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## Identifying opportunities to deliver effective and efficient outcomes from business-biodiversity action

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### ABSTRACT

Business-biodiversity action is increasingly seen as critical for delivering conservation goals, but such action needs to be effective. Using detailed semi-structured interviews with leading business-biodiversity professionals and consultants we aimed to understand the actions currently taken and why, how actions are decided upon, and current challenges that hinder effective, efficient action.

The scale and type of action varied by sector, driven largely by the risks (reputational, financial) of inaction. Cost-effectiveness was important to businesses, but the limited quantification of the economic consequences of biodiversity action hindered uptake. Indirect evidence sources were generally used to guide decision-making including using expert consultants, guidance, standards or certifications. Acquiring better evidence of cost-effectiveness, particularly if embedded within these indirect sources, could improve practice.

A diverse set of challenges emerged that impeded business engagement with biodiversity, effective decision-making, and action implementation. We discuss opportunities to address them and thus improve the effectiveness of business-biodiversity action.

### 1. Introduction

Biodiversity is in large-scale global decline (Diaz et al., 2019; IPBES, 2019). Land use change and habitat loss, driven by industrial and agricultural growth, are often stated to be the primary causes of this decline (Krausmann et al., 2017; IPBES, 2019). The realisation of the risks posed by the degradation of nature has led to greater attention being placed upon businesses activities that impact nature (WEF, 2020a), alongside increasing calls for the private sector to become a substantial player in helping reverse current declines and bring about the transformative change needed to achieve global biodiversity targets (e.g. Convention on Biological Diversity Target 15; CBD, 2022).

Businesses are expected to play an active role in improving the status of biodiversity to achieve global sustainability targets (e.g. CBD targets; Sustainable Development Goals by 2030). This includes actions taken to mitigate their impacts on biodiversity ranging from avoidance and minimization actions that seek to prevent degradation to restoration and compensatory actions that aim to address impacts after they occur. Further proactive biodiversity conservation interventions can be taken to restore and enhance biodiversity values. Actions to reduce impacts

and restore values can include actions focussed on direct operations, through value chains and through investments (CSBI, 2015; Science Based Targets Network, 2020). Many national jurisdictions now have regulatory requirements to mitigate and compensate for impacts, particularly from large direct impacts (GIBOP, 2018). An increasing number of businesses are setting targets specifically related to biodiversity (e.g., No Net Loss; Nature positive; zero deforestation; de Silva et al., 2019), as well as taking action to address biodiversity impacts (Kohsaka et al., 2009; Wolff et al., 2018). Biodiversity loss is increasingly becoming an issue for all industries, and not just those with major direct impacts (e.g. Panwar et al., 2022).

Where action is taken, businesses are often driven by the risks associated with negative impacts including reputational risks due to rising stakeholder awareness and expectations on biodiversity, as well as operational and financial risks associated with impacts (Kohsaka et al., 2009; Boiral and Heras-Saizarbitoria, 2017; Boiral et al., 2018; Macellari et al., 2018). Numerous firms also have a high dependency on the services provided by nature (e.g. pollination, clean water provision) and the risks of negatively impacting these dependencies can provide a direct business incentive to effectively manage biodiversity (Houdet

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et al., 2012). Viewing businesses this way, outlines them as organizations existing within complex socio-ecological systems that both impact and depend on nature. Further research is required to better understand these links and dependencies (Winn and Pogutz, 2013).

Advances in the conservation literature have shown that appropriate use of evidence to guide decision-making can help ensure maximum biodiversity gains from the conservation funds available (Sutherland et al., 2004; Deutz et al., 2020). There are an increasing number of examples of successful mitigation measures that can be put in place (e.g. Berthinussen et al., 2019; Dwyer et al., 2019; Sutherland et al., 2019; Panorama, 2022) and a range of tools and techniques are being developed to help businesses access data, measure and address their impacts on biodiversity (IBAT; EU B4B Finance metrics; GEO 2021).

However, investment in biodiversity issues and effective delivery of biodiversity related actions does not always occur. Firstly, biodiversity is still often seen as peripheral to business strategies and investment decisions (Winn and Pogutz, 2013), with environmental strategies focussed largely on climate and social issues under the ESG (environmental, social and governance) banner (Addison et al., 2019; GEO Business Briefs, 2021). It is still the case that most businesses do not fully integrate biodiversity into environmental strategies (Bhattacharya and Managi, 2013; Addison et al., 2019). Indeed, even with the most engaged sectors, levels of action on biodiversity can be highly variable (Macellari et al., 2018).

Research has shown that there can be differences between perceptions of risk, actual biodiversity impacts and actions taken, with firms often taking token smaller actions, but not the substantive actions required to address biodiversity loss (Smith et al., 2019; Wagner, 2022). If motivations at companies are driven primarily by risk management, then without stringent regulation, it remains possible for smaller actions and disclosures to reduce risks without substantive engagement or conservation gains being realised. In fact, biodiversity disclosure across companies can be very limited, often not consistent or meaningful (Hassan et al., 2020), and can be used as a tool for impression management rather than for delivering real biodiversity gains (Cuckston, 2018).

Even when biodiversity impact mitigation action does occur, there is increasing evidence to suggest that, even in sectors with a stronger history of mitigating impacts to biodiversity, such as infrastructure and extractives, commonly used measures can lack evidence of their success (Drayson and Thompson, 2013; Taylor et al., 2019; Christie et al., 2020; Hunter et al., 2021; Josefsson et al., 2021), and some can be demonstrably ineffective (e.g. Sutherland and Wordley, 2017; Bezombes et al., 2019; zu Ermgassen et al., 2019; Nash et al., 2020). Furthermore, the guidance frequently used by businesses and consultants is often outdated or not necessarily based on the available evidence (Downey et al., 2022). Without access to evidence, and careful decision-making about which actions to implement, we risk implementing actions that are poorly conceived, ineffective, or not based on appropriate evidence – leading to poor outcomes for nature.

There are several challenges that likely hinder businesses taking effective action to address biodiversity impacts, ranging from a limited knowledge of impacts and measurement approaches for biodiversity, to difficulty integrating the management of common resources (such as biodiversity) into the traditional business models (e.g. Lambooy and Levashova, 2011; Bhattacharya and Managi, 2013; Macellari et al., 2018; Winn and Pogutz, 2013). There can also be limited evidence or knowledge of strategies that can be used to effectively address impacts (Panwar et al., 2022). For example, Feger & Mermet (2020) looked at the environmental practices of a large water management company and found the dependence on the normal value creation model difficult to overcome, whilst facing other challenges such as limited funding for

programs, difficulty applying restoration actions across different socio-economic contexts, and lack of staff time and training to deliver programs.

As biodiversity rises up the international agenda, business engagement with biodiversity is expected to keep increasing (WEF, 2020b). Achieving positive outcomes from this transformative change will require larger scale action by businesses and effective evidence-based decision-making to prioritise expenditure on mitigation actions. The interrelationship between business and biodiversity has not been a major topic of research in the corporate sustainability literature. Research is needed on the strategies and tools that can enable businesses to help address biodiversity loss, including in decision-making processes to understand how evidence can be better integrated to improve environmental outcomes (Winn and Pogutz, 2013; Feger et al., 2019; Wagner, 2022; Roberts et al., 2021; Panwar et al., 2022).

To provide data that could help develop such tools and strategies, we aimed to understand business professional's perspectives at a strategic level on:

- (i) Which actions types are currently adopted by various businesses regarding biodiversity and what are the drivers for those actions?
- (ii) How are actions selected, including how information on effectiveness and cost-effectiveness is used?
- (iii) What are the main perceived challenges associated with cost-effectively mitigating impacts, and what recommendations do business professionals have for improvements?

Understanding these would help identify practical points of intervention that may help businesses upscale conservation efforts, and address challenges faced on the ground. In particular, this work looks at the information used to decide upon action, and can therefore help identify where the creation and use of evidence can be improved to guide practice.

Targeting a group of informed business professionals in a range of sectors, we examined these questions using in-depth semi-structured interviews. These respondents met the conditions for elite business interviews, which are routinely used in management research to elicit appropriate information from business interviewees.

## 2. Methods

To investigate these research questions, we conducted a qualitative study using semi-structured interviews within a grounded theory approach to identify themes within the data produced. We detail the study design below. Semi-structured interviews are deemed suitable to promote open, wide-ranging discussion of these issues without pre-determining potential responses at the outset (Bernard, 2006) and have been specifically recommended for elite interviews in the business sector (Aguinis and Solarino, 2019). In the Supporting Information we state how we meet best practice criteria for conducting qualitative research to improve transparency and replicability (Aguinis and Solarino, 2019).

### 2.1. Sampling procedure

We systematically reached out to sustainability professionals in the private sector and specialist biodiversity impact mitigation consultants. Interviewees selected were those who had: i) responsibilities related to biodiversity and environmental management within the company at an organisational level (e.g. chief sustainability officer, managing director) or ii) responsibility related to the management of biodiversity on specific projects or investments of significance to the company (e.g. head of

ecology, environmental project manager). This sample therefore meets the criteria of “elite informants” who are defined as “key decision makers who have extensive and exclusive information and the ability to influence important firm outcomes, either alone or jointly with others (e.g., on a board of directors)” (Aguinis and Solarino, 2019; Solarino and Aguinis, 2021). Interviews with these business individuals offer a good opportunity to gain in-depth understanding of strategy design and decision-making processes.

Accessing “business elites” for interviews can be challenging, as they have limited incentive and time to be interviewed, access to them is often controlled by gatekeepers, and individuals can be suspicious of researcher’s incentives (Solarino and Aguinis, 2021). This approach thus requires adequate prioritisation of questions, selecting experts knowledgeable about the subject base, wishing to raise particular issues of relevance and willing to challenge assumptions made, or questions raised, by the interviewer. This technique is especially tuned to power imbalances between researcher (TBW being a PhD student) and business elites. It facilitates a more natural discussion that elicits the most out of the participant’s knowledge and experiences (Solarino and Aguinis, 2021).

Through both email contacts and, where possible, LinkedIn Premium, we contacted 50 of the world’s top 200 largest companies, randomly selected from the Fortune 2000 list, as well as 25 companies with a leading role in two specialist platforms for integrating biodiversity considerations into business activities. LinkedIn Premium was used to help access individuals directly, and as is recommended for ‘elite interviews’, invitation messages were tailored and personalised based on an approved template to increase likelihood of response (Solarino and Aguinis, 2021). We supplemented this with purposive sampling within the Cambridge Conservation Initiative (a partnership of major international biodiversity conservation organisations and the University of Cambridge) and snowball sampling of individuals at other companies known by the interviewees. Lastly, TBW advertised the interviews at a Conservation Evidence webinar in May 2021, which was attended by over 100 ecological consultants and business professionals, and he asked attendees to share the information with relevant contacts.

## 2.2. Interview Protocol

A detailed interview guide was developed, structured around the three questions listed above, and used to frame hour long interviews. Interviewees were asked questions that focused on the positive and negative impacts of their organisation on biodiversity, the drivers behind taking actions to mitigate impact and improve biodiversity status, how actions were decided upon (including how information on effectiveness and cost-effectiveness influenced that process) and, lastly, their perspectives on challenges and opportunities that could catalyse improved practice in future. The interview guide was reviewed and edited by all co-authors with questions carefully designed to avoid biasing potential responses. For example, we first asked how information was used to guide decision-making before asking specific questions about which, and how, evidence sources (including information on effectiveness and cost-effectiveness) were used in the process. At the end of the interview, respondents were asked if there was anything else they would like to share to ensure coverage of all topics that participants considered relevant (Solarino and Aguinis, 2021). When needed (e.g. the interviewee raised topics related to subsequent questions), the order of the questions was altered, but the interviewer used the interview guide to ensure that all broad questions were covered in every interview.

Due to the coronavirus pandemic and the international setting, all interviews were conducted virtually and recorded via online video conferencing software (*Microsoft Teams*). Prior to starting the interview, the interviewer (TBW) researched the interviewee’s organisation (as recommended for elite interviews) and started the interview with an overview of the research project and institutions. The interview recordings were automatically transcribed using online software (*Otter.ai*).

These automatic transcriptions were downloaded and manually verified to ensure transcription accuracy.

## 2.3. Data analysis

The interview transcripts were analysed using a form of thematic analysis, known as the framework approach – a five step process previously used in conservation studies (Gale et al., 2013; Lyons-White and Knight, 2018). We first familiarised with a random selection of the interview data (representing 54% of the interviews) to gain an understanding of the views and perspectives raised in the interviews and identify broad topics based on the questions. We identified and collated descriptive and value-centred topics that emerged in the responses (e.g., actions taken, particular challenges mentioned, views on how biodiversity is addressed). Second, building on this familiarisation, we then developed a thematic framework categorising the different recurring themes and sub-themes that emerged in the responses. Broad, overarching themes were defined based on the structure of the interview questions. Thirdly, we coded the interview data to each of the themes and sub-themes by selecting data in the transcripts that matched with each of the themes in the thematic framework. Data analysis was conducted using ‘*Nvivo 12 Pro*’ qualitative data analysis software (QSR International Ltd.). An inductive approach was used for coding, where themes and sub-themes were defined based on the responses raised during the interviews. This was important so we could better identify themes raised as important by participants, which may not have been captured by our predetermined knowledge and biases.

Fourthly, we identified a subset of themes to take forward for charting based on the quantity of data collected for each theme and how well represented each theme was across the different sectors based on the interviewees. The charts allowed the display of all data across the interviews for given themes (and sub-themes) split by participants and type of industry represented. Lastly, we analysed the data to produce the results presented here.

The [Supporting Information](#) gives the thematic framework and, as recommended for such qualitative analyses, an observational standpoint (Clark and Clark, 2002).

## 2.4. Ethical procedure

The project was approved by the University of Cambridge Psychological Research Ethics Committee, and conducted in line with the Society of Conservation Biology’s Ethics Policy (Society for Conservation Biology, 2018). Before the interviews, interviewees were sent a Research Information Document, along with a Prior Informed Consent Form (see [Supporting Information](#)). To facilitate unbiased, transparent responses all interviews were conducted confidentially, with full anonymity provided in publication. During the interview process, interviewees were reminded of this condition of anonymity, and questions asked in polite

**Table 1**  
Participant Characteristics.

Characteristic	Sample Details
Sector	agriculture & forestry (4), finance (5), infrastructure, extractives & construction (4), personal goods & beauty (2), technology (2), communications (2) and specialist biodiversity consultants working across sectors (9).
Geography	Europe (UK 15; France 1; Switzerland 1; Netherlands 3; Romania 1), South America (Brazil 2), Africa (Kenya 2; Tanzania 1; Mali 1) and Asia (India 1).
Role	Director (7), Environmental Manager/Consultant (6), Head of Biodiversity/Ecology (4), Head of Climate (1), Head of Sustainability/Environment (7), Senior Management (e.g. CEO/CTO) (2), Other (1).
Interview Length	Range: 25–76 min. Mean 46 min. Interview length varied due to interviewee time constraints and different levels of engagement with the questions.

and understanding ways, to try and facilitate less guarded responses that can be common in business respondents (Solarino and Aguinis, 2021).

### 3. Results

#### 3.1. Interviewee characteristics

We conducted detailed interviews with 28 key informants between May and November 2021. Interviewees were from a range of industry sectors (Table 1). Of those working at private firms, all were either senior sustainability managers or members of senior management with responsibility for environmental decision-making. Within businesses, there was a senior individual in charge of sustainability practice, sometimes overseeing a small team, who directed the sustainability strategy for the company and consulted with business directors. The consultants contacted were mainly senior staff (e.g. directors), helping to direct strategy at the consultancies, or having high level responsibility for key projects. Most individuals worked on general sustainability strategies, although some focussed specifically on biodiversity.

We faced difficulty reaching out to many respondents, and response rate to call outs was low. Those most likely to respond to our requests for interviews were members of business-biodiversity forums, where members had biodiversity-specific strategies, or consultants working specifically on biodiversity issues. Our sample therefore represents a subset of companies most engaged with biodiversity issues, and our results highlight themes, challenges and opportunities that may exist more widely in the business community if the private sector is expected to engage more with biodiversity in future.

The majority of respondents were based in Europe, but with representation from South America, Africa and Asia (Table 1; Fig. 1). Some of these respondents worked for the national arms of larger companies, with headquarters in other geographies (South Africa 1; United States 2; Canada 2) and 71% of interviewees were involved in substantial international work, with corporate level strategies spanning the regions and countries in which the companies operated. 39% of respondents were female.

Eight broad themes were identified in the responses, split into 29 themes (and 55 sub-themes). The themes with the highest number of references within each broad theme were adopted for charting. In the subsequent text, quotes referred to are in Table 2.

#### 3.2. Actions taken and drivers

##### 3.2.1. Actions to address biodiversity impact

Across all participants there was significant interest in engaging with biodiversity, a topic that was seen as rising on the sustainability agenda throughout the different business sectors. However, actions taken to mitigate impacts and restore biodiversity varied considerably by sector. For sectors with large, tangible direct impacts on biodiversity (e.g. agriculture, infrastructure), action was often linked directly to negative impacts (Quote 1A). Whilst action in these sectors was discussed across the mitigation hierarchy, some participants, particularly consultants, highlighted poor implementation of avoidance measures as a key area of concern. In sectors where biodiversity impacts are largely through value chains or investments (e.g. finance, technology, communications), action taken was less directly focussed on biodiversity, with the extent of action often lagging behind the climate and social issues also encompassed by sustainability strategies (Quote 1B). Companies in these latter sectors (e.g. finance) were often hindered by difficulties in understanding or measuring their impacts on biodiversity. However, participants in these sectors often invested in innovative projects to restore biodiversity, or in learning/research opportunities (e.g. landscape regeneration, urban biodiversity, research partnerships) (Quote 1C).

##### 3.2.2. Drivers for engaging with biodiversity

The actions taken, and broad consensus on the need for further action to address biodiversity impacts, were often driven by company policy, financier policy (e.g. IFC [International Finance Corporation] performance standards), national regulations and growing public/shareholder awareness of biodiversity issues (Quotes 2A). Across the interviews, drivers were often from senior management who backed biodiversity-impact mitigation actions across the company, although sometimes driven by staff at lower management levels (Quotes 2B).

Many individuals highlighted that failing to keep up with the sustainability policies and cultural shifts can lead to reputational and financial risks for the company, with reputational risk being the most represented driver in the interviewee's responses (Quote 2C).

For companies operating with easily understood direct footprints (e.g. infrastructure), and for interviewees in countries where regulation mandates action to address impacts (e.g. UK, the Netherlands), regulation was a common driver of action (Quote 2D). However, regulation was sometimes not deemed adequate by participants for helping

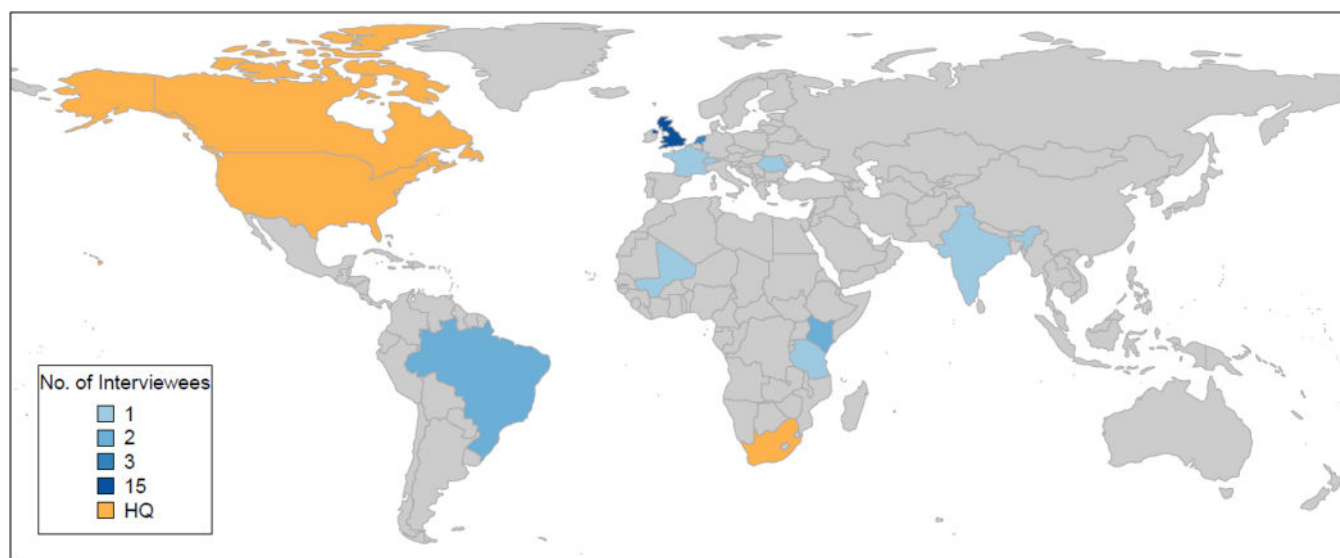


Fig. 1. The number of participants per country. The shades of blue represent the number of interviewees from each country. HQ (orange) identifies countries that have headquarters of companies represented by the interviewees.

**Table 2**  
Representative quotes of themes identified in the dataset quotes of themes identified in the dataset.

Broad Theme	Quotes
(1) Action taken	<p><b>1A</b> - “we follow the mitigation hierarchy in our advice, you know, so depending on where you are in a project, [at the stage of] site selection, early stages, then we’ll look at avoidance and then getting closer to a project, then you’re down to an element of reducing, reducing the impacts, and then kind of like, you know, mitigating the impacts, and compensating where necessary.” R12 - Infrastructure, Energy &amp; Extractives.</p> <p><b>1B</b> - “we have done science-based targets and carbon. We’ve been looking at that but not for biodiversity yet. That’s an area we are interested in. And we’re currently looking at how that might be, what that process looks like, I think, as well, and what the benefits are.” R23 - Infrastructure, Energy &amp; Extractives.</p> <p><b>1C</b> - “you do see some companies that, you know, have these sort of high-profile projects. Right, which is sometimes completely unrelated to their impact. So you know, they might have a little, we’re going to restore 50 ha of the Amazon, despite the fact that they are a UK company that sells sugar, or whatever it is. And I think that’s a very bad, way to have impact.” R20 - Consultancy.</p>
(2) Drivers	<p><b>2A</b> - “There’s been increased, I guess pressure from of course, investors who want to find out what are you doing from an environmental perspective? So investors, shareholders, a lot of questions coming from outside regulators, as well, they’ve started.” R17 - Finance.</p> <p><b>2B</b> - “It’s spread beyond the couple of individuals and sustainability team. And it’s coming from the board. Now, board members, senior executives have heard of biodiversity and realise that it’s something they should be dealing.” R13 - Consultancy.</p> <p><b>2C</b> - “Reputation, of course, is the single biggest driver of why you should spend that kind of money for those companies” R18 - Technology.</p> <p><b>2D</b> - “The government has very high policies, which are then fed down into all their various agencies and departments, which means, you know, they’re legally required to consider sort of all aspects of all these various things. So in that sense, it’s easy for us” R11 - Consultancy.</p>
(3) Decision Making – processes	<p><b>3A</b> - “[long pause]. I mean, we, you compare and contrast, the different projects and their costs and their outputs. And I don’t think it’s an exact science at the minute. But we keep an eye on all of these things. And I think, you know, the accreditations really matter.” R3 - Communications.</p> <p><b>3B</b> - “So in terms of our big capital infrastructure projects, we have something called the [specific tool used], which is basically a seven stage process that includes everything that you need to build a big [infrastructure project] from start to finish. So that has a number of environmental products and decision making products that we call them, which is basically documents that are produced that feed into decision making.” R1 - Infrastructure, Energy &amp; Extractives.</p> <p><b>3C</b> - “as part of the environmental impact assessment, we, we look at different areas that can be impacted, whether it’s forest, whether its water, whether they’re dust, including even the health and safety issues around where we are. And then we address that, you know, as part of our design, and we take action where we think there’s some imminent impact.” R14 - Communications.</p>
(4) Decision Making - Evidence Use	<p><b>4A</b> - “In terms of hard science, the only time by the only time I’ve seen hard, like direct references to individual papers, is when we are trying to prove impacts beyond reasonable scientific doubt.” R1 - Infrastructure, Energy &amp; Extractives.</p> <p><b>4B</b> - “generally we use guidance and experience you know, previous project work but it’s between intends to be whatever, particularly you know, statutory authority, ... require us to do that, you know, they there’s all the guidance on licencing for example.” R12 - Consultancy.</p>

**Table 2 (continued)**

Broad Theme	Quotes
(5) Decision Making - Cost-Effectiveness	<p><b>4C</b> - “our model of working is that we employ consultants who we expect to be technically competent.” R1 - Infrastructure, Energy &amp; Extractives.</p> <p><b>4D</b> - “from personal experiences, it’s mainly based on other similar projects, similar clients and similar kind of ecological conditions and things. But just taking into account what’s on the ground locally.” R10 - Consultancy.</p> <p><b>5A</b> - “I think because the money was not large. There wasn’t too much of a discussion. But let’s say the money had been capital intensive, or the kind of money that goes into capital projects. Right. Then, of course, it would have been a much more involved discussion.” R18 - Technology</p> <p><b>5B</b> - “it’s expensive from an organisation type of view, or lens, but it’s actually not expensive when you look at how it relates to you and the success or the profitability of your organisation in the long run because, if at all biodiversity is affected in a certain area where you have quite a lot of clients in agribusiness and that is affected Because of the loss of biodiversity, eventually that translates into bad debts in your book in the long term.” R17 - Finance.</p> <p><b>5C</b> - “as a biologist working in finance, that we were getting to work on some of these projects, but it was really difficult to show a return or a risk adjusted return that satisfies commercial, you know, commercial finance objectives.” R10 - Consultancy.</p> <p><b>5D</b> - “Another barrier is the management because usually, even though you propose great strategies, actions, the managers are looking only at profit. And they also don’t understand very well those impacts and the triple bottom line and so on. So the management, lack of understanding or buy in is also an issue.” R22 - Consultancy.</p>

companies engage with biodiversity issues. Furthermore, regulations were sometimes not adequately enforced, which was raised as another potential barrier to effective mitigation.

Others, notably those in the agricultural and finance sectors, stated the importance of biodiversity action in maintaining sustainable projects that can create revenue indefinitely, without degrading the ecosystem services on which those projects rely (e.g. maintaining healthy soils, pollination, water availability). Some participants linked these drivers, and associated risks, to financial risks for the companies as the ultimate driver of action (Quote 5B).

### 3.3. Decision making

#### 3.3.1. Information used to guide decisions

When action was taken to address biodiversity loss, those interviewees representing sectors with less tangible impacts on biodiversity (e.g., through supply chains & investments), outlined that decision-making was often not structured, but program-specific and opportunistic, taking advantage of opportunities and collaborations that arose in their areas of specific interest to them (Quote 3A). For example, several companies partnered with conservation NGOs on flagship biodiversity programs, or invested in urban biodiversity work at office sites, or research programs related to biodiversity.

Action by sectors with large direct impacts (e.g., agriculture, infrastructure) often stated more structured risk assessment and planning processes for guiding action. For example, one company used cost-benefit analyses, including considerations of biodiversity, to guide mitigation actions. Similarly, the consideration of biodiversity as part of the environmental permitting, the environment and social impact assessment (ESIA) process, and within environmental management plans, structured the decisions made about actions to reduce impacts and promote biodiversity values (Quotes 3B, 3C). For example, in the UK respondents noted that the impact assessment process helps identify biodiversity baseline values, which then feed into mitigation

requirements and recommendations under national legislation.

When asked about the effectiveness of actions taken, claims for programs/actions to be effective varied, with many companies claiming that their programs are likely to be effective at achieving desired outcomes. However, there was also limited direct use of documented evidence to guide actions, even amongst some consultants (Quotes 4A). The exception was again from sectors with large, tangible direct impacts on biodiversity, where detailed biodiversity baselines were frequently compiled (often required as part of ESIA processes) and used to help guide appropriate mitigation actions. The importance of monitoring was also raised by some participants to help ensure effective action, but the adequacy of monitoring was often questioned due to limited resources to fund monitoring, limited enforcement by regulatory agencies and unclear responsibilities about who is responsible for monitoring actions after actions have been implemented.

To guide action, businesses relied heavily on best practice principles (e.g. BBOP [Business & Biodiversity Offsets Program] principles for biodiversity offsetting), certifications (e.g. Forest Stewardship Council, Round Table for Sustainable Palm Oil), financier standards (e.g. IFC [International Finance Corporation] PS6), and to a lesser extent guidance, to direct decision-making surrounding biodiversity mitigation and to act as a presumed 'seal' of evidence-based practice and cost-effective action (Quote 4B). Similarly, many businesses relied on external experts/consultants to provide the relevant expertise in biodiversity and ecology to help understand and address impacts, with these organisations being seen as technically competent (Quotes 4C).

Several consultants also highlighted the importance of experiences gathered during previous projects, and regulatory drivers to guide decisions about mitigation action (Quote 4D). For example, for infrastructure and extractive projects, participants outlined sets of commonly used mitigation measures now expected and considered as best practice, which they regularly recommend for their projects.

The scientific evidence was rarely consulted directly when deciding upon actions, with business professionals often juggling multiple objectives and responsibilities for all other environmental and social aspects of their company/project (e.g., carbon strategy, social impacts etc.), and thus having little time for a detailed assessment of evidence. However, consultants used scientific evidence more often, with some taking time to look at the evidence – particularly in unusual situations where new approaches for the industry are required (Quote 4A). However, other consultants stated it was rare for them to look at the scientific evidence directly due to limited time availability and resources.

### 3.3.2. Cost-effectiveness

When discussing the effectiveness and efficiency of actions taken, many participants stated the importance of cost-effectiveness in deciding upon mitigation as high costs can be a barrier to implementation. However, others highlighted that the money spent on mitigation is often only a small proportion of overall budgets, and that financial resources will often be made available if mitigation is the difference between a project proceeding or not (e.g. due to mitigation requirements in national or financier policy) (Quote 5A).

Cost-effectiveness of mitigation was often assessed through the lens of financial costs and benefits. When there are requirements or expectations put on companies to mitigate impact, this in effect creates a financial risk associated with not doing so, making it more likely for actions to be put in place (Quote 5B). For example, a company's future financing may depend on them abiding by national legislation or financier expectations (e.g. IFC Performance Standards) that outline specific measures that must be met regarding biodiversity impacts and actions if finances are to be received. These risks were highlighted as key drivers for increasing engagement with biodiversity, yet several businesses' representatives outlined the difficulty in placing financial values on biodiversity outcomes, something that would strengthen the case for biodiversity impact mitigation by helping demonstrate its cost-effectiveness, and promote biodiversity strategies receiving the

adequate funding from finance teams (Quote 5C).

The financial bottom line was identified as a major challenge for increasing impact mitigation activities, with biodiversity often treated as an externality to the economic viewpoint of the business, thus making it difficult to argue the need for action to finance teams. There were several challenges including limited metrics to measure biodiversity impacts (both negative and positive), and limited policy driving the implementation of actions (Quote 5D), that precluded the benefits of biodiversity-related action being considered in economic decision-making.

### 3.4. Challenges and opportunities

Across the interviews, participants mentioned a diversity of challenges that hindered businesses from taking cost-effective actions to address biodiversity impacts, including broad engagement issues (such as a lack of awareness or knowledge of biodiversity impacts), lack of regulations to guide or push more effective actions, biodiversity being seen as an externality to the economic system, and a lack of frameworks or metrics to measure and address impacts. Other challenges were specific to decision making such as limited evidence availability, the research-implementation gap, and difficulties in quantifying the cost-effectiveness of actions. The suggested opportunities largely mirrored these challenges. In Fig. 2 we summarise the challenges raised, and linked opportunities that could address these challenges split into those relevant for enabling action, deciding upon actions, and implementing actions. Representative quotes for these challenges and opportunities are included in the [Supporting Information](#).

## 4. Discussion

Across our interviews, the importance of biodiversity loss was routinely highlighted, in line with the increased attention for this topic in the business community (WEF, 2020b, 2020a). Actions differed markedly by sector, but where action was taken there was a high reliance on authoritative sources of information to direct action including guidance, legislation, standards and principles, as well as expert consultants. Yet there are complex perceived challenges that hinder even the most engaged companies fully incorporating biodiversity into their operations. Research into how biodiversity is accounted for by organizations, and the information used to guide decision-making is an area that has been identified as lacking (Roberts et al., 2021). The understanding of the decision-making context, and challenges of engaging with, deciding upon and implementing biodiversity actions identified in this study, point to opportunities for improving the effectiveness of business-biodiversity action in future. We discuss these opportunities in the following sections.

### 4.1. Enabling action on biodiversity

Our results suggest that policy and societal awareness of biodiversity are key drivers of mitigation action when taken. This is likely due to the increased risk associated with negative, and unmitigated, biodiversity impacts, consistent with other studies that have shown that risk management being a predominant driver of action (Kohsaka et al., 2009; Boiral and Heras-Saizarbitoria, 2017; Macellari et al., 2018). Research has also identified that ensuring the sustainability of projects that are dependent on nature is driving increased interest in biodiversity from the business community (Houdet et al., 2012). The relative importance of these risks and dependencies in driving action will differ depending on sector (see <https://encore.naturalcapital.finance/en>). For example, companies operating in production landscapes may have more tangible, direct links to ecosystem services, making the risks of their degradation more visible in existing business models. Ultimately, businesses are operating within a capitalist system, so it is likely the financial risks that result from biodiversity impacts are the overarching driver, even if there

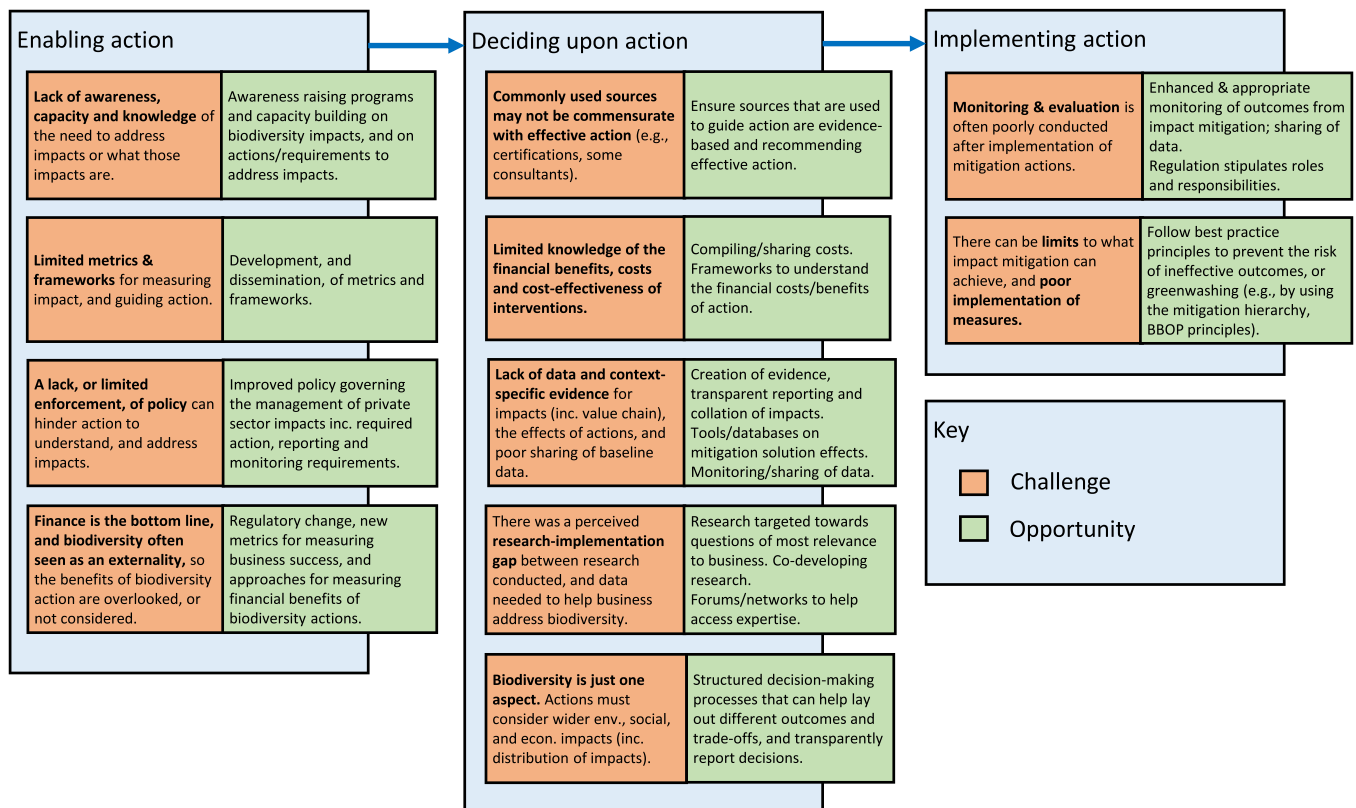


Fig. 2. A synthesis of challenges emerging from the dataset and linked opportunities.

may be a moral imperative from key individuals within companies (Hassan et al., 2020). See Fig. 3 for a conceptualisation of these drivers.

Whilst interest in biodiversity was high, and some companies were taking substantial action to address biodiversity impacts (similar to: Kohsaka et al., 2009; Wolff et al., 2018), the variable levels of action taken by a subset of engaged businesses is cause for concern given the limited engagement with biodiversity more widely in the business community (e.g. Addison et al., 2019). We did however identify variations between sectors, similar to trends identified previously. For example, Bhattacharya and Managi (2013) indicate that sectors in primary industries and consumer goods had a higher percentage of companies taking action on biodiversity than consumer services, technology and finance. These sectors often have more tangible direct impacts, which are better covered by legislation in many nations (e.g., impact assessment requirements), and impacts that may constitute a higher risk to companies historically (Bhattacharya and Managi, 2013; GIBOP, 2018). Although impacts through value chains and investments can be mitigated through action across the mitigation hierarchy and many such



Fig. 3. A framework of drivers for engaging with biodiversity impact mitigation.

actions were raised by interviewees, there is often limited engagement with understanding and reducing negative impacts in these sectors (Macellari et al., 2018), and a strong focus on support measures with less on direct mitigation that is commensurate with impact (Wolff et al., 2018) – perhaps hindered by the difficulty understanding and measuring impacts across value chains – a challenge also identified in our interviews.

Business engagement with biodiversity issues is hindered by a diverse set of challenges, many of which were raised by the interviewees (e.g., Lambooy and Levashova, 2011; Bhattacharya and Managi, 2013; Macellari et al., 2018; Table 2). These challenges point towards opportunities to improve the incorporation of biodiversity into business sustainability strategies. For example, businesses can work to improve staff skills in biodiversity impact mitigation through training programs, and employ and refine metrics for measuring impacts (positive and negative). In the wider community, much work is focussed on how to improve engagement including: i) training and capacity building events for wider business teams in biodiversity risk, reporting and management, ii) stronger regulation and policy surrounding biodiversity impacts and actions to address them (GIBOP, 2018), iii) the development and use of metrics for measuring and reporting biodiversity impacts and actions of operations, value chains and investments (Bhattacharya and Managi, 2013; Lammerant et al., 2018), iv) integrating nature into economic systems (Dasgupta, 2021) and v) frameworks to integrate nature into corporate strategies (SBT for Nature, 2021; TNFD, 2022; Table 2). However, the challenges raised in our interviews suggest the need for further work to disseminate them to business professionals, and further research to ensure the data and guidance they provide is applicable, and relevant to business decision-making.

#### 4.2. Deciding upon and implementing cost-effective action

In the wider conservation literature, the availability of evidence has been increasing (Stephenson and Stengel, 2020; Sutherland et al., 2019),

but there are barriers to using evidence ranging from the limited availability of relevant evidence (Christie et al., 2020) to limited awareness, resources or capacity to access or assess the information available (Walsh et al., 2019). Improving the use of evidence in decision-making can better the biodiversity outcomes from business action. Based on the interviewee’s responses, we discuss specific opportunities for the improved use of evidence:

- **Data for decision-making** – Interviewees frequently perceived the poor availability of data as a challenge, including data on the impacts of their business activities on biodiversity (and the impact from supply chains and investments), the status of biodiversity in an area of interest, and knowledge of what strategies are available to mitigate impact. Indeed, where actions are reported by businesses there is often limited reference to their probability of success (Drayson and Thompson, 2013; Bigard et al., 2017), and evidence can be limited on many conservation actions, species/habitats and regions (Drayson and Thompson, 2013; Junker et al., 2020; Christie et al., 2021; Josefsson et al., 2021). However, there are many resources available to help businesses think through biodiversity values and impacts (IBAT; ENCORE; TRASE; Stephenson and Stengel, 2020), and a growing evidence base on the effectiveness of actions (Conservation Evidence, Evidensia, IUCN Panorama), which can minimise the amount of time required for individuals to assess the evidence base. Businesses should make continued efforts to better understand their impact and possible strategies – by accessing available data and working with researchers and consultants where necessary. Researchers should reach out to businesses to deliver applied and relevant research (Sutherland et al., 2004) - an opportunity raised by several interviewees.
- The lack of monitoring of outcomes and insufficient data sharing, are frequently identified challenges regarding business action on

biodiversity (Tischew et al., 2010; Bull et al., 2013; Drayson and Thompson, 2013). Alongside stronger regulation on the roles and responsibilities for monitoring, we recommend businesses share data collected through open data platforms such as Global Biodiversity Information Facility (www.gbif.org), with monitoring adopted to evaluate the outcomes of mitigation actions (Stephenson and Carbone, 2021; White et al., 2021). If mitigation is designed appropriately – perhaps in collaboration with conservation researchers - monitoring can help build the scientific evidence base on the effectiveness of different actions, benefitting the wider community (Ockendon et al., 2021).

- **Navigating complex decisions** – Multiple interviewees highlighted that mitigation is implemented in environments where trade-offs need to be made, and decision-making is guided not just by information on effectiveness for biodiversity, but local context and values, financial costs and benefits, and other environmental, economic and social priorities (Adams and Sandbrook, 2013; Evans et al., 2017; Christie et al., 2022; Fig. 4). To help navigate these trade-offs structured processes for decision making can be used by businesses to better lay out likely consequences of different actions and guide decisions (see: Cook et al., 2017; Mukherjee et al., 2018; Knight et al., 2019; Christie et al., 2022).
- **Points of intervention in direct/indirect evidence use** – Using indirect sources of evidence can help businesses and consultants access expertise, reduce the time required to assess available information, and act as a seal of effective and evidence-based practice. This can be through the hiring consultants or partnering with other organisations (Wolff et al., 2018), adhering to principles, certification standards or regulations (Boiral et al., 2018), or relying on previous project experience or best-practice guidance documents (Hunter et al., 2021; Fig. 4). However, there are concerning signs that this reliance may not always lead to effective practice. For

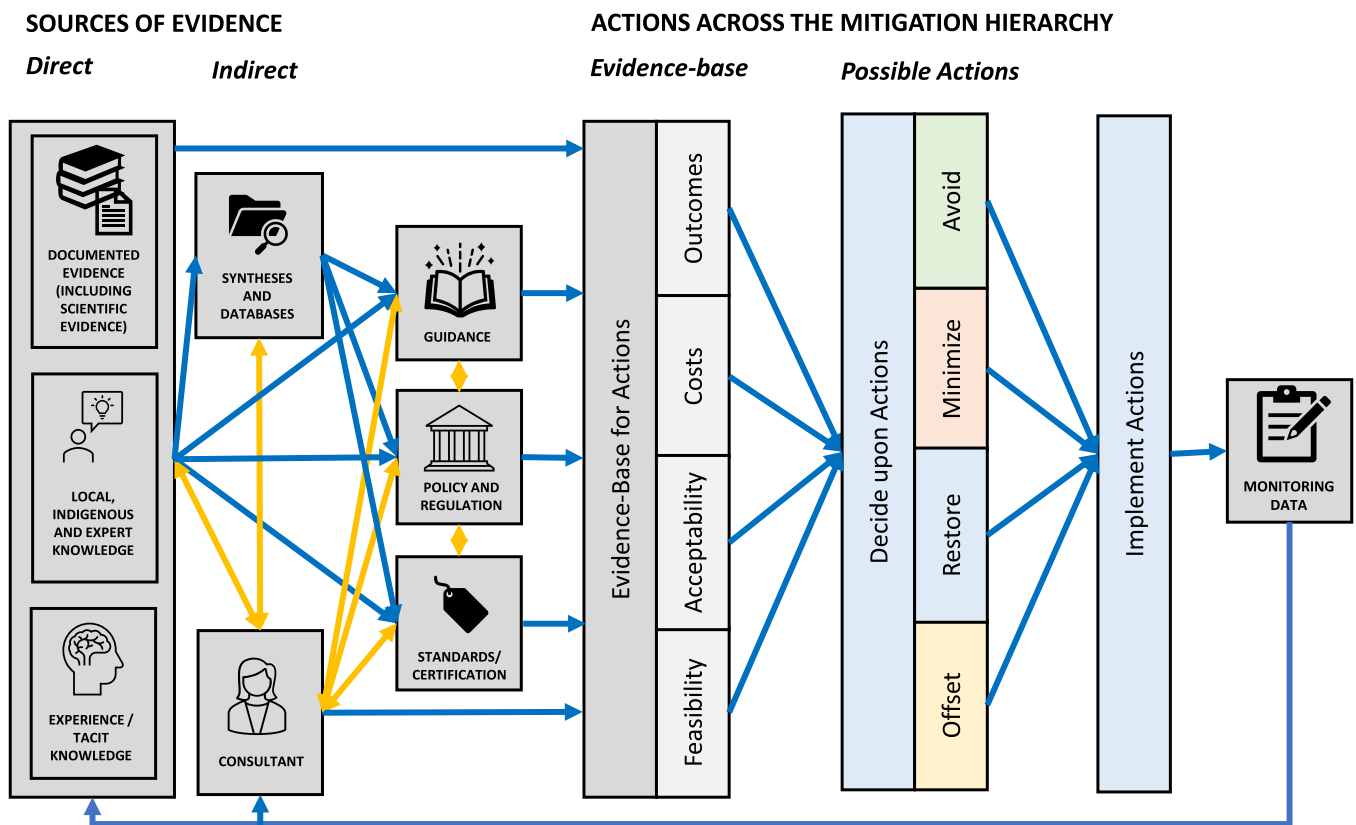


Fig. 4. A conceptual model of decision making for actions to protect and restore biodiversity in the private sector.



example, within mitigation guidance documents in the UK, there is limited reference to evidence backing up commonly used mitigation measures (Hunter et al., 2021; Downey et al., 2022), and some commonly used certifications show mixed effectiveness (Tschamtko et al., 2015). Similarly, commonly used environmental management systems such as ISO14001 or reporting standards such as GRI standards often have limited provision for activities supporting biodiversity and ecosystems (see: Roberts et al., 2021; Wagner, 2022). Companies will often seek third party assurance for biodiversity disclosures, but can seek ‘low quality’ assurance that can satisfy stakeholder concerns whilst reducing the need for effective action to be implemented (Hassan et al., 2020). Ensuring these indirect sources are using, or based on, appropriate evidence could represent a win-win solution - improving conservation outcomes, and saving businesses time and money in accessing the latest information to guide decisions. For example, guidance can be produced in line with principles of evidence-based guidance (Downey et al., 2022). Similarly, professional certification bodies for ecological consultants can include standards on evidence use in their code of conduct (Drayson and Thompson, 2013; CIEEM, 2022). Industry associations (e.g. IPECA, Equator Principles, CSBI, RSPO, Seafood Business for Ocean Stewardship) could play a key role by producing evidence-based guidance or principles specific to industry impacts and how they should be mitigated.

- **Getting better measures of costs and benefits** – Our interviews highlighted that being able to show the financial value and cost-effectiveness of biodiversity actions could help scale up business action by translating actions into the language of wider business teams (Macellari et al., 2018). Where financial risks and opportunities for companies are made explicit, they can be important drivers of action (Boiral and Heras-Saizarbitoria, 2017; Smith et al., 2020; WEF, 2020b). There are also difficulties in measuring the financial costs and benefits of actions (Laurila-Pant et al., 2015; White et al., 2022a), but using frameworks to help think through all the costs and benefits of mitigation action can help elicit the true economic costs (Murphy et al., 2021; White et al., 2022b). Fully realising the value of biodiversity for business operations will require societal level and regulatory change to move away from traditional business models that do not place high value on common goods such as biodiversity (Dasgupta, 2021). Further research is needed to better integrate biodiversity into business models, where the financial bottom line often predominates.

#### 4.3. Implementation of action

Even when companies choose actions likely to be effective, the scale of action required and the adequacy of those actions as part of broader strategies for mitigating impacts is often drawn into question (e.g. Addison et al., 2019). Actions such as restoration projects, campaigns, working with NGOs can be supportive of sustainability efforts, but not directly mitigating negative impacts, and sometimes are token actions (Cuckston, 2018). For example, some interviewees stated that avoidance measures are rarely implemented in practice and are often overlooked, weakening the first and most important step of the mitigation hierarchy (Bigard et al., 2017; Phalan et al., 2018). Businesses should implement strict adherence to the mitigation hierarchy (CSBI, 2015) and best practice principles (BBOP, 2012), alongside appropriate monitoring and adaptive management of progress towards targets can help ensure effective outcomes from actions. Often, the capacity for avoidance is limited due to the business models requiring development to proceed (Panwar et al., 2022). Further research is needed on challenges that can prevent proper implementation of action across the mitigation hierarchy.

Our study does have several limitations that are important to note. Whilst we attempted to cover a broad geographic range and types of

sectors, it is likely that some areas or experiences have been missed. For example, i) some sectors (e.g., fisheries, insurance, apparel) are not represented in the dataset, ii) the focus on the Fortune 2000 could have shifted our sample away from privately held companies that are not represented in the list, and iii) companies less engaged with biodiversity issues were less likely to respond to interview requests. The HQ country of an organization (Fig. 1) may also have influenced actions taken by holding the operations elsewhere to higher company standards, perhaps not required in national law. However, as outlined above, our sample does represent a subset of the business community most engaged with addressing biodiversity impacts, and with a large amount of international experience, so it highlights challenges and opportunities that if tackled could help the wider business community to effectively take biodiversity-relevant action in future.

Whilst business engagement with biodiversity is currently at an early stage, effective action holds promise to help reach ambitious global biodiversity targets such as the CBD targets and SDGs. We hope that the better understanding of current engagement and decision-making processes provided in this study will help identify opportunities to bring about the much-needed transformative change - ensuring that business-biodiversity action becomes more widespread and more effectively contributes towards conservation goals.

#### CRedit authorship contribution statement

All authors contributed to the conceptualization and design of the study. Data collection and analysis was performed by TBW. The first draft of the manuscript was written by TBW, with input from NM. All authors reviewed and edited subsequent versions of the manuscript. The project was supervised by NM, SOP and WJS.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

#### Data Availability

The data that has been used is confidential.

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#### Supporting information

The interview guide (S1), thematic framework (S2), research information document (S3), prior informed consent form (S4), information on how the research met qualitative research transparency criteria (S5), expanded tables of quotes (S6) and an observational standpoint (S7) are included in the Supporting Information.

#### Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.envsci.2022.12.003](https://doi.org/10.1016/j.envsci.2022.12.003).

## References

- Adams, W.M., Sandbrook, C., 2013. Sandbrook Conservation, Evidence and Policy. *Oryx* 47, 329–335.
- Addison, P.F.E., Bull, J.W., Milner-Gulland, E.J., 2019. Using conservation science to advance corporate biodiversity accountability. *Conserv. Biol.* 33, 307–318.
- Aguinis, H., Solarino, A.M., 2019. Transparency and Replicability in Qualitative Research: The Case of Interviews with Elite Informants. *Strateg. Manag. J.* 40, 1291–1315.
- BBOP. 2012. Standard on Biodiversity Offsets. Page Business and Biodiversity Offsets Programm (BBOP). Washington DC. Available from ([https://www.forest-trends.org/wp-content/uploads/imported/BBOP\\_Standard\\_on\\_Biodiversity\\_Offsets\\_1\\_Feb\\_2013.pdf](https://www.forest-trends.org/wp-content/uploads/imported/BBOP_Standard_on_Biodiversity_Offsets_1_Feb_2013.pdf)).
- Bernard, H.R., 2006. Research methods in anthropology: Qualitative and quantitative approaches, 4th edition. Rowman & Littlefield.
- Berthinussen, A., Richardson, O.C., Altringham, J.D., 2019. Bat conservation: global evidence for the effects of interventions, 2019 Edition. Pelagic Publishing Ltd.
- Bezombes, L., Kerbiriou, C., Spiegelberger, T., 2019. Do biodiversity offsets achieve No Net Loss? an evaluation of offsets in a French department. *Biol. Conserv.* 231, 24–29.
- Bhattacharya, T.R., Managi, S., 2013. Contributions of the private sector to global biodiversity protection: case study of the fortune 500 companies. *Int. J. Biodivers. Sci., Ecosyst. Serv. Manag.* 9, 65–86.
- Bigard, C., Pioch, S., Thompson, J.D., 2017. The inclusion of biodiversity in environmental impact. *J. Environ. Manag.* 200, 35–45.
- Boiral, O., Heras-Saizarbitoria, I., 2017. Corporate commitment to biodiversity in mining and forestry: Identifying drivers from GRI reports. *J. Clean. Prod.* 162, 153–161.
- Boiral, O., Heras-Saizarbitoria, I., Brotherton, M.-C., 2018. Corporate biodiversity management through certifiable standards. *Bus. Strategy Environ.* 27, 389–402.
- Bull, J.W., Suttle, K.B., Gordon, A., Singh, N.J., Milner-Gulland, E.J., 2013. Biodiversity offsets in theory and practice. *Oryx* 47, 369–380.
- CBD. 2022. Kunming-Montreal Global biodiversity framework. Available from <https://www.cbd.int/doc/c/e6d3/cd1d/daf663719a03902a9b116c34/cop-15-1-25-en.pdf>.
- Christie, A.P., Downey, H., Frick, W.F., Grainger, M., O'Brien, D., Tinsley-Marshall, P., White, T.B., Winter, M., Sutherland, W.J., 2022. A practical conservation tool to combine diverse types of evidence for transparent evidence-based decision-making. *Conserv. Sci. Pract.* 4 (1), e579.
- Christie, A.P., Amamo, T., Martin, P.A., Petrovan, S.O., Shackelford, G.E., Simmons, B.I., Smith, R.K., Williams, D.R., Wordley, C.F.R., Sutherland, W.J., 2020. Poor availability of context-specific evidence hampers decision-making in conservation. *Biol. Conserv.* 248.
- Christie, A.P., Amamo, T., Martin, P.A., Petrovan, S.O., Shackelford, G.E., Simmons, B.I., Smith, R.K., Williams, D.R., Wordley, C.F.R., Sutherland, W.J., 2021. The challenge of biased evidence in conservation. *Conserv. Biol.* 35, 249–262.
- CIEEM. 2022. Code of Professional Conduct. Available from <https://cieem.net/wp-content/uploads/2019/02/Code-of-Professional-Conduct-FEB-2022.pdf>.
- Clark, T.W., Clark, S.G., 2002. The Policy Process: A Practical Guide for Natural Resources Professionals. Yale University Press.
- Cook, C.N., Pullin, A.S., Sutherland, W.J., Stewart, G.B., Carrasco, L.R., 2017. Considering cost alongside the effectiveness of management in evidence-based conservation: a systematic reporting protocol. *Biol. Conserv.* 209, 508–516.
- CSBI. 2015. A cross-sector guide for implementing the Mitigation Hierarchy. Available from <http://www.csbi.org.uk/wp-content/uploads/2017/10/CSBI-Mitigation-Hierarchy-Guide.pdf>.
- Cuckston, T., 2018. Making accounting for biodiversity research a force for conservation. *Social and Environmental Accountability. Journal* 38, 218–226.
- Dasgupta P. 2021. The economics of biodiversity: The dasgupta review. HM Treasury.
- Deutz A., Heal G.M., Niu R., Swanson E., Townshend T., Zhu L., Delmar A., Meghji A., Sethi S.A., la Puente J. 2020. Financing nature: Closing the global biodiversity financing gap. The Paulson Institute, The Nature Conservancy, and the Cornell Atkinson Center for Sustainability: Chicago, IL, USA.
- Diaz, S., et al., 2019. Pervasive human-driven decline of life on Earth points to the need for transformative change. *Science* 366.
- Downey, H., Bretagnolle, V., Brick, C., Bulman, C.R., Cooke, S.J., Dean, M., Edmonds, B., Frick, W.F., Friedman, K., McNicol, C., Nichols, C., 2022. Principles for the production of evidence-based guidance for conservation actions. *Conserv. Sci. Pract.* 4, e12663.
- Drayson, K., Thompson, S., 2013. Ecological mitigation measures in English environmental. *J. Environ. Manag.* 119, 103–110.
- Dwyer, J.F., Pandey, A.K., McHale, L.A., Harness, R.E., 2019. Near-ultraviolet light reduced Sandhill Crane collisions with a power line by 98%. *The Condor* 121, duz008.
- Evans, M.C., Davila, F., Toomey, A., Wyborn, C., 2017. Embrace complexity to improve conservation decision making. *Nat. Ecol. Evol.* 1, 1588.
- Feger, C., Mermet, L., 2020. New business models for biodiversity and ecosystem management services: action research with a large environmental sector company. *Organ. Environ.* 35, 252–281.
- Feger, C., Mermet, L., Vira, B., Addison, P.F., Barker, R., Birkin, F., Burns, J., Cooper, S., Couvet, D., Cuckston, T., Daily, G.C., 2019. Four priorities for new links between conservation science and accounting research. *Conserv. Biol.* 33, 972–975.
- Gale, N.K., Heath, G., Cameron, E., Rashid, S., Redwood, S., 2013. Using the framework method for the analysis of qualitative data in multi-disciplinary health research. *BMC Med. Res. Methodol.* 13, 117.
- GEO Business Briefs (2021). Global Environment Outlook for Business Briefs. Available at: <https://www.unep.org/global-environment-outlook/geo-business>.
- GIBOP. 2018. Global Inventory of Biodiversity Offset Policies. Available from <https://portals.iucn.org/offsetpolicy/>.
- Hassan, A.M., Roberts, L., Atkins, J., 2020. Exploring factors relating to extinction disclosures: What motivates companies to report on biodiversity and species protection? *Bus. Strategy Environ.* 3, 1419–1436.
- Houdet, J., Trommetter, M., Weber, J., 2012. Understanding changes in business strategies regarding biodiversity and ecosystem services. *Ecol. Econ.* 15, 37–46.
- Hunter, S.B., zu Ermgassen, S.O.S.E., Downey, H., Griffiths, R.A., Howe, C., 2021. Evidence shortfalls in the recommendations and guidance underpinning ecological mitigation for infrastructure developments. *Ecol. Solut. Evid.* 2, e12089.
- IPBES. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES. Available from <https://ipbes.net/global-assessment>.
- Josefsson, J., Widenfalk, L.A., Blicharska, M., Hedblom, M., Pärt, T., Ranius, T., Öckinger, E., 2021. Compensating for lost nature values through biodiversity offsetting - Where is the evidence? *Biol. Conserv.* 257, 109117.
- Junker, J., Petrovan, S.O., Arroyo-Rodríguez, V., Boonratana, R., Byler, D., Chapman, C.A., Chetry, D., Cheyne, S.M., Cornejo, F.M., Cortés-Ortiz, L., Cowlishaw, G., 2020. A severe lack of evidence limits effective conservation of the world's primates. *BioScience* 70, 794–803.
- Knight, A.T., et al., 2019. Improving conservation practice with principles and tools from systems thinking and evaluation. *Sustainability Science* 14, 1531–1548.
- Kohsaka R., Tokuyama M., others. 2009. Incorporating Biodiversity in the Japanese Private Sector: An analysis of a preliminary survey conducted on the Nippon Keidanren Business Association.
- Krausmann, F., Wiedenhofer, D., Lauk, C., Haas, W., Tanikawa, H., Fishman, T., Miatto, A., Schandl, H., Haberl, H., 2017. Global socioeconomic material stocks rise 23-fold over the 20th century and require half of annual resource use. *Proc. Natl. Acad. Sci. U.S.A.* 114, 1880–1885.
- Lambooy, T., Levashova, Y., 2011. Opportunities and challenges for private sector entrepreneurship and investment in biodiversity, ecosystem services and nature conservation. *Int. J. Biodivers. Sci., Ecosyst. Serv. Manag.* 7, 301–318.
- Lammerant J., Muller L., Kisielewicz J. 2018. Assessment of Biodiversity Accounting Approaches for Businesses: Discussion paper for EU Business @ Biodiversity Platform. Available from <https://www.i-care-consult.com/wp-content/uploads/2018/09/Assessment-biodiversity-metrics-for-business-and-FI-draft-report-5Sept2018.pdf>.
- Laurila-Pant, M., Lehtikoinen, A., Uusitalo, L., Venesjärvi, R., 2015. How to value biodiversity in environmental management? *Ecol. Indic.* 55, 1–11.
- Lyons-White, J., Knight, A.T., 2018. Palm oil supply chain complexity impedes implementation of corporate no-deforestation commitments. *Glob. Environ. Change* 50, 303–313.
- Macellari, M., Gusmerotti, N.M., Frey, M., Testa, F., 2018. Embedding biodiversity and ecosystem services in corporate sustainability: A strategy to enable sustainable development goals. *Bus. Strategy Dev.* 1, 244–255.
- Mukherjee, N., Zabala, A., Hüge, J., Nyumba, T.O., Adem Esmail, B., Sutherland, W.J., 2018. Comparison of techniques for eliciting views and judgements in decision-making. *Methods Ecol. Evol.* 9, 54–63.
- Murphy, E.L., Bernard, M., Iacona, G., Borrelle, S.B., Barnes, M., McGovern, A., Emmanuel, J., Gerber, L.R., 2021. A decision framework for estimating the cost of marine plastic pollution interventions. *Conserv. Biol.* <https://doi.org/10.1111/cobi.13827>.
- Nash, D.J., Humphries, N., Griffiths, R.A., 2020. Effectiveness of translocation in mitigating reptile-development conflict in the UK. *Conserv. Evid.* 17, 7–11.
- Ockendon, N., Amamo, T., Cadotte, M., Downey, H., Hancock, M.H., Thornton, A., Tinsley-Marshall, P., Sutherland, W.J., 2021. Effectively integrating experiments into conservation practice. *Ecol. Solut. Evid.* 2, e12069.
- PANORAMA. 2022. PANORAMA: Solutions for a Healthy Planet. Available from <https://panorama.solutions/en>.
- Panwar, R., Ober, H., Pinkse, J., 2022. The uncomfortable relationship between business and biodiversity: Advancing research on business strategies for biodiversity protection. *Bus. Strategy Environ.*
- Phalan, B., Hayes, G., Brooks, S., Marsh, D., Howard, P., Costelloe, B., Vira, B., Kowalska, A., Whitaker, S., 2018. Avoiding impacts on biodiversity through strengthening the first stage of the mitigation hierarchy. *Oryx* 52, 316–324.
- Roberts, L., Hassan, A., Elamer, A., Nandy, M., 2021. Biodiversity and extinction accounting for sustainable development: A systematic literature review and future research directions. *Bus. Strategy Environ.* 1, 705–720.
- Science Based Targets Network. 2020. Science-Based Targets for Nature Initial Guidance for Business. Available from <https://sciencebasedtargetsnetwork.org/wp-content/uploads/2020/11/Science-Based-Targets-for-Nature-Initial-Guidance-for-Business.pdf>.
- de Silva, G.C., Regan, E.C., Pollard, E.H.B., Addison, P.F.E., 2019. The evolution of corporate no net loss and net positive impact biodiversity commitments: Understanding appetite and addressing challenges. *Bus. Strategy Environ.* 28, 1481–1495.
- Smith, T., Paavola, J., Holmes, G., 2019. Corporate reporting and conservation realities: Understanding differences in what businesses say and do regarding biodiversity. *Environ. Policy Gov.* 29, 3–13.
- Smith, T., Beagley, L., Bull, J., Milner-Gulland, E.J., Smith, M., Vorhies, F., Addison, P.F.E., 2020. Biodiversity means business: Reframing global biodiversity goals for the private sector. *Conservation Letters* 13, e12690.
- Society for Conservation Biology. 2018. Code of Ethics. Washington DC. Available from <https://conbio.org/about-scb/who-we-are/code-of-ethics> (accessed May 14, 2018).

- Solarino, A.M., Aguinis, H., 2021. Challenges and best-practice recommendations for designing and conducting interviews with elite informants. *J. Manag. Stud.* 58, 649–672.
- Stephenson, P.J., Stengel, C., 2020. An inventory of biodiversity data sources for conservation monitoring. *PLoS one* 15, e0242923.
- Stephenson, P.J., Carbone, G., 2021. Guidelines for planning and monitoring corporate biodiversity performance. IUCN, Gland, Switzerland.
- Sutherland, W.J., et al., 2019. Building a tool to overcome barriers in research-implementation spaces: The conservation evidence database. *Biol. Conserv.* 238, 108199.
- Sutherland, W.J., Wordley, C.F.R., 2017. Evidence complacency hampers conservation. *Nat. Ecol. Evol.* 1, 1215–1216.
- Sutherland, W.J., Pullin, A.S., Dolman, P.M., Knight, T.M., 2004. The need for evidence-based conservation. *Trends Ecol Evol.* 19, 305–308.
- Taylor, N., et al., 2019. A synthesis of evidence for the effects of interventions to conserve peatland vegetation: overview and critical discussion. *Mires and Peat* 24. <https://doi.org/10.19189/MaP.2018.OMB.379>.
- Tischew, S., Baasch, A., Conrad, M.K., Kirmer, A., 2010. Evaluating restoration success of frequently implemented compensation measures: Results and demands for control procedures. *Restor. Ecol.* 18, 467–480.
- Tscharntke, T., Milder, J.C., Schroth, G., Clough, Y., DeClerck, F., Waldron, A., Rice, R., Ghazoul, J., 2015. Conserving biodiversity through certification of tropical agroforestry crops at local and landscape scales. *Conservation Letters* 8, 14–23.
- Wagner, M., 2022. Business, biodiversity and ecosystem services: Evidence from large-scale survey data. *Bus. Strategy Environ.* <https://doi.org/10.1002/bse.3141>.
- Walsh, J.C., Dicks, L.V., Raymond, C.M., Sutherland, W.J., 2019. A typology of barriers and enablers of scientific evidence use in conservation practice. *J. Environ. Manag.* 15, 109481.
- WEF. 2020a. Global Risks Report 2020. Available from <https://www.weforum.org/reports/the-global-risks-report-2020>.
- WEF. 2020b. Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy. Available from [http://www3.weforum.org/docs/WEF\\_New\\_Nature\\_Economy\\_Report\\_2020.pdf](http://www3.weforum.org/docs/WEF_New_Nature_Economy_Report_2020.pdf).
- White, T.B., Viana, L.R., Campbell, G., Elverum, C., Bennun, L.A., 2021. Using technology to improve the management of development impacts on biodiversity. *Bus. Strategy Environ.* <https://doi.org/10.1002/bse.2816>.
- White, T.B., Petrovan, S., Christie, A., Martin, P., Sutherland, W., 2022a. What is the price of conservation; a review of the status quo and recommendations for improving cost reporting. *BioScience* 72, 461–471. <https://doi.org/10.1093/biosci/biac007>.
- White, T.B., Petrovan, S.O., Booth, H., Correa, R.J., Gatt, Y., Martin, P.A., Newell, H., Worthington, T.A., Sutherland, W.J., 2022b. Determining the economic costs and benefits of conservation actions: A decision support framework. *Conserv. Sci. Pract.* e12840.
- Winn, M.I., Pogutz, S., 2013. Business, ecosystems, and biodiversity: new horizons for management research. *Organ. Environ.* 26, 203–229.
- Wolff, A., Gondran, N., Brodhag, C., 2018. Integrating corporate social responsibility into conservation policy. The example of business commitments to contribute to the French National Biodiversity Strategy. *Environ. Sci. Policy* 86, 106–114.
- zu Ermgassen, S.O.S.E., Baker, J., Griffiths, R.A., Strange, N., Struebig, M.J., Bull, J.W., 2019. The ecological outcomes of biodiversity offsets under “no net loss” policies: a global review. *Conservation Letters* 12, e12664.