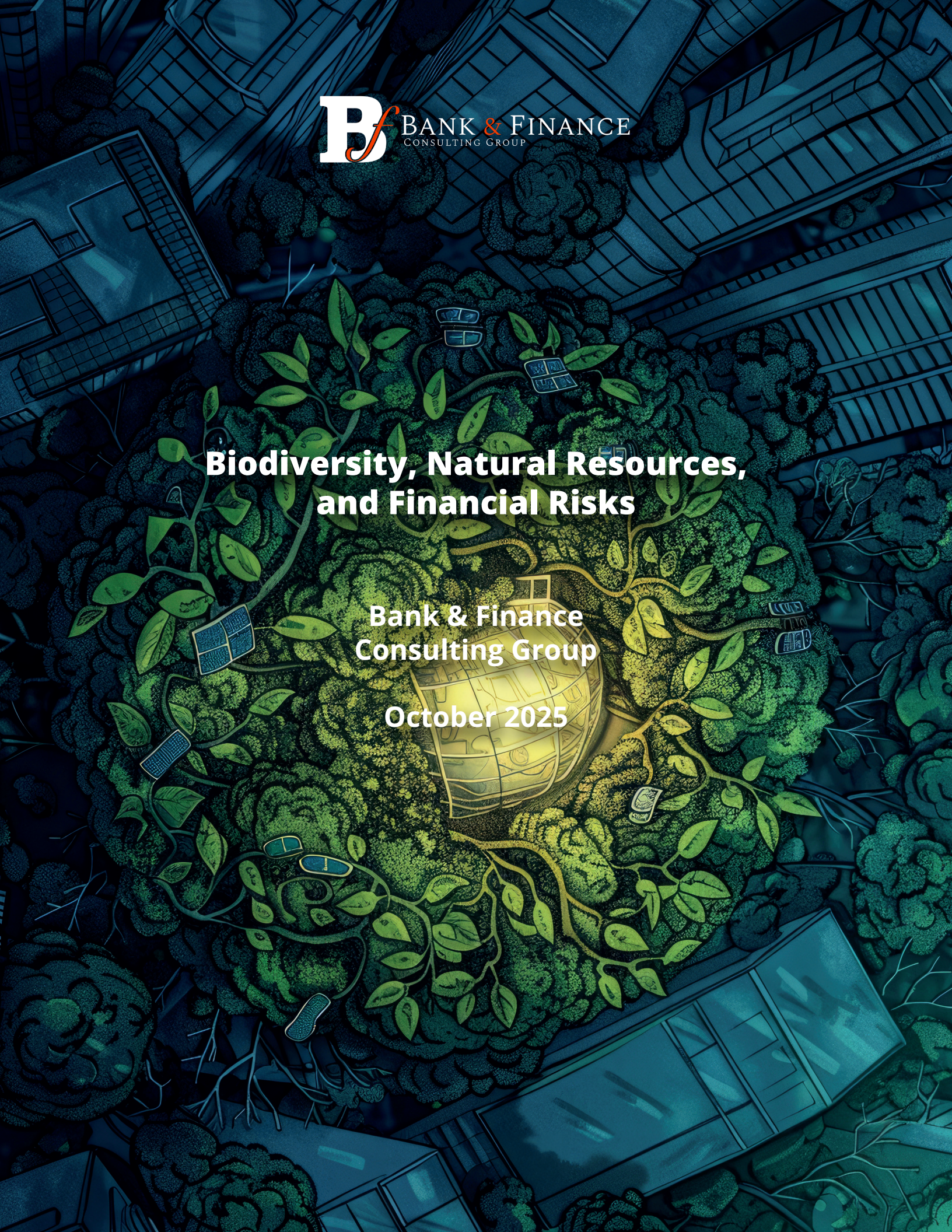

BANK & FINANCE
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Biodiversity, Natural Resources, and Financial Risks

Bank & Finance
Consulting Group

October 2025

Preface

This report, **Biodiversity, Natural Resources, and Financial Risks**, is part of the **Bank & Finance Deep-Dive Series**. The series provides forward-looking analysis on the strategic, financial, and policy implications of emerging global trends, with a focus on the challenges and opportunities facing institutional investors, regulators, and financial market participants.

Biodiversity loss and the depletion of natural resources are no longer peripheral environmental concerns — they are systemic financial risks. Over half of global GDP depends on ecosystem services such as pollination, water regulation, and soil fertility. Their degradation directly affects productivity, creditworthiness, and fiscal stability. As climate change, deforestation, and resource scarcity intensify, nature loss is emerging as a major channel of financial disruption — affecting agriculture, insurance, supply chains, and sovereign balance sheets.

This study examines how biodiversity and natural-capital degradation translate into financial risks and how financial systems can adapt. It analyzes the channels through which ecosystem loss propagates into markets — physical, transition, and liability risks — and identifies the sectors and geographies most exposed. The report reviews the evolving architecture of biodiversity finance, including the Taskforce on Nature-related Financial Disclosures (TNFD), biodiversity bonds, and debt-for-nature swaps, and outlines policy and market pathways toward a nature-positive financial system. It concludes with strategic implications for investors, regulators, and sovereigns.

The report is intended for public authorities (finance ministries, central banks, regulators, and supervisors), multilateral institutions, and private-sector financial actors seeking to integrate nature-related risks into macro-financial surveillance, stress testing, and investment strategies.

This publication extends the Bank & Finance Deep-Dive Series, which includes:

1. Financing Infrastructure with Private Participation
2. Artificial Intelligence Industry Deep-Dive Report: Investment Implications and Strategic Outlook 2025 – 2030
3. Unveiling the Future of Digital Currency Infrastructure: Navigating the Transformation of Finance in a Tokenized World
4. Demographic Change: Challenges and Opportunities in the Age of Low Fertility and Aging Populations
5. Climate Change and Financial Risks: Navigating the Transition and Managing Physical Exposure
6. Global Financial Stability in Transition: Structural Risks, Regulatory Challenges, and Strategic Pathways
7. Open Finance: Unleashing the Next Wave of Financial Innovation
8. The Future of Payments and Cross-Border Finance: Navigating Transformation Amid Risk and Opportunity
9. Cyber Resilience in Finance: From Risk Mitigation to Competitive Advantage
10. Ponzi Games: Anatomy, Evolution, and Containment Strategies
11. The Value of Truth: Information Integrity in Global Finance
12. Sovereign Debt and Global Financial Stability: A Market-Oriented Lens on Risks, Restructurings, and Opportunities
13. Navigating the Financial Stability Risks of Inequality, Polarization, and Eroding Trust
14. Financial Geopolitics and Global Fragmentation

As part of the expanded series, we are adding new volumes: (15) *Biodiversity, Natural Resources, and Financial Risks* (this report); (16) *Capital Markets and Risks of Non-Bank Financial Institutions*; (17) *Quantum Technology and the Future of Financial Security*; (18) *Macro-Financial Vulnerabilities;* and (19) *Global Coordination and Standards*.

We hope this report helps financial institutions, regulators, and policymakers better understand how nature loss translates into financial risk — and how finance can become a lever for restoration and resilience. Our objective is to support strategies that strengthen the stability of financial systems while advancing sustainable and inclusive growth.

Bank & Finance
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List of Acronyms

ADB – Asian Development Bank

B&F – Bank & Finance Consulting Group

BIS – Bank for International Settlements

BNG – Biodiversity Net Gain

BoE – Bank of England

CBD – Convention on Biological Diversity

DNB – De Nederlandsche Bank

DFI – Development Finance Institution

ECB – European Central Bank

EIB – European Investment Bank

EUDR – EU Deforestation Regulation

FAO – Food and Agriculture Organization of the United Nations

FfB – Finance for Biodiversity Foundation

GBF – Global Biodiversity Framework (Kunming–Montreal)

GEF – Global Environment Facility

GDP – Gross Domestic Product

IDB – Inter-American Development Bank

IFRS – International Financial Reporting Standards

IMF – International Monetary Fund

IPBES – Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

ISSB – International Sustainability Standards Board

MAS – Monetary Authority of Singapore

MDB – Multilateral Development Bank

MoF – Ministry of Finance

ND-GAIN – Notre Dame Global Adaptation Initiative

NGFS – Network for Greening the Financial System

NCA – Natural Capital Accounting

NbS – Nature-based Solutions

OECD – Organisation for Economic Co-operation and Development

PRI – Principles for Responsible Investment

PPP – Public-Private Partnership

RST – Resilience and Sustainability Trust (IMF)

SBTN – Science-Based Targets Network

SEEA – System of Environmental-Economic Accounting

SIDS – Small Island Developing States

TCFD – Task Force on Climate-related Financial Disclosures

TNFD – Taskforce on Nature-related Financial Disclosures

TNC – The Nature Conservancy

UN – United Nations

UNDP – United Nations Development Programme

UNEP FI – United Nations Environment Programme Finance Initiative

UNEP-WCMC – UNEP World Conservation Monitoring Centre

USD – United States Dollar

WAVES – Wealth Accounting and the Valuation of Ecosystem Services (World Bank)

WCMC – World Conservation Monitoring Centre

WRI – World Resources Institute

WWF – World Wildlife Fund

Executive Summary

Main message: Biodiversity risk is financial risk.

The degradation of ecosystems and depletion of natural resources constitute systemic financial risks that remain underappreciated compared with climate change. More than half of global GDP depends on ecosystem services—from pollination and soil fertility to fisheries and freshwater supply. As these natural assets erode, the stability of entire sectors, sovereigns, and financial systems comes into question.

This report identifies **five key findings**:

1. **Biodiversity underpins economic resilience.** Agriculture, forestry, fisheries, and water-intensive industries rely directly on ecosystem services. Their deterioration translates into productivity losses, supply-chain shocks, and sovereign revenue volatility.

2. **Nature loss transmits through financial risk channels.** Physical risks (reduced yields, resource scarcity), liability risks (litigation and reputational exposure), and transition risks (policy shifts, changing consumer preferences) interact to amplify systemic fragility.

3. **Sectoral and sovereign exposures are significant.** Food systems, insurance, and sovereign debt markets stand at the frontline, particularly in emerging economies rich in biodiversity but constrained by limited fiscal buffers.

4. **Market and regulatory responses are accelerating.** Frameworks such as the Taskforce on Nature-related Financial Disclosures (TNFD), biodiversity bonds, and debt-for-nature swaps are shaping a new financial architecture for nature.

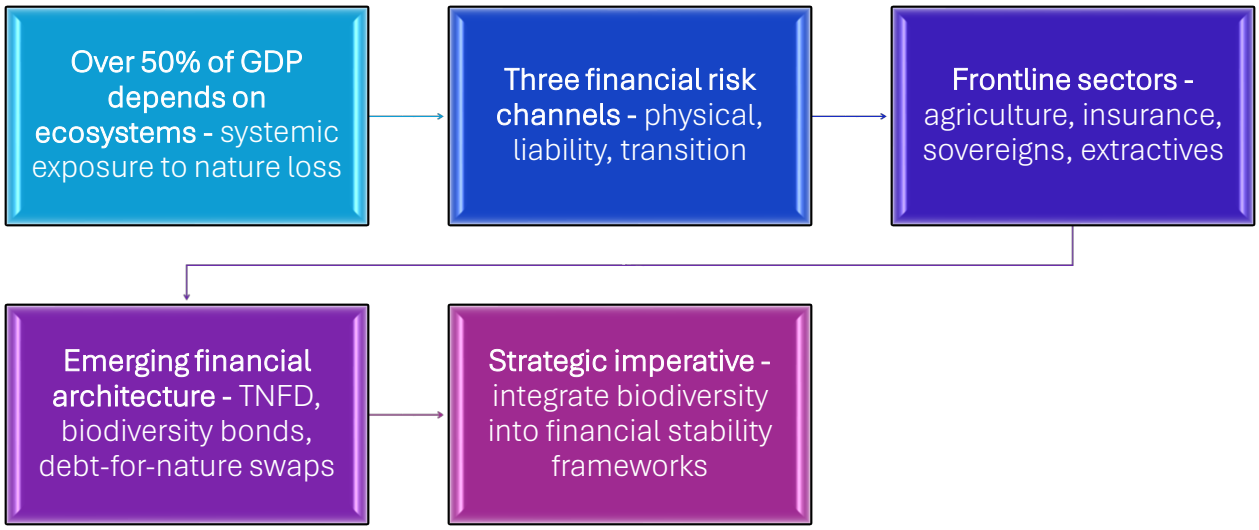
5. **Strategic alignment is essential.** Investors, regulators, and sovereigns must integrate biodiversity into financial stability frameworks, disclosure regimes, and capital allocation decisions. The trajectory of "nature-positive" finance mirrors the rise of green finance but demands stronger coordination to ensure credibility and scale.

Together, these findings underscore a simple truth: biodiversity loss is not only an ecological crisis but also a financial one. Embedding biodiversity considerations into the architecture of financial governance is a precondition for macro-financial resilience.

Policy takeaway: Financial stability institutions, investors, and governments should treat biodiversity degradation as a measurable source of financial risk—integrating it into prudential supervision, sovereign risk assessment, and investment mandates within the next five years.

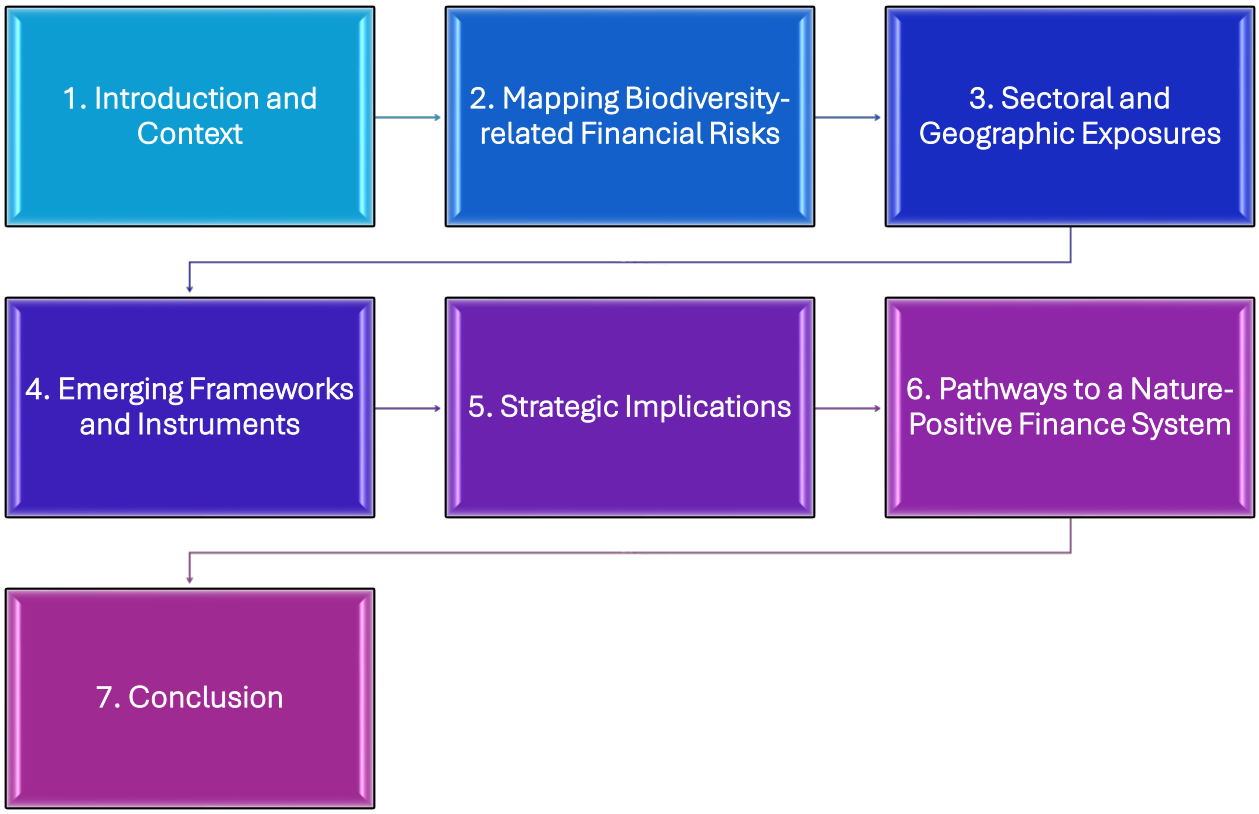
Figure 1 highlights the report's key findings. **Figure 2** outlines the roadmap.

Figure 1 – Key Highlights of the Report



Source: *Bank & Finance analysis based on TNFD (2023), World Bank (2024), OECD (2023), and IMF (2023).*

Figure 2 – Report Roadmap



Source*: Bank & Finance.*

1. Introduction and Context

Biodiversity and natural resources form the foundation of the global economy. Healthy ecosystems provide food, water, clean air, fertile soils, pollination, climate regulation, and resilience against extreme events. Yet these assets, often referred to as *natural capital*, are being depleted at an unprecedented pace. Current estimates suggest that more than half of global GDP is moderately or highly dependent on ecosystem services, while the cost of nature loss is measured in trillions of dollars annually.

The financial system has only recently begun to recognize these exposures. For decades, biodiversity was treated as a scientific or conservation concern, peripheral to markets and investment decisions. However, the accelerating frequency of natural shocks, coupled with mounting regulatory and societal expectations, is reshaping this perception. Nature loss is emerging as a systemic financial risk, comparable in scope and complexity to climate change, but with distinct dynamics.

Three factors underscore the urgency:

- Scale and pervasiveness. Biodiversity underpins sectors ranging from agriculture and fisheries to pharmaceuticals and tourism. Its degradation transmits directly into economic volatility and sovereign stress.
- Irreversibility and tipping points. Unlike cyclical market risks, ecosystem collapse can cross thresholds beyond which recovery is impossible or prohibitively costly.
- Interconnection with other global risks. Biodiversity loss amplifies climate risk, food insecurity, migration pressures, and inequality — creating feedback loops that threaten both financial stability and social cohesion.

From a financial perspective, biodiversity loss crystallizes through three risk channels:

- Physical risks, such as reduced crop yields, fisheries collapse, and freshwater scarcity.
- Liability risks, including lawsuits and reputational damage for firms, as well as sovereign obligations for environmental harm.
- Transition risks, as policy frameworks, supply chains, and consumer preferences increasingly penalize unsustainable practices.

The growing recognition of these risks is fostering a new agenda in financial regulation and market innovation. Frameworks such as the Taskforce on Nature-related Financial Disclosures (TNFD), biodiversity bonds, and debt-for-nature swaps are gaining momentum, signaling that biodiversity is no longer a niche concern but a frontier for financial markets.

This report analyzes the implications of biodiversity and natural resource loss for the global financial ecosystem. It seeks to answer three questions:

1. How does biodiversity loss translate into financial risks across physical, liability, and transition channels?
2. Which sectors, regions, and sovereigns are most exposed, and how might these exposures evolve?
3. What frameworks, instruments, and strategies can investors, regulators, and sovereigns deploy to mitigate risks and capture opportunities in a "nature-positive" transition?

In doing so, the report situates biodiversity alongside other transformative forces explored in this series — including climate change, demographic shifts, and digital transformation — underscoring that safeguarding natural capital is integral to financial stability and long-term economic resilience.

The following section maps how biodiversity loss translates into financial risks across physical, liability, and transition channels, establishing the analytical foundation for the sectoral and geographic exposure analysis that follows.

2. Mapping the Financial Risks of Biodiversity Loss

Biodiversity loss manifests in financial systems through three interconnected channels: physical, liability, and transition risks. These channels mirror those of climate change, but biodiversity adds distinctive local, sectoral, and irreversible dynamics.

2.1 Physical Risks

Physical risks arise when the degradation of ecosystems disrupts economic activity. Examples include:

- **Agriculture and food production:** Declining pollinator populations threaten up to $500 billion in annual crop output. Soil degradation affects nearly one-third of global agricultural land.
- **Fisheries and coastal economies:** Overfishing and coral reef decline jeopardize food security and the livelihoods of 200 million people worldwide.
- **Water stress:** Deforestation and watershed depletion reduce freshwater supply, creating bottlenecks for energy and manufacturing.
- **Health risks:** Biodiversity loss contributes to the emergence of zoonotic diseases, with severe economic costs as seen during COVID-19.

These shocks can reduce GDP, trigger commodity price volatility, and erode sovereign creditworthiness.

2.2 Liability Risks

Liability risks emerge as firms and sovereigns are held responsible for biodiversity damage:

- **Litigation against corporations:** Mining, agribusiness, and chemical firms face lawsuits and compensation claims for environmental degradation.
- **Investor pressure:** ESG-aligned funds increasingly exclude companies linked to deforestation or biodiversity harm.
- **Sovereign obligations:** Governments may face penalties under trade agreements or investor treaties for inadequate environmental protection.
- **Reputational spillovers:** Institutions financing unsustainable projects risk loss of market value and higher funding costs.

These liabilities are set to expand as disclosure frameworks (e.g., TNFD) and mandatory due-diligence laws (e.g., EU deforestation regulation) gain traction.

2.3 Transition Risks

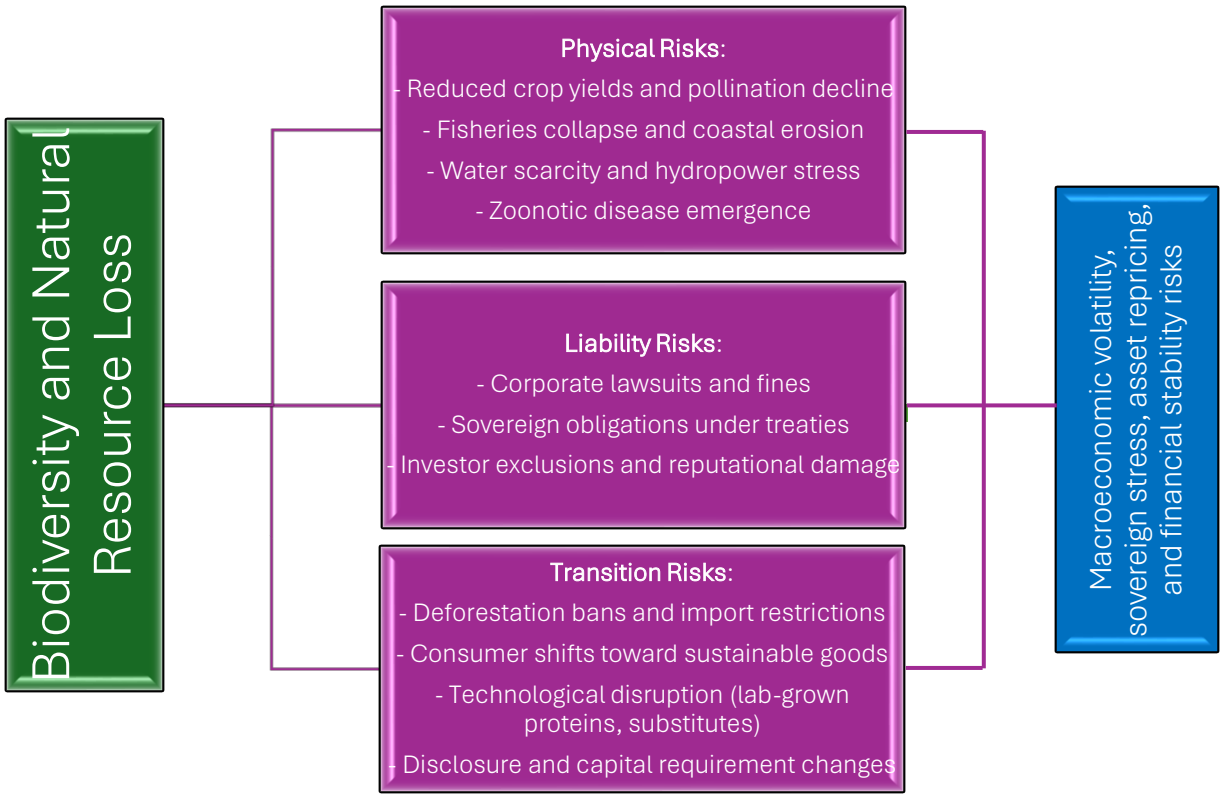
Transition risks reflect the costs of adjusting to more sustainable economic and financial practices:

- **Policy and regulation:** Bans on deforestation-linked imports, carbon border adjustment mechanisms, and new conservation mandates alter trade and investment flows.
- **Market dynamics:** Consumer demand is shifting toward sustainable food, fashion, and materials, penalizing unsustainable producers.
- **Technological disruption:** Advances in lab-grown proteins, alternative materials, and circular economy models reduce demand for resource-intensive products.
- **Financial disclosure requirements:** Integration of biodiversity risks into reporting and capital requirements could reprice assets and portfolios.

Transition risks can create stranded assets in sectors from palm oil to industrial fishing, while also generating opportunities for firms positioned to deliver “nature-positive” solutions.

Biodiversity loss translates into financial instability through three distinct but overlapping channels: physical risks, liability risks, and transition risks. Each channel propagates shocks from ecosystem degradation into markets, sovereigns, and financial institutions. **Figure 3** illustrates these channels and the pathways by which they converge into systemic financial risks.

Figure 3 – Channels Linking Biodiversity Loss to Financial Risks



Source: Bank & Finance analysis based on TNFD (2023), World Bank (2021), OECD (2022), and NGFS (2023).

This mapping establishes the mechanisms by which biodiversity risks propagate into the financial system, setting the stage for the next section on sectoral and geographic exposures. Together, these three channels illustrate how biodiversity risk is more than an ecological concern. Physical shocks, liability exposures, and transition dynamics reinforce each other, amplifying systemic vulnerabilities. As ecosystems degrade, financial institutions face a growing challenge: to integrate these risks into models, stress tests, and supervisory frameworks before tipping points are reached.

3. Sectoral and Geographic Exposures

Biodiversity loss and natural resource depletion do not impact all sectors or geographies equally. Their distribution reflects the degree of economic reliance on ecosystem services, the resilience of natural capital stocks, and the fiscal and institutional capacity of states to respond. Understanding these patterns is critical for investors, financial institutions, and regulators to anticipate where financial risks are most likely to crystallize.

3.1 Sectoral Vulnerability: Nature-Dependent Industries

Some sectors are structurally dependent on biodiversity and ecosystem services, leaving them directly exposed to nature-related shocks:

- **Agriculture and Food Systems.** Pollination, soil fertility, pest control, and freshwater are essential inputs for crop and livestock production. Declines in bee populations alone threaten up to $500 billion in annual agricultural output, while soil degradation already affects one-third of farmland worldwide.
- **Forestry, Timber, and Commodities.** Unsustainable logging, palm oil, and soy production drive both biodiversity loss and systemic commodity risks. Stranded assets may emerge as global markets impose sustainability requirements (e.g., EU deforestation ban).
- **Fisheries and Aquaculture.** Overfishing, ocean acidification, and coral reef loss threaten the livelihoods of 200 million people. The World Bank estimates that depleted fish stocks result in annual economic losses of $80 billion.
- **Insurance and Reinsurance.** Insurers face higher claims from biodiversity-linked catastrophes, including floods intensified by mangrove and wetland loss, and crop failures driven by soil and water degradation.
- **Pharmaceuticals and Biotechnology.** More than half of modern medicines derive from natural compounds. Species extinction reduces the pipeline for new treatments, eroding long-term R&D opportunities.
- **Sovereign Debt and Public Finance.** Economies highly dependent on agriculture, forestry, and tourism are particularly vulnerable. Nature-related shocks can erode fiscal revenues, widen current account deficits, and increase sovereign credit risk.

To operationalize how biodiversity-related risks map onto financial systems, **Table 1** presents a sectoral risk matrix. It classifies selected industries by their exposure to biodiversity-related physical, liability, and transition risks, and provides brief commentary on the underlying vulnerabilities. This framework parallels the climate risk matrix from our earlier report, but shifts the emphasis to ecosystem dependencies and natural capital depletion.

The matrix underscores that biodiversity-related financial risks extend beyond traditionally "green" sectors such as agriculture or forestry. Insurance, pharmaceuticals, tourism, and even financial services are materially exposed — whether directly, through dependence on ecosystem services, or indirectly, via liability and transition channels. For investors and regulators, this means biodiversity risk is not confined to niche portfolios but is systemic, with broad cross-sectoral implications.

Table 1 – Sectoral Risk Matrix: Exposure to Biodiversity-Linked Financial Risks

Sector	Exposure to Physical Risk	Exposure to Liability Risk	Exposure to Transition Risk	Comments
Agriculture and Food Systems	High	Medium	Medium	Strong dependence on pollination, soil fertility, and water cycles; exposure to lawsuits over land use and sustainability claims.
Forestry and Timber / Palm Oil / Soy	High	High	High	Deforestation-driven; lawsuits and trade restrictions (e.g., EU bans) raise liability and transition risks.
Fisheries and Aquaculture	High	Medium	Medium	Ocean acidification, overfishing, and coral reef loss; regulatory quotas and trade restrictions add transition risks.
Insurance and Reinsurance	Medium	Low	Medium	Rising claims from biodiversity-related catastrophes; exposure to litigation for underwriting unsustainable projects.
Pharmaceuticals and Biotechnology	Medium	Low	Low	Dependence on biodiversity for natural compounds; risk from loss of species and liability if linked to biopiracy.
Tourism and Hospitality	High	Medium	Medium	Heavy reliance on coral reefs, forests, and wildlife; reputational and regulatory risks from unsustainable operations.
Extractives and Mining	Medium	High	Medium	Liability risks from pollution and habitat destruction; physical risks from water stress; rising ESG scrutiny.
Sovereign Debt Markets	High	Medium	Medium	Fiscal and credit exposures where GDP depends on natural resources (agriculture, forestry, tourism).
Financial Services (Banks, Asset Managers)	Indirect	Medium	Medium	Indirect exposure through lending, portfolios, and reputational risks; transition risks from biodiversity disclosure rules.

***Source**: Bank & Finance analysis based on World Bank (2021), OECD (2022), TNFD (2023), NGFS (2023), and sectoral studies.*

3.2 Geographic Exposure: Biodiversity Hotspots and Fiscal Vulnerability

The geographic distribution of biodiversity risk reflects both ecological hotspots and the socioeconomic dependence on natural capital. Key regions include:

- **Latin America.** The Amazon basin is approaching ecological tipping points. Its deforestation threatens rainfall patterns critical for agriculture across Brazil and neighboring countries, and undermines hydropower generation that supplies more than 60% of Brazil's electricity.
- **Sub-Saharan Africa.** More than 60% of employment is in agriculture, largely rain-fed and vulnerable to ecosystem degradation. Limited fiscal space constrains governments' ability to finance adaptation or conservation.
- **South and Southeast Asia.** Coral reef decline and mangrove loss amplify storm surge risks. Fisheries that sustain hundreds of millions of livelihoods are under pressure, while rice systems are threatened by changing water cycles.
- **Small Island Developing States (SIDS).** Tourism and fisheries, both biodiversity-dependent, are the economic backbone of many islands. Coral bleaching and declining fish stocks have direct fiscal and credit rating implications.
- **Advanced Economies.** While direct exposure is lower, these countries face imported biodiversity risks. For example, the EU's reliance on soy, palm oil, and timber imports ties its supply chains and financial system to overseas deforestation.

Figure 4 – Global Biodiversity Financial Vulnerability Heatmap

Region	Ecosystem Exposure	Economic Dependence	Readiness (Capacity)	Composite Vulnerability
Latin America (Amazon)	85	70	55	76
Sub-Saharan Africa	80	75	40	82
South Asia	75	65	45	76
Southeast Asia	78	68	50	74
Small Island Developing States (SIDS)	82	72	35	84
MENA Drylands	60	55	50	61
Advanced Economies	45	40	75	39

Note: *Scale 0 – 100. Composite Vulnerability = 0.5·Exposure + 0.3·Dependence + 0.2·(100 − Readiness). Higher values indicate worse vulnerability.*

Source*: Bank & Finance analysis based on TNFD, World Bank, OECD, NGFS, ND-GAIN; illustrative regional aggregation for presentation.*

Biodiversity-related financial risk is concentrated where ecosystem exposure and economic dependence on nature are high, and institutional readiness is low. **Figure 4** presents a regional heatmap that combines these dimensions into a composite vulnerability score to indicate where financial risks from biodiversity loss are most likely to crystallize first.

The heatmap highlights three clusters of concern: (i) SIDS and Sub-Saharan Africa, where high exposure and dependence meet low readiness; (ii) Latin America (Amazon) and Southeast Asia, where ecological tipping risks interact with trade and supply-chain dependence; and (iii) South Asia, where dense populations and critical food systems create systemic stakes. By contrast, advanced economies face lower direct vulnerability yet remain exposed via trade, capital flows, and portfolio channels.

3.3 Most Vulnerable Countries: Multidimensional Exposure Profiles

Nature-related risks are particularly acute in countries where economic dependence on natural capital intersects with weak fiscal and institutional capacity. These sovereigns face multidimensional challenges:

- **Brazil and Indonesia** – high deforestation risk with sovereign debt implications.
- **Madagascar and Kenya** – high biodiversity value combined with agricultural dependence and limited fiscal buffers.
- **Philippines** – reliance on fisheries and exposure to typhoons and coral reef decline.
- **Belize and Fiji** – small island economies dependent on biodiversity-driven tourism and fisheries.
- **Bangladesh** – dependence on mangroves and delta ecosystems for flood protection.

While biodiversity loss is a global phenomenon, some countries face multidimensional exposure due to their ecological endowments, economic dependence on natural resources, and limited fiscal or institutional capacity. **Table 2** presents illustrative cases of sovereigns with high biodiversity-related financial risk, highlighting the drivers of vulnerability and implications for sovereign credit, financial stability, and development prospects.

These cases illustrate that biodiversity risks are not confined to low-income countries. Emerging markets such as Brazil and Indonesia face material transition and liability risks due to their integration into global commodity supply chains, while small island states like Belize and Fiji are acutely exposed to physical and tourism-related shocks. Even middle-income countries such as the Philippines and Bangladesh show how biodiversity loss directly threatens sovereign solvency and development prospects. For investors, this signals that biodiversity risk premia may increasingly shape sovereign spreads and access to finance.

Table 2 – Countries with High Biodiversity-Related Financial Exposure

Country	Primary Risk Type	Key Drivers of Vulnerability	Implications for Financial Risk
Brazil	Physical + Transition	Amazon deforestation; reliance on agriculture and hydro; rising global scrutiny of supply chains	Export restrictions, sovereign spread volatility, potential credit downgrades tied to ESG exclusions
Indonesia	Transition + Liability	Palm oil and timber exports; high deforestation; litigation and NGO pressure	Rising cost of capital, ESG-driven divestment, liability risk for corporates and sovereign issuers
Madagascar	Physical	Extreme biodiversity richness; soil erosion and deforestation; poverty and weak governance	Agricultural shocks, food insecurity, sovereign distress due to adaptation costs
Kenya	Physical + Sovereign	Dependence on rain-fed agriculture; water scarcity; reliance on natural tourism	Credit and fiscal stress, currency volatility, sovereign rating pressure
Philippines	Physical	Fisheries and coral reef dependence; frequent typhoons; mangrove loss	Sovereign risk through food security, tourism revenue loss, banking sector NPLs in rural lending
Belize	Tourism + Transition	Heavy reliance on coral reefs and marine biodiversity for tourism; exposure to bleaching events	Tourism revenue decline, sovereign fiscal stress, exposure to sustainability-linked debt conditions
Fiji	Physical + Tourism	Coral reef degradation; rising sea levels; concentrated dependence on fisheries and tourism	Fiscal vulnerability, rising insurance costs, reduced access to global credit markets
Bangladesh	Physical	Dependence on mangroves for flood protection; dense population in delta ecosystems	Rising disaster recovery costs, microfinance strain, sovereign borrowing needs

***Source**: Bank & Finance analysis based on World Bank (2021), OECD (2022), IMF Natural Capital Accounting (2023), TNFD (2023), and ND-GAIN Index (2023).*

Key takeaway: The countries most exposed to biodiversity-related financial risks face fiscal and credit challenges comparable to those of high-carbon transition exposure. Nature degradation simultaneously erodes export revenues, raises sovereign borrowing costs, and heightens the likelihood of debt-distress episodes—making biodiversity loss a core component of sovereign-risk analysis.

3.4 Inequality and Regional Disparities

Within countries, biodiversity risks are unevenly distributed. Rural and Indigenous communities depend disproportionately on forests, fisheries, and soils for livelihoods, yet they often have the weakest adaptive capacity, access to finance, or political voice. Urban poor populations are also exposed, for example where wetland loss exacerbates flooding in informal settlements.

Global trade links further magnify disparities: while advanced economies import nature-related risks through commodities, the costs of ecosystem degradation are borne disproportionately by emerging markets. This asymmetry raises both equity concerns and financial stability implications, particularly as sovereign spreads begin to reflect biodiversity risk premia.

4. Emerging Frameworks and Market Instruments

The recognition that biodiversity loss constitutes a material financial risk has catalyzed the emergence of new regulatory, disclosure, and market frameworks. Much as the *Task Force on Climate-related Financial Disclosures (TCFD)* reshaped corporate governance on climate risk, the growing architecture around nature-related financial disclosures aims to mainstream biodiversity within financial decision-making.

These initiatives are evolving rapidly, spanning policy, regulatory, and market domains. They serve three interconnected purposes: (i) to improve transparency on nature-related dependencies and impacts; (ii) to channel capital toward conservation and restoration; and (iii) to align public and private incentives around "nature-positive" economic transformation.

4.1 Taskforce on Nature-related Financial Disclosures (TNFD) and Global Reporting Convergence

Launched in 2021 and formally completed in 2023, the Taskforce on Nature-related Financial Disclosures (TNFD) provides the leading global framework for identifying, assessing, managing, and disclosing nature-related risks and opportunities. It mirrors the TCFD structure—covering governance, strategy, risk management, and metrics—but expands the lens beyond carbon to include land, freshwater, ocean, and biodiversity dimensions (TNFD, 2023).

TNFD recommends that organizations assess both dependencies (how firms rely on ecosystem services) and impacts (how their activities affect natural capital). By 2025, over 300 financial institutions and corporates, representing more than USD 20 trillion in assets, had piloted the TNFD framework, with early adopters including BNP Paribas, AXA, and GSK. Regulators in jurisdictions such as the EU, UK, and Singapore are exploring integration of TNFD principles into

disclosure mandates, extending the climate disclosure momentum established by the *ISSB IFRS S1/S2* standards (IFRS Foundation, 2023).

4.2 Natural Capital Accounting and Sovereign Integration

Parallel to corporate disclosures, efforts are advancing to integrate biodiversity and natural resources into sovereign accounting and fiscal frameworks. The *UN System of Environmental-Economic Accounting (SEEA)* provides a standardized approach to measuring natural capital stocks and ecosystem services. More than 90 countries are implementing SEEA modules with technical support from the *World Bank's WAVES* program and the *UN Statistics Division* (World Bank, 2024).

Multilateral institutions are exploring how natural-capital metrics can inform sovereign credit assessments and fiscal sustainability analysis. The *IMF (2023)* has begun incorporating natural resource depletion into its Debt Sustainability Analysis (DSA) models, while rating agencies such as *Moody's* and *S&P* have signaled that environmental degradation and biodiversity dependence can influence sovereign credit risk.

These initiatives underscore a paradigm shift: biodiversity is no longer external to macroeconomic policy—it is becoming part of the sovereign balance sheet.

4.3 Financial Innovation: Biodiversity Bonds, Credits, and Debt-for-Nature Swaps

Financial markets are experimenting with new instruments to translate conservation outcomes into investable assets. The most prominent include biodiversity bonds, biodiversity credits, and debt-for-nature swaps, each representing a mechanism to mobilize capital toward conservation or restoration.

- Biodiversity Bonds – Modeled on the success of green and sustainability-linked bonds, biodiversity bonds channel proceeds into projects that protect or restore ecosystems. The *World Bank (IBRD)* issued one of the first pilot biodiversity bonds in 2022, tied to marine conservation in the Seychelles and forest management in Brazil. Several *Development Finance Institutions (DFIs)*—including the *Inter-American Development Bank (IDB)* and *Asian Development Bank (ADB)*—are developing similar frameworks.

- Biodiversity Credits – Emerging voluntary markets are experimenting with "nature units" that quantify verified biodiversity outcomes (e.g., habitat restoration, species recovery). Although still at an early stage, initiatives such as the *UK Biodiversity Net Gain (BNG)* scheme and the *Voluntary Biodiversity Credits Alliance (VBCA)* are advancing measurement and verification standards (OECD, 2023; UNEP FI, 2024).

- **Debt-for-Nature Swaps and Sustainability-Linked Debt** – These instruments restructure sovereign liabilities in exchange for conservation commitments. Belize (2021) and Ecuador (2023) executed landmark transactions reducing external debt while securing marine and forest protection funding. Similar deals are under design in Gabon and Sri Lanka with support from *The Nature Conservancy* and *IMF Resilience and Sustainability Trust (RST)* facilities (IMF, 2024).

Table 3 – Emerging Financial Instruments for Biodiversity and Natural Capital

Instrument Type	Primary Objective	Target Risk Channel	Typical Issuers / Users	Implementation Challenges
Biodiversity Bonds	Finance ecosystem conservation and restoration projects	Physical / Transition	Sovereigns, DFIs, Corporates	Project pipeline scarcity; verification of biodiversity outcomes
Biodiversity Credits / Nature Units	Monetize verified biodiversity outcomes	Transition / Liability	Corporates, Investors, Conservation Funds	Standardization; additionality; price discovery
Debt-for-Nature Swaps	Exchange debt relief for conservation commitments	Sovereign / Physical	Sovereigns, DFIs, NGOs	Complex structuring; credit enhancements; monitoring
Sustainability-Linked Loans / Bonds with Biodiversity KPIs	Align financing costs with biodiversity performance	Transition / Liability	Corporates, Banks	KPI integrity; data reliability; potential greenwashing
Natural Capital Funds / Blended Finance Vehicles	De-risk private investment in conservation	Mixed	DFIs, Impact Investors	Governance; limited track record; valuation of natural assets
Parametric and Ecosystem Insurance	Transfer biodiversity-related disaster risk (e.g., reef, mangrove, crop failure)	Physical	Insurers, Sovereigns, Tourism Boards	Basis risk; data gaps; affordability
Nature-Based Solutions (NbS) Finance	Scale investment in projects with co-benefits for climate and biodiversity	Physical / Transition	Municipalities, Corporates, DFIs	Measurement of co-benefits; coordination with climate finance

Source: *Bank & Finance analysis based on TNFD (2023), OECD (2023), IMF (2024), World Bank (2024), UNEP FI (2024), and The Nature Conservancy (2023).*

Table 3 provides a taxonomy of financial instruments currently being deployed or developed to integrate biodiversity into capital markets. It classifies each instrument by primary objective, target risk type, typical issuers or users, and implementation challenges, mirroring the structure used in the climate-finance deep dive.

These instruments illustrate the early but accelerating convergence of climate finance and nature finance. Market innovation is strongest where biodiversity outcomes can be quantified and monetized, such as through verified credits, insurance triggers, or sustainability-linked KPIs. However, the credibility and scalability of these markets hinge on robust metrics, transparent governance, and standardized disclosure—precisely the domains where TNFD and natural-capital accounting frameworks can provide backbone infrastructure.

While innovation in biodiversity bonds, credits, and swaps is accelerating, credibility remains the principal constraint. Market participants identify verification, additionality, and permanence as critical bottlenecks. TNFD's Data Catalyst (2024) highlights that fewer than one-third of pilot projects meet full additionality criteria, and valuation methodologies still diverge across markets. Developing standardized monitoring, reporting, and verification (MRV) frameworks is therefore essential to scale these instruments responsibly.

4.4 Integration with Carbon Markets and Climate Frameworks

Biodiversity finance is increasingly intersecting with carbon markets. Many carbon-offset projects deliver co-benefits for ecosystems and communities; conversely, biodiversity restoration can enhance carbon sequestration. The *Voluntary Carbon Market Integrity Initiative (VCMI)* and the *Science-Based Targets Network (SBTN)* are developing methodologies to account for both carbon and nature outcomes in tandem.

Emerging "carbon-plus-nature" credits link emissions reductions to verified biodiversity restoration, such as mangrove or peatland projects that provide measurable carbon and habitat value. As *REDD+* and jurisdictional carbon programs evolve, dual-certification models could expand investment in conservation while reducing risks of double counting or greenwashing (FAO, 2023; UNEP FI, 2024).

This integration marks a pragmatic frontier: aligning financial incentives across climate and nature domains to create coherent transition pathways. Yet, without harmonized taxonomies, disclosure standards, and monitoring systems, fragmentation remains a risk.

Collectively, these frameworks and instruments represent the early architecture of nature-positive finance. The challenge now lies in mainstreaming these tools across portfolios, prudential frameworks, and fiscal strategies. The next section examines the strategic

implications for investors, regulators, and sovereigns as biodiversity risk becomes a core financial stability concern.

5. Strategic Implications for Investors, Regulators, and Sovereigns

The growing integration of biodiversity and natural resource risks into financial systems signals a structural transformation in how markets, regulators, and sovereigns perceive environmental value. As biodiversity loss increasingly interacts with physical, transition, and liability risk channels, the implications extend beyond ESG investing—affecting asset valuation, creditworthiness, and macro-financial stability.

For investors, this means rethinking portfolio exposure to nature-dependent sectors and supply chains. For regulators and central banks, it requires embedding biodiversity into prudential supervision, scenario analysis, and data frameworks. For sovereigns, it redefines the concept of fiscal resilience to include natural capital preservation as a component of creditworthiness and growth potential.

5.1 Institutional Investors: From ESG Integration to Nature-Positive Portfolios

Institutional investors—pension funds, sovereign wealth funds, and asset managers—hold the leverage to mainstream biodiversity through capital allocation. Yet current practices remain dominated by carbon metrics, leaving nature-related exposures largely unquantified.

Recent initiatives seek to bridge this gap. The *Finance for Biodiversity (FfB) Pledge*, now backed by over 160 institutions representing USD 25 trillion in assets, commits signatories to assess and disclose nature-related dependencies (FfB, 2024). Similarly, the *Principles for Responsible Investment (PRI)* and *UNEP Finance Initiative (UNEP FI)* are piloting biodiversity value-at-risk (BioVaR) models, adapting climate value-at-risk methodologies to capture ecosystem shocks (UNEP FI, 2024).

Investors are moving beyond negative screening toward engagement and reallocation strategies—pressuring investee firms to adopt TNFD-aligned disclosures, supporting biodiversity bonds, and developing thematic funds targeting regenerative agriculture, sustainable forestry, and water resilience. Still, a major gap persists: the absence of standardized nature-related benchmarks and credible data at the asset level.

5.2 Financial Institutions and Supervisory Authorities

For banks, insurers, and asset managers, biodiversity risks increasingly intersect with core prudential concerns—credit risk, operational risk, and systemic stability. A growing number of supervisors now recognize nature loss as a macroprudential risk factor.

The *Network for Greening the Financial System (NGFS)* has launched a Task Force on Nature-Related Risks, developing guidelines for scenario analysis and stress testing that extend climate models to incorporate biodiversity variables (NGFS, 2024). The *European Central Bank (ECB)*, *Monetary Authority of Singapore (MAS)*, and *De Nederlandsche Bank (DNB)* have begun evaluating nature-related financial risks through portfolio-level exposure mapping.

The Financial Stability Board (FSB) has also entered the debate, launching in 2024 a consultation on nature-related financial disclosures and the integration of biodiversity risks into cross-border prudential standards. This signals growing convergence between global supervisory initiatives on climate and nature risk management.

Banks are responding by integrating biodiversity into credit underwriting policies, risk-weighted asset models, and sectoral lending limits, especially in agribusiness, mining, and forestry. Insurers, in turn, are revising catastrophe models to account for biodiversity-related physical risks—such as flood exposure linked to mangrove degradation or wildfire intensity driven by ecosystem change (Swiss Re Institute, 2024).

However, biodiversity stress testing remains in its infancy. Unlike climate models, which rely on standardized emissions data and temperature pathways, biodiversity lacks a common metric of change. This underscores the importance of data harmonization across TNFD, NGFS, and IMF initiatives to enable comparable scenario analysis.

5.3 Sovereigns and Public Finance: Integrating Natural Capital into Fiscal Resilience

For sovereigns, biodiversity degradation is not just an environmental concern—it is a credit risk multiplier. Countries heavily dependent on ecosystem services (agriculture, fisheries, forestry, or tourism) face rising fiscal vulnerability as these services deteriorate.

The *IMF (2023)* and *World Bank (2024)* are piloting frameworks to integrate natural capital accounting into fiscal analysis and debt sustainability assessments. *Moody's (2023)* has begun incorporating biodiversity-related indicators into sovereign risk ratings, flagging deforestation and soil degradation as material long-term credit factors.

Some sovereigns are adopting proactive approaches:

- **Costa Rica and Colombia** are embedding biodiversity outcomes into national investment plans.
- **Ecuador and Belize** have executed **debt-for-nature swaps**, combining fiscal relief with conservation spending.
- **Indonesia and Kenya** are developing **sovereign biodiversity bonds** supported by multilateral guarantees.

These innovations represent the early stages of a **nature-aligned fiscal architecture**, where the protection of natural assets becomes integral to debt management, public investment, and macroprudential policy.

Table 4 summarizes key implications for major financial stakeholders—investors, financial institutions, regulators, and sovereigns—highlighting strategic actions required to integrate biodiversity risk into governance, portfolios, and policy frameworks.

Table 4 – Strategic Implications by Stakeholder Type

Stakeholder	Strategic Imperatives	Examples / Emerging Practices	Challenges
Institutional Investors	Integrate biodiversity into ESG and portfolio risk analysis; develop biodiversity value-at-risk models	TNFD pilots by BNP Paribas, AXA; Finance for Biodiversity Pledge signatories	Data gaps; lack of benchmarks; limited biodiversity-linked products
Banks and Insurers	Embed biodiversity in credit and underwriting standards; adjust capital requirements	DNB, MAS biodiversity stress tests; AXA and Swiss Re natural capital insurance	Scenario uncertainty; modeling complexity; disclosure alignment
Regulators and Supervisors	Expand prudential frameworks to include nature-related risks; integrate biodiversity into systemic surveillance	NGFS Task Force on Nature-Related Risks; ECB and BoE pilot assessments	Data harmonization; coordination with climate frameworks
Sovereigns and Fiscal Authorities	Integrate natural capital into fiscal accounting, budget planning, and debt management	SEEA implementation; Belize and Ecuador debt-for-nature swaps	Institutional capacity; valuation of ecosystem services
Development Finance Institutions (DFIs)	De-risk biodiversity projects via blended finance; support national natural capital integration	World Bank WAVES, IMF RST, IDB biodiversity bonds	Limited project pipeline; monitoring and verification constraints

Source: *Bank & Finance analysis based on TNFD (2023), NGFS (2024), IMF (2023), World Bank (2024), UNEP FI (2024), PRI (2024), and Finance for Biodiversity (2024).*

The strategic integration of biodiversity into financial governance will require a combination of regulatory foresight, data infrastructure, and market innovation. Financial actors that anticipate this transition will gain both resilience and strategic advantage—reducing exposure to stranded natural assets while positioning themselves to capture the upside of the emerging nature-positive economy.

Having analyzed how biodiversity considerations are reshaping investment, regulation, and fiscal policy, the next section outlines the pathways toward a nature-positive financial system, identifying policy priorities and market mechanisms needed to scale and mainstream biodiversity integration globally.

6. Pathways to a Nature-Positive Finance System

Biodiversity and natural-capital risks have moved from the periphery of sustainability debates to the core of financial-stability concerns. Yet the transition from awareness to systematic integration remains in its infancy. A nature-positive financial system—one that protects, restores, and sustainably uses ecosystems—requires coordinated action across markets, institutions, and public policy.

The pathway toward that system mirrors, but extends beyond, the climate-finance transition: it must internalize nature dependencies, price ecosystem services, and embed biodiversity considerations into every layer of decision-making—from loan origination to sovereign debt management.

6.1 Building the Foundations: Data, Metrics, and Disclosure

The first step is to correct the market's "information failure." Investors cannot manage what they cannot measure.

- **Data infrastructure:** Global initiatives such as the *UN Biodiversity Lab*, *TNFD Data Catalyst*, and *World Bank Natural Capital Accounting Partnership* are building interoperable geospatial and satellite-based datasets linking corporate activity with ecosystem conditions. These platforms allow financial institutions to map nature dependencies at asset level for integration into disclosure frameworks.
- **Disclosure and metrics:** The *International Sustainability Standards Board (ISSB)* is considering biodiversity-specific metrics to complement IFRS S2. Combined with *TNFD* guidelines, these frameworks could make nature exposure a reportable financial variable.
- **Taxonomies and classification:** The *EU Sustainable Finance Taxonomy*, *ASEAN Taxonomy for Sustainable Finance*, and emerging *Latin American Green Taxonomy* now include biodiversity criteria, facilitating capital reallocation toward conservation and restoration.

Establishing these foundations will enable consistent risk pricing and regulatory supervision.

6.2 Embedding Biodiversity into Financial Stability Frameworks

The second step is integration into the architecture of financial stability.

- **Prudential regulation:** The *Network for Greening the Financial System (NGFS)* and several central banks (ECB, MAS, BoE) are developing nature-inclusive scenario analyses, expanding climate stress testing to cover land-use and water dependencies.
- **Macro-fiscal linkages:** The *IMF* and *World Bank* are piloting natural-capital-adjusted debt sustainability analyses, where degradation affects sovereign risk parameters.
- **Systemic-risk monitoring:** Financial Stability Boards and regional supervisors are incorporating biodiversity risk indicators into macroprudential dashboards, mirroring approaches already used for climate exposures.

This integration aligns biodiversity preservation with the core mandate of financial stability rather than treating it as a peripheral ESG concern.

6.3 Scaling Finance through Market Innovation and Public-Private Partnerships

A third priority is to mobilize and de-risk capital flows toward biodiversity-positive outcomes.

- **Public-private partnerships (PPPs):** Blended-finance structures, first-loss guarantees, and multilateral trust funds (e.g., *Global Environment Facility* and *Green Climate Fund* biodiversity windows) are essential to crowd in private capital.
- **Institutional mandates:** Development banks can integrate biodiversity targets into their investment policies, supporting "bankable" nature projects such as mangrove restoration, regenerative agriculture, or sustainable aquaculture.
- **Financial innovation:** As seen in Section 4, biodiversity bonds, credits, and parametric insurance mechanisms can be mainstreamed through transparent standards and sovereign credit enhancements.

Expanding this market requires credible measurement of outcomes and harmonized verification methodologies to build investor confidence.

6.4 Aligning Incentives: Fiscal Policy, Valuation, and Global Coordination

Biodiversity protection must also be embedded in fiscal and macroeconomic policy.

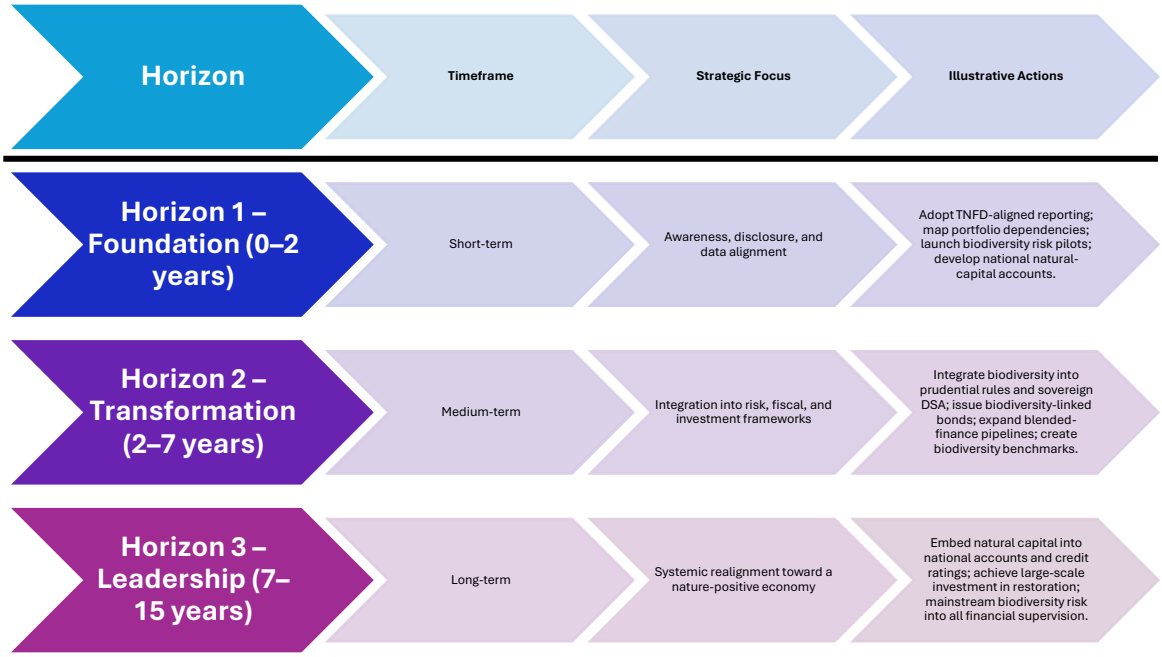
- **Natural-capital accounting:** Integrating SEEA data into national accounts ensures that ecosystem depletion is reflected in GDP and fiscal indicators.
- **Budgeting and taxation:** Governments can adopt *nature-based performance budgeting* and reform subsidies harmful to biodiversity—currently estimated at over USD 500 billion annually (OECD, 2023).

- **International coordination:** Cross-border biodiversity risks—such as deforestation linked to commodity trade—require harmonized disclosure and trade standards (e.g., EU Deforestation Regulation, emerging ASEAN frameworks).

Global coordination under the *Kunming-Montreal Global Biodiversity Framework (GBF)*, which targets protection of 30 percent of land and sea by 2030, provides a common policy anchor for these efforts.

Figure 5 conceptualizes the progressive integration of biodiversity into finance along three reinforcing horizons—*Foundation, Transformation, and Leadership*—mirroring the staged approach adopted in climate finance but oriented toward nature outcomes.

Figure 5 – The Nature-Positive Finance Transition Pathway



Source: *Bank & Finance analysis based on TNFD (2023), IMF (2023), World Bank (2024), OECD (2023), NGFS (2024), UNEP FI (2024), and Global Biodiversity Framework (2022).*

The transition will not be linear. Progress across horizons will differ by region and institutional capacity. However, sequencing actions—from disclosure to integration and systemwide alignment—ensures coherence and minimizes market disruption. Early movers can shape methodologies and capture first-mover advantages as biodiversity finance scales.

6.5 Policy Priorities and Enabling Conditions

To consolidate the nature-positive transition, four enablers stand out:

1. **Data and interoperability:** standardized biodiversity metrics, geospatial mapping, and open-data platforms.

2. **Market infrastructure:** trusted registries and verification bodies for biodiversity credits and bonds.
3. **Regulatory convergence:** alignment of taxonomies and disclosure frameworks to avoid fragmentation.
4. **Capacity building:** technical assistance and blended-finance facilities for emerging markets, where biodiversity value is highest but fiscal space is limited.

Together, these pillars define the scaffolding for an integrated financial ecosystem that values and safeguards nature.

The journey toward a nature-positive financial system is underway but incomplete. The concluding section distills the overarching lessons: biodiversity risk is financial risk, and addressing it is essential to both economic resilience and long-term prosperity.

7. Conclusion

Biodiversity loss is no longer a peripheral environmental issue—it is a structural source of financial instability. The degradation of natural capital underpins a growing class of physical, transition, and liability risks that affect firms, sovereigns, and households alike. More than half of global GDP depends on ecosystem services, and yet these foundations of value creation—soil fertility, pollination, water regulation, coastal protection, and genetic diversity—are being eroded faster than they can regenerate.

The evidence throughout this report confirms the central message: biodiversity risk is financial risk. When ecosystems fail, so too do the economic systems built upon them. Supply-chain disruptions, sovereign downgrades, insurance losses, and investment impairments are already emerging as measurable consequences of ecological decline. The channels of transmission may be complex, but their direction is clear—nature loss undermines asset values, credit quality, and macroeconomic resilience.

Main Messages

- Biodiversity loss is a material source of systemic financial risk.
- Integrating natural capital into financial stability and fiscal frameworks is essential for long-term resilience.
- Finance can be a driver of regeneration by mobilizing capital toward nature-positive outcomes.

7.1 From Awareness to Integration

In recent years, the financial community has begun to recognize these linkages. Frameworks such as the Taskforce on Nature-related Financial Disclosures (TNFD), natural capital

accounting, and biodiversity-linked finance represent a major step toward visibility and accountability. Yet awareness alone is insufficient. True risk management requires integration—embedding biodiversity into risk models, regulatory frameworks, fiscal planning, and portfolio strategy.

Just as climate risk reshaped the global financial architecture, biodiversity will demand an equivalent transformation. The task is more complex: while climate change can be expressed in carbon metrics, biodiversity encompasses diverse ecosystems and localized dependencies. This complexity is precisely why early institutional coordination, data transparency, and capacity building are critical.

7.2 Systemic Implications and Cross-Layer Linkages

The financial ecosystem cannot isolate nature loss from other systemic risks. Biodiversity degradation amplifies climate vulnerability, worsens inequality, and strains sovereign balance sheets—creating feedback loops that propagate across markets and borders. Conversely, integrating biodiversity into finance reinforces climate resilience, enhances fiscal stability, and supports inclusive growth.

The lesson is consistent with the logic of the broader **Bank & Finance Five-Layer Framework**: stability depends on the health of interconnected systems—information, infrastructure, innovation, integration, and governance. Biodiversity and natural resources underpin all five. When they weaken, financial and institutional capacities erode in parallel.

7.3 The Call to Action

To prevent biodiversity loss from becoming the next systemic financial crisis, three priorities stand out:

1. **Integrate biodiversity into financial stability and supervision.**
   Central banks, regulators, and supervisors should incorporate nature-related risks into stress testing, capital adequacy rules, and disclosure mandates, ensuring that systemic exposures are identified early.
2. **Mobilize capital for restoration and resilience.**
   Investors and financial institutions should expand biodiversity-linked finance—through bonds, credits, blended finance, and PPPs—and support the creation of credible markets for ecosystem services.
3. **Revalue natural capital in public policy.**
   Governments and international financial institutions should embed natural capital accounting into fiscal frameworks, aligning debt sustainability and growth strategies with the protection of ecological assets.

These steps together will help shift finance from being a driver of degradation to an engine of regeneration.

7.4 A Strategic Outlook

The transition to a nature-positive financial system will define the next decade of sustainable finance. Its success depends not only on technical progress—data, taxonomies, disclosure—but also on political will, institutional coordination, and societal commitment. The choice before us is stark: continue to erode the natural assets upon which all economic value depends, or build a financial architecture that safeguards them.

As this report concludes, one truth stands out: biodiversity loss is not merely an environmental externality; it is a systemic financial liability. Recognizing and acting upon this insight will determine not only the resilience of markets, but the sustainability of prosperity itself.

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Appendices

The appendices provide supporting material that complements the core analysis of this report. They document the methodology and data sources used, clarify technical terms and acronyms, and map each exhibit to its primary references. Together, these annexes ensure transparency, facilitate further research by readers, and reinforce the analytical rigor of the report.

A. Methodology and Data Sources

This report combines quantitative analysis, qualitative assessment, and comparative synthesis to examine the financial implications of biodiversity and natural resource degradation. The methodology builds on prior *Bank & Finance Deep-Dive Series* studies, especially those addressing climate risk, inequality, and sovereign stability, ensuring conceptual and empirical coherence across reports.

A.1 Analytical Approach

1. **Risk Typology:** The study applies the standard *physical–transition–liability* risk typology developed by the Network for Greening the Financial System (NGFS) and adapted to biodiversity contexts using TNFD's *dependencies–impacts–risks* framework.

2. **Sectoral and Geographic Mapping:** Sectoral exposure estimates were derived from global input–output datasets, natural capital accounts, and biodiversity-dependence coefficients (World Bank WAVES, OECD Natural Capital Database, TNFD Data Catalyst). Geographic exposure incorporated ecosystem-dependence indices and fiscal-readiness data from ND-GAIN (2023) and IMF debt-sustainability metrics.

3. **Composite Vulnerability Index (Figure 4):** Computed as: *0.5 × Ecosystem Exposure + 0.3 × Economic Dependence + 0.2 × (100 – Readiness)* All variables scaled 0–100; higher values = greater vulnerability.

4. **Financial Instruments Review:** Compiled through desk research of multilateral, market, and academic sources (World Bank, IMF, OECD, UNEP FI, IDB, TNFD, NGFS, The Nature Conservancy), capturing all biodiversity-linked issuances and pilot programs between 2020–2025.

5. **Qualitative Validation:** Cross-checked against case studies and supervisory pilots (ECB, MAS, DNB, Bank of England), and biodiversity-finance evaluations from the World Bank, IMF, and major DFIs.

A.2 Data Sources

- **Institutional datasets:** TNFD Data Catalyst (2023); NGFS Scenarios (2024); World Bank WAVES (2024); IMF RST and DSA frameworks (2023–24); OECD Natural Capital (2023).

- **Geospatial data:** UN Biodiversity Lab (2023); NASA MODIS land-cover; Global Forest Watch deforestation indices.

- **Financial databases:** Bloomberg ESG (2024); Refinitiv ESG Datastream; Climate Bonds Initiative (2024); IMF FSI (2023).

- **Case references:** World Bank (2024) Belize and Ecuador debt-for-nature swaps; IDB and ADB biodiversity bond frameworks; OECD (2023) subsidy inventory; FAO (2023) REDD+ co-benefits.

A.3 Limitations

Data availability remains uneven. Biodiversity metrics are site-specific and not fully comparable across jurisdictions. Most financial instruments are pilot-stage, limiting statistical depth. Despite these constraints, triangulation of multiple institutional datasets ensures analytical robustness and replicability.

B. Glossary of Terms

This appendix provides definitions of key concepts and a list of acronyms used throughout the report, ensuring clarity and accessibility for a diverse readership.

Biodiversity bonds are fixed-income instruments whose proceeds finance projects that conserve or restore ecosystems, following the model of green and sustainability-linked bonds. They are issued by sovereigns, corporates, or development banks and help channel capital toward measurable nature-positive outcomes.

Biodiversity credits—sometimes called *nature units*—are tradable certificates that quantify verified biodiversity gains, such as restored habitat or improved species populations. These credits enable investors and companies to compensate for ecological impacts or invest in restoration projects.

Biodiversity risk refers to the financial exposure that arises when the loss of species, habitats, or ecosystem services disrupts economic activity. Because over half of global GDP depends on nature, biodiversity decline represents a material source of market, credit, and sovereign risk.

Blended finance is the strategic use of concessional or public capital to mobilize private investment in projects with high environmental or social value. It de-risks biodiversity-related investments in emerging markets by combining development and commercial funding.

Debt-for-nature swap designates a sovereign-level transaction in which a portion of external debt is restructured in exchange for commitments to fund conservation or ecosystem restoration. These swaps provide fiscal relief while strengthening natural-capital protection.

Ecosystem services are the benefits that humans derive from nature, encompassing provisioning services (food, timber, and water), regulating services (carbon sequestration and flood control), supporting services (soil formation and nutrient cycling), and cultural services (recreation and spiritual value).

Global Biodiversity Framework (GBF), adopted at Kunming-Montreal in 2022, sets international targets to protect 30 percent of land and sea by 2030 and provides the overarching policy reference for national biodiversity strategies and financial-sector alignment.

Liability, physical, and transition risks describe the three main channels through which environmental degradation affects finance. *Physical risks* stem from direct ecosystem damage; *transition risks* arise from policy, technology, or market shifts toward sustainability; and *liability risks* emerge from litigation, fiduciary duties, or reputational harm.

Natural capital denotes the stock of renewable and non-renewable natural resources—plants, animals, soils, minerals, and water—that generate flows of ecosystem services such as food, energy, and climate regulation. Its depletion constitutes a loss of productive wealth comparable to the depreciation of physical capital.

Natural capital accounting (NCA) integrates environmental assets into economic measurement, ensuring that national income and wealth statistics reflect the value of ecosystems. NCA provides the analytical foundation for green fiscal policy, sovereign risk assessment, and sustainable debt management.

Nature-positive economy describes an economic model that halts and reverses biodiversity loss by aligning production, consumption, and finance with ecological limits. It seeks to make restoration of natural capital a source of growth and resilience.

Parametric insurance provides pre-agreed payouts based on the occurrence of measurable environmental events—such as drought, rainfall, or coral bleaching—without requiring loss assessment. It offers rapid recovery and resilience financing for biodiversity-related shocks.

System of Environmental-Economic Accounting (SEEA) is the UN statistical standard that integrates environmental and economic data, enabling governments to measure stocks and changes in natural capital and embed these within national accounts.

Taskforce on Nature-related Financial Disclosures (TNFD) is a global initiative launched in 2021 to provide a standardized framework for assessing, managing, and reporting nature-related risks and opportunities. Modeled on the TCFD, it guides organizations in disclosing both dependencies on nature and impacts upon it.

C. Source–Exhibit Matrix

This appendix maps each figure, table, and box in the report to its primary sources, ensuring transparency and facilitating further reference.

Exhibit	Title	Primary Data / Source Basis	Analytical Contribution
Figure 1	Key Highlights of the Report	Bank & Finance analysis based on TNFD (2023), World Bank (2024), OECD (2023), and IMF (2023)	Summarizes core messages linking biodiversity and financial risk.
Figure 2	Report Roadmap	Bank & Finance design template	Outlines structure and logical flow of the analysis.
Figure 3	Channels Linking Biodiversity Loss to Financial Risks	Adapted from TNFD (2023); NGFS (2024)	Conceptual framework mapping physical, liability, and transition risk channels.
Figure 4	Global Biodiversity Financial Vulnerability Heatmap	ND-GAIN (2023); World Bank (2024); Bank & Finance estimates	Regional vulnerability index integrating exposure, dependence, and readiness.
Table 1	Sectoral Risk Matrix	OECD (2023); TNFD Data Catalyst; Bank & Finance analysis	Classifies biodiversity-linked risks by sector and risk type.
Table 2	Countries with High Biodiversity-Related Financial Exposure	World Bank WAVES; IMF RST; ND-GAIN Index (2023)	Illustrates multidimensional sovereign exposure profiles.
Table 3	Emerging Financial Instruments for Biodiversity and Natural Capital	TNFD (2023); OECD (2023); World Bank (2024); UNEP FI (2024)	Provides taxonomy of biodiversity-finance instruments.
Table 4	Strategic Implications by Stakeholder Type	NGFS (2024); PRI (2024); IMF (2023)	Summarizes institutional actions for integrating biodiversity risk.
Figure 5	Nature-Positive Finance Transition Pathway	Bank & Finance framework; analogous to Three-Horizon Climate Strategy	Outlines sequential phases for embedding biodiversity into finance.