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Perspective

The "nature-positive" journey for business: A conceptual research agenda to guide contributions to societal biodiversity goals

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SUMMARY

Biodiversity is rising rapidly on the global agenda, prompting businesses to adopt the "nature-positive" framing, expressing a commitment to combat biodiversity loss and contribute to global nature recovery goals. However, realizing these ambitions requires transformative changes in business operations, which will be challenging given the uncertainties surrounding possible strategies and pathways. A research-driven approach for business action on biodiversity is vital to prevent unintended environmental and social consequences, but there is currently no coordinated research effort on this topic. Here, we present our vision of a conceptual framework for nature positive extending beyond individual business actions, encompassing processes that influence business involvement, a spectrum of sectoral strategies, and the need for impact measurement at various scales. We utilize this framework to propose high-priority research questions where we believe collaboration between researchers, consultants, and sustainability practitioners is needed to guide effective, feasible, and equitable action to protect and restore nature.

INTRODUCTION

In December 2022, the Kunming-Montreal Global Biodiversity Framework (GBF) was agreed by parties to the United Nations Convention on Biological Diversity.[1] The framework offers an ambitious vision to address the dramatic, ongoing biodiversity loss observed globally through several priority targets. Target 15 of the GBF explicitly acknowledges the role of the private sector, calling on parties to take legal, administrative, and policy action to push businesses, including those within the financial sector, to reduce their negative impacts on biodiversity, increase positive impacts, reduce biodiversity-related risks, and ensure sustainable patterns of production.[1] Here, we use the term "business" broadly to refer to any corporation, financial institution, or large organization that impacts or depends upon nature. However, we note that many of the principles discussed also apply to other large organizations that interact with nature, even if revenue generation is not their sole purpose (e.g., public sector bodies, non-governmental organizations [NGOs], research institutes).

Biodiversity loss is largely driven by economic activities, precipitating land use change, overexploitation, pollution, and climate change, which endanger species and ecosystems.[2–4] For example, forested habitats continue to decline in extent and condition,[5,6] species in both the terrestrial and marine environments are facing expanding and intensifying threats over much of their range,[7–9] and many ecosystems are under high levels of pressure from human activity.[10] Without radical transformative change in production and consumption patterns, the observed loss and degradation of species and ecosystems will continue to worsen.[11,12]

An increasing number of businesses and industry platforms now consider biodiversity loss to be a major risk to businesses, global economies, and society at large.[13,14] Where historically businesses have paid little attention to biodiversity or nature in environmental social governance (ESG) reporting,[15,16] a growing number of forward-thinking businesses are developing targets and strategies to address their biodiversity impacts or including biodiversity in their wider environmental strategies.[17] Regulations and voluntary standards are also emerging that require businesses to understand their impacts on biodiversity and align their business models with principles of biodiversity protection and restoration.[18] This includes the EU Corporate Sustainability Reporting Directive/Sustainable Finance Disclosure Regulation, the Taskforce for Nature Related Financial Disclosures, Science-based Targets Network, as well as private sector coalitions to

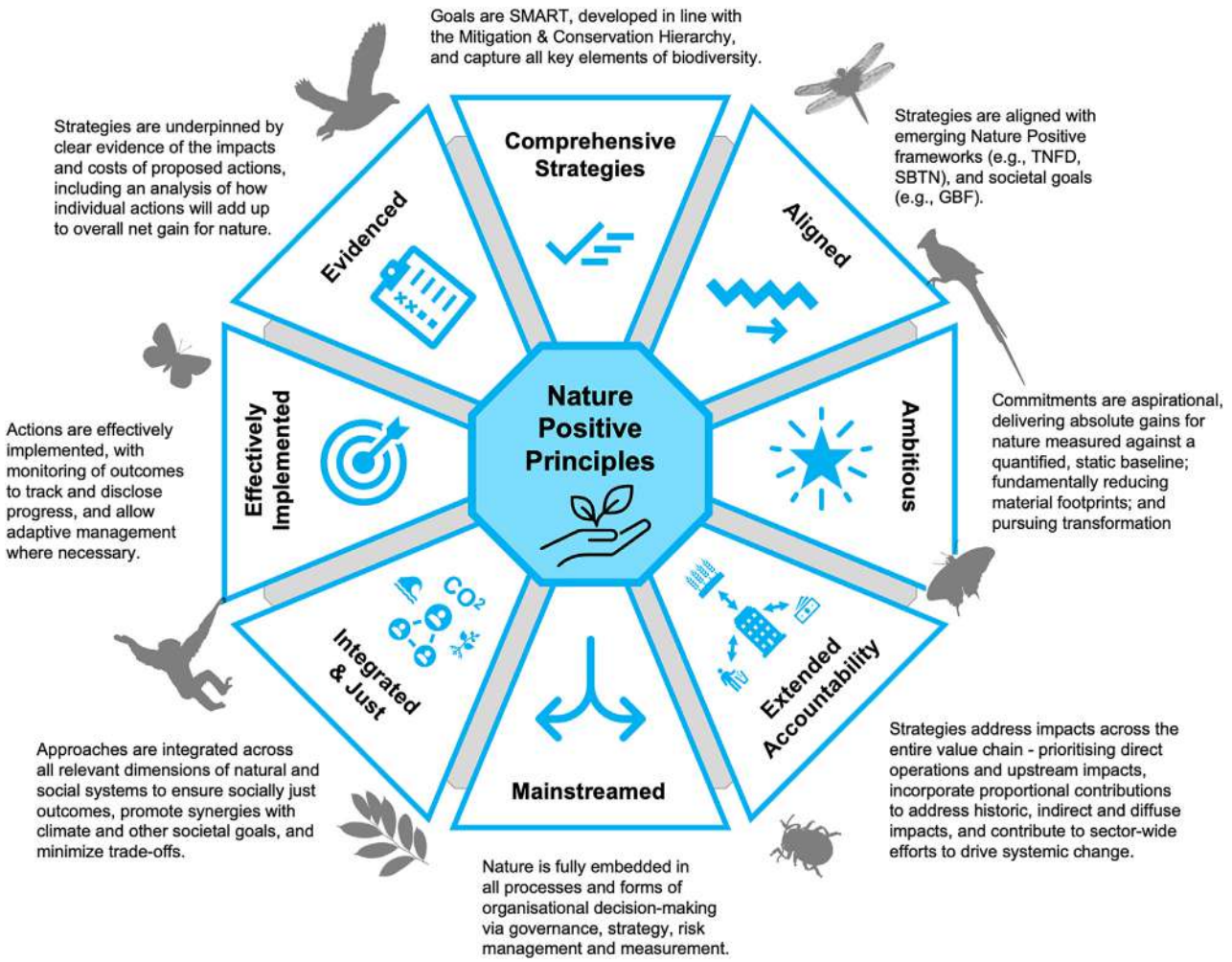


Figure 1. Principles for nature positive

A summary of the proposed core principles for a nature-positive approach to biodiversity management in business (reproduced from Booth et al.,[23] following Milner-Gulland; [21] and zu Ermgassen et al.[17]).

support businesses to act for nature (e.g., Nature Action 100, Finance for Biodiversity Foundation).

"Nature positive" has emerged as a term used by NGOs, governments, and businesses to indicate their aspiration to move beyond concepts of no net loss or net positive impacts, and toward a key outcome where a complete transformation of how societies and global economies operate leads to a future where nature is visibly and measurably improved in absolute terms[18–20] (e.g., naturepositive.org). Many organizations, including businesses, have signed nature-positive pledges (e.g., getnaturepositive.com, naturepositiveuniversities.net) to express a call for action toward achieving this goal. However, as a new term, nature positive is often poorly or inconsistently defined, posing a risk of being applied to ineffective or suboptimal actions that neither lead to net positive outcomes for biodiversity nor contribute toward wider societal goals for nature recovery.[17,21,22] Thus, a clear, consistent definition and guiding principles are needed[20,23] (Figure 1). So as not to dilute its meaning, nature positive is better viewed not as a target for individual businesses but as a wider global goal to halt and reverse nature loss. Within this broader agenda, businesses have a vital role to play in contributing toward this goal by setting and meeting ambitious targets to (1) address their impacts using the mitigation hierarchy (with offsets as the final step after avoidance, reduction, and remediation of impacts[22]), (2) take positive actions to enhance biodiversity (e.g., direct restoration action, purchasing biodiversity credits), and (3) drive broader transformative change.[18,23]

A considerable shift away from business as usual is needed to align with the proposed nature-positive principles in Figure 1 and make a substantive contribution to delivering GBF goals.[24] Assessments of businesses' biodiversity strategies highlight that ambitious, large-scale institutional change will be necessary to achieve nature positive-aligned goals.[25,26] For example, transitioning the agricultural sector to a nature-positive future will require transformative change to current intensive agricultural practices and policies,[27,28] including actions to protect existing natural areas, minimize impacts and increasing efficiencies of ongoing production, restore and regenerate marginal lands to deliver additional conservation gains, and transition to a circular economy, e.g., through reducing waste. Understanding how to instigate this ambitious change, let alone deliver it, appears

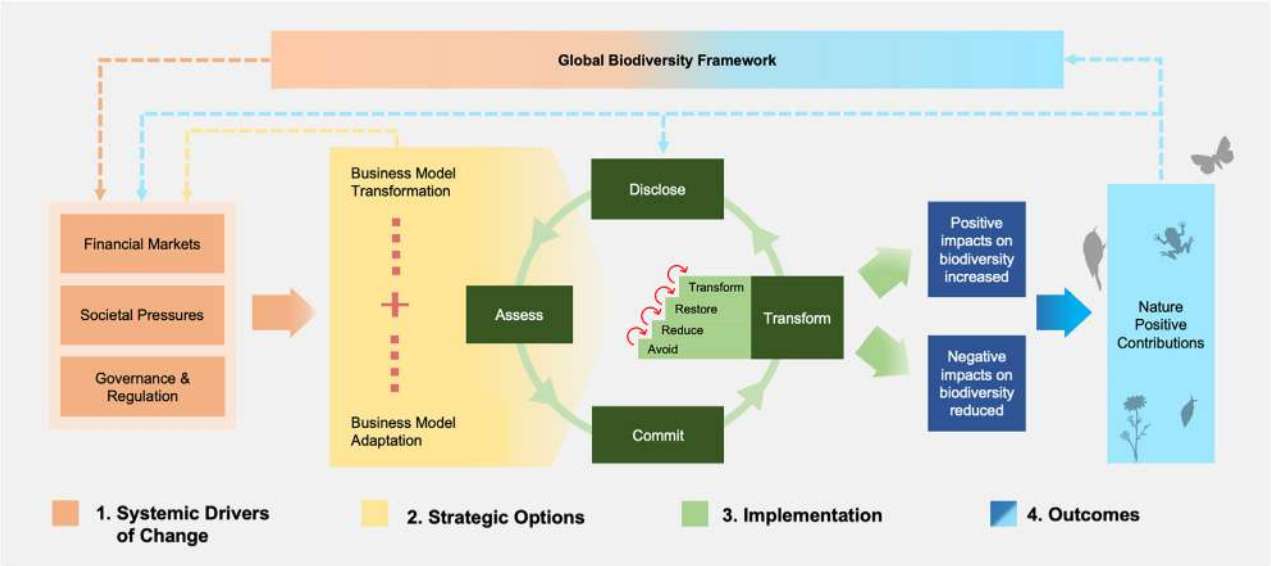


Figure 2. A proposed nature-positive research framework outlining the processes and actions through which business contributions to a nature-positive future could be realized to meet the goals of the Global Biodiversity Framework

Our research framework incorporates four key components: (1) the systemic drivers of change needed to bring about nature-positive transformation; (2) the strategic options for individual businesses and entire sectors across a spectrum from complete business model transformation to a business model adaptation approach; (3) the practical implementation by businesses using the ACT-D framework; and (4) the outcomes from business actions, both in increasing positive impacts and reducing negative impacts on biodiversity to realize nature-positive contributions. All these components are interlinked and will feedback into each other over time.

daunting for businesses wishing to show leadership in this space.

Many questions remain unanswered. Academic research in close collaboration with business and governmental partners is needed to reduce uncertainties, help guide effective business strategies, and drive the technological, economic and policy innovations required to realize a nature-positive future.[27] However, there is currently no coordinated approach to identify and fund priority research areas.

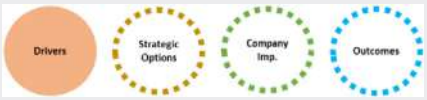
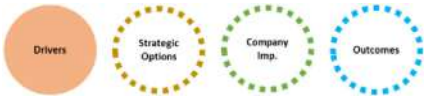
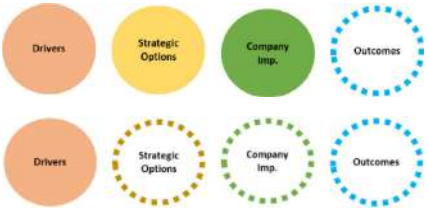
Here we present a conceptual framework and proposed series of priority research questions that, if addressed, we believe would help deliver more effective business contributions to the GBF goals. The framework and research questions are the outcomes of a workshop held in Oxford in May 2023 between researchers and consultants undertaking practical work at the interface between academic biodiversity conservation science and business. The research questions presented here are reflective of the author's views from experience researching and implementing policy mechanisms, designing business strategies, measuring biodiversity outcomes, and working with businesses across different sectors and industry initiatives. The framework identifies four core components where research is needed on systemic drivers of change, strategic options for businesses, implementation by individual businesses, and outcomes. We discuss how research projects to address priority questions across the framework could be designed, including two tangible research project examples, the outlook for nature positive, and the enabling conditions and partnerships needed to realize effective action for nature. We hope that others can use and build upon this framework to identify priorities suited for different sectoral and geographic contexts.

THE NATURE-POSITIVE JOURNEY: A CONCEPTUAL FRAMEWORK AND RESEARCH AGENDA

Our proposed research framework for capturing the broad processes and actions necessary for businesses to contribute toward a nature-positive future is outlined in Figure 2. The framework highlights four core components where we propose research is needed: (1) understanding the systemic drivers of nature-positive change, including how regulators, markets, or society can influence the direction and effectiveness of business action for biodiversity; (2) the broad strategic approaches available for businesses; (3) the practical implementation of these strategies and what actions they involve at the level of individual businesses; and (4) how the outcomes of business action for nature should be monitored and reported to ensure nature positive is being delivered in absolute terms.

In the sections below, we discuss each of the four broad components, outlining the key associated research questions where we believe there are important uncertainties or a lack of evidence to support a global nature-positive agenda (Tables 1, 2, 3, and 4). The research questions are targeted toward researchers, consultants, and business professionals working at the interface between business and biodiversity, with the goal of facilitating effort and funding toward research projects that will help realize practical and effective biodiversity outcomes. Some questions will be more suited to purely academic research, whereas others will require collaboration with businesses and sustainability professionals. Many of the proposed questions are suited for work across academic disciplines, from ecological and conservation sciences to economics and business management. In the supplemental information, we provide expanded research question

Table 1. Proposed research questions on systemic drivers of change including: actions taken by regulators, markets, or society, which can influence the scale and effectiveness of business action

Topic	Priority research questions	Stage(s) of nature positive conceptual framework (Figure 2)
Instruments	1.1. What is the optimal mix of market-based, voluntary, and regulatory instruments for driving business action? In which cases are bottom-up (e.g., industry-led) or top-down (e.g., government prescribed) approaches more likely to be effective?	
Governance	1.2. Which type of regulation and policy instruments are most conducive to nature-positive reform for businesses?	
Finance	1.3. What financial mechanisms can deliver the necessary capital to implement nature-positive strategies?	
Public and civil society	1.4a. What opportunities and barriers exist to ensure widespread stakeholder support for adopting nature-positive actions, and how can they be addressed? 1.4b. What framing of nature positive is most likely to encourage action by businesses and avoid risks of negative perceptions?	

An expanded table including the rationale for each question and proposed level of research collaboration are included in the supplemental information (Table S1).

tables (Tables S1–S4), which include a rationale, and further details on the approach taken to develop a conceptual framework, identify priority research questions, and select priority areas (Note S1). Priorities will evolve over time given the rapidly changing landscape, and we hope that others can update and modify our research agenda to ensure research is targeted toward areas that are fully representative of different sectors, geographies, and perspectives.

Systemic drivers of change

Financial institutions, states, and societies all have access to various leverage points for driving systemic transformation. Such levers can influence the design and uptake of action across businesses and sectors at all stages of business model transformation.[29] However, questions surround the precise mechanisms and instruments that can best promote change, the governance and implementation of such mechanisms, and the risks of unintended negative outcomes (e.g., disengagement with the issue and greenwashing; Table 1).

Steering nature-positive action requires an understanding of the driving forces that can promote business engagement with biodiversity, including motivations, risks, and economic opportunities.[30,31] Businesses often address biodiversity loss in the context of transition risks, which occur if businesses fail to keep up with changing societal expectations surrounding biodiversity impacts.[31–33] These risks include regulatory drivers (e.g., legal penalties for non-compliance); financial risks (e.g., losing access to finance due to biodiversity impacts)[30,33]; or wider market and reputational risks driven by biodiversity-focused consumers, employees, and shareholders. Physical risks to operations and finances can also occur due to the dependence of businesses on ecosystem services that are being degraded.[14] The extent to which these risks and related opportunities drive action on biodiversity is influenced by how risks are assessed and framed, how widespread societal support is for nature-positive action, whether businesses consider the risks material, and the governance and policy instruments put in place to drive systemic change.

Governments have critical roles to play in shifting the economy toward nature-positive outcomes through direct investment in biodiversity as a public good, as well as through introducing regulations, policies, and incentive structures to shape and oversee markets to address biodiversity loss.[27,34,35] For example, Panwar et al.[35] argue that industrial policies are vital to set high regulatory benchmarks, address failures in market-based initiatives, and guide the development of effective mitigation action.

Firstly, governments can regulate the permitted activities for different industries to avoid negative impacts, set thresholds,

and manage trade-offs.[35] Examples include large-scale actions to prohibit certain actions or industries (e.g., banning use of neonicotinoid insecticides) or setting limits on "safe" levels and locations of negative impacts (e.g., emissions caps). Secondly, governments can enact large-scale market-focused policies that promote private investment in conservation, curb subsidies in harmful practice, and change industry incentives.[35] At a more transformative level, these actions could include deep reforms to monetary policy, including tax incentives and subsidy reform or moving away from GDP as an indicator of prosperity. For example, van Rees et al.[36] suggest governments can act to change incentive structures to promote the integration of nature-positive approaches into core objectives for civil engineering. Similarly, Booth et al.[37] outline how innovative blue taxes could reconcile trade-offs between economic activities in the ocean and marine biodiversity conservation. Government action to curb harmful subsidies could have large benefits for incentivizing business action.[38] However, research is needed to help understand these subsidies, who benefits, and the environmental and social impacts of their removal.[39] Thirdly, governments could promote a "green recovery" approach through the development of new technologies and financial innovations to partially decouple economic growth from biodiversity loss.[35,40] In addition, governments can influence markets through mandating the disclosure of business impacts and dependencies across the value chain and regulating to ensure inclusivity and community benefits from business engagement with biodiversity.[35]

Different approaches may place a varying importance on the role of market and non-market actors in delivering conservation goals and the role of the state in governing market-based forces. However, understanding the impacts of these different approaches is vital for guiding effective nature-positive action at the broader scale, including how likely they are to engage both leading and laggard businesses.

In the case of the finance sector, there is increasing research on the integration of nature-related financial risks into existing risk management systems, given their potential to affect investment returns or future business valuation (or, in the case of central banks, the security or stability of the financial system).[14,41] For example, Jouffray et al.[42] investigate how different existing investment mechanisms could steer the seafood industry toward more sustainable practices. Processes are now underway for increasing the transparency and standardization of reporting on businesses' exposure to nature-related risks (such as the Taskforce for Nature-related Financial Disclosure[14]). The implicit theory of change suggests that informed investors will alter their investment decisions, as early studies demonstrate that biodiversity risks appear widely underpriced.[43] However, it has been argued that this rationale does not hold[44] and preliminary evidence suggests that investment decisions may not currently be highly influenced by businesses' biodiversity footprints.[45] There is room for this sentiment to evolve in the future with increasing public awareness and regulatory pressure, and thus there are large gaps for research on the finance sector's contributions to nature positive. Identifying the most effective policy options requires an understanding of drivers of responses to risks, such as whether decisions are made due to informational deficits or to (real or perceived) lack of materiality. If research determines that the barrier is a lack of materiality, then direct public regulation of biodiversity loss caused by the financial sector will be essential.

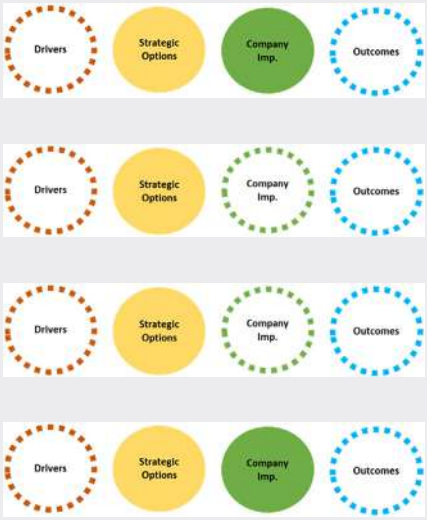
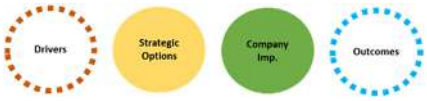
Strategic options for businesses

There is a spectrum of strategic approaches through which businesses can engage with biodiversity.[46–48] At one end of the spectrum, a "business transformation" approach could involve strong avoidance of impacts, while integrating nature-related considerations into core business objectives and shifting the business strategy to adopt value chains that better align with societal goals (e.g., fossil fuel companies switching to renewable energy sources, or civil engineering explicitly integrating biodiversity conservation as a core objective in development projects[36]). The implementation of such strategic actions faces various challenges: for one, approaches that rely heavily on avoidance actions may be dismissed by businesses because of perceived high costs and conflicts with existing business models and stakeholder preferences.[49,50] Uncertainties in quantifying and accounting for avoidance-related biodiversity actions may hinder their adoption into sustainability strategies.[46] Therefore, research is needed to overcome these constraints and assess the effectiveness and feasibility of more widespread transformative action (Table 2).

At the other end of the spectrum, a "business adaptation" approach largely maintains business as usual, with changes made to improve the resource efficiency of operations and reduce negative impacts, without imposing transformative changes on the core business model. For example, strategies could include reduction in high-impact business travel, switching to paperless offices, improving recycling, or reducing electricity use. Business adaptation strategies will tend to rely more heavily on offsets to compensate for negative impacts to achieve net gain or net positive impact for biodiversity, rather than implement avoidance actions within the value chain.[46] There is also increasing interest in biodiversity credits and their appropriate and responsible use in strategies to deliver nature-positive outcomes.[51] These discussions raise important questions around how offsets and credits can be successfully implemented,[52] how scalable they are,[53] and in what situations they can be justifiably used to contribute to nature-positive strategies.[22] In practice, any given business may need to adapt certain parts of their business and transform others, depending on how their operations and value chain interface with biodiversity and the degree to which different business activities impact biodiversity.

Despite the need for transformative strategic approaches to reducing businesses' biodiversity impacts, there are practical considerations around how fast businesses can change. The chosen strategies, in practice, may be dictated by many factors, including feasibility, costs (including opportunity costs), market demand, shareholder pressure, societal norms, regulation, business indebtedness, equity considerations, the availability of relevant technology, and the limits of organizational and sectoral will to embrace radical changes (for example, privately owned versus shareholder-managed businesses may face different degrees of flexibility).[47] There are also considerations surrounding the integration of biodiversity strategies with existing efforts surrounding climate change and social inequalities to develop multifunctional interventions.[54] In addition, there is the potential that as incentives, technologies, and the capability for systemic

Table 2. Proposed research questions on strategic options for businesses including: broader business and sectoral approaches for delivering nature-positive contributions

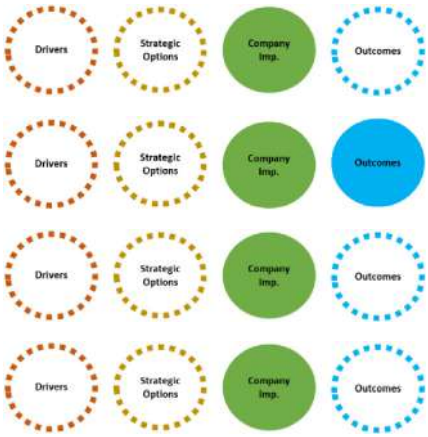
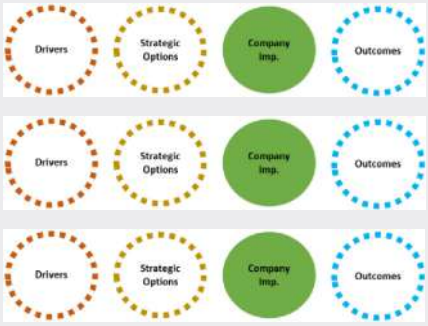
Topic	Priority research questions	Stage(s) of nature positive conceptual framework (Figure 2)
Business transformation vs. business adaptation	2.1a. How and when will business model transformation (e.g., avoidance-heavy strategies) be necessary, and when is business adaptation (e.g., significant offsetting) sufficient for delivering effective biodiversity outcomes? 2.1b. What are the enablers and barriers to incentivizing more radical and widespread transformative business action to address biodiversity loss? 2.1c. How can the adaptation of existing business models be improved in effectiveness and scaled? 2.1d. How and where can offsets be implemented successfully by businesses? Are there limits to how offset-heavy a business strategy can be? What role can biodiversity credits play in nature-positive strategy design?	
Collaborative approaches	2.2a. What impacts on nature can be effectively addressed by individual businesses and for which is a sectoral approach more efficient or effective? 2.2b. How to assess contributions to nature positive using a regional approach, collaborating with others in the same land/seascape to address indirect and cumulative impacts?	
Technology and Innovation	2.3. How can future technological innovations support impact reduction strategies, over what timescales, and with what risks?	
Trade-offs and synergies	2.4. What are the trade-offs and synergies between nature positive and other climate and social strategies for business?	
Equity and social justice	2.5. What are the equity and social justice implications of different business strategies, and how can they be managed?	

An expanded table including the rationale for each question and proposed level of research collaboration is included in the supplemental information (Table S2).

change grow, individual business and sectors may be more likely, able, and willing to shift to a more transformative strategy.[23]

Sectoral or regional collaboration at different geographic scales will also be needed to develop effective strategies for nature recovery at the societal scale, to coordinate action across industries and land/seascapes of highest priority, drive action across all businesses (including leaders and laggards), and to address situations where there may be uncertainty in the calculation of individual businesses' impacts, but more clarity at the sectoral or land/seascape level. For example, cumulative impacts can lead to large impacts in some land/seascapes and are challenging to manage by individual businesses where their individual impacts can appear insignificant.[55] Similarly, positive actions of individual companies may not always lead to positive outcomes at the societal scale due to displacement

Table 3. Proposed research questions on the design and implementation of business actions to deliver nature-positive contributions

Topic	Priority research questions	Stage(s) of nature positive conceptual framework (Figure 2)
Metrics and measurement	3.1a. How can businesses measure biodiversity impacts along the entire value chain, including investments and upstream/downstream impacts? 3.1b. What are appropriate methods and metrics for quantifying and incorporating uncertainty when calculating the negative and positive impacts of businesses on biodiversity?	
Target setting	3.2a. What business-level targets would, in the aggregate, contribute to global nature-positive outcomes when achieved? 3.2b How should businesses define the appropriate baseline and reference states against which targets should be set and progress measured? 3.2c. What are the advantages and disadvantages of different target-setting frameworks for businesses (e.g., prescriptive vs. more flexible) to achieve nature-positive contributions? 3.2d. How should responsibility for impacts be allocated between actors in complex value chains; what is the appropriate scope for the impacts covered by business-level targets?	
Action planning and implementation	3.3a. What combinations of actions across the mitigation and conservation hierarchy can be effective in different sectors to deliver nature-positive outcomes? 3.3b. How feasible are different combinations of nature-positive actions (e.g., cost, acceptability, practicality)? 3.3c. At what threshold is it appropriate for businesses to adopt actions at different stages of the mitigation and conservation hierarchy? E.g., when is it more effective or necessary to move from avoidance to later stages of the hierarchy?	

An expanded table including the rationale for each question and proposed level of research collaboration is included in the supplemental information (Table S3).

and leakage.[23] Understanding where sectoral and regional approaches can be effective and usefully developed are among the key research topics identified (Table 2).

Implementation by individual businesses

Within any given approach, the nature-positive journey will require businesses to assess their impacts and dependencies on nature, set credible commitments, and design and implement plans and actions that deliver positive outcomes for nature[18,20] (the Assess, Commit, Transform and Disclose [ACT-D] framework following SBTN's AR3T mitigation hierarchy steps; Figure 2). Targeted scientific research efforts are vital to inform choices around which actions to implement, with some of the particularly high-priority research questions outlined in Table 3.

Businesses need to assess which of their activities have material impacts on nature to develop a biodiversity strategy (businesses may also be interested in assessing their dependencies on nature, but it is impacts on nature that are important for nature-positive outcomes). This is challenging, requiring detailed information on business operations, decisions on which aspects of biodiversity to measure, and the metrics to use to quantify impacts.[56,57] The largest sources of negative biodiversity impacts, for instance, are often not in a business's direct operations but rather embedded in their upstream or downstream supply chains.[26,58,59] Methods exist to assess these wider impacts in value chains and investments, ranging from life-cycle assessment tools for individual products to global supply-and-use tables or input-output databases for broader

monetary flows.[60] The scale and location of impacts of varying scopes (direct/indirect, stages of the value chain, historical/current), and the assignment of proportionate responsibility for them to individual businesses or sectors, are often still highly uncertain. Determining when there is enough information to act or when further evidence is required to resolve critical uncertainties is a key issue highlighted in the identified research questions.

The next step of the nature-positive journey for a business is to set appropriate specific, measurable, achievable, realistic, time-bound (SMART) targets that can deliver positive outcomes for nature.[61,62] Aligning these targets with international biodiversity goals is challenging, requiring that appropriate ambitions, time frames, pressures, and components of biodiversity are accounted for.[63,64] To achieve such targets, businesses must commit to actions and interim milestones that can deliver the changes required, prioritizing action based on the mitigation and conservation hierarchy.[65,66] These plans need to consider the specificities of sectors, geographies, and impact scopes. For example, actions to address the impacts of mining or renewable energy projects may focus heavily on site-based avoidance measures, technologies to reduce species-specific impacts, and the development of site-level offset strategies.[67] The set of actions for consumer goods firms or multinational businesses, in contrast, will likely prioritize measures that can be implemented to minimize impacts across the value chain as well as compensatory and proactive measures to improve biodiversity in regions impacted by material sourcing where there may be less control over the implemented actions. The overall effects of mitigation actions need exploration, and trade-offs may need to be made based on costs and feasibility.[68,69] For example, avoiding impacts in fisheries through closures can lead to large opportunity costs that may be inefficient, inequitably distributed between stakeholders, and result in the displacement of negative impacts elsewhere. Therefore, fishing businesses may focus instead upon technological improvements to reduce their impacts.[70,71] These challenges and considerations are important to address to facilitate the implementation of corporate biodiversity targets and nature-positive strategies.

Implementing actions at the appropriate scale will also require designated resources and internal expertise and capacity if a business wishes to contribute meaningfully to systemic transformation. They will also require resources and capacity to measure and disclose their impacts, which may initially be limited. Given this, businesses may need to ratchet up their ambition over time by monitoring and reporting progress and maintain a degree of flexibility by adapting plans if problems or opportunities are identified. A range of additional barriers to implementation include political lobbying, lack of organizational buy-in, and conflicting incentives for individual employees, teams, and for the business as a whole.[72,73]

Outcomes

The ultimate goal of a business's nature-positive biodiversity strategy should be to deliver positive outcomes for nature in absolute terms relative to a current static baseline.[21] Monitoring outcomes at a project, business, or societal scale is therefore fundamental to measuring success, but questions arise as to when, where, and how outcomes should be measured and how contributions across businesses scale to meet nature-positive goals (Table 4).

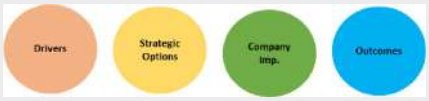
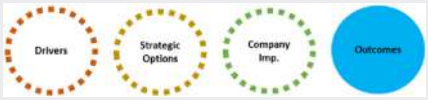
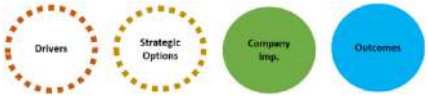
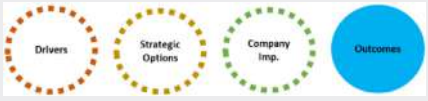
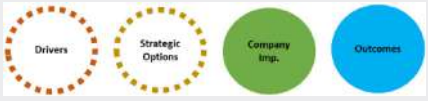
There are many metrics available to measure outcomes, and it is often difficult for businesses to decide on suitable measurement approaches to capture relevant components of biodiversity and subsequently navigate the associated measurement uncertainties and discrepancies between estimates of impacts from different approaches.[74–77] Given capacity constraints, there are also trade-offs between comprehensiveness and feasibility of monitoring.[78] For example, it is important to measure biodiversity outcomes (e.g., the presence or abundance of species, the extent and condition of ecosystems), but it can be costly and challenging to monitor outcomes in a way that allows attribution to specific business actions, enables comparison across sites and business operations, and produces time-series data that are sensitive enough to inform adaptive management. For these reasons, businesses may find it more feasible to measure indicators of responses or pressures rather than direct changes to the state and condition of ecosystems, but these may not always reliably predict biodiversity outcomes.

The scope of monitoring also needs consideration. Narrowly targeted monitoring programs could show positive impacts from a business's activities without accounting for indirect and cumulative impacts, leakage effects, or substantial impacts within value chains.[79] This could give a misleading picture of benefits at the societal level.[23] For example, if a business's measures to enhance or restore biodiversity at agricultural sites (e.g., through regenerative practices or offsets) also decrease production yields, this could risk agricultural expansion and intensification elsewhere if the overall demand for products is not reduced.[80,81] Deciding at what scale to monitor and what impacts are in scope is therefore key, as is selecting metrics that can be aggregated and compared between sectors and scales. Although this poses significant practical challenges, methods are being actively developed that could be applied across organizational scales and be responsive to changes in business management (e.g., STAR[57] and Ecosystem Condition Indices[82]). Outcome data should also be fed back into the assessment of impacts and strategy development to enable learning and adaptive management, and ideally be shared to improve the evidence base and guide more effective action.[83]

Designing research projects

Given the time frames required in the GBF to deliver full nature recovery by 2050, we believe there is a need for rapid action to address the priority questions we have identified. Researchers, business professionals, and consultants can conduct collaborative research based on tangibility, importance, and questions tailored to sectoral needs.[19,36] Some questions are immediately practical and relevant to on-the-ground operations, where collaborative research can help businesses immediately begin a nature-positive journey. Quick potential wins include using existing data to determine the return on investment of initiatives to promote biodiversity in agricultural landscapes (e.g., through improving or increasing the stability of yields,[84] testing the effectiveness and feasibility of commonly used mitigation actions,[85] or supporting the development of metrics for value chain impacts that align with field-based outcomes[56]). Other questions may be of lower immediate priority for individual businesses

Table 4. Proposed research questions on measuring and delivering outcomes at business, sectoral, national, and global levels from business action

Topic	Priority research questions	Stage(s) of nature positive conceptual framework (Figure 2)
Scaling and coordinating action to deliver nature positive	4.1a. How can individual businesses scale and allocate their contributions to the GBF so they are proportionate to their impacts and add up to achieve societal goals? What gaps are left, and why might they exist?	
	4.1b. How can businesses measure impacts and outcomes across sectors, operational areas, and types of biodiversity impacts in a way that allows easy comparison within and between businesses?	
	4.1c. How can businesses be incentivized to share data and outcomes on their nature-positive strategies in ways that enable rapid uptake of effective action?	
Measuring and monitoring implementation and outcomes	4.2a. How can businesses quantify the outcomes of nature-positive actions at each stage of the mitigation and conservation hierarchy, particularly the net outcomes of avoidance measures?	
	4.2b. How can businesses monitor processes and outcomes across the different stages of the nature-positive journey (from driving processes to measuring outcomes; see Figure 2)?	
Scope, necessity, and feasibility of monitoring	4.3a. Given monitoring can be resource and time intensive, what amount and need is there for businesses to monitor outcomes before taking action? Are there situations where it is more appropriate to monitor processes?	
	4.3b. How should the potential displacement of impacts (i.e., leakage) be accounted for and monitored in business strategies? How feasible and at what scale can this be addressed?	

An expanded table including the rationale for each question and proposed level of research collaboration is included in the supplemental information (Table S4).

but are important for coordination and scaling of approaches at a wider scale, necessitating collaboration with academic or other business stakeholders. This could include questions around the allocation of mitigation requirements between different actors and sectors or strategies for monitoring outcomes at different scales (Table 4). Some questions may be less suitable for collaborative approaches (for example, where it is deemed that involving certain business actors may compromise the independence of research). In all cases, researchers are encouraged to be mindful of potential conflicts of interest when working with business actors to ensure effective and fruitful collaborations. Public sharing of these collaborative research outputs can help deliver data needed on the ground to realize effective biodiversity strategies.

Tangible research projects can be created to address these questions, suited to different actors, budgets, and timescales (see examples in Table 5). As the engagement of businesses with biodiversity increases, future exercises could investigate emerging issues through horizon scanning approaches to help guide research and action before significant risks emerge.[86]

OUTLOOK

Effective and equitable pathways for nature positive

There are many different pathways for businesses to contribute to a nature-positive future, and the optimal routes will differ depending on the sector, geography, and societal and political context within which they operate. The pathways will also likely change over time as societal, ecological, institutional, and technological contexts evolve. Governments, financial stakeholders, and societal actors can also work in conjunction with businesses to promote or disincentivize action. Ensuring that the pathways taken are well designed and effective at reaching desired business and societal goals will require research questions to be

Table 5. Hypothetical interdisciplinary research projects

Question 4.1a (Table 4). How can individual businesses scale and allocate their contributions to the GBF so they are proportionate to their impacts and add up to achieve societal goals? What gaps are left, and why might they exist?
Wasteful use of water in commercial horticulture for export is a major biodiversity and social justice issue in water-stressed regions of the world, causing the drying of natural systems and difficulties in finding adequate water for local communities.I n recognition of the issue, a large NGO could initiate a project with university researchers in an area of the world particularly vulnerable to these environmental pressures and collaborate with major commercial horticulture businesses to quantify their water use. Together, they would explore how these businesses could avoid and reduce water use, reuse wastewater, and develop proactive conservation actions to improve water retention in natural areas and provide clean water to local communities—taking into account the likely effectiveness, feasibility (e.g., staffing, timelines), and costs associated with each action. The researchers would co-design the work with the businesses and communities, and the NGO would work in partnership with them to implement and monitor the activities. Other collaborating researchers would track the exported horticultural produce along the value chain to retail businesses selling to consumers. These retailers could contribute finances to cover the implementation costs of the water-enhancing activities and report these activities as part of their contribution to systemic nature-positive global outcomes. Analysis across these different scales of action could explore whether these combined mitigation actions are sufficient to make horticultural activities across entire nations net positive for nature, having considered leakage and the social justice outcomes for communities. If societal goals are not equitably met, the results could identify gaps, imbalances, and implementation barriers and begin exploring solutions to these issues.
Question 3.1b (**Table 3**). What are appropriate methods and metrics for quantifying and incorporating uncertainty when calculating the negative and positive impacts of businesses on biodiversity?
A coalition of financial organizations and biodiversity specialist researchers could be formed to help assess the effectiveness of different metrics to measure the biodiversity impacts of investments. The financial organizations would provide anonymized data on the locations and sizes of projects and businesses they invest in and, where possible, the associated suppliers of those businesses. A research project could be planned to assess the biodiversity footprint of these portfolios of investments using a combination of different metrics. The project would assess how estimates of the absolute footprint of the portfolio, and the relative footprints of different activities within it, differed depending on the metrics chosen. The results of the study could be used to assess the synergies between different metrics and as a basis to discuss the limitations of different approaches. This could involve developing a typology of uncertainties in the different approaches and systematically exploring which are more or less important in influencing the results, in addition to identifying what additional data are needed (including business-level, economic supply chain, and ground-truthed biodiversity data) to improve the robustness of footprinting approaches.
Example hypothetical research projects designed to address two of the proposed high-priority research questions from Tables 1, 2, 3, and 4.

answered across all stages of our proposed framework[23] (Figure 1; Tables 1, 2, 3, and 4).

The costs and benefits of different pathways will be unequally distributed across sectors, geographies, and stakeholders.[87] Some sectors may be completely incompatible with a nature-positive future and therefore could justifiably be phased out—although such action would require careful navigation of related social issues and transition risks. For example, coal power is often deemed incompatible with environmental goals and has been excluded from the EU taxonomy for classifying environmentally sustainable economic activities.[88] Other sectors may conduct activities that are inherently damaging to biodiversity but need to be included in a nature-positive future because they are necessary for the broader transition to a sustainable economy or to provide major human welfare outcomes. For instance, mining and minerals extraction for renewable energy production,[89] medical research, or some types of agricultural production may have unavoidable impacts on biodiversity but are essential for social benefit.[26] Sector-specific strategies may be required to help foster nature-positive transitions, requiring sector-specific research priorities. For example, Hodson de Jaramillo et al.[28] outline a vision for nature-positive agricultural production to meet production needs within planetary boundaries. Their approach fits under three main pillars: (1) protecting natural habitats and giving land back to nature, (2) sustainably managing existing food production systems, and (3) restoring and rehabilitating degraded systems for sustainable production and ecosystem services. However, they also highlight feasibility concerns (e.g., yield reductions, higher transaction costs) as well as opportunities for research (e.g., understanding available government policies and their potential impacts).

For these sectors to form part of a global push toward nature-positive outcomes, there needs to be wider agreement around activities that are permissible (and under what circumstances) and clear compensation and mitigation requirements and responsibilities established at a landscape or sectoral scale. For example, compensation requirements to achieve GBF goals could be divided between different actors depending on their level of damage to biodiversity, their role in the sustainability transition, historic impacts, and equity considerations.[90,91] The case has recently been made that richer nations or highly polluting sectors, who, through their current consumption and historic impacts, have been responsible for the drivers of biodiversity loss globally, should foot up a larger proportion of the bill than other actors.[92,93] Assigning such responsibilities would require policy and regulatory change to incentivize and define appropriate levels of action and a better understanding of the mechanisms available that can best promote change (see Table 1).

In addition to the distribution of costs between sectors, there will be social equity disparities inherent to different nature-positive pathways that must be addressed to avoid detrimental societal impacts. Some stakeholders have historically faced significant injustices and social costs through the implementation of conservation actions.[94] Similarly, the transformation of business

strategies to address biodiversity impacts may disadvantage certain groups disproportionately. For example, a study of a major biodiversity offset in Madagascar showed costs and benefits to wellbeing from the mining and offset activities were unevenly distributed, and costs were higher to poorer and more marginalized stakeholders.[95] For contributions to nature positive to be socially just, research is vital to understand these costs and benefits and to minimize trade-offs[71] (Table 2).

Enabling action and impactful research

Taking swift action to address priority research questions, such as those we have identified (Tables 1, 2, 3, and 4), relies on a range of enabling conditions that underpin the nature-positive journey. Firstly, given the nascent nature of this topic, transformative change will require a culture of innovation where new tools and approaches can be developed to meet the GBF targets. This could take the form of new financial mechanisms or modified economic policies that encourage business action on biodiversity and internalize some of the costs of addressing negative biodiversity impacts[96] or developing and testing the effectiveness and feasibility of new technologies to monitor and mitigate impacts.[97] For example, technological innovation for bycatch reduction in fisheries is essential for maintaining catches of target species while preventing overfishing or incidental catch of threatened slower-growing species.[98,99] There is also a necessity for capacity building and potentially funding from government or sectoral businesses to provide the expertise and oversight needed to coordinate, monitor, and scale efforts to address research questions and mitigate impacts.[36] This is in addition to the increased resourcing that will be required within businesses to acquire the biodiversity expertise needed to deliver strategies and research outputs and collaborate effectively with researchers, consultants, and sustainability professionals on research projects to benefit the wider community.

Additionally, partnerships need to be encouraged between actors experienced in nature conservation activities (i.e., NGOs, government agencies, consultancies), academia, and business to facilitate the transfer of knowledge, the integration of strategies into existing conservation efforts, and the identification of questions of highest importance to businesses. For example, Addison et al.[16] highlight the transferability of concepts from systematic conservation planning to business strategies for biodiversity. Indeed, the inefficient exchange of knowledge between different groups, including researchers and potential end users, is a commonly identified challenge.[100,101]

For nature-positive action, environmental consultancies could play a key role in bridging the space between research and practice (akin to "evidence bridges" or "knowledge-broker" organizations, which have been widely called for in the conservation literature[102,103]). Consultancies possess practical experience working with businesses to address biodiversity impacts and a high level of technical expertise in the subject area.

Similarly, business-biodiversity groups (e.g., Business for Nature) or sectoral organizations (e.g., IEMA, ICMM, Textile Exchange) could facilitate partnerships and promote research, as research can be hindered when a single business does not wish to take responsibility or expend resources on projects that benefit the wider community. Such groups could engage businesses within and across sectors, develop research agendas, and prioritize research, including developing sector-specific strategies to deliver nature-positive outcomes.

CONCLUSIONS

Biodiversity is still at the fringe of most businesses' engagement with the environment. However, achieving the GBF's 2030 mission of halting and reversing the loss of biodiversity will require rapid transformative action across society, including substantial action by businesses to address their impacts and contribute toward these goals. Major challenges remain to be overcome, and many uncertainties exist over how best to deliver nature-positive ambitions.

The research framework presented offers our perspective on major gaps in understanding that we believe should be prioritized for immediate research by academic and business stakeholders. Framed under four key pillars (systemic drivers, strategic options, implementation, outcomes), the research questions provide a starting point for research engagement at the business, sectoral, and societal level. Our research agenda can be applied by different stakeholders, who we hope can assess and build upon the priorities we have identified. Business sustainability teams may use the framework as a guide to prioritize the data collection or resourcing that underly the development of an effective nature strategy or nature-related risk disclosure. Sectoral coalitions (e.g., Sustainable Apparel Coalition, Business for Nature) or industry-led initiatives (e.g., Nature Action 100) may use the framework to pinpoint focal areas for sectoral engagement and the design of effective industrial policies. Our framework could also help align academic research endeavors with the broader needs of business and society. In sum, we hope the research agenda outlined here can foster collaborations for targeted and timely research that drive business contributions toward a nature-positive future.

SUPPLEMENTAL INFORMATION

Supplemental information can be found online at https://doi.org/10.1016/j.oneear.2024.07.003.

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AUTHOR CONTRIBUTIONS

All authors contributed to the design of the conceptual model and priority research questions. H.B. ran and organized the workshop, with input from T.B.W. and T.B. T.B.W. and T.B. wrote the first draft of the manuscript. All authors commented on and edited subsequent versions.

DECLARATION OF INTERESTS

T.B.W., T.B., A.B., L.B., J.B., H.B., G.W.P., and M.S. receive income from commercial consultancy services related to biodiversity mitigation in the private sector.

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