

# Natural Capital Accounting as a Strategic Tool for Biodiversity Preservation in Resource-Intensive Firms

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## ARTICLE HISTORY

Received: October 15, 2025

Revised: December 11, 2025

Accepted: December 11, 2025

## DOI

<https://doi.org/10.52970/grcsd.v6i1.1941>

## ABSTRACT

This study examines the role of Natural Capital Accounting (NCA) as a strategic instrument for biodiversity preservation within resource-intensive firms, a sector characterized by significant ecological dependencies and impacts. The research aims to evaluate how NCA reshapes corporate governance, supports ecological risk management, and enhances biodiversity-related decision-making processes. Employing a qualitative research design through a systematic literature study, the analysis synthesizes theoretical contributions and empirical evidence from interdisciplinary scholarship in environmental accounting, ecological economics, and sustainability management. The methodological approach includes thematic content analysis of peer-reviewed studies, institutional reports, and contemporary policy frameworks to identify patterns in NCA implementation, operational challenges, and biodiversity outcomes. The findings reveal that firms adopting NCA meaningfully integrate ecological considerations into strategic planning, risk assessment, and performance evaluation, demonstrating clearer pathways toward biodiversity stewardship. However, the study also identifies significant methodological limitations, including data gaps, valuation complexities, and organizational constraints that hinder effective application. The results underscore that NCA contributes positively to biodiversity preservation when supported by strong governance structures, robust ecological data, and institutional commitment. The study concludes that NCA has considerable potential as a transformative sustainability tool, offering theoretical insights into multi-capital accounting and practical implications for aligning corporate operations with global biodiversity objectives.

**Keywords:** Natural Capital Accounting, Biodiversity Preservation, Resource-Intensive Firms, Sustainability Governance, Ecological Economics.

## I. Introduction

Natural capital has increasingly emerged as a central construct in contemporary sustainability discourse, particularly as global economic systems confront escalating ecological degradation and biodiversity loss. Defined as the world's stock of natural assets—including soil, air, water, and living organisms—natural capital serves as the biophysical foundation upon which economic activities depend. Yet, despite its intrinsic and instrumental value, natural capital has historically been overlooked in corporate

decision-making, resulting in a persistent misalignment between ecological realities and organizational strategies. The acceleration of biodiversity decline, driven by land conversion, pollution, overexploitation, and unsustainable industrial practices, has intensified calls for more structured mechanisms to incorporate ecological considerations into business operations. Among emerging frameworks, Natural Capital Accounting (NCA) is increasingly recognized as a strategic tool capable of capturing ecological costs and benefits that conventional financial accounting systems fail to represent. By quantifying environmental dependencies and impacts, NCA offers a pathway for resource-intensive firms to operationalize sustainability commitments while simultaneously preserving biodiversity that underpins long-term business viability (Dasgupta, 2021).

As the global economy becomes more resource dependent, industries such as mining, energy, pulp and paper, and large-scale agriculture occupy a central position in shaping ecological outcomes. These sectors extract, transform, and commodify natural capital at scales that exert profound ecological pressure. Consequently, resource-intensive firms are confronted with heightened regulatory scrutiny, stakeholder expectations, and reputational risks associated with environmental degradation. Biodiversity loss poses operational vulnerabilities for such firms by reducing ecosystem resilience, disrupting supply chains, and amplifying legal and financial risks. Recent international initiatives—including the Kunming-Montreal Global Biodiversity Framework (2022) and the Taskforce on Nature-related Financial Disclosures (TNFD)—have underscored the urgency for companies to measure, manage, and disclose their impacts and dependencies on nature. Natural Capital Accounting is therefore positioned not merely as an environmental reporting mechanism but as a strategic management instrument that integrates biodiversity considerations into core business planning, risk assessment, and value-creation processes (TNFD, 2023). In this context, NCA's capacity to translate ecological variables into quantifiable and decision-informing metrics becomes particularly vital for firms whose operations are deeply intertwined with natural ecosystems.

The need for structured biodiversity preservation strategies is amplified by empirical evidence demonstrating the severity and speed of ecological decline. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) estimates that one million species are threatened with extinction, many within decades, primarily due to human activities (IPBES, 2019). Resource-intensive industries contribute disproportionately to habitat fragmentation, soil depletion, water contamination, and greenhouse gas emissions, creating cumulative pressures that destabilize ecological networks. Yet, these same industries also possess the greatest capacity to reverse biodiversity decline through targeted investments, ecological restoration, and sustainable resource management. The integration of NCA allows firms to map ecological dependencies with granular precision, identify critical biodiversity hotspots, and evaluate the ecological consequences of operational alternatives. This structured approach can support the development of long-term conservation strategies while aligning corporate incentives with ecological stewardship. Such alignment is increasingly recognized as essential for achieving global biodiversity targets and securing sustainable development trajectories.

Beyond environmental benefits, NCA serves strategic corporate objectives by enhancing risk management, improving regulatory compliance, and strengthening stakeholder engagement. Research evidence indicates that firms integrating environmental accounting systems are better positioned to anticipate regulatory changes, mitigate ecological liabilities, and maintain competitiveness in markets increasingly shaped by sustainability demands (Khan et al., 2023). Investors, consumers, and civil society organizations are demonstrating heightened expectations for transparent reporting on nature-related risks. Consequently, firms that adopt NCA signal strong commitment to sustainability governance, thereby enhancing legitimacy and trust. For resource-intensive firms frequently scrutinized for ecological harm, NCA becomes a means of reframing organizational narratives—from extractive and harmful to restorative and responsible. Moreover, natural-capital-based assessments support strategic transformations such as transitioning to circular production models, optimizing resource efficiencies, and identifying innovation opportunities that align with corporate sustainability objectives.

From a theoretical standpoint, Natural Capital Accounting intersects with several streams of sustainability research, including ecological economics, corporate environmental responsibility, and strategic

management. Ecological economics provides the conceptual basis for understanding nature as a form of capital that generates measurable economic value, while corporate environmental responsibility emphasizes the moral and managerial obligations of firms to reduce ecological harm. Strategic management literature, meanwhile, highlights how environmental capabilities can become sources of competitive advantage. NCA synthesizes these perspectives by providing a methodological approach to quantify ecological inputs and outputs in ways that facilitate strategic decision-making. Scholars have increasingly argued that natural capital frameworks can reshape how organizations perceive environmental responsibility by embedding ecological constraints within operational boundaries (Gupta & Mason, 2020). As such, NCA is not merely a reporting mechanism but part of a broader evolution toward regenerative business strategies.

A growing body of empirical research reinforces NCA's potential for biodiversity preservation. For instance, studies show that firms adopting nature-based metrics experience improved ecosystem outcomes through better resource allocation, enhanced restoration planning, and stronger alignment between operational activities and conservation priorities (Vardon et al., 2022). Other research demonstrates that integrating natural capital assessments into corporate risk models enables firms to anticipate ecological disruptions and adapt their strategies accordingly (Beltramello et al., 2023). Evidence also suggests that NCA contributes to enhanced collaboration among firms, governments, and environmental organizations by providing a common language for biodiversity valuation and impact measurement. This shared vocabulary reduces informational asymmetries and strengthens multi-stakeholder governance frameworks necessary for effective conservation.

At the same time, the operationalization of NCA within resource-intensive industries remains constrained by methodological complexities, inconsistent data quality, and limited organizational capacity. Many firms struggle to quantify ecological variables, assign monetary values to ecosystem services, or integrate natural capital metrics into managerial dashboards. Biodiversity, in particular, presents unique measurement challenges due to its multidimensional nature and context-specific variability. As a result, despite global momentum and growing regulatory pressures, adoption rates of NCA remain uneven. Research indicates that firms frequently apply natural capital frameworks superficially, emphasizing disclosure over substantive ecological outcomes (Reed et al., 2021). This gap between conceptual ambition and practical implementation underscores the need for empirical studies that examine how NCA can function strategically within biodiversity-sensitive industries, rather than merely as a compliance exercise.

The phenomenon of resource-intensive firms adopting or resisting NCA provides fertile ground for descriptive quantitative research. As governments and international bodies expand requirements for nature-related reporting, firms must navigate shifting expectations while assessing their own ecological dependencies. Trends in sustainability reporting reveal increased inclusion of natural capital indicators, yet significant variability persists concerning measurement rigor, strategic integration, and biodiversity relevance. Some firms have begun to embed NCA into operational planning, risk modeling, and investment decisions, whereas others employ it solely for external reporting. Understanding what drives these variations, how NCA influences biodiversity-related decision-making, and how firms perceive its strategic value becomes crucial in mapping future trajectories of sustainable business transformation.

Against this backdrop, the present study seeks to examine Natural Capital Accounting as a strategic tool for biodiversity preservation in resource-intensive firms by employing a descriptive quantitative approach grounded in previous empirical evidence. Prior studies highlight correlations between environmental accounting practices and ecological outcomes, yet gaps remain regarding how NCA specifically supports biodiversity-focused strategies. Research by Jones et al. (2020), for example, demonstrates positive associations between environmental accounting integration and ecological performance but does not focus explicitly on biodiversity metrics. Meanwhile, work by Vardon et al. (2022) and Dasgupta (2021) emphasizes the theoretical potential of natural capital frameworks but provides limited insight into firm-level implementation patterns. Quantitative descriptive research is therefore essential to map existing practices, assess adoption levels, and evaluate perceived strategic benefits among companies with significant environmental footprints.

This study is also relevant due to emerging global policy frameworks that mandate nature-related disclosures. As the TNFD becomes operational and as countries implement biodiversity-related financial regulations, firms will face increasing obligations to quantify natural capital impacts and dependencies. By examining the current landscape of NCA adoption in resource-intensive industries, the study can generate insights that support policy refinement, corporate strategy development, and academic theory-building. Furthermore, the descriptive nature of the research aligns with the need to document existing conditions before modeling causal relationships or developing predictive frameworks. Such baseline data are critical for informing future empirical research that may examine the effectiveness of NCA in driving biodiversity outcomes longitudinally or within specific industrial contexts.

Finally, the objective of this research is to provide a comprehensive, evidence-based understanding of how Natural Capital Accounting is currently utilized by resource-intensive firms in relation to biodiversity preservation. Specifically, the study seeks to identify patterns of NCA implementation, evaluate the extent to which firms perceive NCA as a strategic asset, and assess the alignment between natural capital measurement and biodiversity conservation practices. By synthesizing prior empirical findings and collecting quantitative descriptive data, the research aims to contribute to theoretical debates on environmental accounting and strategic sustainability while generating practical insights for firms and policymakers. Ultimately, the study aspires to highlight how NCA can evolve from a reporting instrument into a transformative strategic tool capable of preserving biodiversity within industries that exert the greatest pressure on natural ecosystems. In doing so, it offers a foundation for subsequent research exploring causal pathways, organizational barriers, and long-term conservation impacts associated with natural capital integration.

## II. Literature Review and Hypothesis Development

### 2.1. Conceptual Foundations of Natural Capital and Biodiversity in Corporate Sustainability

Natural capital represents the stock of renewable and non-renewable natural resources that provide ecosystem services required for economic activities, and its relevance in corporate sustainability has expanded rapidly as ecological risks intensify. Recent literature underscores that global biodiversity loss and ecosystem degradation have undermined economic stability, prompting scholars to frame natural capital as a strategic rather than merely ecological concern (Dasgupta, 2021). Biodiversity is defined not only as the variety of living organisms but also the ecological interactions that sustain ecosystem function, making it indispensable for firms relying on land, water, and raw materials. As resource-intensive firms often impose significant environmental pressures, the integration of natural capital into corporate strategies is increasingly viewed as a necessary corrective to traditional accounting approaches that neglect ecological externalities (Vardon et al., 2022). Scholars agree that biodiversity contributes to operational resilience by stabilizing supply chains, maintaining ecosystem productivity, and reducing firms' exposure to climate-related and ecological risks (IPBES, 2019; Khan et al., 2023). This understanding has shifted biodiversity from being perceived as a philanthropic or peripheral initiative toward a core strategic asset. For industries such as mining, energy, or large-scale agriculture, biodiversity underpins the quality and continuity of resource inputs fundamental to production. Thus, biodiversity preservation is not only environmentally imperative but also economically rational, as firms with degraded ecosystems face higher long-term operational costs (Gupta & Mason, 2020).

Natural Capital Accounting (NCA) emerges as a response to longstanding gaps in conventional corporate reporting systems, particularly the failure to capture environmental degradation as a quantifiable corporate liability. Prior studies indicate that traditional accounting models externalize ecological costs, enabling firms to disregard their impacts on biodiversity without financial repercussions (Reed et al., 2021). NCA attempts to resolve this deficiency by embedding ecological considerations within corporate valuation, thereby aligning environmental well-being with financial metrics. Through this integration, NCA enables firms to recognize environmental risks as strategic and material, accelerating the shift toward proactive biodiversity preservation. The academic discourse increasingly positions NCA as a transformative tool capable of

reconfiguring corporate decision-making. Scholars argue that NCA not only quantifies natural capital flows but also reveals how firms depend on ecosystem services, thereby making environmental degradation legible within managerial frameworks (Beltramello et al., 2023). This recognition is crucial for resource-intensive firms, whose extractive operations amplify ecological vulnerability. Hence, the conceptual foundation of natural capital and biodiversity forms the theoretical backbone for understanding the strategic role of NCA in corporate sustainability.

## 2.2. Evolution and Frameworks of Natural Capital Accounting in Industrial Contexts

Natural Capital Accounting has evolved from ecological economics into a structured corporate management tool supported by international policy frameworks, including the System of Environmental-Economic Accounting (SEEA) and the Taskforce on Nature-related Financial Disclosures (TNFD). Recent studies emphasize that NCA's methodological advances have enabled firms to measure biophysical changes, ecosystem service flows, and biodiversity impacts with increasing precision (United Nations, 2021). The rise of mandatory and voluntary reporting initiatives has also accelerated NCA adoption among multinational corporations, though implementation quality varies widely across sectors (TNFD, 2023). Research in resource-intensive industries reveals that firms adopt NCA primarily for risk mitigation and regulatory compliance rather than ecological restoration. For instance, mining companies use NCA frameworks to quantify land disturbance, rehabilitation liabilities, and water use intensity, enabling more accurate assessment of operational risks (Jones et al., 2020). Similarly, agricultural conglomerates employ NCA to assess soil fertility, pollination services, and water dependency patterns, providing insights into the ecological sustainability of their supply chains (Mace et al., 2022). These practices illustrate how NCA can support strategic planning, though its potential for biodiversity preservation is not fully realized.

Despite expanding global uptake, several studies highlight methodological and institutional challenges that constrain effective NCA deployment. Researchers note that biodiversity is inherently multidimensional and difficult to monetize, leading to oversimplifications when firms attempt financial valuation (Vardon et al., 2022; Deutz et al., 2021). Data limitations, inconsistent measurement standards, and lack of internal expertise further hinder implementation. Consequently, many firms apply NCA superficially, focusing on disclosure over ecological outcomes, a gap that scholars attribute to institutional pressures rather than genuine ecological commitment (Reed et al., 2021). Nonetheless, the literature identifies promising developments where NCA effectively informs biodiversity strategies. Case studies show that firms integrating natural capital metrics into investment planning and operational management achieve stronger conservation outcomes, reduced ecological liabilities, and greater stakeholder trust (Khan et al., 2023). These findings suggest that NCA's transformative potential lies in its ability to reposition biodiversity as a strategic priority embedded within corporate governance structures.

## 2.3. Empirical Findings Linking NCA to Biodiversity Preservation

Empirical research provides growing evidence of a positive relationship between NCA adoption and biodiversity outcomes. Studies demonstrate that firms incorporating natural capital metrics are more likely to invest in habitat restoration, regenerative agriculture, and ecosystem-based management approaches (Beltramello et al., 2023; Mace et al., 2022). These investments not only support conservation but also enhance long-term resource stability, illustrating the alignment between ecological integrity and corporate value. Such findings reinforce theoretical claims that NCA enables firms to internalize ecological costs, prompting more responsible resource management. Quantitative analyses reveal that NCA contributes to improved environmental performance indicators, including reductions in land degradation, enhanced water stewardship, and increased investment in biodiversity offsets (Kumar et al., 2020). Moreover, firms implementing NCA demonstrate higher compliance with environmental regulations and better performance in ESG ratings, reflecting stronger alignment with stakeholder expectations (Gupta & Mason, 2020). These

empirical patterns highlight NCA's ability to influence operational behaviors that directly impact biodiversity preservation.

Although empirical results are promising, scholars emphasize that the relationship between NCA and biodiversity outcomes is not universally linear. Some studies note that firms may adopt NCA to conform to institutional pressures without substantively altering their ecological practices, resulting in "symbolic compliance" rather than meaningful biodiversity protection (Reed et al., 2021). In such cases, NCA functions more as a reporting mechanism than a strategic tool. This gap underscores the need for deeper organizational changes, including leadership commitment, internal capacity building, and integration of natural capital metrics into core decision-making processes. Even with these limitations, research increasingly suggests that NCA is a catalyst for ecological innovation. Firms using natural capital assessments to inform product redesign, supply chain restructuring, or technological upgrades achieve measurable ecological benefits, including improved habitat connectivity and reduced pollution loads (Dasgupta, 2021; Vardon et al., 2022). These findings indicate that NCA can support biodiversity preservation when embedded meaningfully within corporate strategy rather than treated as a compliance exercise.

#### 2.4. Research Gaps and Theoretical Implications for Strategic Sustainability

Despite progress in NCA scholarship, significant research gaps persist, particularly concerning its strategic role in biodiversity preservation within resource-intensive industries. Existing studies often focus on the technical aspects of NCA rather than its organizational implications, leaving unanswered questions about how firms internalize and act upon natural capital insights (Beltramello et al., 2023). Moreover, literature lacks robust empirical evaluations of NCA's long-term ecological impacts, partly due to methodological challenges and insufficient longitudinal data. This gap limits understanding of the causal mechanisms linking NCA adoption to biodiversity outcomes. Theoretical discussions highlight the need to integrate natural capital frameworks with strategic management perspectives, particularly resource-based theory and institutional theory. Resource-based perspectives suggest that biodiversity and natural capital capabilities can generate sustained competitive advantage when embedded in firm culture and processes (Gupta & Mason, 2020). Institutional theory, however, acknowledges that external pressures often drive NCA adoption, raising concerns about symbolic compliance (Reed et al., 2021). Bridging these perspectives is essential for understanding how NCA can transition from a compliance mechanism to a strategic tool.

Additionally, scholars call for comparative analyses across sectors to examine how industry characteristics shape NCA effectiveness. Resource-intensive firms vary widely in ecological footprint, regulatory exposure, and stakeholder sensitivity, all of which influence NCA integration and biodiversity outcomes (Kumar et al., 2020). Understanding these variations can inform more tailored and impactful biodiversity strategies. The literature also emphasizes the need for improved metrics to evaluate ecological impacts, particularly metrics that reflect biodiversity's multidimensional nature rather than simplified monetary proxies. The literature points to a growing recognition of NCA's strategic relevance but highlights persistent challenges that limit its transformative potential. These gaps justify further empirical exploration, particularly quantitative descriptive research that maps adoption patterns, evaluates perceived benefits, and identifies barriers to effective implementation. Such research can deepen theoretical understanding while supporting more effective biodiversity preservation within resource-intensive industries.

#### 2.5. Hypothesis Development

Based on the reviewed literature, the study formulates the following directional hypothesis:

*H1: Natural Capital Accounting adoption is positively associated with biodiversity preservation practices in resource-intensive firms.*

This hypothesis reflects empirical evidence that firms implementing NCA demonstrate stronger conservation behaviors, while recognizing variability in implementation depth. The hypothesis is suitable for quantitative descriptive analysis that examines patterns, relationships, and strategic implications of NCA adoption.

### III. Research Method

The methodological foundation of this research is grounded in a qualitative approach that employs a systematic literature study as the primary means of inquiry. Qualitative research is particularly suitable for exploring complex and multidimensional constructs such as natural capital accounting and biodiversity preservation, as it allows for the deep interpretation of concepts, theoretical frameworks, and empirical patterns that cannot be fully captured through numerical indicators alone. In the context of this study, the qualitative paradigm facilitates the examination of how NCA has evolved, how it is conceptualized across various domains, and how it is applied within resource-intensive firms from different industrial contexts. Rather than quantifying relationships or testing statistical associations, the objective of this qualitative method is to interpret the meanings embedded within the literature, identify thematic patterns, and construct an integrated analytical understanding of how NCA functions as a strategic mechanism for biodiversity preservation. This orientation is aligned with the nature of the research questions, which aim to understand conceptual linkages, practical implications, and methodological challenges within the existing body of knowledge.

The use of a systematic literature study within a qualitative methodological framework enables the researcher to trace the intellectual development of NCA and biodiversity-related practices over time. A systematic literature study is distinct from a narrative review because it follows a structured, transparent, and replicable process for collecting, selecting, evaluating, and synthesizing relevant academic sources. This approach reduces personal bias by establishing predetermined criteria for source inclusion and exclusion, thereby enhancing the credibility and dependability of the findings. The selection of a systematic literature study is particularly appropriate for this research because the topic spans multiple disciplines—environmental accounting, sustainability management, ecological economics, corporate governance, and conservation science—requiring a method capable of synthesizing fragmented and interdisciplinary insights. As NCA has gained prominence only recently due to the growing urgency of biodiversity risks, synthesizing the most recent literature is crucial for capturing debates, controversies, and methodological innovations surrounding its adoption by resource-intensive firms.

Data for this qualitative research are derived entirely from secondary sources, specifically peer-reviewed journal articles, scholarly books, institutional reports, and policy guidelines published by reputable organizations such as the United Nations, the Taskforce on Nature-related Financial Disclosures (TNFD), and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). The primary justification for relying on high-quality secondary data is that the research aims to interpret existing knowledge rather than gather new empirical evidence. Furthermore, because natural capital accounting and biodiversity metrics are subjects of rapidly evolving global policy discussions, authoritative reports and academic studies serve as essential sources for understanding current conceptual frameworks and implementation practices. The reliance on peer-reviewed and institutionally vetted literature ensures that the data included in the analysis represent rigorous and credible scholarship, thereby strengthening the study's academic integrity.

The literature selection process begins with the identification of relevant databases and repositories. Although the qualitative method does not require the exhaustive search characteristic of quantitative meta-analysis, this study maintains a structured approach by using widely recognized academic search engines, such as Scopus, Web of Science, ScienceDirect, JSTOR, and Google Scholar. These platforms ensure coverage of interdisciplinary research spanning environmental science, sustainability management, accounting, and ecology. The search strategy relies on combinations of key terms, including “natural capital accounting,”

“biodiversity preservation,” “resource-intensive industries,” “environmental governance,” “ecosystem services valuation,” and “corporate sustainability reporting.” Boolean operators and filters are used to refine the search to documents published primarily within the last decade, ensuring that the literature reflects contemporary theoretical and practical developments in the field. Additional seminal works predating this timeframe are included when they provide foundational definitions or conceptual frameworks essential for understanding the evolution of natural capital theory.

Once a comprehensive pool of sources is established, the next step involves applying inclusion and exclusion criteria. Inclusion criteria involve selecting studies that directly examine natural capital accounting, biodiversity management, sustainability strategies within resource-intensive firms, ecosystem service valuation, or related strategic management frameworks. Studies that focus solely on unrelated environmental issues, do not involve corporate applications, or lack conceptual relevance are excluded to maintain thematic coherence. The researcher also evaluates the methodological rigor of each source to ensure that only credible, conceptually sound studies contribute to the synthesis. Institutional reports and policy documents are evaluated based on their relevance, authority, and methodological foundations. Through this process, the final dataset includes a diverse yet thematically cohesive body of literature that represents the breadth of academic and practical discourse on NCA.

Data analysis follows a qualitative content analysis approach, a method widely employed in interpretive research for identifying patterns, themes, and conceptual linkages across textual data. The analysis begins with multiple readings of each selected source to gain familiarity with the text and identify key arguments, definitions, theoretical contributions, and empirical findings. During this stage, the researcher extracts meaningful concepts and categorizes them into preliminary codes. These codes are derived inductively, meaning they emerge from the literature rather than being imposed prior to the analysis. Inductive coding is critical in this study because the academic discourse on NCA is continually evolving, and the researcher must remain open to identifying novel insights that may not fit preexisting theoretical categories.

Through iterative comparison and conceptual refinement, initial codes are consolidated into broader thematic categories. Examples of emergent themes include the strategic importance of natural capital, the role of NCA in corporate governance, challenges in biodiversity measurement, methodological controversies surrounding ecosystem valuation, and the integration of NCA into risk management processes within resource-intensive firms. Each theme represents a recurring pattern across multiple sources, allowing the researcher to produce an analytical narrative that captures the complexity of the subject matter. Thematic synthesis enables the researcher to trace how different studies complement, contradict, or expand upon one another, thereby generating a holistic understanding of how NCA is conceptualized and operationalized across various contexts. The qualitative synthesis also involves identifying gaps and limitations within the literature. Because natural capital accounting is a relatively new field, much of the existing scholarship focuses on conceptual frameworks and early-stage implementation rather than long-term empirical outcomes. The lack of consensus on biodiversity valuation methods, inconsistent measurement standards, and limited adoption across industries also emerge as recurring limitations. By identifying these gaps, the qualitative literature study not only synthesizes existing knowledge but also highlights areas where future empirical research is needed. This interpretive component is essential for positioning the study within the broader academic discourse and for demonstrating the relevance of its research objectives.

To ensure methodological rigor, the study adheres to the criteria commonly used to evaluate qualitative research quality: credibility, transferability, dependability, and confirmability. Credibility is achieved through the systematic and transparent documentation of the literature search and selection process, ensuring that the synthesis accurately reflects the current state of scholarship. Transferability is addressed by providing rich descriptions of the context and themes, allowing readers to determine the applicability of the findings to different environmental or industrial contexts. Dependability is maintained by following a replicable research procedure, including clear documentation of search strategies, inclusion

criteria, and analytical processes. Confirmability is ensured by grounding interpretations in the literature itself, supported by direct citations and thematic evidence rather than the researcher's subjective assumptions.

Ethical considerations in qualitative literature research are primarily concerned with the responsible use of secondary data and the acknowledgement of intellectual property. All sources included in the analysis are cited appropriately using standard academic referencing formats, and interpretations are grounded in the scholarly contributions of the authors. Because no human participants are involved, formal ethical approval is not required. However, the researcher remains aware of potential biases arising from selective interpretation or overreliance on certain types of literature. Efforts are made to maintain balance by incorporating studies from diverse methodological orientations and theoretical perspectives.

The qualitative methodological design adopted in this study is thus well-suited for achieving its research aims. By synthesizing a broad range of interdisciplinary studies, the method provides a robust foundation for understanding the conceptual significance of natural capital accounting, its role in corporate strategy, and its implications for biodiversity preservation in resource-intensive firms. The systematic literature study facilitates a comprehensive examination of how NCA is theorized, implemented, and critiqued across various academic domains, allowing the researcher to develop an integrated analytical perspective that contributes meaningfully to the ongoing discourse. Ultimately, this methodological approach ensures that the research findings are grounded in a rigorous and interpretive synthesis of the existing literature, offering a nuanced understanding that can inform both academic inquiry and strategic practice.

## IV. Results and Discussion

Natural capital accounting (NCA) has emerged as a prominent analytical and managerial tool that enables firms, particularly those operating in resource-intensive industries, to integrate nature-related information into strategic decision-making and sustainability planning. This section presents a comprehensive result and discussion narrative that synthesizes findings from contemporary literature, interprets the implications of NCA implementation, and evaluates the extent to which it influences biodiversity preservation outcomes. Drawing from interdisciplinary research in environmental accounting, ecological economics, corporate governance, and conservation biology, the discussion unfolds across four major thematic sub-sections: the strategic integration of natural capital into corporate systems, empirical impacts of NCA on biodiversity-related performance, ongoing challenges and methodological barriers in operationalizing NCA, and emerging trajectories for sustainable corporate practice. These sub-sections combine theoretical insights with empirical observations to provide a holistic understanding of how NCA can function as both a measurement tool and a strategic driver for biodiversity protection.

### 4.1. Strategic Integration of Natural Capital into Corporate Systems

The integration of natural capital into corporate governance frameworks represents a significant shift in how firms conceptualize and manage their interactions with the environment. Historically, corporate accounting systems have focused on financial transactions while excluding ecological costs, leading to systematic undervaluation of biodiversity and ecosystem services (Dasgupta, 2021). Recent literature reveals a growing awareness that traditional accounting frameworks are insufficient for capturing ecological dependencies and risks, especially in sectors such as mining, agriculture, fisheries, and forestry, where production processes directly rely on natural systems (Vardon et al., 2022). As firms confront escalating environmental degradation, regulatory scrutiny, and stakeholder expectations, the inclusion of natural capital metrics becomes essential to maintaining operational resilience and long-term value creation.

Researchers argue that NCA facilitates the recognition of nature as a strategic asset rather than an externality. By quantifying stocks and flows of ecosystem services, firms are better positioned to understand how biodiversity contributes to productivity, risk mitigation, and supply chain stability (Gupta & Mason, 2020). This aligns with the broader shift toward integrated reporting frameworks, which encourage firms to

acknowledge multiple forms of capital — natural, social, human, and financial — in their disclosures. The integration of natural capital into corporate strategy requires firms to embed environmental considerations across departments, from finance and risk management to operations and long-term planning. Such integration is supported by empirical studies indicating that firms adopting NCA often experience improved stakeholder trust, enhanced regulatory compliance, and strengthened reputational standing (Khan et al., 2023).

The strategic relevance of NCA becomes particularly compelling in resource-intensive sectors where ecological degradation directly affects operational viability. For example, agricultural enterprises are highly dependent on soil fertility, water availability, and pollination services — all of which degrade when biodiversity declines. By incorporating NCA into decision-making, firms can identify ecological thresholds and prioritize investments in conservation to safeguard resource availability. In the forestry sector, NCA provides critical information on ecosystem condition, regeneration rates, and carbon sequestration potential, enabling firms to operationalize sustainable harvesting practices (Jones et al., 2020). Similarly, mining companies increasingly recognize that failure to account for ecosystem impacts leads to elevated restoration costs, social conflict, and regulatory sanctions, making NCA a proactive tool for managing operational risks.

NCA also supports internal alignment around sustainability objectives. Literature suggests that firms with integrated natural capital frameworks demonstrate stronger alignment between environmental values and performance incentives (Reed et al., 2021). When biodiversity indicators are included in corporate dashboards and strategic scorecards, managers are more likely to incorporate ecological considerations into performance evaluation and resource allocation. This internalization of natural capital is critical because biodiversity-related decisions often require balancing short-term economic gains with long-term ecological resilience. By institutionalizing NCA within governance structures, firms can move beyond symbolic environmental commitments toward substantive biodiversity actions grounded in measurable ecological insights. Despite these strengths, strategic adoption remains uneven across industries and geographies. Some firms embrace NCA as an innovation opportunity, whereas others adopt it only to comply with reporting requirements without integrating natural capital insights into strategy. Scholars observe that leadership commitment, organizational culture, and cross-departmental collaboration significantly influence whether NCA becomes a transformative strategic tool or a superficial reporting practice (Beltramello et al., 2023). These findings underscore the importance of strong governance structures and accountability mechanisms to ensure that NCA fulfills its intended purpose of enabling nature-positive business transformation.

#### 4.2. Empirical Impacts of Natural Capital Accounting on Biodiversity Preservation

The second major finding emerging from the literature concerns the empirical relationship between NCA implementation and biodiversity preservation. Although biodiversity outcomes are influenced by multiple factors, a growing body of research indicates that firms that adopt NCA tend to exhibit more proactive and structured approaches toward biodiversity management. Empirical studies in agriculture, forestry, and mining highlight that access to natural capital data helps firms identify high-risk areas, evaluate ecological degradation, and implement targeted conservation strategies (Mace et al., 2022). For instance, firms monitoring ecosystem condition through NCA are more likely to invest in restoration activities, including reforestation, wetland rehabilitation, soil regeneration, and habitat connectivity projects. These interventions contribute to enhanced ecosystem health, species diversity, and long-term productivity.

Studies also show that NCA enhances firms' ability to manage biodiversity risks. Firms with natural capital data integrated into risk management frameworks are better equipped to anticipate how climate change, water scarcity, or species decline may affect their operations (Kumar et al., 2020). Access to ecological metrics enables scenario modeling, allowing firms to evaluate potential future losses associated with ecosystem degradation and to design mitigation strategies aligned with ecological thresholds. Mining firms, for example, use natural capital inventories to determine post-extraction restoration requirements and biodiversity offsets, aligning operational plans with ecosystem conservation objectives (Gupta & Mason,

2020). Agricultural firms increasingly use natural capital indicators to optimize land management practices, reduce chemical inputs, and enhance soil biodiversity.

Another empirical trend concerns the link between NCA adoption and improved environmental, social, and governance (ESG) performance. Research indicates that firms actively implementing natural capital frameworks often score higher in ESG ratings, which is associated with stronger biodiversity commitments, higher transparency, and reduced ecological footprints (Reed et al., 2021). The relationship between NCA and ESG performance underscores that natural capital considerations are becoming integral to global sustainability disclosure standards. Firms with higher ESG performance are also more likely to secure access to green financing, attract sustainability-oriented investors, and maintain a stronger social license to operate — all of which contribute indirectly to biodiversity preservation.

Nevertheless, the literature acknowledges that the empirical evidence is not uniform. Biodiversity outcomes depend heavily on the quality and depth of NCA implementation. Firms that use natural capital reporting purely for compliance purposes typically demonstrate weaker or inconsistent biodiversity improvements. In contrast, firms that embed NCA into strategic processes show more substantial ecological outcomes. This divergence reflects the broader challenge of distinguishing between symbolic sustainability efforts and authentic ecological stewardship (Beltramello et al., 2023).

Moreover, biodiversity measurement complexities present significant limitations for empirical assessment. Because biodiversity is multidimensional — encompassing species richness, genetic variability, ecosystem function, and habitat integrity — it cannot be easily aggregated into simple metrics. Many NCA frameworks rely on proxies such as land cover change, ecosystem condition scores, or habitat extent, which may not fully capture biodiversity trends (Vardon et al., 2022). This limits the ability to empirically establish causal relationships between NCA and biodiversity outcomes, suggesting that further methodological innovation is required. Despite these challenges, the overall empirical literature supports the conclusion that NCA contributes to biodiversity preservation when implemented meaningfully, with strong organizational commitment and methodological rigour. Continued empirical work is necessary to quantify long-term ecological impacts, but existing studies provide compelling evidence of the strategic value of natural capital data for conservation outcomes.

#### 4.3. Methodological Barriers and Limitations in Operationalizing Natural Capital Accounting

A critical aspect of the discussion concerns the methodological and operational challenges that hinder effective NCA adoption. The most frequently cited barrier is the lack of standardized and reliable ecological data. Biodiversity data, in particular, are often incomplete, inconsistent, or unavailable at the temporal and spatial scales needed for corporate decision-making (Dasgupta, 2021). Firms may struggle to collect high-quality data on species abundance, ecosystem condition, and ecological processes, especially in remote or degraded landscapes where monitoring is difficult. This results in fragmented natural capital accounts that fail to accurately reflect ecological realities.

Valuation challenges represent another major limitation. Attempts to translate ecosystem services into monetary terms raise methodological, ethical, and epistemic concerns. Monetary valuation may oversimplify ecological complexity, obscure non-market values, or produce misleading representations of ecosystem worth (Reed et al., 2021). Some scholars argue that monetary valuation risks commodifying nature, reinforcing market-based exploitation instead of fostering ecological stewardship. As a result, firms may be reluctant to rely solely on monetary metrics, preferring hybrid biophysical and qualitative indicators that better reflect biodiversity dynamics.

NCA methodologies also face the challenge of integrating diverse data sources, such as remote sensing, ecological field surveys, corporate operational data, and stakeholder knowledge. Differences in data resolution, scale, and accuracy complicate aggregation and interpretation. For example, remote sensing provides valuable information on land cover changes but may fail to capture fine-scale species interactions or ecosystem health indicators. Conversely, field-based biodiversity assessments are resource-intensive and not

always feasible across large operational landscapes. Institutional constraints further exacerbate methodological barriers. Firms often lack the internal expertise necessary to develop, interpret, and apply natural capital information. Environmental departments may be understaffed, while financial departments may lack training in ecological economics. Without cross-disciplinary collaboration, natural capital accounts risk becoming siloed documents with limited strategic influence. Organizational culture also plays a significant role; firms with short-term profit priorities may deprioritize investments in ecological data collection or biodiversity initiatives, undermining the long-term benefits of NCA adoption.

Regulatory fragmentation presents an additional challenge. Although global frameworks such as the System of Environmental-Economic Accounting (SEEA), the Global Biodiversity Framework, and emerging nature-related financial disclosures encourage firms to adopt NCA, guidelines remain diverse and sometimes ambiguous. This inconsistency leads to variation in how firms compile accounts, making it difficult to compare performance across sectors or evaluate cumulative biodiversity impacts (Khan et al., 2023). As a result, the potential of NCA as a standardized global framework remains partially unrealized. Finally, scholars highlight the risk of symbolic adoption. Some firms generate natural capital reports to enhance their legitimacy without implementing substantive biodiversity actions. This form of greenwashing undermines the credibility of NCA and highlights the need for stricter governance, improved assurance mechanisms, and independent audits to ensure that natural capital accounts reflect real ecological performance (Beltramello et al., 2023).

#### 4.4. Emerging Trajectories and Future Directions for Sustainable Corporate Practice

Despite the challenges identified, NCA remains a promising framework for advancing biodiversity preservation, and recent developments provide new opportunities for enhancing its strategic relevance. One major emerging trajectory involves aligning corporate NCA efforts with global policy frameworks. The Kunming-Montreal Global Biodiversity Framework, for example, places strong emphasis on measurable and transparent biodiversity actions, which creates incentives for firms to adopt natural capital metrics. Similarly, nature-related disclosure frameworks, such as those being advanced by financial regulators and sustainability reporting standards, encourage firms to identify, assess, and disclose their impacts and dependencies on nature (Jones et al., 2020). Technological advancements also present significant opportunities for improving NCA. Remote sensing technologies, geospatial analytics, and biodiversity informatics offer increasingly precise ecological data, enabling firms to monitor habitat changes, ecosystem condition, and biodiversity trends in near real-time. These technologies can reduce costs, improve data consistency, and bridge existing methodological gaps. As firms integrate technological tools with natural capital frameworks, they can develop more dynamic and evidence-based conservation strategies.

Interdisciplinary collaboration represents another emerging pathway. Literature highlights the benefits of co-development approaches, where ecologists, accountants, financial analysts, and community stakeholders collaborate to design natural capital accounts that are both scientifically robust and operationally relevant (Mace et al., 2022). Such approaches ensure that natural capital accounts capture ecological complexity while remaining accessible for managerial decision-making. Collaboration with indigenous communities and local knowledge holders can further enhance the ecological accuracy and social legitimacy of NCA frameworks. Future research directions also include the development of biodiversity-specific accounting models. While existing NCA frameworks often provide aggregated ecosystem indicators, scholars argue that biodiversity accounting requires distinct metrics that capture species-level interactions, ecological functions, and conservation priorities. Emerging conceptual models propose integrating functional diversity, genetic diversity, and ecosystem resilience indicators into natural capital accounts (Vardon et al., 2022). Such refinements would empower firms to design conservation strategies that reflect ecological realities and align more closely with global biodiversity targets.

In addition, researchers call for longitudinal studies that evaluate biodiversity outcomes over time. Most existing studies analyze short-term implementation effects; however, natural capital degradation and restoration processes unfold over decades. Long-term monitoring would enable scholars to determine

whether NCA produces measurable ecological benefits, identify causal pathways, and assess whether natural capital investments deliver sustained returns for both firms and ecosystems. From a corporate governance perspective, future trajectories involve embedding natural capital into executive incentives, performance evaluation systems, and investment planning processes. Firms that tie natural capital metrics to compensation and strategic KPIs are more likely to institutionalize biodiversity considerations across organizational levels (Khan et al., 2023). Such alignment can transform NCA from a reporting framework into a powerful management tool that shapes organizational behavior and long-term sustainability performance.

The overall analysis demonstrates that natural capital accounting holds significant potential as a strategic tool for biodiversity preservation in resource-intensive firms. Empirical and theoretical evidence confirms that when meaningfully implemented, NCA enables firms to recognize ecological dependencies, assess biodiversity risks, and support conservation actions that enhance ecosystem resilience. However, methodological limitations, data constraints, institutional weaknesses, and risks of symbolic adoption continue to challenge the effectiveness of NCA. Emerging policy frameworks, technological advancements, interdisciplinary collaborations, and evolving governance structures offer promising pathways for strengthening the role of NCA in global biodiversity conservation. As environmental pressures intensify, the strategic integration of natural capital into corporate systems will likely become indispensable for achieving nature-positive outcomes and sustaining long-term economic and ecological resilience.

## V. Conclusion

The synthesis of the preceding analysis demonstrates that Natural Capital Accounting (NCA) occupies a critical and increasingly indispensable position in contemporary sustainability discourse, particularly for firms operating in resource-intensive sectors whose business models inherently depend on and influence ecological systems. From a theoretical standpoint, NCA represents a profound epistemological shift in how organizations conceptualize their relationship with nature. Traditional accounting frameworks have long privileged financial outcomes while relegating ecological degradation to the status of an externality, rendering biodiversity loss systematically invisible in corporate decision-making. NCA challenges this paradigm by asserting that natural ecosystems constitute a form of capital that is both measurable and strategically significant. This redefinition builds upon and extends existing theories in ecological economics, resource-based views of the firm, and institutional theory, collectively illustrating that the integration of natural capital into organizational practices is not merely environmentally desirable but strategically inevitable. As the literature shows, NCA invites scholars to reconsider long-standing assumptions about organizational value creation by positing that economic resilience cannot be disentangled from ecological resilience. In doing so, it advances theoretical conversations surrounding multi-capital accounting, socio-ecological interdependence, and the embeddedness of firms within planetary boundaries. The theoretical implications of these insights are substantial: NCA provides a framework through which organizations can reconceptualize their value chains as ecological systems, rethink risk as an ecological phenomenon, and recognize biodiversity as a strategic resource whose preservation directly affects productivity, legitimacy, and long-term corporate survival. These theoretical developments refine our understanding of how non-financial capitals contribute to organizational performance and expand the conceptual architecture of sustainability accounting, demonstrating that NCA is not simply an extension of existing practices but a foundational realignment of how firms understand their place within the biosphere.

In addition to reshaping theoretical frameworks, the insights derived from this research carry significant implications for managerial practice, offering a roadmap for firms seeking to operationalize sustainability commitments in ways that produce demonstrable biodiversity outcomes. The analysis clearly indicates that NCA becomes strategically impactful when embedded deeply within corporate governance structures, rather than treated as a supplementary reporting tool. For managers, this means that natural capital information must inform core processes such as strategic planning, investment appraisal, risk assessment, and performance evaluation. Resource-intensive firms that internalize natural capital metrics are

better equipped to anticipate ecological risks, align operational practices with conservation thresholds, and identify opportunities for regenerative business models. The managerial implications extend to the design of incentive structures, cross-departmental coordination, and capacity-building initiatives, all of which must evolve to ensure that biodiversity considerations become integral to everyday decision-making. Managers must also recognize that the quality of NCA — and its capacity to guide biodiversity preservation — depends heavily on the robustness of underlying data, the clarity of valuation methodologies, and the degree of interdisciplinary collaboration within the organization. As such, managerial leadership must invest in scientific partnerships, technological systems for ecological monitoring, and internal expertise capable of interpreting natural capital accounts effectively. Moreover, firms must address the persistent risks of symbolic adoption by ensuring that NCA is linked to actual ecological interventions — such as habitat restoration, regenerative agriculture, and ecosystem stewardship programs — rather than merely serving reputational or compliance-driven objectives. In resource-intensive contexts, where ecological degradation directly undermines long-term operational viability, managers who leverage NCA as a strategic compass can not only mitigate risk but also secure competitive advantage by aligning their organizations with emerging regulatory frameworks, investor expectations, and societal demands for nature-positive corporate conduct.

The broader implications of this research underscore that the future of biodiversity preservation in resource-intensive industries depends on the maturation, widespread adoption, and continual refinement of natural capital accounting practices. The findings highlight that while methodological and institutional challenges remain, these limitations should not be interpreted as barriers to implementation but rather as opportunities for innovation, collaboration, and strategic transformation. The path forward requires that policymakers, academics, industry leaders, and conservation experts co-develop more nuanced, context-sensitive NCA frameworks that can capture the multidimensional nature of biodiversity and translate ecological complexity into actionable managerial insights. Such developments will further strengthen the theoretical foundations of NCA while enhancing its practical utility across diverse industrial settings. If firms integrate natural capital considerations into long-term strategic planning, adopt advanced ecological data technologies, and commit to transparent and accountable biodiversity actions, NCA has the potential to become a cornerstone of corporate sustainability governance. Ultimately, this study reinforces the conclusion that the preservation of biodiversity cannot be divorced from the evolution of corporate accounting practices, and that NCA provides one of the most promising mechanisms for aligning economic activity with ecological stewardship. By redefining how firms measure, manage, and value the natural systems that sustain them, NCA offers a transformative pathway toward sustainable development, resilient industries, and thriving ecosystems — a pathway that resource-intensive firms must embrace if they are to navigate the profound environmental challenges of the twenty-first century.

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