

Title: Using conservation science to advance corporate biodiversity accountability

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Abstract

Biodiversity declines threaten the sustainability of global economies and societies. Acknowledging this, businesses are beginning to make commitments to account for and mitigate their influence on biodiversity, and report this in sustainability reports. The top 100 of the 2016 Fortune 500 Global companies' (the Fortune 100) sustainability reports were assessed to gauge the current state of corporate biodiversity accountability. Many companies acknowledged biodiversity, but corporate biodiversity accountability is in its infancy. Almost half (49) of the Fortune 100 mentioned biodiversity in reports, and 31 made clear biodiversity commitments, of which only 5 could be considered specific, measureable and time-bound. A variety of biodiversity-related activities were disclosed (e.g., managing impacts, restoring biodiversity, and investing in biodiversity), but only 9 companies provided quantitative indicators to verify the magnitude of their activities (e.g., area of habitat restored). No companies reported quantitative biodiversity outcomes, making it difficult to determine whether business actions were of sufficient magnitude to address impacts, and are achieving positive outcomes for nature. Conservation science can help advance approaches to corporate biodiversity accountability through developing science-based biodiversity commitments, meaningful indicators, and more targeted activities to address business impacts. With the "biodiversity policy super-year" of 2020 rapidly approaching, now is the time for conservation scientists to engage with and support businesses to play a critical role in setting the new agenda for a sustainable future for the planet, with biodiversity at its heart.

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1 Introduction

Biodiversity underpins and sustains ecosystems globally, and declines in biodiversity threaten the resilience of nature, global economies, and societies (Duffy et al. 2017; Venter et al. 2016). International targets exist to direct governments and inspire society as a whole to take steps towards the conservation of biodiversity, in the broader context of global sustainable development (e.g., the Convention on Biological Diversity (CBD) Aichi targets (CBD 2011) and the Sustainable Development Goals (SDGs; United Nations 2016)). The public sector has mobilized and are working towards the achievement of international targets; however, efforts to conserve biodiversity are still falling short (Butchart et al. 2010; Geldmann et al. 2013).

The international goal to “mainstream biodiversity” (CBD Strategic Goal A; CBD 2011), sets out a vision for shared responsibility across public and private sectors for the conservation of nature balanced with sustainable development (Redford et al. 2015). The mainstreaming biodiversity agenda has predominantly been led by the public sector, where guidance, tools, standards, and regulations have been developed to both mandate and encourage the private sector to understand and manage their impacts and dependencies on biodiversity (e.g., Forest Trends 2017; TEEB 2010). Bottom-up signals of mainstreaming biodiversity are also emerging, where companies are recognizing biodiversity loss as a risk to their operations (e.g., threatening operational productivity, access to finance, regulatory compliance, or reputation; Addison & Bull in press; Dempsey 2013). A public signal of businesses identifying biodiversity as a material risk is when they make commitments to or account for their influence on biodiversity in sustainability reporting (Boiral 2016).

Corporate biodiversity accountability (through external disclosure of commitments, activities, and performance) is an important aspect of organizational stewardship and legitimacy, which an increasing number of businesses are undertaking (Jones & Solomon 2013). Businesses in the extractives sector (a heavily regulated sector for impact mitigation) are increasingly making biodiversity commitments (e.g., no net loss (NNL) or better); and companies from a range of other sectors (e.g., food, financial services, and technology) are beginning to make similar commitments (e.g., to protect the environment, or reduce impacts on the environment; Adler et al. 2017; Rainey et al. 2015; van Liempd & Busch 2013). Despite these seemingly positive moves, accounting studies suggest that corporate biodiversity accountability is very much in its infancy (Adler et al. 2017; Boiral 2016; Jones & Solomon 2013).

Redford and colleagues (2015) suggest that conservation scientists have failed to engage with the mainstreaming biodiversity agenda to date. They suggest that there is an urgent need for a “science-driven field of biodiversity mainstreaming”, where conservation scientists should critically analyze progress, to help support and improve current mainstreaming activities. In parallel, science-based processes and tools are being called for to evaluate corporate social and environmental performance (Vörösmarty et al. 2018). A key requirement for tracking progress towards biodiversity mainstreaming is an analysis of corporate biodiversity accountability, as communicated through sustainability reports. Here, we carry out an exploratory analysis of some of the worlds’ largest companies to: i) provide a snapshot of current global corporate commitments and actions for

biodiversity; and, ii) illustrate how conservation science could help inform more robust corporate biodiversity accountability, to support the science-driven field of biodiversity mainstreaming.

2 The biodiversity commitments and actions of the world's top 100 companies

To ascertain the current status of current global commitments and actions for biodiversity, we turned to some of the world's largest companies – the Global Fortune 500. Every year Fortune generate an annual ranking of the largest 500 corporations worldwide as measured by total revenue, and assess corporate profits, assets, and employee numbers (Fortune 2016). The analysis does not include any assessment of sustainability reporting. The Fortune 500 represents an ideal opportunity to explore the extent to which companies are engaging in public disclosure of environmental and social issues, to assess the current level of corporate biodiversity accountability.

The sustainability reports of the top 100 of the 2016 Fortune 500 Global companies' (hereafter the Fortune 100; Fortune 2016) were assessed to understand how biodiversity is being integrated into business decision-making and externally reported. We chose the top 100 companies in the Fortune 500, as these represent a cross-sector of industries that are exposed to different levels of biodiversity risk (as defined by F&C (2004); e.g., through access to land, capital or markets, and relations with regulators). Thirty-one 31 companies are from sectors classified as high risk (e.g., energy), 32 as medium risk (e.g., finance), and 37 as low risk (e.g., health care; see SI Table 1). We investigated: i) which companies mention or make commitments for biodiversity; ii) what biodiversity-related activities are disclosed; and iii) whether information about biodiversity activities is being disclosed qualitatively and/or quantitatively.

Online searches for the Fortune 100 sustainability reports were conducted using the GRI sustainability disclosure database (GRI 2016b; searching by company name) or using Google (using the search term 'sustainability', and by company name). The most recent reports (dated up to 2016; searched for during September 2017) were collated (n.b., 'sustainability reports' can also be referred to as Environmental, Corporate Social Responsibility, Sustainability, Registration Reports, or Financial Reports that contain non-financial information). Companies made up of multiple subsidiary companies (e.g., the Exor Group), were only assessed when sustainability reporting was done for the Fortune listed company as a whole, not subsidiary companies. Websites were not included in our analysis when the year of biodiversity commitments/activities were not stated; only dated interactive online sustainability reports were analyzed. Reports were searched for 'biodiversity' OR 'nature' OR 'species' OR 'ecosystem' (acknowledging the broad definition of biodiversity; CBD 2017). Additional search terms related to biodiversity were also used ('forest' OR 'palm' oil OR 'seafood'); these terms were commonly used in relation to nature-based commodities, without any mention of biodiversity-related terms.

Reports were searched for concise biodiversity commitments, which were commonly associated with a dedicated chapter or sub-chapter in the sustainability report or were listed as a commitment in disclosure/materiality tables of reports (e.g., Walmart: "To conserve one acre of wildlife habitat

for every acre of land occupied by Walmart U.S. through 2015"; SI Table 2). We evaluated corporate biodiversity goals against a sub-set of SMART criteria (Doran 1981), to assess whether goals were: Specific – the element of biodiversity that the goal relates to is articulated beyond simply ‘biodiversity’ (e.g., forest, threatened species or wetlands); Measurable – a quantifiable reduction/improvement is stated along with a defined baseline (e.g., 10% of land protected compared to 2010 levels); and, Time-bound – the goal is associated with a year or time-frame over which the company aims to achieve the goal (e.g., to achieve...by 2020).

When biodiversity was mentioned in reports, we recorded whether this was in line the Global Reporting Initiative (currently the most common voluntary reporting framework used for biodiversity; Boiral 2016; Boiral & Heras-Saizarbitoria 2017) or other relevant international conventions (e.g., the SDGs biodiversity related goals 14 and 15; and the CBD). Search terms used included: ‘GRI’ OR ‘Global Reporting Initiative’ OR ‘Sustainable Development Goal’ OR ‘SDG’ OR ‘Convention on bio’ OR ‘Convention for bio’ OR ‘CBD’.

To assess the types of biodiversity activities undertaken by companies, reports were open-coded to develop common themes, following an inductive category development methodology (Patton 2002). Activities were grouped into common themes once searching of all reports was complete. For each activity disclosed, we assessed whether it was described qualitatively (descriptive text provided in the sustainability report only) or quantitatively (e.g., key performance indicators or metrics presented in supporting tables or figures).

The quantitative content analysis of all reports was undertaken by the primary author, and this analysis was independently undertaken by a co-author, who coded 25% of the reports. The coders discussed the coding of the reports to assess any discrepancies. Inconsistencies were reconciled prior to data analysis, to achieve a minimum inter-coder agreement of 80% (similar to methods used recent sustainability research; e.g., Boiral & Heras-Saizarbitoria 2017).

2.1 Biodiversity mentions and commitments

In 2016 the Fortune 100 represented 15 sectors, and was dominated by the financial and energy sector companies (Figure 1). Their headquarters were located in 15 countries, with over half located in the USA and China. In 2016, Fortune 100 companies employed a total of 26.4 million staff, and had a total revenue of US\$12.6 trillion. Sustainability reporting was undertaken by the majority of the Fortune 100 companies, with 86 having publicly available sustainability reports (Figure 1; SI Table 1). These reports were predominantly from 2016 (74 company reports), otherwise were the most recent reports available (2015 (7 reports), 2014 (2 reports), 2013 (2 reports), 2012 (1 report)). See SI Table 1 for a full list of the 2016 Fortune 100 companies, including sector and biodiversity risk categories, and links to their sustainability reports.

Almost half (49) of the Fortune 100 mentioned biodiversity or related terms, and an additional 16 companies mentioned sustainable forestry or fishing (without specifically mentioning biodiversity; see SI Appendix 1 for more details). Companies from higher biodiversity risk sectors did not make greater mention of biodiversity compared to lower risk sectors (percentages mentioning biodiversity: 71% in high risk, 53% in medium risk, and 70% in low risk sectors; SI Figure 1a). This

suggests that the risk biodiversity poses to business operations is not the sole driver for inclusion of biodiversity in sustainability reports. Only 4 companies mention biodiversity and state that it is not a material risk to their operations, and therefore do not report on it any further (BMW, HSBC Holdings, Dong Feng, and Banco Santander).

The 49 companies that mentioned biodiversity all used a typical format of sustainability disclosure, which included a predominantly qualitative narrative explaining the importance of biodiversity and what actions they take regarding biodiversity. Their treatment of biodiversity could be as brief as a single mention in the context of other environmental issues (e.g., climate change, water, and waste reduction), through to a dedicated biodiversity chapter, with clear biodiversity commitment(s) and disclosure of biodiversity-related activities.

Twenty-four of the 49 companies that mentioned biodiversity made links with the biodiversity-focussed SDGs. This is far greater than the 6 companies that acknowledged the CBD. Although not intended as a reporting framework, the SDGs resonate with the private sector and are being used to frame their sustainability commitments and activities.

Only 31 of Fortune 100 companies had clearly stated commitments relating to biodiversity (SI Table 2). Commitments most commonly related to protecting biodiversity (e.g., Volkswagen: “we promise to support the protection of species at all locations”) and/or to managing impacts on biodiversity (e.g., BP: “We work to avoid activities in or near protected areas and take actions to minimize and mitigate potential impacts on biodiversity”). A higher proportion of companies from high biodiversity risk sectors made biodiversity commitments compared to lower risk sectors, but unexpectedly fewer companies from medium risk sectors made biodiversity commitments compared to low risk sectors (52%, 13%, and 30% in high, medium, and low risk sectors respectively; SI Figure 1b). This pattern is attributable to so few finance companies (classed as medium risk, which include insurance, banks, and diversified financials) making biodiversity commitments (2 out of 23 companies).

Of the 23 finance sector companies, 12 were banks, and 9 of these are Equator Principles Financial Institutions (EPFIs). Eight EPFIs mentioned their adherence to the Equator Principles (which have requirements to ensure impacts on biodiversity are minimized; Equator Principles 2013), but only one company had a biodiversity commitment (BNP Paribas, which commits to ‘combating loss of biodiversity’). Six EPFIs mentioned biodiversity, but did not translate the Equator Principles (to minimize biodiversity impacts) into a corporate commitment. One EPFI (Banco Santander) stated that biodiversity was not of material risk to them, justifying why no biodiversity information is disclosed further. The remaining 4 non-EPFIs did not mention or make commitments for biodiversity.

Only five businesses (of 31) had commitments which could be classified as specific, measurable and time bound (Walmart, Hewlett Packard, AXA, Nestlé and Carrefour; Figure 1; SI Table 2). Most of these related to commodities (e.g., Hewlett Packard: “To help protect forests, in 2016 HP set a goal to achieve zero deforestation associated with HP brand paper and paper-based product packaging by 2020”). By contrast, the 12 of the 16 companies that made commodity commitments (but did not mention biodiversity) made specific, measurable and time-bound commitments (SI Table 2). The only specific, measurable and time bound biodiversity commitment made was Walmart’s (out of

date) commitment: "To conserve one acre of wildlife habitat for every acre of land occupied by Walmart U.S. through 2015". Beyond Walmart's commitment, none of the remaining Fortune 100 had adopted quantifiable biodiversity commitments (e.g., NNL or better), unlike the small but rising number of corporations outside of the Fortune 100 (Rainey et al. 2015). The lack of specific, measurable or time-bound features of corporate biodiversity commitments has also been observed in other recent sector-specific and nation-specific studies (e.g., Adler et al. 2017; Boiral 2016; Jones & Solomon 2013).

2.2 What biodiversity activities were disclosed and in what format?

The 49 companies that mentioned biodiversity and additional 16 that mentioned sustainable forestry or fishing disclosed a range of activities. Activities included managing or preventing impacts, protecting and restoring biodiversity, monitoring biodiversity, engaging and connecting people with biodiversity, and investing in biodiversity (a much greater diversity of activities than the GRI areas of biodiversity disclosure; Figure 2; SI Table 3). These activities were typically described qualitatively, involving short case study narratives or general descriptions. Only 9 companies provided quantitative performance indicators associated with descriptions.

The lack of standardized quantitative performance indicators creates challenges for comparing performance both between companies, and for individual companies through time. Although the Global Reporting Initiative (GRI) suggest performance indicators for use alongside qualitative disclosures for biodiversity, this is a voluntary framework (GRI 2016a) and not all businesses report against this for biodiversity (only 26 companies report against at least one of the GRI areas of biodiversity disclosure).

The most commonly disclosed qualitative information concerned habitats protected or restored, and partnerships formed (disclosed by 37 companies respectively; Figure 2). Examples of disclosed activities provided in SI Table 3 illustrate the brevity of statements made about habitats protected or restored (e.g., the reforestation of E.ON woods) and partnerships formed with NGOs and government agencies (e.g., Shell's partnerships with the IUCN). Other common activities included GRI biodiversity disclosure areas (GRI 2016a), including companies outlining the strategies or management approaches they use to manage impacts (33 companies; e.g., Société Générale follow the Equator Principles biodiversity standards), and how businesses manage their biodiversity impacts (e.g., Citigroup follow the International Finance Corporation Performance Standards by avoiding impacts on critical biodiversity habitats). Three companies discussed using natural capital assessments to help understand their impacts and dependencies on biodiversity (Walmart, Hitachi, and Nestlé; SI Table 2); this is likely to rise in the future with the recent release of the Natural Capital Protocol, which has gained considerable traction with the private sector internationally (Natural Capital Coalition 2016).

The most commonly disclosed quantitative biodiversity information also concerned habitats protected or restored (9 companies, Figure 2). For example, Hitachi reported the number of ecosystem preservation activities implemented. The next most commonly cited quantitative indicator for biodiversity related to the proportion of commodities which have been sustainably sourced (e.g., Carrefour reported on the percentage increase in sales of certified seafood; SI Table

2). Other quantitative information disclosed included the GRI areas of disclosure demonstrating the avoidance of protected areas (e.g., Glencore reported on their operations which are located in, adjacent to, or that contain protected areas) and threatened species (e.g., Enel reported on the number of IUCN Red List species affected by projects in different countries of operation); but these activities are disclosed by a very small fraction of companies, suggesting the GRI areas of biodiversity disclosure are of limited relevance to the majority of the Fortune 100. Few companies attempted to disclose quantitative information about the magnitude of their impact on biodiversity versus the magnitude of the activities they undertake which are designed to be beneficial for biodiversity (with the exception of Glencore, who disclosed the area of impacted vs rehabilitated land). Finally, no companies reported quantitative outcomes of their activities for biodiversity, which makes it very difficult to verify whether the implemented actions have any positive outcomes for nature.

3 How conservation science could inform robust and impactful corporate biodiversity accountability

Our assessment of the 2016 Fortune 100 Global companies has revealed that big businesses are giving biodiversity limited treatment in sustainability reports. These empirical findings support accounting and accountability research suggesting that corporate biodiversity accountability is in its infancy (Adler et al. 2017; Boiral 2016; Jones & Solomon 2013).

This analysis has also helped identify some critical areas where conservation science could contribute to the science-driven field of biodiversity mainstreaming (Redford et al. 2015), particularly to support more robust corporate biodiversity accountability approaches. Here we outline three critical areas where conservation science approaches, which have been successfully applied for decades to support environmental policy and management, can help businesses clarify and deepen their commitments to biodiversity, and support the international biodiversity mainstreaming agenda.

1) Developing science-based corporate biodiversity commitments

Corporate biodiversity commitments are only made by a fraction of the Fortune 100, and these commitments often lack clarity (Figure 1; Boiral 2016; Jones & Solomon 2013). In addition, many businesses disclose information about biodiversity actions without having a clearly stated biodiversity commitment (Figure 1). An absence of clearly defined corporate biodiversity commitments means that it is impossible to measure whether businesses are genuinely making progress in relation to managing their impacts and dependencies on biodiversity, and whether they are contributing to international goals to halt the loss of biodiversity and address the underlying threats to biodiversity.

By comparison, in 2015, 80% of the world's largest 250 companies have made science-based climate commitments, and disclosed information about carbon emission reductions in their sustainability reports (KPMG 2015). The widely accepted 'science-based' commitments (that are specific, measurable and time bound) used to set corporate climate commitments are a model for the

general improvement of corporate biodiversity commitments. Such commitments include clearly defined aspects of climate (e.g., greenhouse gas emissions), baselines, and end dates, to allow for quantitative evaluation of corporate performance. However, it is much more challenging to make science-based biodiversity commitments. 'Biodiversity' is a vague and complex concept, which is impossible to capture in a single or set of indicators (Purvis & Hector 2000). The CBD's definition encompasses all living things from genes to ecosystems (CBD 2017). This is where conservation science can help, as many approaches have been successfully applied for decades to help set clear objectives to guide the management and measurement of biodiversity, informing both policy and site-level management decisions (Table 1).

Decades of conservation science have reinforced the need for commitments that are specific, measurable and time bound to guide effective conservation action (Brown et al. 2015; Maxwell et al. 2015; Table 1). Decision-support frameworks, such as structured decision-making (Addison et al. 2013), adaptive management (Runge 2011), management strategy evaluation (Bunnefeld et al. 2011), and the mitigation hierarchy (Arlidge et al. 2018; Bull et al. 2013), can all be useful in guiding the development of science-based corporate biodiversity commitments (Table 1). These frameworks and their associated tools can help in developing clear commitments that: are specific to business influence and impacts; include quantifiable targets, accounting for both biodiversity gains and losses (e.g., NNL or better); use meaningful spatial and temporal frame(s) of reference; and, align with international strategic goals for biodiversity (e.g., reduce impacts, improve biodiversity status, enhance benefits to society, support and engage in knowledge sharing; CBD 2011; Table 1).

2) Developing transparent and comparable corporate biodiversity indicators to evaluate achievement of corporate biodiversity commitments

The limited standards for corporate biodiversity disclosure means that there are no consistent approaches to reporting biodiversity information (Figure 2; Adler et al. 2017; van Liempd & Busch 2013). Some businesses disclosed information about the activities they undertake to address their impacts. However, few provided details of the magnitude of these activities or quantified whether they are adequate to address the scale of the negative impacts the business is having on biodiversity (Figure 2). In addition, few report on the outcomes of their activities for biodiversity, that is, answering the question: is the biodiversity affected by the business's direct or indirect operations improving, declining, or being maintained? The general failure to report on the magnitude of negative impacts versus beneficial activities and their outcomes for biodiversity, makes it enormously difficult for stakeholders and shareholders to obtain a complete and transparent view of a company's biodiversity performance, and at worst could be camouflaging unsustainable business practices (Fonseca et al. 2014; Vörösmarty et al. 2018).

Conservation approaches can support the development of indicators to transparently account for biodiversity gains and losses, and directly evaluate corporate commitments. Protected area management effectiveness evaluation encourages the development of indicators to address the full process of biodiversity management: from inputs (resources spent), outputs (activities undertaken), to outcomes (changes in biodiversity; Hockings et al. 2006). Approaches used in conservation science and policy like Essential Biological Variables (e.g., for measures ecosystem structure or function, or

species persistence; Pereira et al. 2013), global biodiversity indicators (e.g., for measures of state, pressure and response; Butchart et al. 2010), and scalable composite indicators (Burgass et al. 2017) can help businesses develop indicators that support quantitative evaluation of progress towards achieving commitments. These approaches encourage careful consideration of components of biodiversity that are fundamentally important to business operations, directly under business control or influence, and development of indicators that account for both gains and losses of biodiversity. Lessons from the development of international-level biodiversity indicators (Nicholson et al. 2012) emphasize the necessity not only to develop and implement indicators, but also to thoroughly test the performance and sensitivity of indicators in relation to the contexts within which they are applied (e.g., correct spatial and temporal resolution, and sensitivity to change in response to policy/management interventions).

3) Expanding and deepening corporate biodiversity action

The range of actions for biodiversity which businesses disclosed (Figure 2) can help improve corporate social legitimacy, but may do little to genuinely address the magnitude of their environmental impacts (Boiral & Heras-Saizarbitoria 2017; Jones & Solomon 2013). Conservation approaches can be used to target activities so that they directly address biodiversity commitments, and can help businesses to predict their likely effectiveness (Table 1). Frameworks such as structured decision-making, adaptive management and management strategy evaluation, and the process models used within these frameworks, will help explicitly account for the uncertainties surrounding the effectiveness of activities (Milner-Gulland & Shea 2017). The mitigation hierarchy can guide the selection of activities to mitigate impacts and create biodiversity gains (Arlidge et al. 2018; Bull et al. 2013).

Going beyond undertaking activities to account for the direct footprint of a business's impacts, a wider question is: how are these activities contributing to global priorities for action to conserve biodiversity? The key international biodiversity targets (CBD Aichi Biodiversity Targets and the UN's SDGs (CBD 2011; United Nations 2016)) can, and should, be used to provide an overarching framework to guide businesses towards expanding and deepening their biodiversity activities, so that they become part of the international community involving the public sector, civil society and private sector, that work towards a more sustainable world (Table 1).

Scientists must not underestimate the private sector's focus on risk as a reason to drive action on social and environmental issues, rather than the misconception that only companies that stand to benefit directly from the environment will take action (Addison & Bull in press; Barbier et al. 2018). When business operations are threatened by biodiversity loss, then biodiversity becomes a material business risk. Only once this risk is quantified, and realized through materiality assessment will biodiversity become more visible to the decision-making departments of corporations that manage finance and risk, and will be truly integrated into corporate accountability and mainstreamed through the private sector (Dempsey 2013). Our study adds to the accountability literature, that biodiversity is yet to be consistently perceived as a material risk across the private sector (Adler et al. 2017; Boiral 2016). Advances in quantitative risk assessment are also needed to increase the

visibility of biodiversity across business operations and across far more sectors to drive corporate action to halt biodiversity loss.

4 Advancing the science-driven field of biodiversity mainstreaming in the lead up to 2020

The mainstreaming biodiversity agenda is designed to engage the private sector and encourage shared responsibility for the conservation of nature balanced with sustainable development (Redford et al. 2015). Corporate biodiversity accountability - where businesses make biodiversity commitments, disclose information about biodiversity related activities, and evaluate their corporate performance in relation to their own or international biodiversity commitments – remains in its infancy (Adler et al. 2017; Boiral 2016; Jones & Solomon 2013). In order to genuinely contribute to the mainstreaming biodiversity agenda, businesses will need credible and robust ways to account for biodiversity throughout the supply chain, that can be reported concisely at the corporate level and acted upon.

What would a more accountable business need to commit to and measure in order to demonstrate they are doing their bit for biodiversity? We believe corporate commitments of ‘no net loss’ or better for biodiversity, applied with flexibility to target the species and ecosystems that a company impacts. This commitment should be aligned with existing international biodiversity policy (CBD 2011; United Nations 2016), and couched within a global mitigation hierarchy, to help shift business activities from compensatory measures (remediation, offsets) across to preventative measures (avoidance, minimization of impacts; Arlidge et al. 2018; Bull et al. 2013). Beyond objectives, quantitative measures for biodiversity outcomes are the ideal and should be specific to a company and its biodiversity risks and impacts.

What actions should a more accountable business undertake? The expertise of conservation scientists will be vital to help target corporate action where it is needed most: helping hone attention to operations that pose the greatest impact on biodiversity (e.g., agriculture and extractives; Maxwell et al. 2016); and direct corporate action in conservation priority areas by avoiding impacting the most threatened species and ecosystems (Brauneder et al. 2018; Martin et al. 2015), and helping conserve the last of the wilderness areas (Watson et al. 2016).

Finally, where can conservation scientists and businesses start to tackle the complexities of business interactions with biodiversity? The approaches outlined here are all broadly applicable, but need to be tailored to ensure that biodiversity risks and impacts are captured and translated into practical advice relevant to the sector concerned. For example, some high biodiversity risk sectors like extractives (oil & gas, electricity, mining) and agriculture, have direct footprint impacts on biodiversity, and will require approaches that focus business understanding of risks and impacts at site-level operations when developing commitments, actions and performance measures. Other high biodiversity risk sectors like food retailers will require approaches that trace the biodiversity impacts of commodities through sometimes long supply chains. Finally, medium biodiversity risk sector companies, like finance and insurance firms, will require approaches that can capture indirect

biodiversity impacts (e.g., through financing third parties and projects) in order to address biodiversity performance (e.g., through risk management).

Now is a critical time for conservation scientists to engage, in order to generate a science-driven field of biodiversity mainstreaming. Although our analysis highlights that the world's biggest businesses have a long way to go in developing, and reporting on, such commitments, the scene is set for rapid improvements. If these were set in place prior to the "biodiversity policy super-year" of 2020, when the international biodiversity conservation strategy will be revisited, then businesses could truly start to play a part in the new agenda for a sustainable future for the planet, which has biodiversity at its heart.

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Table 1. Examples of conservation science approaches (frameworks and modeling approaches) and their potential for: developing science-based corporate biodiversity commitments; transparent and comparable corporate biodiversity indicators; and identifying additional avenues of corporate biodiversity action.

Conservation science approach	1) Developing science-based biodiversity commitments	2) Developing transparent and comparable biodiversity indicators	3) Expanding and deepening corporate biodiversity action
Decision-making frameworks and associated modelling techniques (e.g., structured decision-making, adaptive management, and management strategy evaluation frameworks; Addison et al. 2013; Bunnefeld et al. 2011; Milner-Gulland & Shea 2017; Runge 2011)	<ul style="list-style-type: none"> – Develop specific commitments that are relevant to business influence and impacts on biodiversity (e.g., using values-focused thinking and conceptual models in structured decision-making). 	<ul style="list-style-type: none"> – Develop indicators to evaluate corporate commitments and activities (e.g., using objectives hierarchies and conceptual models in structured decision-making). 	<ul style="list-style-type: none"> – Develop actions that directly address business impacts or influence (e.g., conceptual models, consequence models and cost-benefit analysis in structured decision-making or adaptive management) – Prioritize areas for biodiversity action (e.g., systematic conservation planning) – Guide the evaluation and reporting on the effectiveness of biodiversity actions in contributing to corporate biodiversity commitments (e.g., using statistical models in structured decision-making or adaptive management) – Account for uncertainty in the effectiveness of a proposed action, and help determine the magnitude of activity to be implemented (e.g., using process models within management strategy evaluation)
The mitigation hierarchy and associated principles of biodiversity management and modelling techniques (Arlidge et al. 2018; Bull et al. 2013)	<ul style="list-style-type: none"> – Develop measurable commitments (e.g., following the principles of no net loss (NNL), or net positive impact (NPI)). – Develop meaningful spatial and temporal frame(s) of reference for commitments (e.g., baseline or counterfactual) 	<ul style="list-style-type: none"> – Develop indicators that can account for biodiversity gains/benefits and losses/impacts. 	<ul style="list-style-type: none"> – To guide the avoidance, minimisation, restoration and offsetting of predicted biodiversity impacts from development (i.e., applying the mitigation hierarchy). – Ensure that any activities are new contributions to biodiversity conservation, when the

Conservation science approach	1) Developing science-based biodiversity commitments	2) Developing transparent and comparable biodiversity indicators	3) Expanding and deepening corporate biodiversity action
	development)		activity undertaken is designed to offset negative impacts (i.e., demonstrating additionality) – Account for uncertainty in the effectiveness of a proposed activity, and help determine the magnitude of activity to be implemented (e.g., guided by multipliers).
Protected Area Management Effectiveness Evaluation framework and associated modelling techniques (Hockings et al. 2006)	– Develop specific, measurable and time bound commitments that are relevant to business influence and impacts (e.g., using conceptual models).	– Develop indicators that address the full management process (from inputs (resources spent), outputs (activities undertaken), to outcomes (changes in biodiversity).	– To guide the evaluation and reporting on the effectiveness of biodiversity activities in contributing to corporate biodiversity commitments (e.g., expert judgement, statistical models and report cards).
SMART biodiversity commitments (Maxwell et al. 2015)	– Guide the development of specific, measurable, ambitious, realistic, and time-bound commitments.		
Essential Biological Variables (Pereira et al. 2013)		– Identify what components of biodiversity are fundamentally important, and directly under their control or influence, which relate to corporate biodiversity commitments.	
Global biodiversity indicators (e.g., Butchart et al. 2010; Nicholson et al. 2012)		– Develop a suite of indicators that paint a picture of both <i>pressures</i> , <i>biodiversity status</i> (i.e., <i>outcomes</i>), and <i>management responses</i> to address biodiversity declines. – Testing the	

Conservation science approach	1) Developing science-based biodiversity commitments	2) Developing transparent and comparable biodiversity indicators	3) Expanding and deepening corporate biodiversity action
Composite indicator development (e.g., Burgass et al. 2017)		<p data-bbox="778 331 1011 555">performance and sensitivity of indicators in relation to the business contexts within which they are applied</p> <p data-bbox="740 562 1011 815">– Develop indicators that can be aggregated from site to corporate level, which account for bias and uncertainty through the aggregation process.</p>	<p data-bbox="1059 824 1385 1144">– Understand the types of priority biodiversity activities needed to contribute to international effort to conserve and sustainably use biodiversity, and guide more influential corporate biodiversity activity.</p>
International biodiversity goals, e.g., CBD Aichi targets (CBD 2011) and the Sustainable Development Goals (United Nations 2016)			

At a glance... How is biodiversity treated by the world's biggest companies?

2016 Fortune 100 Global

We analyzed the sustainability reports of the 2016 Fortune Global 100 companies



Represent **15 sectors**, dominated by the financial sector (23 companies) and the energy sector (21 companies)



Have **headquarters located in 15 countries**, dominated by USA (38 companies) and China (19 companies)



Total revenue = US\$12.6 trillion



Total employees = 26.4 million staff

Of the **top 100** companies, **86** have publicly available sustainability reports:

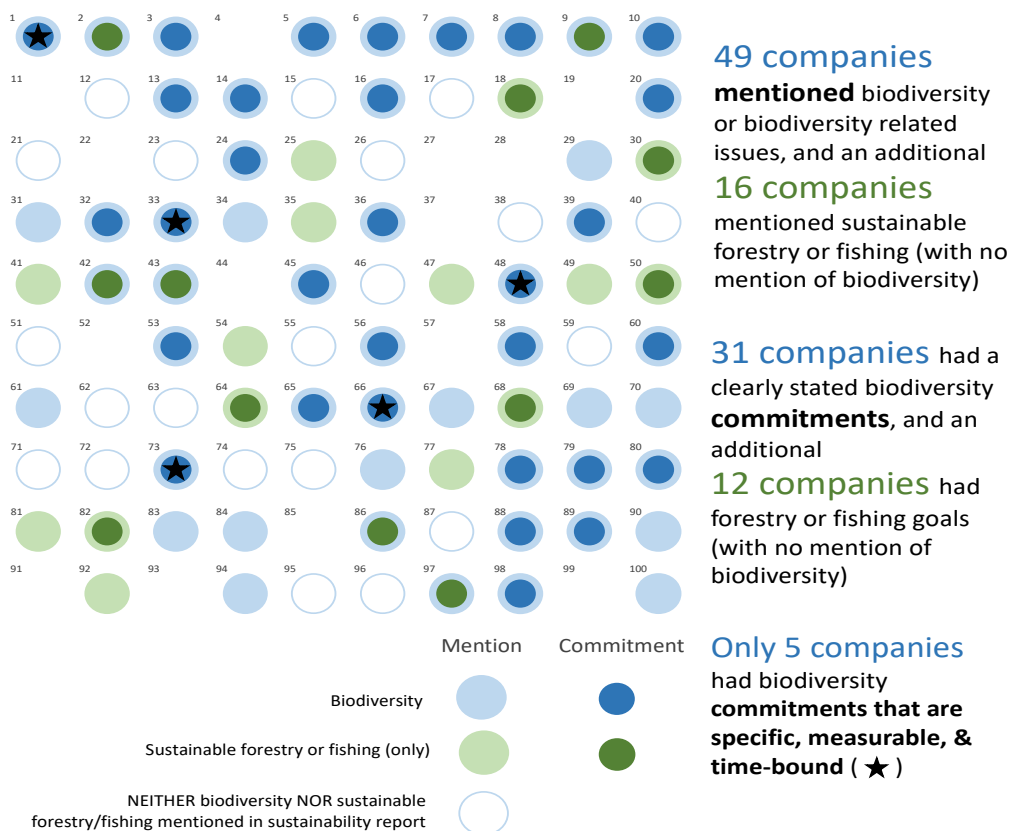


Figure 1. The Fortune 100 Global companies (with corresponding 2016 rankings), and their progress towards incorporating biodiversity into sustainability reporting – through mentions and commitments relating to biodiversity, sustainable forestry or fishery. Details regarding sector descriptions, headquarter locations, revenue and employee numbers can be found in SI Table 1 and the on the Fortune 500 Global website (Fortune 2016).

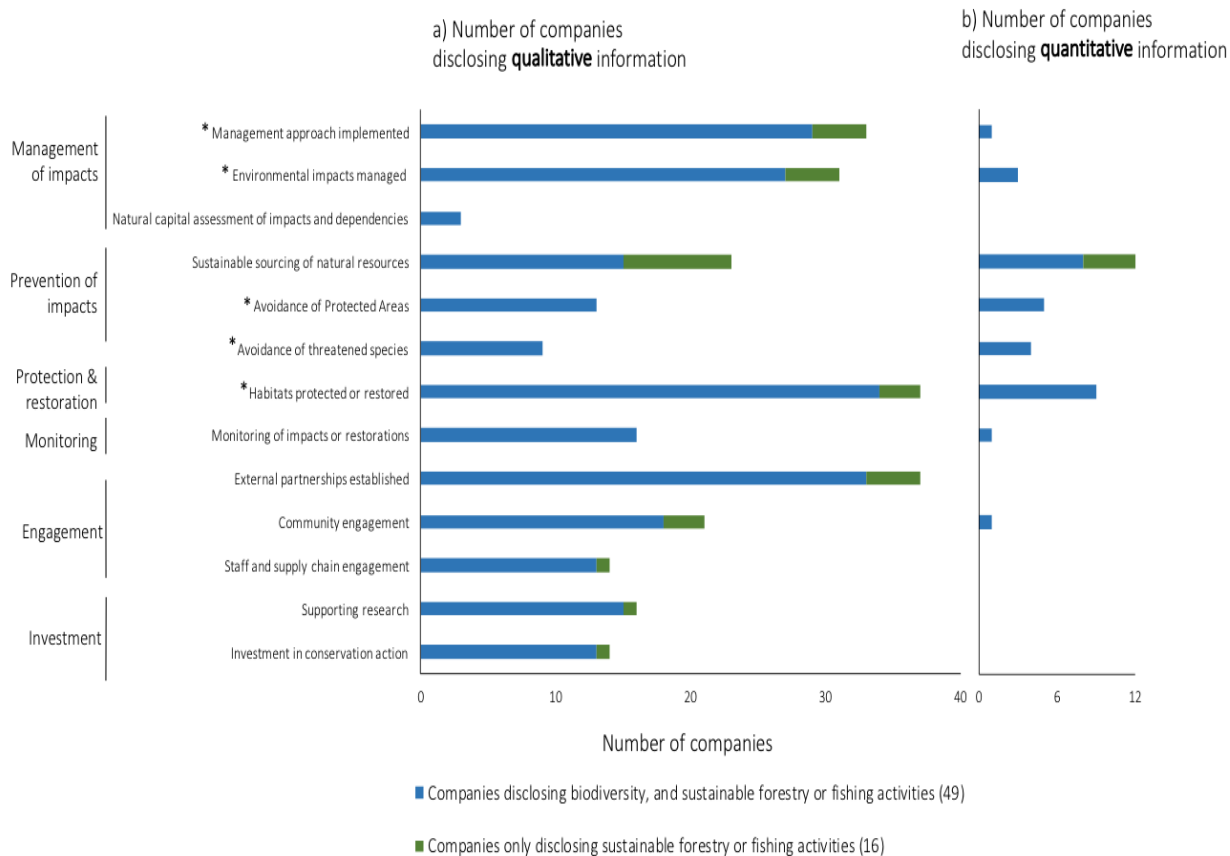


Figure 2. The number of companies disclosing a) qualitative biodiversity information about activities, and/or b) quantitative biodiversity information about activities. Companies are differentiated as those that disclose biodiversity information (including sustainable forestry or fishing information; 49 companies; shown in blue) or those companies that only disclose forestry or fishing information (an additional 16 companies; shown in green). The GRI areas of disclosure are indicated with an asterisk (*).