minimizes authorial bias (Arksey and O'Malley 2005; Levac et al. 2010). Systematic reviews or meta-analyses are suitable for quantitatively summarizing literature findings with rigor and transparency, while scoping reviews excel for mapping emerging evidence, examining diverse research areas, exploring broad fields with open-ended questions, and informing rapid policy assessments (Munn et al. 2018; Page, McKenzie, et al. 2021; Page, Moher, et al. 2021). It is particularly relevant in agricultural/environmental economics and conservation science (Liverpool-Tasie et al. 2020), for example, to synthesize the link between farmers' motivations, sustainable practices, and their outcomes globally (Piñeiro et al. 2020), or to map outcomes of European rewilding projects (Hart et al. 2023).

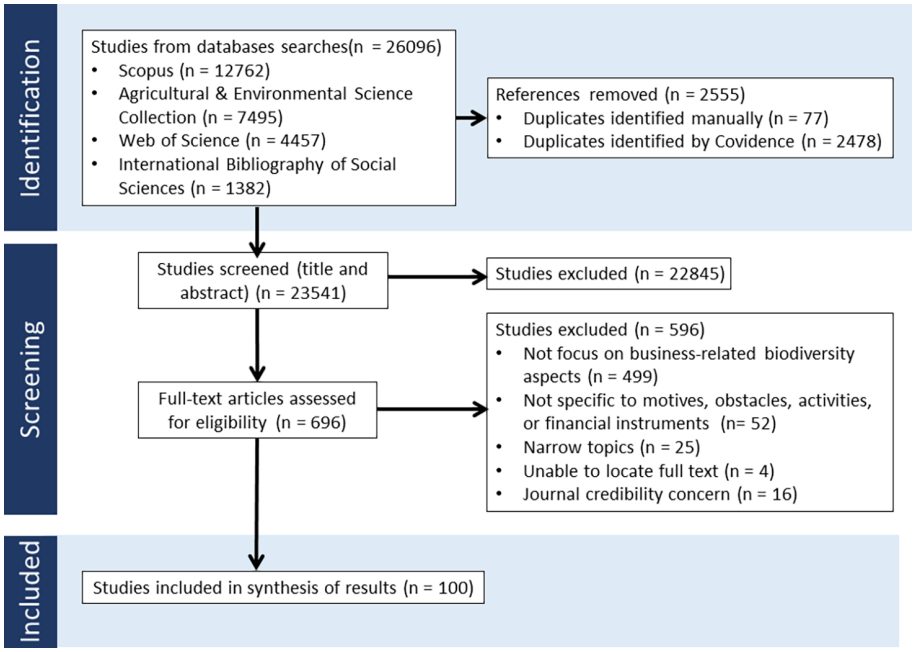

FIGURE 1 | PRISMA flow diagram for paper selection.

We use the five-stage methodological framework proposed by Arksey and O'Malley (2005), Levac et al. (2010), and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping reviews (PRISMA-ScR; Page, McKenzie, et al. 2021; Page, Moher, et al. 2021; Tricco et al. 2018) guidelines. This includes: (1) identifying the research question, (2) identifying relevant studies, (3) performing study selection, (4) extracting and charting the data, and (5) collating, summarizing, and reporting the results. All study materials, such as the pre-registered protocol (Appendix S1), complete search strategies (Appendix S2), metadata on search records (Appendix S3) and included studies (Appendix S4), code framework (Appendix S5), data extraction form (Appendix S6), data extracted from the form with frequencies (Appendix S7), and terminology used in the study (Appendix S10), were pre-published on the Open Science Framework (OSF; https://osf.io/6u2kw/) (cf. Supporting Informations).

2.2 | Data Sources and Searches

The scoping review is guided by the research question: "What is the peer-reviewed evidence on the determinants for businesses to engage in biodiversity conservation?" Consequently, we executed a comprehensive search strategy to identify all available studies addressing this question if not as their main research question, then at least indirectly. Search terms included key concepts related to the research question: biodiversity (e.g., biodiversity, conservation, ecosystem, restoration), investment (e.g., invest*[4], private sector, compan*, financ*), and determinants (e.g., motiva*, driver*, barrier*, challenge*, risk*) (for full details, see Appendix S2). We conducted searches in four datasets: *Scopus*, *Web of Science Core Collection*, *Agricultural and Environmental Science database*, and *International Biography of Social Sciences*. The search process was assisted by two librarians at the Royal Danish Library (Det Kgl. Bibliotek; KB), who provided recommendations for selecting databases and helped in reviewing the strategy. The strategy was drafted by one author (QL), discussed and reviewed by two other authors (TL and CS) and the librarians from KB, and was tested and finalized by QL. We imported 26,096 found records into Covidence, a systematic review software, to facilitate article screening, study selection, and data extraction.

2.3 | Eligibility Criteria and Study Selection

Screening and selection involved two stages: (i) title and abstract review, and (ii) full-text review. QL assessed the predefined eligibility criteria at both stages while TL and CS checked a subset for discussing reliability. Studies were eligible for inclusion if they were:

1. Published between January 2000 and June 2023[5]
2. Published in English-language[6]
3. Original research (qualitative, quantitative[7]), incl. reviews
4. Explicitly mentioned business motives for investing in biodiversity conservation
5. Explicitly mentioned business obstacles to investing in biodiversity conservation
6. Explicitly mentioned business invest in biodiversity conservation
7. Financial instruments applied to biodiversity conservation

To be included, studies were to meet the first three criteria, and at least one of criteria 4–7. In Figure 1, a PRISMA flow diagram presents the study selection process. From 26,096 imported records (Appendix S3), we deduplicated 2555 for title and abstract screening. Here, 22,845 records were excluded, leaving 696 full-text articles to be retrieved and assessed for eligibility. Of these, 596 were excluded: 499 did not address business-related biodiversity aspects, 52 were not specific to motives, barriers, actions, or financial instruments, 25 focused on non-business contexts,

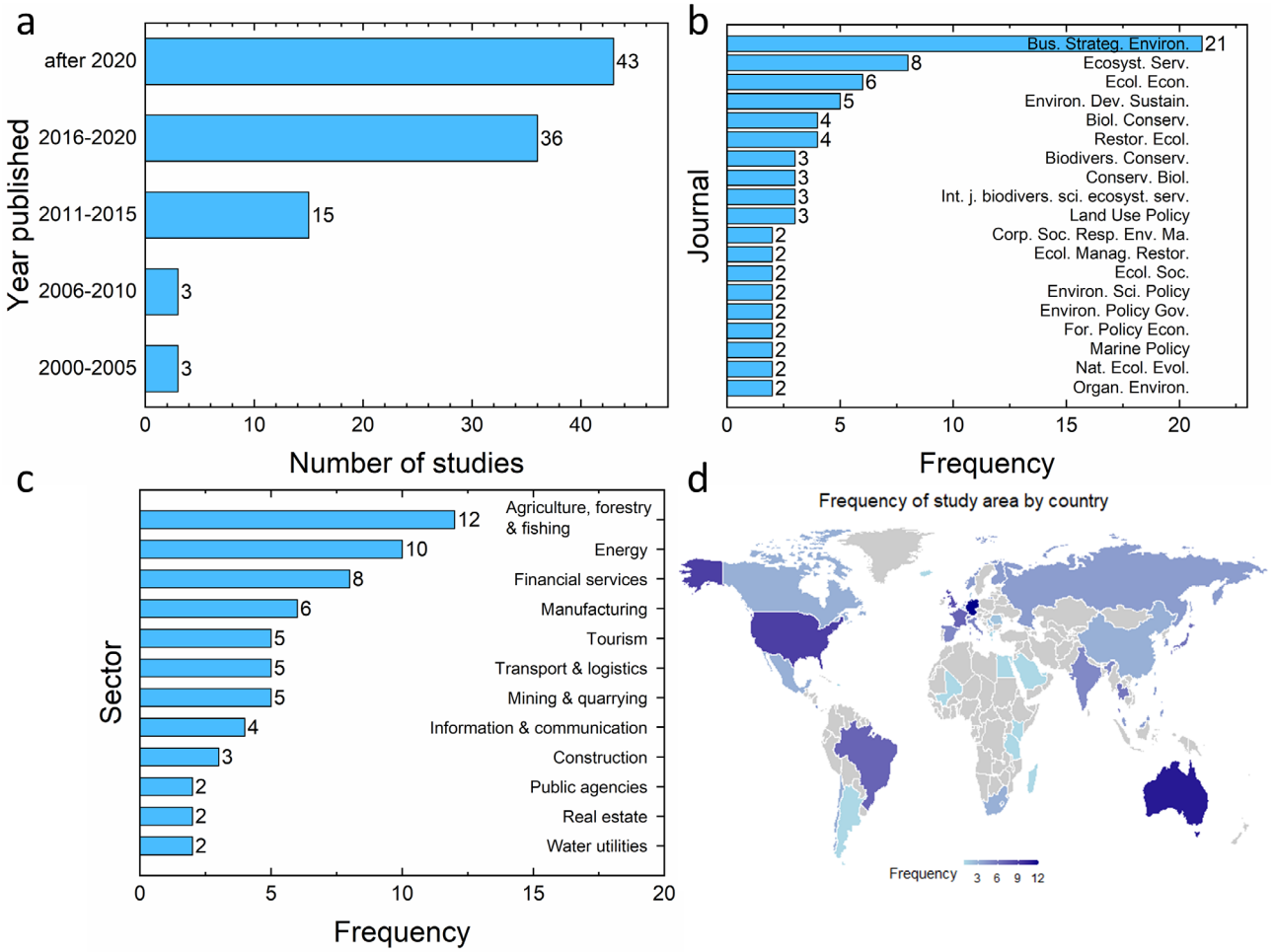

FIGURE 2 | (a) Included studies ($N = 100$) by publication year (2000–2023). (b) Frequency of journals (minimum twice, $N = 100$). (c) Industry sector mentioned ($N = 100$). Sectors categorized according to EU classification of economic activities, Nomenclature of Economic Activities (NACE) Rev. 2 codes. (d) Study area by country. Darker shade indicates higher frequency.

four had inaccessible full texts, and 16 due to quality concerns. One hundred articles met the final inclusion criteria (for publicly accessible database, see Appendix S4).

2.4 | Data Extraction

Automated extraction was applied to collect metadata and study characteristics such as publication journal and year. A categorization framework was created, initially based on several preliminary categories aligned with the study's main objectives (Appendix S5 code framework). To ensure all necessary information was included for addressing the research question, a data extraction form was collaboratively developed and tested by two authors (QL and TL) (see Appendix S6 for the data extraction template). One author (QL) performed manual extraction and recorded detailed information from each study, including drivers, obstacles, activities, financial instruments, study type (qualitative or quantitative), sample size (if applicable), business characteristics (sector and geographic scope), and biodiversity/environmental/ecosystem realm (specific types of ecosystems or natural environments such as forests, wetlands and grasslands, or marine areas). Additionally, we noted whether a study addressed specific metrics used as tools for evaluating corporate engagement with biodiversity.

A risk of bias assessment or critical appraisal was not carried out because scoping reviews are generally conducted to map existing evidence regardless of methodological quality or risk of bias (PRISMA-ScR; Page, McKenzie, et al. 2021; Tricco et al. 2018).

2.5 | Summarizing the Evidence

A thematic analysis was conducted to organize and highlight various subcategories, based on data from the extraction grid (Tricco et al. 2018). This synthesis elucidates how companies engage with biodiversity conservation. Additionally, frequencies and averages were calculated to examine the number of times various codes and themes appear within the data.

3 | Results

3.1 | Sample Overview

Over the past decade, peer-reviewed studies reporting on businesses' engagement with biodiversity have multiplied: almost half were published in the last 4 years, and 80+% within the last decade (Figure 2a). The preferred journals were *Business Strategy and the Environment* (20 articles), followed by *Ecosystem Services*

(eight articles), *Ecological Economics* (six articles), *Environment, Development and Sustainability* (five articles), and *Land Use Policy*, *Biological Conservation*, and *Restoration Ecology* (four articles each) (Figure 2b). Still, the top-10 finance journals (as measured by their impact factor) and top-five economics journals are absent: the topic has not received higher-level economics attention (Karolyi and Tobin-de la Puente 2023).

Our sample includes two review papers: Coralie et al. (2015) on biodiversity offsets and Maier et al. (2021) on incentives for ecological enhancements in forest management. Only 13 studies used a quantitative approach involving numerical data and statistical analysis to assess findings: Coralie et al. (2015) analyzing 477 articles on biodiversity offsets; Carvalho et al. (2023) assessing biodiversity risk responses in 11,812 companies, and Sardá et al. (2023) examining 69 companies operating in the marine realm. Six studies on corporate motivations included Brody et al. (2006) (38 companies), Koellner et al. (2010) (60 companies), Krause et al. (2021) (618 companies), Meißner and Winter (2019) (39 companies), Urbaniec et al. (2022) (10 respondents from academia, companies, NGOs, public administration), and Wagner (2023) (270 companies). Four studies on biodiversity disclosure included Cubilla-Montilla et al. (2020) (201 companies), Hassan et al. (2022) (200 companies), Hassan et al. (2020) (200 companies), and Issa and Zaid (2023) (7890 companies). See Appendix S6. Additionally, Flammer et al. (2025) examined the risk–return trade-off in 33 biodiversity finance deals. Overall, empirical and quantitative studies are scarce, rely on disclosed data from companies, and lack primary survey data. As biodiversity finance grows and more data becomes available, future research should provide larger-scale evidence.

Almost half of the articles offered a generic discussion on business engagement in biodiversity, without a specific geographic focus. Specific-location studies were conducted across 44 countries, covering all major regions (Figure 2d, Table S7). Most were in Europe, with Germany hosting 12 studies, followed by the UK (8) and France (7). Asia is notable with Thailand (6) and Japan (6). Oceania, especially Australia, also has a strong presence with 11 studies. Latin America showcases Brazil (7) and Costa Rica (4), while North America includes the USA (9) and Canada (3).

When examining industries involved in corporate biodiversity engagement, 57% of the articles did not specify a particular sector. Among those that do (Figure 2c; Table SI.7.4), the most frequently mentioned industries[8] were Agriculture, Forestry, and Fishing (12 studies) and, second, Energy (10 studies), both being closely linked to ecosystems in production landscapes (White, Mukherjee, et al. 2023; White, Petrovan, et al. 2023). Financial institutions were the third-most mentioned sector (eight studies), indicating scholars' recognition of their role in biodiversity conservation, particularly in how evaluations of natural capital risks shape investment decisions and influence companies' access to capital (Ascui et al. 2021).

Most studies featured the general biodiversity/ecosystem realm rather than specific themes, such as forests, marine environments, grasslands and wetlands, and agriculture. However, 10% of the studies specifically mentioned forests, making them the most frequently discussed habitat type, as forests are home to a significant portion of the Earth's threatened terrestrial biodiversity (Bongers et al. 2021).

3.2 | Determinants of Business Biodiversity Engagement

3.2.1 | Motivations for Engaging With Biodiversity

All included studies discussed at least one motivation for engaging in biodiversity conservation. Using Carroll's (1991) corporate social responsibility (CSR) framework, we categorize them into four groups: (1) economic, (2) legal, (3) ethical, and (4) discretionary/philanthropic[9]. We analyze each motivation through the lenses of risk and opportunity, as business actions are driven by both potential negative impacts and opportunities for biodiversity gains (White, Mukherjee, et al. 2023; White, Petrovan, et al. 2023). By outlining these associated risks and opportunities, we show how they incentivize companies to engage in biodiversity conservation (see Table 1).

3.2.1.1 | Economic Motivation. The driver *financial profitability* refers to companies investing in biodiversity to protect existing revenue or boost profits, as noted in 60% of analyzed studies (Figure 3a). The way companies manage biodiversity is considered relevant to their bottom line (Potdar et al. 2016): if biodiversity investments can achieve financial returns, help maximize earnings, and ensure consistent profitability or maintain a strong competitive position, they will be a fundamental driver for business organizations (Potdar et al. 2016). Businesses can have financial benefits from investments in biodiversity management through mechanisms such as reducing operating expenditures in cases where investments in land management activities can save business costs, increasing the value of real estate, selling price-premium eco-friendly products and services, or selling carbon credits (Flammer et al. 2025; Haas 2022; Meißner and Grote 2017).

Operational management (59%) serves as another economic motivation for businesses, referring to companies' efforts to manage and sustain biodiversity to ensure stable supply chains, secure resource availability, and maintain or mitigate the effects of ecosystem degradation on operational efficiency. Businesses dependent on biodiversity for essential inputs in products and processes recognize that biodiversity and related ecosystem services (e.g., pollination) are critical resources for several industries. Negative impacts on these services can lead to substantial risks, including disruptions in supply chains and increased operating costs (Bhattacharya and Managi 2013; Houdet et al. 2012). These risks create a direct business incentive for effective biodiversity management, particularly for companies in resource-based sectors such as forestry, tourism, fishery, food, utilities, and the chemical industry, which are motivated to engage in biodiversity conservation in some form due to their heavy reliance on healthy ecosystems (Bhattacharya and Managi 2013; Brody et al. 2006; Lambooy and Levashova 2011).

3.2.1.2 | Legal Motivation. *Regulatory compliance*, observed as a driver in 54% of included studies, is defined as adherence to legislative requirements influenced by government control and the pressure from norms and regulations.

TABLE 1 | Main motivations, opportunities, and risks of corporate biodiversity engagement.

Category	Motivation	Opportunity	Risk
Economic	Financial profitability	Increased profit margins; meet purchaser/investor expectation; access to finance	Reduced finance opportunities; reduced credit quality
	Operational management	Securing biodiversity inputs to support operations; maintain supply chains	Reduced productivity; scarcity and increased cost of resources; operational and supply chain disruption
Legal	Regulatory compliance	Leadership with governments to help shape policies and regulations; competitive edge in new markets	Fines and project delays; liability for biodiversity impacts
Ethical	Reputation and brand value	Preferred operator status; staff loyalty; brand differentiation	Loss of social license to operate; restricted access to land and resources; damage to brand; boycotts
	NGOs help (and pressure)	Boost reputation; improve stakeholder relationships; access to expertise	
Discretionary/ philanthropic	Moral incentives	Good corporate citizen; improve social license to operate	Increased scrutiny; green washing

Note: Inspired by Craig et al. (2012) for business opportunities and risks, and Carroll's (1991) CSR framework.

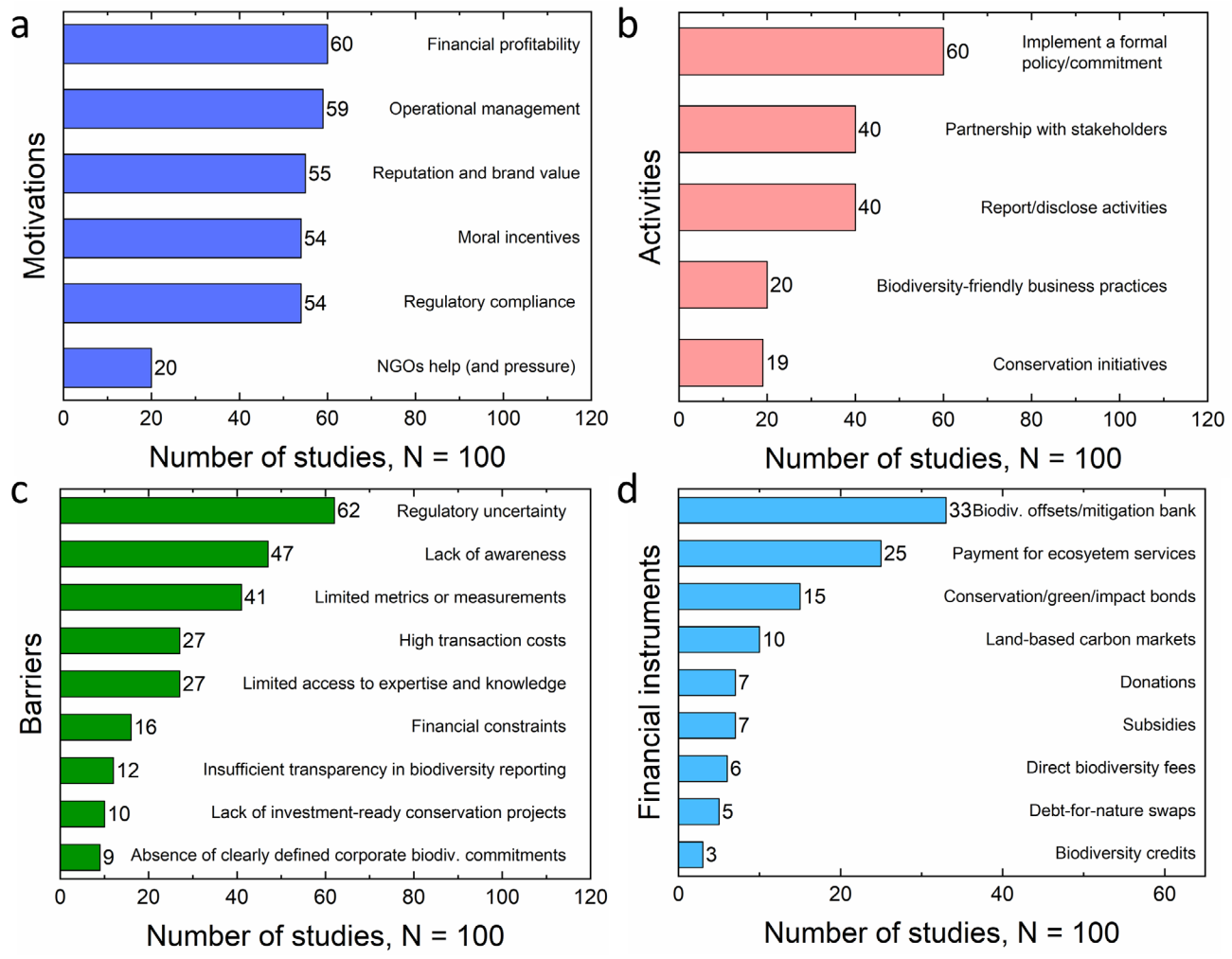

FIGURE 3 | Frequency of determinants: Motivations, activities, barriers, and financial instruments ($N = 100$). Each study may address multiple categorized items.

It mandates and encourages the private sector to manage their impacts and dependencies on biodiversity. Firstly, this includes specific mandates such as legal licenses to operate, carbon and biodiversity offsets (Alvarado-Quesada et al. 2014) or codes of conduct in buyer–supplier relationships (Meißner and Grote 2017; Pedersen and Andersen 2006). For example, mining companies are often legally required to restore extraction sites[10]. Secondly, compliance involves navigating regulations across different levels: globally and supra-nationally, including policies such as the EU Biodiversity Strategy for 2030 and the EU Nature Restoration Law; federally, involving directives such as National Biodiversity Strategy and Action Plans; and regionally, addressing specific local laws and regulations. Where these regulations exist and are enforced, they induce companies to integrate biodiversity considerations into their operations (Athanas 2005). Moreover, companies are driven not only by current, but also by anticipated future regulations. They ensure meeting at least the minimal existing legal requirements to avoid immediate legislative control, and invest in strategies to preempt future regulation, that is, reduce or slow down future regulatory pressures, swiftly adapt to mandatory requirements, and gain a competitive edge in developing new markets (Athanas 2005; Meißner and Grote 2017; Wunder et al. 2024). Companies may even actively engage with governments to help shape and influence future policy development (Booth et al. 2024).

3.2.1.3 | Ethical Motivation. *Reputation and brand value* (55%) refers to companies engaging in biodiversity conservation as an opportunity to enhance their public image, align with societal expectations and norms, and gain acceptance and support from consumers and investors. This motivation goes beyond legal compliance and profit maximization. It includes meeting shareholder requirements, such as the financier policy (e.g., International Finance Corporation [IFC] performance standards) to gain access to financial support (White, Mukherjee, et al. 2023; White, Petrovan, et al. 2023). It includes responding to consumer demand for sustainable practices (e.g., especially in the food and agriculture industry) (Zimmerer and de Haan 2017); building trust and credibility with stakeholders, increasing brand loyalty, demonstrating CSR leadership, and ultimately enhancing long-term shareholder value. In addition, internal pressure from employees also drives businesses to incorporate biodiversity into their corporate agenda. Meeting employee expectations and values helps attract and retain high-quality staff (Grigg 2005; Krause and Matzdorf 2019).

3.2.1.3.1 | Pressure (And Help) From NGOs. This motivation involves the influence and support of NGOs, as noted in 20% of articles. Environmental NGOs, being a diverse group with various views and strategies, engage with the private sector in different ways. Some act as advocates and watchdogs, monitoring business activities and holding companies accountable by alerting the public to deviations from stated standards (Athanas 2005). Some collaborate directly with businesses to gain related knowledge and develop effective strategies for managing biodiversity risks and opportunities, while others utilize their network to connect businesses to potential conservation projects and stakeholders (Anyango-van Zwieten et al. 2019). Together, NGOs aim to push and pull the private sector toward better biodiversity practices.

3.2.1.4 | Discretionary/Philanthropic Motivation. *Moral incentives* (54%) refer to companies' biodiversity actions driven by an intrinsic sense of duty, that is, to act responsibly and respond to society's expectations that businesses should be good corporate citizens enhancing positive impacts. Such companies may invest in biodiversity out of a sense of moral obligation and a desire to contribute positively to human welfare and ecological responsibility (Bhattacharya and Managi 2013; Boiral and Heras-Saizarbitoria 2017; Houdet et al. 2012; Koellner et al. 2010; Schaltegger et al. 2022). However, if the company's actions are perceived as insufficient or insincere relative to their environmental claims, it risks facing increased scrutiny and potential accusations of greenwashing (Meißner and Grote 2017; Potdar et al. 2016).

3.2.2 | Corporate Biodiversity Actions

Corporate biodiversity actions refer to initiatives, strategies, and measures that businesses take to conserve, manage, and enhance biodiversity within their operations, supply chains, investments, and broader impacts, aiming to minimize harm, promote conservation, and integrate biodiversity into decision-making processes, policies, and practices (White, Mukherjee, et al. 2023; White, Petrovan, et al. 2023). Eighty-five percent of the included studies mentioned at least one corporate biodiversity action, which we group into five categories (Figure 3b):

First, *implement a formal policy/commitment* (60%) involves establishing structured frameworks and strategic plans aimed at guiding biodiversity conservation efforts within the organization. For example, many companies adopt formal biodiversity policies such as making biodiversity commitments, such as no net loss, nature-positive impact, and zero deforestation. Clearly defined policies and commitments not only provide a roadmap for implementation, but also demonstrate a company's genuine dedication (Boiral and Heras-Saizarbitoria 2017; de Silva et al. 2019; Potdar et al. 2016), serving to evaluate the importance and stature of biodiversity beyond the operational level (Athanas 2005; Grigg 2005), as an important element in standards guidelines such as the TNFD framework and the European Financial Reporting Advisory Group (EFRAG) Biodiversity and Ecosystems Exposure Draft Standard (ESRS E4; see ESRAG 2022).

The literature indicates a gradual increase in biodiversity targets among companies, although study samples are different. For instance, Boiral and Heras-Saizarbitoria (2017) found 25% of sampled companies had formal biodiversity policies for the 2008–2012 period, while Potdar et al. (2016) noted that up to 25% had a formal biodiversity policy or strategy, with fewer having formal targets based on company reports from 2009 to 2011. zu Ermgassen et al. (2022) reported that 10 of the Fortune 100 had specific, measurable, and time-bound goals in 2021, up from five in 2016 (Addison et al. 2019). Additionally, a 2019 survey found that 41% of sampled German companies had set biodiversity targets (Krause et al. 2021) while de Silva et al. (2019) found over half of their sample had similar targets. Despite these commitments, concerns remain about their effectiveness due to challenges in implementation, monitoring, and the risk of greenwashing, which can lead to symbolic rather than substantive actions (zu Ermgassen et al. 2022; Talbot and Boiral 2021).

Second, *report and disclose activities (40%)* refers to biodiversity accounting, which involves integrating biodiversity considerations into a company's financial and non-financial reporting frameworks. Effective biodiversity reporting involves detailed documentation of biodiversity-related initiatives, progress, and outcomes to enhance transparency and communication with stakeholders. It clarifies actions needed for biodiversity improvements, identifies best practices, and provides insights that support investor decisions, influence customer choices (Maignan and Ferrell 2003). A clear indicator that businesses acknowledge biodiversity as a material risk is their disclosure of and reporting on their biodiversity impacts in sustainability reports (Boiral 2016). Frameworks such as the Global Reporting Initiative (GRI) offer guidelines and indicators (EN11-15) for measuring and disclosing ESG performance related to biodiversity, helping organizations of all sizes and sectors standardize and enhance their reporting practices (Addison et al. 2019; Cubilla-Montilla et al. 2020; Potdar et al. 2016).

The literature shows a growing trend in companies' inclusion of biodiversity in their reports. Rimmel and Jonäll (2013), van Liempd and Busch (2013) found that between 2006 and 2011, the extent of biodiversity reporting among sampled companies in Sweden and Denmark was limited to no more than 40%. However, Potdar et al. (2016) found that 76.2% of sampled companies reported on biodiversity from 2009 to 2011. zu Ermgassen et al. (2022) showed that the number of Fortune 100 companies mentioning biodiversity in their company reports rose from 50 to 70 between 2016 and 2021. This may be due to increased focus on external communication by companies, viewing biodiversity as an important aspect of organizational stewardship and legitimacy, along with policy changes. Also, biodiversity accounting has shifted from voluntary to mandatory reporting with the introduction of the European Directive 2014/95/EU (Corvino et al. 2021); however, it remains in the early stages of development due to a lack of quantifiable documentation (Addison et al. 2019).

Third, *biodiversity-friendly business practices* (20%) involve integrating biodiversity-responsible and sustainable approaches into company operations and supply chains. Examples of biodiversity-friendly business practices include sourcing materials from suppliers who adhere to sustainable and biodiversity-friendly methods, reducing habitat destruction by minimizing land use and preserving natural habitats, developing eco-friendly products, and implementing practices that support diverse ecosystems (Moon et al. 2014). Companies across various industries are adopting innovative practices with a lower biodiversity footprint (White, Mukherjee, et al. 2023; White, Petrovan, et al. 2023). For instance, apparel companies are adopting alternative fibers like hemp to reduce soil toxicity and support biodiversity by promoting healthier soil and minimizing harmful pesticides and fertilizers. Fashion leaders like Kering reduce their land footprint to minimize habitat destruction, while the Textile Exchange's CFMB program promotes biodiversity by encouraging sustainable practices and materials in the textile industry. In real estate, the International Biodiversity and Property Council has introduced the biodiversity label to standardize biodiversity benchmarks in built environments (Panwar et al. 2022).

Fourth, *conservation initiatives* (17%) involve companies making direct investments and participating in projects dedicated to biodiversity conservation. Such initiatives may include habitat restoration, species preservation, and other efforts aimed at mitigating the environmental impact of business activities. For example, companies might invest in reforestation projects to restore degraded forests, fund conservation programs for endangered species, or establish protected areas to preserve critical habitats (Bosshard et al. 2021; Lamont et al. 2023). Traditionally, companies have engaged through donations to environmental agencies or organizing their own projects such as wetland restoration. More recently, they have participated in initiatives including biodiversity offsetting, PES, and land-based carbon markets, as well as utilizing biodiversity credits and conservation bonds (Kedward et al. 2023). The financial instruments related to these initiatives are elaborated on in Section 3.2.5.

Fifth, *partnership with stakeholders*, mentioned in 40% of studies, involves companies actively collaborating with various stakeholders, including local communities, governmental bodies, and NGOs, to leverage collective efforts in biodiversity conservation. Bosshard et al. (2021) found that 36 out of 40 reviewed companies collaborated with third-party non-profits or NGOs with international projects or with local experts and communities to implement restoration activities. Potdar et al. (2016) presented several international multi-stakeholder alliances between companies and stakeholders: the Climate, Community, and Biodiversity Alliance established in 2003, the Energy and Biodiversity Initiative, which ran from 2001 to 2007, and the Flora and Fauna International Global Business Partnership. The International Union for Conservation of Nature–International Council on Mining and Metals (IUCN–ICMM) Mining Dialoge was active from 2004 to 2008 and from 2012 to 2016. Additionally, the World Business Council for Sustainable Development, founded in 1992, promotes sustainable practices across industries.

3.2.3 | Barriers

The barriers for businesses biodiversity engagement are covered in 86% of analyzed studies and we grouped them into nine categories (Figure 3c)

1. *Regulatory uncertainty*, the main barrier mentioned in 62% of the articles, stems from the absence, conflict, and vagueness of regulations, alongside frequent policy shifts, inconsistent enforcement (Athanas 2005; Cortina-Segarra et al. 2021), and inadequate institutional frameworks (White, Mukherjee, et al. 2023; White, Petrovan, et al. 2023). These issues undermine the credibility of conservation agreements, create doubts about long-term funding to cover the maintenance costs of landowners (Alvarado-Quesada et al. 2014), and deter private sector investment. Consequently, firms tend to meet only minimum regulation standards, while potential investors worry that sudden regulatory changes could jeopardize their investments (Meißner and Grote 2017), causing them to withdraw and cancel planned investments (Clark et al. 2018). This is especially problematic in developing countries, where supply chains often intersect with high-biodiversity areas, yet relevant regulations are frequently absent (Rainey et al. 2015).

2. *Lack of awareness* is noted in 47% of the included studies and signifies inadequate understanding or recognition of the importance of biodiversity and its implications for business practices. Companies often view biodiversity as a complex public good primarily managed by governments, leading to its neglect in business priorities (Addison et al. 2019; Adler et al. 2018). This perception can cause businesses to view their own actions as having minimal impact or being unnecessary (Potdar et al. 2016; Schaltegger et al. 2022), leading to an underestimation of risks and reluctance to invest due to the lack of immediate financial returns (Meißner and Grote 2017). Within the ESG framework, businesses frequently prioritize climate change and social issues over biodiversity (White, Mukherjee, et al. 2023; White, Petrovan, et al. 2023), while concerns about greenwashing—the fear of being perceived as insincere in environmental commitments since core operations may harm nature—further deter genuine engagement with biodiversity (Krause and Matzdorf 2019). An early survey of 112 UK companies over 20 years ago found that biodiversity impacts were hardly recognized as a business issue (Hood and Nicholl 2002). It remains the case that most businesses do not fully integrate biodiversity into their environmental strategies (Addison et al. 2019; Bhattacharya and Managi 2013; zu Ermgassen et al. 2022), with neglect outside major industries including food and forestry (Panwar et al. 2022). To address this, enhanced financial, technological, and social knowledge at the corporate, managerial, and national levels—especially in developing countries—is crucial for recognizing and valuing natural capital.

3. *Limited metrics or measurements*, as mentioned in 41% of studies, refer to the lack of both standardized general metrics for biodiversity and effective assessment of business-specific biodiversity performance. General biodiversity metrics are crucial for monitoring and evaluating ecological trends as well as for measuring both the positive and adverse impacts of projects (Strange et al. 2024). However, the inherent complexity of biodiversity, which spans genetic, species, and ecosystem levels, is not fully captured by fragmented current indicators or a single metric, and no consistent metrics are available to accurately attribute biodiversity loss to a company's economic activities (Nedopil 2023; Santini et al. 2017). The absence of coherent, actionable metrics makes it difficult for businesses to quantify and manage their biodiversity impacts, which hinders the effective integration of biodiversity considerations into corporate decision-making (Addison et al. 2020; Dempsey 2013). This issue is further exacerbated on a global scale, where inconsistent standards across regions and supply chains complicate the comparison of biodiversity assessments (Addison et al. 2019; Athanas 2005; Lindenmayer et al. 2023). Additionally, even if such metrics existed at the project or firm level, the ongoing lack of data for measuring biodiversity impacts and dependencies further complicates the issue (Skidmore et al. 2021). This also limits financial decision-makers' ability to measure or value biodiversity risks, leading to inconsistent reporting and making it challenging for companies to align their actions with global efforts to halt biodiversity loss (Roberts et al. 2021; Schaltegger et al. 2022).

4. *Limited access to expertise and knowledge* is mentioned in 27% of the studies. Companies often lack the specialized knowledge required for successful biodiversity conservation actions, including assessing the impact of their activities on biodiversity, understanding the status of biodiversity in relevant areas, and knowing how to apply strategies to mitigate their impacts. This may lead to overreliance on external consultants and in-house teams, who may not have sufficient expertise in either conservation biology (Krause et al. 2021) or social welfare (Bidaud et al. 2018), resulting in biased or inadequate assessments. Further, dependence on external consultants who are not regularly on-site concentrates biodiversity management knowledge in a few individuals, rather than spreading it throughout the organization (Boiral et al. 2018). Additionally, biodiversity information is frequently dispersed among various actors, which complicates access to comprehensive data and leads to redundant efforts as companies may duplicate existing baseline data (Athanas 2005). Furthermore, inadequate communication and collaboration between the business sector and conservationists hinder the identification of biodiversity opportunities and the structuring of effective projects (Lambooy and Levashova 2011). To overcome these challenges, there is a need to enhance internal capabilities, improve information-sharing platforms, and foster better collaboration between businesses and conservation experts (Krause et al. 2021).

5. *High transaction costs*[11] (mentioned in 27% of studies). Implementing a biodiversity management system requires substantial expenses for assessments, documentation, expert recruitment, and training (Boiral et al. 2018). For small- and medium-sized enterprises (SMEs), these high costs, including those for due diligence and long-term project assessments, can make biodiversity investments seem excessive (Lambooy and Levashova 2011). Compounding the issue are weak institutions, smallholder involvement, and the need for intermediaries (Alvarado-Quesada et al. 2014). Additionally, the reluctance of customers to pay a premium for biodiversity-friendly products and the costs associated with managing and certifying protected areas further increase the financial burden (Meißner and Grote 2017). Difficulties in linking beneficiaries with investors and addressing information gaps also complicate cost recovery (Nedopil 2023).

6. *Financial constraints*, covered in 16% of the reviewed literature, show that companies, particularly SMEs, face limited resources for voluntary biodiversity initiatives due to fluctuating budgets and insufficient funds (Krause and Matzdorf 2019; Krause et al. 2021).

7. *Insufficient transparency in biodiversity reporting* (12%) refers to the lack of clear, comprehensive, and accessible information regarding a company's biodiversity impact and conservation efforts in its reporting practices. This issue impedes effective communication and trust-building, as many companies struggle to provide comprehensive information about their biodiversity-related activities, complicating the linkage between reports and actual impacts (Boiral and Heras-Saizarbitoria 2017; Smith et al. 2019). As a result, biodiversity disclosures across companies are often limited, inconsistent, and lack meaningful impact

(Hassan et al. 2020). This lack of transparency is also seen in the phenomenon of "greenhush," where companies downplay their environmental disclosures, obscuring their true commitment to biodiversity and diminishing the visibility of biodiversity reporting (Addison et al. 2019).

8. *Lack of investment-ready conservation projects* (10%), marked by unclear goals, conflicting agendas, time constraints, and a mismatch between investor expectations for low-risk, well-defined opportunities and the experimental, high-risk nature of many projects—limits their appeal and investment viability (Dunn-Capper et al. 2023).
9. *Absence of clearly defined corporate biodiversity commitments* refers to the lack of formal policies or explicit, quantifiable biodiversity goals within a company, noted in 9% of studies. It hampers effective action by lacking specific, measurable goals and accountability frameworks, making it difficult to gauge progress and hold companies accountable for their impacts (Boiral and Heras-Saizarbitoria 2017; zu Ermgassen et al. 2022).

3.2.4 | Co-Occurrence Between Motivations, Activities, and Barriers

In this section, we quantify the co-occurrence of categorized motivations, barriers, and activities in the examined records to investigate intricate thematic, though not necessarily causal, linkages (Figure 4; for complete metric details, see Appendix S8).

Financial profitability demonstrates significant co-occurrence with various other motivations, such as *operational management* (43), *regulatory compliance* (36), *reputation and brand value* (37), *moral incentives* (33), as well as organizational actions like *reporting and disclosing activities* (25), *partnering with stakeholders* (28), and *implementing formal policies and programs* (41). It is also frequently mentioned alongside barriers such as *regulatory uncertainty* (39), *limited metrics or measurements* (24), and *lack of awareness* (30). These results align with our expectations, as it is almost impossible to discuss the motivations behind corporate investment without factoring in profitability for business nature and sustainability, even if there may be moral incentives. This also suggests that *financial profitability* is not only an important factor in corporate biodiversity conservation discussions but also not a standalone element; it reflects researchers' perspectives on the interconnectedness and complexities of these elements in corporate decision-making regarding biodiversity engagement.

Regulatory uncertainty frequently appears in discussions with motivations such as *operational management* (41), *moral incentives* (37), *reputation and brand value* (35), and *regulatory compliance* (35), as well as actions like *implementing a formal policy or program* (44), and challenges like *lack of awareness* (32). This suggests that *regulatory uncertainty* is a recurring theme in the literature on corporate biodiversity conservation, aligning with broader discussions on public goods investment, where public policy and regulatory clarity are often debated as a critical factors influencing both opportunities and obstacles.

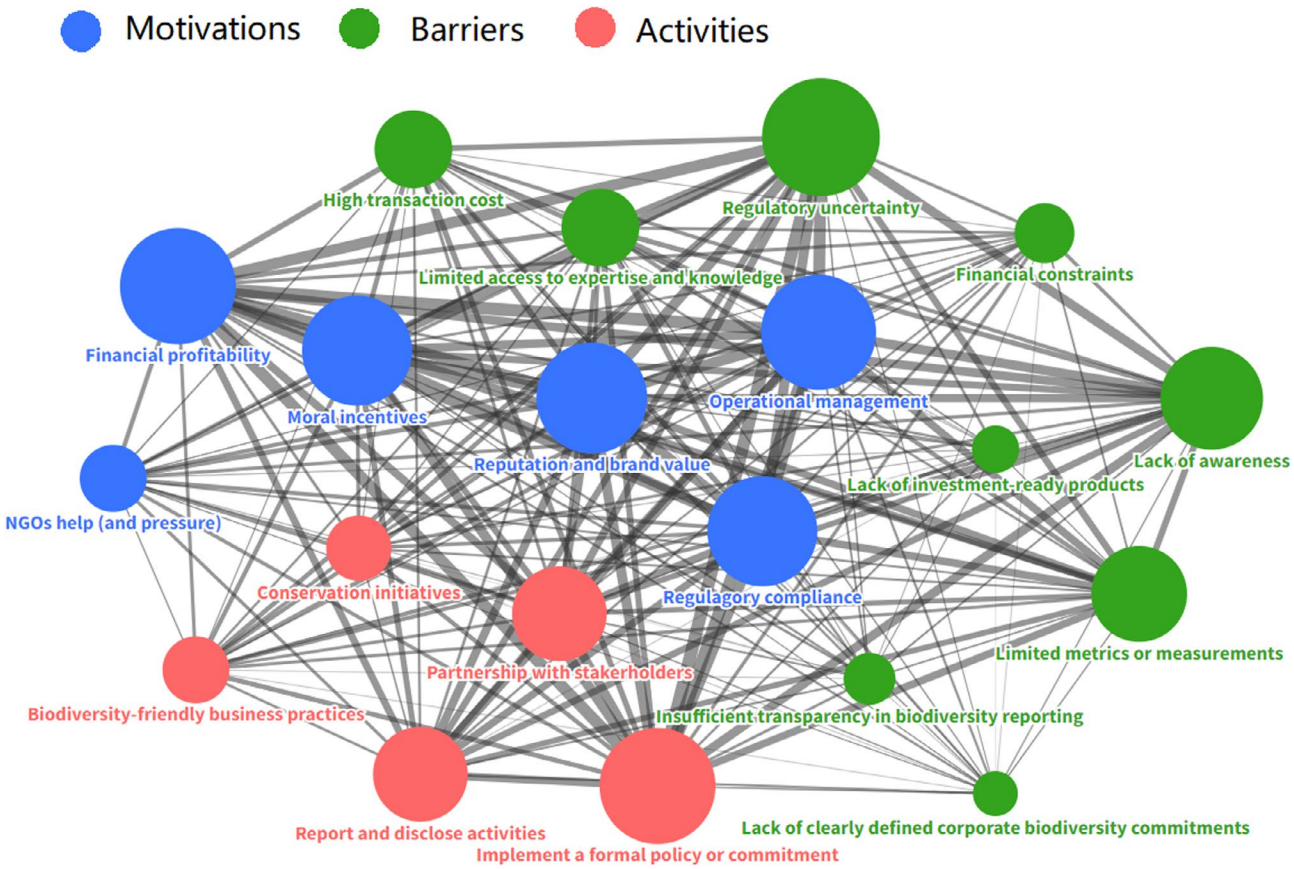

FIGURE 4 | Network linking motivations, activities, and barriers. Bubble size represents frequency of records; thicker lines between bubbles indicate higher frequency of co-occurrence.

3.2.5 | Financial Instruments

Figure 3d illustrates the frequency of recorded financial instruments for biodiversity conservation. Almost half explicitly discussed financial mechanisms for biodiversity protection, categorized as follows: *biodiversity offsets/mitigation banks* (33%), *biodiversity credits* (3%), *PES* (25%), *conservation/green/impact bonds* (15%), *philanthropic donations* (7%), *land-based carbon markets* (10%), *debt-for-nature swaps* (6%), *subsidies* (7%), and *direct biodiversity fees* (6%). We summarize these instruments, including their descriptions, financial sources, and mechanism types, in Appendix S9.

Various instruments discussed involve businesses paying for conservation services via systems overseen by the state or driven by regulation, emphasizing that historically and presently, public mechanisms and regulation serve as the predominant source for biodiversity funding protection (Bull and Strange 2018; Kedward et al. 2023; Zu Ermgassen et al. 2025). Financing mechanisms, including public-led *debt-for-nature swaps*, *subsidies*, and other instruments, all heavily involve the public sector. Business conservation activities are also funded through philanthropic contributions from private donors and organizations. The literature demonstrates an increasing emphasis on potential solutions for deriving financial returns from business investment in nature (Karolyi and Tobin-de la Puente 2023; Zu Ermgassen et al. 2025; den Heijer and Coppens 2023), but in line with other related work our review finds that the significance of public mechanisms cannot be overlooked (Kedward et al. 2023). It is imperative to capitalize on and leverage different mechanisms and sources, exploring avenues to mobilize additional capital for the effective protection of nature and its associated ecosystem services (Löfqvist et al. 2023). This involves the establishment of new funding structures and fostering innovative public-private partnerships in financial markets (Clark et al. 2018). Scholars argue that although leveraging insights from the carbon market could incentivize corporate investment in biodiversity, the creation of a biodiversity market presents greater challenges due to the inherently localized nature of biodiversity loss (Hogg 2024; Nedopil 2023). Given that current efforts to engage businesses in biodiversity primarily rely on voluntary initiatives and disclosure mechanisms, the challenge remains in effectively driving significant corporate investment and sustained action.

4 | Discussions and Perspectives

Section 3 has outlined motivations, barriers, actions, and financial instruments recorded in connection with business engagement in biodiversity conservation. Here, we will further discuss some key determinants.

4.1 | Is Financial Profitability a Prerequisite for Firms to Engage in Biodiversity Protection?

Financial profitability is an important motivator for many companies, especially those with a strong profit orientation. In this context, they are inclined to incorporate conservation projects into their core business only when a robust business case and assured economic value are evident. However, current literature suggests that the expectation of immediate financial return alone may not be a sufficient or even a core element driving investments in biodiversity (Koellner et al. 2010). This is partly due to the difficulties in monetizing biodiversity currently, as many of its values—such as existence, bequest, and option values—are considered public goods: hard to measure, and harder to monetize. Additionally, challenges including limited investable products and high-risks, as discussed in the barriers section, further complicate investment in this area. This also makes biodiversity investment challenging to mainstream for businesses purely on financial grounds (Zu Ermgassen et al. 2025), leading many companies to view such investments more as a moral effort with the hoped-for by-product of direct financial gain (Koellner et al. 2010; Krause et al. 2021; Thompson 2018). With the exception of investments driven by regulations requiring investments in nature under compliance markets (e.g., Biodiversity Net Gain in England, US wetland mitigation markets; Bull and Strange 2018), motivations for such investment mainly stem from concerns related to enhancing reputation, attracting investors, and achieving long-term social and environmental goals (Koellner et al. 2010; Mohr and Metcalf 2018; Varumo et al. 2022; Löfqvist et al. 2023). Thus, the market for voluntary commitments and biodiversity solutions remains currently a niche. Some scholars suggest integrating biodiversity into financial analysis and investment strategies can stimulate private sector demand for ecosystem services, creating win–win opportunities that extend beyond environmental goodwill and encourage long-term commitments (Flammer et al. 2025; Koellner et al. 2010).

Moreover, different companies and investors vary in their expectations regarding risk and return, pursuant to their different motivations (Thompson 2023). For example, Löfqvist and Ghazoul (2019) and Starks (2023) found that traditional investors expected returns that meet or exceed risk-adjusted market levels. Some impact investors may accept lower immediate returns for their impacts, although many still seek risk-adjusted market returns. Socially Responsible Investing and ESG investors typically aim for returns close to risk-adjusted market levels, with some willing to accept lower returns. Additionally, Bosshard et al. (2021) categorized the companies into for-profit businesses, certified social enterprises, and non-profit organizations, each with different financial expectations.

4.2 | Regulation: Shaping and Impeding Business Biodiversity Engagement

Our results indicate that regulatory frameworks have a dual role on corporate biodiversity engagement. Regulatory compliance acts as a strong motivator for companies to engage in biodiversity initiatives, while regulatory uncertainty and conflicting policies can be obstacles.

On the one hand, there has been a significant push for new policies and regulations to hold companies accountable for their biodiversity impacts, driving rapid advancements in corporate biodiversity engagement. For instance, the EU's CSRD may mark a transformative shift in firms' attention to ESG reporting (Zu Ermgassen et al. 2025), shaping motivations and strategies going forward. The CSRD's focus on transparency and comprehensive reporting, first for a limited, but later

growing number of firms, will likely tap into multiple motivations uncovered in this review and shift biodiversity concerns up the corporate agenda. This in turn would increase firms' attention to and vocalization of the need to deal with for example, the barriers identified in our analyses above, like the lack of investable actions, reliable metrics, monitoring systems, etc.

On the other hand, to maximize the positive impact of regulations, it is important to provide steady and consistent regulatory signals along with clear implementation guidelines to alleviate investor uncertainties. Additionally, toward a broader intervention logic, governments should create a supportive policy environment for businesses to commit to biodiversity targets, using both regulatory and enabling approaches to mobilize companies with diverse motivations and strategies through various incentives and triggers (van Oorschot et al. 2020). Moreover, improving alignment between various funding sources—such as non-return-seeking grants and subsidies, alongside private investment opportunities—can help mitigate risks associated with biodiversity investments (Zu Ermgassen et al. 2025).

4.3 | Research Gap and Future Research Agenda

Overall, our scoping review reveals a growing academic interest in corporate engagement in biodiversity conservation. We also identify several research gaps for future research, which match up with the research agenda for business biodiversity management outlined in White et al. (2024). Our study provides quantitative support that evidences the severe shortfall of rigorous empirical work exploring business engagement with biodiversity: more qualitative and quantitative empirical work is necessary to enable general conclusions about how to better incentivize corporate biodiversity efforts and address the barriers we have identified, while considering the different sectors, geographies, and societal and political contexts in which they operate. The proposed directions for future research are: pricing biodiversity risk, identifying the optimal mix of financial instruments to drive business actions, understanding the role of regulation and policy in shaping business strategies, and developing viable business models that integrate biodiversity. Additionally, research should explore how to foster stakeholder and sectoral engagement, as well as what methods and metrics are appropriate for measuring, reporting, and monitoring biodiversity impacts in business operations and along supply chains. Other critical areas include ensuring transparent reporting and accountability for biodiversity impacts, and scaling up corporate biodiversity efforts.

Moreover, the existing literature exhibits a clear bias toward self-reported company disclosure. Yet, Smith et al. (2019) demonstrated stark differences between self-reported company information and more objective perceptions of their operations and practices, demonstrating clear limitations on relying on the former. Interdisciplinary and international collaboration is needed to generate and share context-specific data (including both biological outcomes and financial accounting) to improve transparency, support business biodiversity commitments, inform policy, and advance research.

4.4 | Limitations

Several limitations should be acknowledged in this study. First, we restricted our review to English-language publications and excluded "gray," non-peer-reviewed literature. Additionally, our selection process involved subjective decisions, such as excluding low-quality predator journals, which may introduce bias. Despite these limitations, we adhered to PRISMA-ScR guidelines to minimize bias and ensure a rigorous review process. Finally, this study, like all subjective classification studies, serves as a snapshot of the overall literature; therefore, the classifications of individual studies may not be used in isolation as definitive categorizations.

5 | Conclusion

This study provides an overview of factors influencing corporate engagement in biodiversity, based on a scoping review of 100 studies from four major databases covering literature from this Millennium. We find a rising academic focus on corporate biodiversity conservation, differentiating biodiversity conservation and finance from broader sustainability issues. Findings indicate that corporate motivations are multifaceted, encompassing economic benefits (such as financial profitability and operational management), ethical considerations (including reputation and brand value, and NGOs help and pressure), and moral incentives. Regulatory frameworks can both facilitate and hinder biodiversity engagement, with compliance acting as a motivator and regulatory uncertainty as a barrier. While the literature frequently emphasizes reporting, formal commitments, and partnerships with stakeholders, biodiversity-friendly business practices and conservation initiatives receive comparatively less attention. Barriers arise from external challenges (e.g., lack of investable products and metrics, regulatory uncertainties) and internal issues (e.g., low awareness and financial constraints). While various financial instruments for biodiversity conservation have been identified, further research is needed to explore innovative funding structures that enhance business investment in conservation efforts. Our findings provide entry points for future empirical research on designing tailored policies and instruments to engage businesses in scaling up biodiversity efforts, considering the different incentives and triggers that arise from the diversity of corporate motivations and strategies. As corporate biodiversity engagement ascends on the international agenda, future empirical research is called for to better understand corporate involvement in biodiversity conservation and to address the limitations of self-reported company disclosures.

Acknowledgments

This research was funded by EU Horizon 2020 project SUPERB (Systemic solutions for upscaling of urgent ecosystem restoration for forest-related biodiversity and ecosystem services) (GA-101036849). We thank Anne Cathrine Trumpy and Bjørn Christian Arleth Viinholt at the Royal Danish Library for their guidance in conducting this scoping review and reviewing our search strategy. We also received access to the Covidence software from the Royal Danish Library. We are grateful for the valuable feedback received during the IUFRO 2024 conference in Stockholm, Sweden. We would like to acknowledge the valuable suggestions from Clara G. Bouyssou and Carl-Emil Pless during the earlier

stages of the research. We also thank anonymous reviewers and the editor, who provided thoughtful comments improving the quality of the paper.

Endnotes

[1] "Biodiversity" amalgamates the terms "biological diversity," indicating the range of living organisms from various origins—terrestrial, marine, and other aquatic ecosystems, along with their interconnected ecological systems (CBD 1992). We use the term "nature" interchangeably with "biodiversity" to refer to the combined richness of living organisms and the ecosystem services provided by natural habitats.

[2] In this study, businesses broadly include companies, firms, corporations, and financial institutions—different from public and non-governmental organizations (NGOs). The terms private sector, business, firm, company, and corporation are used interchangeably.

[3] Biodiversity finance is the practice of raising and managing capital and using and economic incentives to support sustainable biodiversity management (Flammer et al. 2025; Karolyi and Tobin-de la Puente 2023).

[4] The asterisk * is used in search strategy as a wildcard to capture different word endings and variations, such as "investment" or "investing" for "invest*."

[5] This study's search is current only up to June 9, 2023, and the rapidly evolving field may yield new insights in future research.

[6] Due to limitations in time, cost, and expertise with non-English languages, we restricted our review to English-language papers. English remains the dominant languages in the biodiversity-related literature. In medical sciences, exclusion of non-English languages was found not to trigger any bias (Morrison et al. 2012). However, it should be noted that by concentrating solely on English-language papers, we may miss insights from non-English sources (Angulo et al. 2021).

[7] Quantitative analysis focuses on correlational studies, examining relationships between quantitative variables (categorical, ordinal, and interval/ratio) using structured methods like surveys and experiments. Qualitative analysis relies on nonnumerical data to construct inferences, often through case studies that include interviews, focus groups, and observations (Cox 2015).

[8] We used the EU classification of economic activities, Nomenclature of Economic Activities (NACE) Rev. 2 codes to categorize sectors.

[9] According to Carroll (1991), economic responsibility means businesses strive for profitability to support their survival and growth. Legal responsibility requires companies to obey the law and protect stakeholder rights. Ethical responsibility involves doing what is right and fair for employees, customers, and other stakeholders. In contrast, philanthropic responsibility entails contributing to society and supporting community development as good corporate citizens. The distinguishing feature between ethical and philanthropic responsibilities is that ethical responsibilities are normative obligations requiring businesses to act justly and avoid harm, while philanthropic responsibilities are voluntary contributions aimed at enhancing societal welfare and quality of life, which are not considered morally obligatory.

[10] In the USA, abandoned mining sites are regulated by the Surface Mining Control and Reclamation Act, The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the Resource Conservation and Recovery Act. In Europe, the Environmental Impact Assessment Directive and various waste directives govern soil and water restoration efforts, all contributing to biodiversity conservation.

[11] The term "high transaction cost" in this context appears somewhat generic, as many of the previously mentioned barriers also contribute to increased transaction costs. Here, we specifically refer to factors beyond those aforementioned, collectively denoted as "high transaction cost." This term is employed to encapsulate elements other than the barriers discussed earlier that significantly contribute to elevated transaction costs.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.