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1 **Title: Using conservation science to advance corporate biodiversity**  
2 **accountability**

3 **Abstract**

4 Biodiversity declines threaten the sustainability of global economies and societies. Acknowledging  
5 this, businesses are beginning to make commitments to ~~biodiversity~~, account for and mitigate their  
6 influence on biodiversity, and report this ~~to stakeholders~~ in sustainability reports. The top 100 of the  
7 2016 Fortune 500 Global companies' (the Fortune 100) sustainability reports were assessed to gauge  
8 the current state of corporate biodiversity accountability. ~~Our analysis revealed that~~ Many  
9 ~~companies/corporations~~ big businesses are ~~acknowledg~~edging biodiversity, but corporate biodiversity  
10 accountability is in its infancy. Almost half (49) of the Fortune 100 mentioned biodiversity in ~~their~~  
11 ~~sustainability~~ reports, and 31 made clear biodiversity commitments, of which only 5 could be  
12 considered specific, measurable and time-bound. A variety of biodiversity-related activities were  
13 ~~described qualitatively in reports~~ disclosed by 49 companies (e.g., managing impacts, restoring  
14 biodiversity, ~~connecting people with biodiversity~~, and investing in biodiversity), ~~but only~~. ~~However,~~  
15 ~~only~~ 9 companies provided quantitative information/indicators to verify the magnitude of their  
16 activities (e.g., area of habitat restored). ~~Only 1 company disclosed quantitative information about~~  
17 ~~the magnitude of business impacts on biodiversity as opposed to the activities undertaken to mitigate~~  
18 ~~those impacts~~. No companies reported ~~on~~ quantitative biodiversity outcomes, ~~of their activities,~~  
19 ~~making it~~. ~~This makes it very~~ difficult to determine whether business actions ware of sufficient  
20 magnitude to address impacts, and are achieving positive outcomes for nature. Conservation science  
21 can help ~~businesses~~ advance their approaches to corporate biodiversity accountability through  
22 developing science-based biodiversity commitments, meaningful indicators, and more targeted  
23 activities ~~that to not only~~ address business ~~business~~ impacts ~~and but contribute to international~~  
24 ~~conservation priorities~~. With the "biodiversity policy super-year" of 2020 rapidly approaching, now

25 is the time for conservation scientists to engage with and support businesses to play a critical role in  
26 setting the new agenda for a sustainable future for the planet, with biodiversity at its heart.

## 27 **1 Introduction**

28 Biodiversity underpins and sustains ecosystems globally, and ~~the declines in biodiversity witnessed~~  
29 ~~in recent decades are not only eroding the~~ threaten the resilience of nature, ~~but threatening the~~  
30 ~~sustainability of~~ global economies, and societies (Duffy et al. 2017; Venter et al. 2016). International  
31 ~~biodiversity targets have~~ targets have been established exist to direct governments and inspire society  
32 as a whole to take steps towards the conservation of biodiversity, in the broader context of global  
33 sustainable development (e.g., the Convention on Biological Diversity (CBD) Aichi targets (CBD  
34 2011) and the Sustainable Development Goals (SDGs; United Nations 2016)). The public sector has  
35 mobilized and ~~are~~ working towards the achievement of ~~these biodiversity~~ international targets; ~~h-~~  
36 However, efforts to conserve biodiversity are still falling short (Butchart et al. 2010; Geldmann et al.  
37 2013). Butchart et al. 2015; Butchart et al. 2010; Geldmann et al. 2013; Huwyler et al. 2016).

38 ~~The international conservation community has set a~~ The strategic policy goal to “mainstream  
39 biodiversity” (CBD Strategic Goal A; CBD 2011), ~~which~~ sets out a vision for shared responsibility  
40 across ~~the~~ public and private sectors for the conservation of nature balanced with sustainable  
41 development (Redford et al. 2015). The mainstreaming biodiversity agenda has predominantly been  
42 led by the public sector, where guidance, tools, ~~policies,~~ standards, and regulations have been  
43 developed to both mandate and encourage the private sector to understand and manage their impacts  
44 and dependencies on biodiversity (e.g., Forest Trends 2017; TEEB 2010). Bottom-up signals of  
45 mainstreaming biodiversity are also emerging, where companies are recognizing biodiversity loss as  
46 a risk to their operations (e.g., threatening operational productivity, access to finance, regulatory  
47 compliance, or reputation; Bottom-up approaches to mainstreaming biodiversity are also emerging,  
48 where the private sector Dempsey 2013), is beginning to recognize the importance of biodiversity  
49 and account for it in business decision-making. A public signal of businesses identifying biodiversity  
50 as a material risk is when they make commitments to ~~biodiversity~~ or account for their influence on

51 ~~biodiversity in , and report this to their stakeholders through sustainability reportings~~ A public signal  
52 ~~of this is through sustainability reports, where businesses make commitments to biodiversity, account~~  
53 ~~for their influence on biodiversity, and report this to their stakeholders~~ (Boiral 2016).

54 Corporate biodiversity accountability (~~through external disclosure of commitments, activities, and~~  
55 ~~performance~~) is ~~an important a vital part~~ aspect of organizational stewardship and legitimacy, ~~which~~  
56 ~~an increasing number of businesses are undertaking~~ and is viewed as an important way to ~~helping to~~  
57 ~~transform attitudes and behavior within businesses~~ (Jones & Solomon 2013). ~~Dempsey~~  
58 ~~2013~~ Businesses in the extractives sector (~~one of the more~~ heavily regulated ~~sector sectors~~ for  
59 ~~biodiversity~~-impact mitigation) are increasingly making biodiversity commitments (e.g., no net loss  
60 ~~(NNL) or better~~) of biodiversity; and companies from a range of other sectors (e.g., food, financial  
61 services, ~~and~~ technology, ~~and telecommunications~~) are beginning to make similar commitments (e.g.,  
62 to protect the environment, or reduce impacts on the environment; Adler et al. 2017; Rainey et al.  
63 2015; van Liempd & Busch 2013). Despite these seemingly positive moves, accounting studies  
64 suggest that corporate biodiversity accountability is very much in its infancy (Adler et al. 2017;  
65 Boiral 2016; Jones & Solomon 2013).

66 Redford and colleagues (2015) suggest that conservation scientists have failed to engage with the  
67 mainstreaming biodiversity agenda to date. They suggest that there is an urgent need for a “science-  
68 driven field of biodiversity mainstreaming”, ~~in which~~ where conservation scientists should critically  
69 analyze progress, to help support and improve current mainstreaming activities. In parallel, ~~calls~~  
70 ~~have been made for scientific research to develop~~ science-based processes and tools ~~are being called~~  
71 ~~for~~ to evaluate corporate social and environmental performance ~~associated with businesses~~  
72 ~~sustainability reports and financial statements~~ (Vörösmarty et al. 2018). A key requirement for  
73 tracking progress towards biodiversity mainstreaming is an analysis of ~~public~~ corporate biodiversity  
74 ~~accountability, as communicated through~~ ~~commitments, and the associated actions disclosed in~~

75 sustainability reports. Here, we carry out ~~this an exploratory~~ analysis ~~of some of the worlds' largest~~  
76 ~~companies; in order~~ to: i) provide a snapshot of current global corporate commitments and actions  
77 for biodiversity; and, ii) illustrate how conservation science could help inform more robust corporate  
78 biodiversity ~~commitments and actions~~ ~~accountability~~ ~~accountability~~, to support the science-driven  
79 field of biodiversity mainstreaming.

## 80 **2 The biodiversity commitments and actions of the world's top 100 companies**

81 ~~In order~~ ~~I~~ to ascertain the current status of current global commitments and actions for biodiversity,  
82 we turned to ~~some of~~ the world's largest companies – the Global Fortune 500. Every year Fortune  
83 generate an annual ranking of the largest 500 corporations worldwide as measured by total revenue,  
84 and assesses ~~the state of large corporations in relation to their~~ ~~corporate~~ profits, assets, and employee  
85 numbers (Fortune 2016). The analysis does not include any assessment of ~~corporate social~~  
86 ~~responsibility~~ ~~sustainability reporting~~. ~~However, many large corporation~~ ~~companies are beginning to~~  
87 ~~connecting with changing stakeholder and shareholder expectations of sustainable and responsible~~  
88 ~~business practice, and are publicly communicating their sustainability commitments and initiatives~~  
89 ~~through sustainability reports~~ (Bocken et al. 2014; Clark et al. 2015; Kareiva et al. 2015; Rainey et  
90 al. 2015). The Fortune 500 represents an ideal opportunity to explore the extent to which ~~big~~  
91 ~~business is~~ ~~companies are~~ engaging in public disclosure of environmental and ~~for~~ social ~~sustainability~~  
92 ~~commitments and initiatives~~ ~~issues~~, to assess the current level of corporate biodiversity  
93 accountability.

94 The sustainability reports of the top 100 of the 2016 Fortune 500 Global companies' (hereafter the  
95 Fortune 100; Fortune 2016) were assessed to understand how ~~seriously~~ biodiversity is being  
96 integrated into business decision-making and ~~externally~~ reported ~~to stakeholders and shareholders~~.  
97 ~~We chose the top 100 companies in the Fortune 500, as these represent a cross-sector of industries~~  
98 ~~that are exposed to different levels of biodiversity risk (as defined by F&C (2004); e.g., through~~

99 [access to land, capital or markets, and relations with regulators](#)). ~~Thirty-one 31 companies are from~~  
100 [sectors classified as high risk \(e.g., energy\), 32 as medium risk \(e.g., finance\), and 37 as low risk](#)  
101 [\(e.g., health care; see SI Table 1\)](#). We investigated: i) which companies mention [biodiversity](#)-or make  
102 [clear corporate biodiversity commitments for biodiversity](#); ii) what [type of biodiversity-related](#)  
103 activities are disclosed; and iii) whether information about biodiversity activities is being disclosed ~~is~~  
104 [in-qualitatively and/or quantitatively-formats](#). ~~The Fortune 100 are categorized into sectors (Fortune~~  
105 ~~2016), and we matched these with high, medium, or low ‘biodiversity risk’ sectors (as defined by~~  
106 ~~F&C (2004); based on the biodiversity risk posed to different sectors, e.g., through access to land,~~  
107 ~~capital or markets, and relations with regulators).~~

108 Online searches for the Fortune 100 sustainability reports were conducted using the GRI  
109 sustainability disclosure database (GRI 2016b; searching ~~for the by~~ company name) or using Google  
110 ~~search engine~~-(using the search term ‘sustainability’, and ~~the by~~ company name). The most recent  
111 reports (dated up to 2016; searched for during September 2017) were collated (n.b., ‘sustainability  
112 reports’ can also be referred to as Environmental, Corporate Social Responsibility, Sustainability,  
113 Registration Reports, or Financial Reports [that contain non-financial information, which were also](#)  
114 [included in the analysis](#)). Companies made up of multiple subsidiary companies (e.g., the Exor  
115 Group), were only assessed when sustainability reporting was done for the Fortune listed company as  
116 a whole, ~~and not some of their not~~ subsidiary companies. Websites were not included in our analysis  
117 when the year of biodiversity commitments/activities ~~could not be verified were not stated~~; only  
118 ~~dated~~ interactive online sustainability reports ~~that clearly stated year of publication~~ were ~~included in~~  
119 ~~the analysis analyzed~~. Reports were searched for ‘biodiversity’ OR ‘nature’ OR ‘species’ OR  
120 ‘ecosystem’ (acknowledging the broad definition of biodiversity; CBD 2017). Additional search  
121 terms related to biodiversity were also used (‘forest’ OR ‘palm’ oil OR ‘seafood’); these terms were  
122 commonly used in relation to [nature-based sustainable natural resource extraction commodities in](#)

123 ~~reports, but appeared often to be mentioned~~ without any ~~mention of association to~~ biodiversity-related  
124 terms.

125 Reports were searched for concise ~~biodiversity goals or statements~~ ~~commitments made about~~  
126 ~~biodiversity~~, which were commonly associated with a dedicated chapter or sub-chapter in the  
127 sustainability report or were listed as a ~~goal that was reported against commitment~~ in  
128 disclosure/materiality tables of reports (e.g., Walmart: ~~has a goal~~ “To conserve one acre of wildlife  
129 habitat for every acre of land occupied by Walmart U.S. through 2015”; ~~Walmart 2016~~ ~~SI Table 2~~).

130 We evaluated corporate biodiversity goals against a sub-set of SMART criteria ~~used in conservation~~  
131 (Doran 1981), to assess whether goals were: Specific – the element of biodiversity that the goal  
132 relates to is articulated beyond simply ‘biodiversity’ (e.g., forest, threatened species or wetlands);  
133 Measurable – a quantifiable reduction/improvement is stated along with a defined baseline (e.g., 10%  
134 of land protected compared to 2010 levels); and, Time-bound – the goal is associated with a year or  
135 time-frame over which the company aims to achieve the goal (e.g., to achieve...by 2020). ~~Note~~  
136 ~~these criteria are a subset of the recommended SMART goals (e.g., Maxwell et al 2015); whilst A~~  
137 ~~and R (ambitious and realistic) are important aspects of targets, the assessment of these aspects can~~  
138 ~~be subjective and difficult when dealing with selectively reported business information in public~~  
139 ~~reports, so were not assessed here.~~

140 When biodiversity was mentioned in reports, we recorded whether this ~~disclosure was made in~~  
141 ~~relation to was in line~~ ~~voluntary reporting standards, such as the Global Reporting~~ ~~Initiative~~ ~~Index~~  
142 (currently the most common ~~voluntary~~ reporting framework used for biodiversity; Boiral 2016;  
143 Boiral & Heras-Saizarbitoria 2017) or other relevant international conventions (e.g., the ~~Sustainable~~  
144 ~~Development Goals~~ ~~SDGs~~ biodiversity related goals 14 and 15; and the ~~Convention for Biological~~  
145 ~~Diversity~~ ~~CBD~~). Search terms used included: ‘GRI’ OR ‘Global Reporting ~~Imitative~~ ~~Initiative~~’ OR

**Commented [JB1]:** So Rainey et al. consider this a>NNL objective (acre for acre). See my comments in the response letter on this.



146 'Sustainable Development Goal' OR 'SDG' OR 'Convention on bio' OR 'Convention for bio' OR  
147 'CBD'.

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

154 The quantitative content analysis of all reports was undertaken by the primary author, and this  
155 analysis was independently undertaken by a co-author, who coded 25% of the reports. The coders  
156 discussed the ~~categorization of information and~~ coding of the reports to assess any discrepancies.  
157 Inconsistencies were reconciled prior to data analysis, to achieve a minimum inter-coder agreement  
158 of 80% (~~following similar to methods used in the coding of recent~~ sustainability reporting ~~s from~~  
159 ~~recent~~ studies; e.g., Boiral & Heras-Saizarbitoria 2017).

## 160 **2.1 Biodiversity mentions and commitment goals**

161 In 2016 the Fortune 100 represented 15 sectors, and was dominated by the financial and energy  
162 sector companies (Figure 1). Their headquarters were located in 15 countries, with over half located  
163 in the USA and China. In 2016, Fortune 100 companies employed a total of 26.4 million staff, and  
164 had a total revenue of US\$12.6 trillion. ~~These companies represented a cross-sector of businesses~~  
165 ~~classified by their 'biodiversity risk' (F&C 2004) in high (31 businesses), medium (32 businesses)~~  
166 ~~and low (37 businesses) risk categories.~~ Sustainability reporting was undertaken by the majority of  
167 the Fortune 100 companies, with 86 having publicly available sustainability reports (Figure 1; SI  
168 Table 1). These reports were predominantly from 2016 (74 company reports), otherwise were the

169 most recent reports available (2015 (7 reports), 2014 (2 reports), 2013 (2 reports), 2012 (1 report).  
170 See SI Table 1 for a full list of the 2016 Fortune 100 companies, including sector and biodiversity  
171 risk categories, and links to their sustainability reports.

172 Almost half (49) of the Fortune 100 mentioned biodiversity or related terms, and an additional 16  
173 companies mentioned sustainable forestry or fishing (without specifically mentioning biodiversity;  
174 see SI Appendix 1 for more details). ~~There was no pattern in~~ Companies from higher biodiversity  
175 risk sectors did not make ~~ing~~ greater mention of biodiversity compared to lower risk sectors  
176 (percentages mentioning biodiversity: 71% in high risk, 53% in medium risk, and 70% in low risk  
177 sectors; SI Figure 1a). This suggests that the risk biodiversity poses to business operations is  
178 currently not the sole driver for ~~when businesses inclu~~ inclusion of ~~de~~ biodiversity in their  
179 sustainability reports. Only 4 companies mention biodiversity and state that it is not a material risk to  
180 their operations, and therefore do not report on it any further (BMW, HSBC Holdings, Dong Feng,  
181 and Banco Santander).

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

188 Twenty-four of the 49 companies that mentioned biodiversity made links with the biodiversity-  
189 focussed ~~UN Sustainable Development Goals~~ SDGs. This is far greater than the 6 companies that  
190 acknowledged the ~~Convention on Biological Diversity~~ CBD. Although not intended as a reporting  
191 framework, the SDGs ~~appear to be resonat~~ ing with the private sector and are being used to frame  
192 their sustainability commitments and activities ~~in sustainability reports~~.

193 Only 31 of Fortune 100 companies had clearly stated commitments relating to biodiversity (~~See SI~~  
194 ~~Table 2) for a full list of the 2016 Fortune 100 companies with clearly stated biodiversity, or~~  
195 ~~biodiversity related (e.g., forestry, palm oil, or seafood) commitments.~~ Commitments most  
196 commonly related to protecting biodiversity (e.g., Volkswagen: “we promise to support the  
197 protection of species at all locations”) and/or to managing impacts on biodiversity (e.g., BP: “We  
198 work to avoid activities in or near protected areas and take actions to minimize and mitigate potential  
199 impacts on biodiversity”). ~~We found no evidence that companies from higher biodiversity risk~~  
200 ~~sectors. A higher proportion of companies from high biodiversity risk sectors made biodiversity~~  
201 ~~commitments compared to lower risk sectors, but unexpectedly fewer companies from medium risk~~  
202 ~~sectors made biodiversity commitments compared to low risk sectors (52%, 13%, and 30% in high,~~  
203 ~~medium, and low risk sectors respectively; SI Figure 1b). This pattern is attributable to so few~~  
204 ~~finance sector companies (classed as medium risk, and which include insurance, banks, and~~  
205 ~~diversified financials) making biodiversity commitments (2 out of 23 companies).~~

206 ~~Of the 23 finance sector companies, 12 were banks, and 9 of these are Equator Principles Financial~~  
207 ~~Institutions (EPFIs). Eight EPFIs mentioned their adherence to the Equator Principles (which have~~  
208 ~~requirements to ensure impacts on biodiversity are minimized; Equator Principles 2013), but only~~  
209 ~~one company had a biodiversity commitment (BNP Paribas, which commits to ‘combating loss of~~  
210 ~~biodiversity’). ~~An additional 6~~Six EPFIs mentioned biodiversity, but did not translate ~~the~~~~  
211 ~~biodiversity requirement of the Equator Principles (to minimize biodiversity impacts) into a~~  
212 ~~corporate commitment. One EPFI (Banco Santander) stated that biodiversity was not of material risk~~  
213 ~~to them, justifying why no biodiversity information is disclosed in their sustainability report further.~~  
214 ~~The remaining 4 non-EPFIs did not mention or make commitments for biodiversity.~~

215 ~~are more likely to make biodiversity commitments than those from medium or low biodiversity risk~~  
216 ~~sectors (SI Figure 1; SI Table 1).~~

217 Only five ~~of the 31 businesses with biodiversity commitments~~ businesses (of 31) had commitments  
218 which could be classified as specific, measurable and time bound (Walmart, Hewlett Packard, AXA,  
219 Nestlé and Carrefour; Figure 1; SI Table 2). Most of these related to ~~natural resource~~  
220 ~~extraction commodities~~ (e.g., Hewlett Packard: “To help protect forests, in 2016 HP set a goal to  
221 achieve zero deforestation associated with HP brand paper and paper-based product packaging by  
222 2020”). By contrast, the 12 of the 16 companies that made ~~nature-based natural resource~~  
223 ~~extraction commodity~~ commitments (but did not mention biodiversity) made specific, measurable and  
224 time-bound commitments (SI Table 2). The only specific, measurable and time bound biodiversity  
225 commitment made ~~by a Fortune 100 company, which was not related to natural resource extraction,~~  
226 was Walmart’s ~~(out of date)~~ commitment: “To conserve one acre of wildlife habitat for every acre of  
227 land occupied by Walmart U.S. through 2015”. Beyond Walmart’s commitment, none of the  
228 remaining Fortune 100 had adopted quantifiable biodiversity commitments (e.g., no net loss (NNL) or  
229 better (NNL) or net positive impact (NPI) on biodiversity), unlike the small but rising number of  
230 corporations outside of the Fortune 100 (Rainey et al. 2015). The lack of specific, measurable or  
231 time-bound features of corporate biodiversity commitments has also been observed in other recent  
232 sector-specific and nation-specific studies (e.g., Adler et al. 2017; Boiral 2016; Jones & Solomon  
233 2013), ~~and even for companies that make seemingly more quantifiable corporate commitments like~~  
234 ~~no net loss (NNL) and net positive impact (NPI) on biodiversity (Rainey et al. 2015).~~

## 235 **2.2 What biodiversity activities were disclosed and in what format?**

236 The 49 companies that mentioned biodiversity and additional 16 that mentioned sustainable forestry  
237 or fishing disclosed a range of ~~biodiversity related~~ activities. Activities included managing or  
238 preventing impacts, protecting and restoring biodiversity, monitoring biodiversity, engaging and  
239 connecting people with biodiversity, and investing in biodiversity (a much greater diversity of  
240 activities than the ~~areas of GRI areas of~~ biodiversity disclosure ~~included in the GRI~~; Figure 2; SI  
241 Table 3). These activities were typically described qualitatively, involving short case study

242 narratives or general descriptions. Only 9 companies provided quantitative ~~information about their~~  
243 ~~activities, which was in the form of~~ performance indicators associated with descriptions, presented in  
244 supporting tables or figures, about their activities.

245 The lack of ~~widely used, standardized,~~ quantitative ~~biodiversity~~ performance indicators creates  
246 challenges for comparing performance both between companies, and for individual companies  
247 through time. Although the Global Reporting Initiative (GRI) suggest ~~some~~ performance indicators  
248 for use alongside qualitative disclosures for biodiversity, this is a voluntary framework (GRI 2016a)  
249 and not all businesses report against this for biodiversity (only 26 ~~of the 49 companies that mention~~  
250 ~~biodiversity companies~~ report against at least one of the GRI areas of biodiversity disclosure).

251 The most commonly disclosed qualitative information ~~about biodiversity activities~~ concerned  
252 habitats protected or restored, and partnerships formed (disclosed by 37 companies respectively;  
253 Figure 2). Examples of disclosed activities provided in SI Table 3 illustrate the brevity of statements  
254 made about habitats protected or restored (e.g., the reforestation of E.ON woods) and partnerships  
255 formed with NGOs and government agencies (e.g., Shell's partnerships with the IUCN). Other  
256 common activities included ~~some of the GRI voluntary areas of~~ biodiversity disclosure areas (GRI  
257 2016a), including companies outlining the strategies or management approaches they use to manage  
258 impacts (33 companies; e.g., Société Générale follow the Equator Principles biodiversity standards),  
259 and how businesses manage their biodiversity impacts (e.g., Citigroup follow the International  
260 Finance Corporation Performance Standards by avoiding impacts on critical biodiversity habitats).  
261 Three companies discussed using natural capital assessments to help understand their impacts and  
262 dependencies on biodiversity (Walmart, Hitachi, and Nestlé; SI Table 2); this is likely to rise in the  
263 future with the recent release of the Natural Capital Protocol, which has gained considerable traction  
264 with the private sector internationally (Natural Capital Coalition 2016).

265 The most commonly disclosed quantitative biodiversity information also concerned habitats  
266 protected or restored (9 companies, Figure 2). For example, Hitachi reported the number of  
267 ecosystem preservation activities implemented. The next most commonly cited quantitative indicator  
268 for biodiversity related to the proportion of ~~natural resources~~commodities which have been  
269 sustainably sourced (e.g., Carrefour reported on the percentage increase in sales of certified seafood;  
270 SI Table 2). Other quantitative information disclosed included the GRI areas of disclosure  
271 demonstrating the avoidance of protected areas (e.g., Glencore reported on their operations which are  
272 located in, adjacent to, or that contain protected areas) and threatened species (e.g., Enel reported on  
273 the number of IUCN Red List species affected by projects in different countries of operation); but  
274 these activities are disclosed by a very small fraction of companies, suggesting the GRI areas of  
275 biodiversity disclosure are of limited relevance to the majority of the Fortune 100. ~~Very few~~  
276 companies attempted to disclose ~~comprehensive~~ quantitative information about the magnitude of  
277 their impact on biodiversity versus the magnitude of the activities they undertake which are designed  
278 to be beneficial for biodiversity (with the exception of Glencore, who disclosed the area of impacted  
279 vs rehabilitated land). Finally, no companies reported ~~on the~~ quantitative outcomes of their activities  
280 for biodiversity, which makes it very difficult to verify whether the implemented actions have any  
281 positive outcomes for nature.

### 282 **3 How conservation science could ~~help~~ inform robust and impactful corporate** 283 **biodiversity accountability**

284 Our assessment of the 2016 Fortune 100 Global companies has revealed that big businesses ~~take~~  
285 ~~notice of biodiversity, but most~~ are giving biodiversity limited treatment in sustainability reports.  
286 These empirical findings support ~~suggestions from the~~ accounting and accountability research  
287 ~~community suggesting~~ that corporate biodiversity accountability is in its infancy (Adler et al. 2017;  
288 Boiral 2016; Jones & Solomon 2013).

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

### 296 **1) Developing science-based corporate biodiversity commitments**

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

305 By comparison, in 2015, 80% of the worlds' largest 250 companies have made science-based climate  
306 commitments, and disclosed information about carbon emission reductions in their sustainability  
307 reports (KPMG 2015). ~~Science-based climate commitments are in line with the level of~~  
308 ~~decarbonization that adheres to reaching the goals under the Paris Agreement (i.e., keeping global~~  
309 ~~warming well below a 2°C increase; Science-Based Targets 2018).~~ The widely accepted 'science-  
310 based' commitments (~~goals and targets that are specific, measurable and time bound~~) used to set  
311 corporate climate commitments are a model for the general improvement of corporate biodiversity  
312 commitments. Such commitments include clearly defined aspects of climate (e.g., greenhouse gas

313 emissions), baselines, and end dates, to allow for quantitative evaluation of corporate performance.  
314 However, it is much more challenging to make science-based biodiversity commitments.  
315 ‘Biodiversity’ is a vague and complex concept, which is impossible to capture in a single or set of  
316 indicators (Purvis & Hector 2000). The CBD’s definition encompasses all living things from genes to  
317 ecosystems (CBD 2017). This is where conservation science can help, as many approaches have  
318 been successfully applied for decades to help set clear objectives to guide the management and  
319 measurement of biodiversity, informing both policy and site-level management decisions (Table 1).

320 Decades of conservation science have reinforced the need for ~~explicit objectives~~commitments that  
321 are specific, measurable and time bound to guide effective conservation action (Brown et al. 2015;  
322 Maxwell et al. 2015; Table 1). Decision-support frameworks, such as structured decision-making  
323 (Addison et al. 2013), adaptive management (Runge 2011), management strategy evaluation  
324 (Bunnefeld et al. 2011), and the mitigation hierarchy (Arlidge et al. 2018; Bull et al. 2013), can all be  
325 useful in guiding the development of science-based corporate biodiversity commitments (Table 1).

326 These frameworks and their associated tools can help in developing: clear ~~goals~~commitments that;  
327 are ~~relevant~~specific to business influence and impacts; ~~robust targets associated with these~~  
328 goals include quantifiable targets, which accounting for both biodiversity gains and losses (e.g.,  
329 ~~following the principles of NNL or NPI~~better); ~~and~~and use, meaningful spatial and temporal  
330 frame(s) of reference; and, align with international strategic goals for biodiversity (e.g., reduce  
331 impacts, improve biodiversity status, enhance benefits to society, support and engage in knowledge  
332 sharing; CBD 2011; ~~for targets associated with biodiversity goals~~ (Table 1).

333

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



336 The ~~lack of enforced~~ limited standards for corporate biodiversity disclosure means that there are no  
337 consistent approaches to reporting biodiversity information, ~~resulting in a diverse array of~~  
338 ~~information being disclosed and a general avoidance of quantitative accounting of negative~~  
339 ~~biodiversity impacts~~ (Figure 2; Adler et al. 2017; van Liempd & Busch 2013). Some businesses  
340 disclosed information about the activities they undertake to address their impacts. However, few  
341 provided details of the ~~scale or~~ magnitude of these activities or quantified whether they are adequate  
342 to address the scale of the negative impacts the business is having on biodiversity (Figure 2; ~~Boiral &~~  
343 ~~Heras Saizarbitoria 2017a~~). In addition, few report on the outcomes of their activities for  
344 biodiversity, that is, answering the question: is the biodiversity affected by the business's direct or  
345 ~~indirect~~ operations ~~or supply chain~~ improving, declining, or being maintained? The general failure to  
346 report on the magnitude of negative impacts versus beneficial activities and their outcomes for  
347 biodiversity, makes it enormously difficult for stakeholders and shareholders to obtain a complete  
348 and transparent view of a company's biodiversity performance, and at worst could be camouflaging  
349 unsustainable business practices (Fonseca et al. 2014; Vörösmarty et al. 2018).

350 CThe conservation approaches ~~outlined in Table 1~~ can support the development of indicators to  
351 transparently account for biodiversity gains and losses, and directly evaluate corporate commitments.  
352 Protected area management effectiveness evaluation encourages the development of indicators to  
353 address the full process of biodiversity management: from inputs (resources spent), outputs  
354 (activities undertaken), to outcomes (changes in biodiversity; Hockings et al. 2006). Approaches  
355 used in conservation science and policy like Essential Biological Variables (e.g., for measures  
356 ecosystem structure or function, or species populations; Pereira et al. 2013), global biodiversity  
357 indicators (e.g., for measures of state, pressure and response; Butchart et al. 2010), and scalable  
358 composite indicators (Burgass et al. 2017) can help businesses develop indicators that support  
359 quantitative evaluation of progress towards achieving commitments. These approaches encourage  
360 careful consideration of components of biodiversity that are fundamentally important to business

361 operations, directly under business control or influence, and development of indicators that account  
362 for both gains and losses of biodiversity. Lessons from the development of international-level  
363 biodiversity indicators (Nicholson et al. 2012) emphasize the necessity not only to develop and  
364 implement indicators, but also to thoroughly test the performance and sensitivity of indicators in  
365 relation to the contexts within which they are applied (e.g., correct spatial and temporal resolution,  
366 and sensitivity to change in response to policy/management interventions).

### 367

### 368 **3) Expanding and deepening corporate biodiversity action**

369 The range of actions for biodiversity which businesses disclosed (Figure 2) can help improve  
370 corporate social legitimacy, but may do little to genuinely address the magnitude of their  
371 environmental impacts (~~(Boiral & Heras-Saizarbitoria 2017; Jones & Solomon 2013)~~). Conservation  
372 ~~decision support~~ approaches can be used to target activities so that they ~~directly address~~ ~~support the~~  
373 ~~business's~~ biodiversity commitments, and can help businesses to predict their likely effectiveness  
374 (Table 1). Frameworks such as structured decision-making, adaptive management and management  
375 strategy evaluation, and the process models used within these frameworks, will help explicitly  
376 account for the uncertainties surrounding the effectiveness of activities (Milner-Gulland & Shea  
377 2017). The mitigation hierarchy can guide the selection of activities to mitigate impacts and create  
378 biodiversity gains (Arlidge et al. 2018; Bull et al. 2013).

379 Going beyond undertaking activities to account for the direct footprint of a business's impacts, a  
380 wider question is: how are these activities contributing to global priorities for action to conserve  
381 biodiversity? The key international biodiversity targets (CBD Aichi Biodiversity Targets and the  
382 UN's SDGs (CBD 2011; United Nations 2016)) can, and should, be used to [provide an overarching](#)  
383 [framework to guide](#) businesses towards expanding and deepening their biodiversity activities,

384 so that they become part of the international community involving the public sector, civil society and  
385 private sector, that ~~work is working~~ towards a more sustainable world (Table 1). ~~Barbier et al. 2018~~  
386 ~~Conservation efforts are still falling short of maintaining even the currently impoverished global~~  
387 ~~levels of biodiversity (Butchart et al. 2010). The mainstreaming biodiversity agenda is designed to~~  
388 ~~engage the private sector, and encourage shared responsibility for nature conservation balanced~~  
389 ~~with sustainable development (Redford et al. 2015).~~ ~~SBarbier et al. 2018~~ scientists must not  
390 underestimate the private sector's focus on risk as a reason to drive action on social and  
391 environmental issues. When business operations are threatened by biodiversity loss, then biodiversity  
392 becomes a material business risk. Only once this risk is quantified, will biodiversity become more  
393 visible to the decision-making departments of corporations that manage finance and risk, and will be  
394 truly integrated into corporate accountability and mainstreamed through the private sector (Dempsey  
395 2013). Our study adds to the accountability literature, that biodiversity is yet to be consistently  
396 perceived as a material risk across in the private sector ~~-particularly to those companies that are in~~  
397 ~~high and medium risk sectors (Adler et al. 2017; Boiral 2016). Advances in~~ ~~critical contribution that~~  
398 ~~conservation science can also make to corporate biodiversity accountability, is the development of~~  
399 quantitative risk assessment are also needed to increase the visibility of biodiversity across business  
400 operations and across far more sectors to drive corporate action to halt biodiversity loss.  
401 ~~The approaches outlined above can support businesses in identifying how and where they can~~  
402 ~~mitigate their own impacts, and contribute to international conservation efforts where it is needed~~  
403 ~~most: addressing the most impactful private sector activities (Maxwell et al. 2016); protecting the~~  
404 ~~most threatened species and ecosystems (Butchart et al. 2010); and conserving the last of the~~  
405 ~~wilderness areas (Watson et al. 2016).~~

#### 406 **4 Advancing the science-driven field of biodiversity mainstreaming in the lead** 407 **up to 2020**

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

417 ~~Brauneder et al. 2018; Martin et al. 2015~~ Conservation science can help businesses advance their  
418 approaches to corporate biodiversity accountability, particularly with distilling complex, dynamic,  
419 and uncertain information about biodiversity into business decision-making. What would a more  
420 accountable business need to commit to and measure in order to demonstrate they are doing their bit  
421 for biodiversity? We believe corporate commitments of ‘no net loss’ or better for biodiversity,  
422 applied with flexibility to target the species and ecosystems that a company impacts. This  
423 commitment should be aligned with existing international biodiversity policy (CBD 2011; United  
424 Nations 2016), and couched within a global mitigation hierarchy, to help shift business activities  
425 from compensatory measures (remediation, offsets) across to preventative measures (avoidance,  
426 minimization of impacts; Arlidge et al. 2018; Bull et al. 2013). Beyond objectives, quantitative  
427 measures for biodiversity outcomes are the ideal and should be specific to a company and its  
428 biodiversity risks and impacts.

429 What actions should a more accountable business undertake? The expertise of conservation scientists  
430 will be vital to help target corporate action where it is needed most: helping hone attention to  
431 operations that pose the greatest impact on biodiversity (e.g., agriculture and extractives; Maxwell et

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432 al. 2016); and contribute to direct corporate action in conservation priority areas by avoiding  
433 impacting the most threatened species and ecosystems (Brauneder et al. 2018; Martin et al. 2015),  
434 and helping conserve the last of the wilderness areas (Watson et al. 2016),

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

447 Adler et al. 2017; Boiral 2016; Dempsey 2013; World Economic Forum 2018

448 The Sustainable Development Goals, which include specific goals for the conservation of  
449 biodiversity and sustainable use of natural resources, have captured the attention of the private sector  
450 (SDG Compass 2015). Twenty four of the Fortune 100 companies made reference to the  
451 biodiversity focussed UN Sustainable Development Goals. In addition, businesses are convening in  
452 large numbers through initiatives such as the Natural Capital Coalition (Natural Capital Coalition  
453 2016), which is introducing, testing and integrating natural capital approaches and biodiversity  
454 concepts into business decision-making. These new ways to frame biodiversity could help contribute  
455 to the system-level change needed to This pattern is promising, and could encourage be a sign of

456 increased corporate biodiversity accountability in the future. The SDGs currently map to the CBD  
457 Aichi targets (CBD 2011), which expire in 2020. Work is underway to develop the CBD post 2020  
458 global biodiversity framework, and links to the 2030 Agenda for Sustainable Development and the  
459 SDGs will be enhanced (CBD 2017a). In addition, businesses are convening in large numbers through  
460 initiatives such as the Natural Capital Coalition (Natural Capital Coalition 2016), which is  
461 introducing, testing and integrating natural capital approaches and biodiversity concepts into  
462 business decision-making. The annual expenditure on conservation is currently estimated at US\$52  
463 billion, and an additional US\$200–400 billion is required within the next three years to address this  
464 shortfall if international biodiversity targets are to be achieved (Huwyler et al. 2016). Viewing  
465 biodiversity through a natural capital lens, could help businesses not only manage their own impacts  
466 and dependencies on biodiversity, but may also encourage business investment in biodiversity  
467 conservation helping address the substantial conservation finance shortfall.

468 Now is a critical time for conservation scientists to engage, in order to generate a science-driven field  
469 of biodiversity mainstreaming. ~~This will to help businesses to develop science based biodiversity~~  
470 ~~commitments, meaningful indicators, and activities that not only address business impacts but~~  
471 ~~contribute to international conservation priorities.~~ Although our analysis highlights that the world's  
472 biggest businesses have a long way to go in developing, and reporting on, such commitments, the  
473 scene is set for rapid improvements. If these were set in place prior to the "biodiversity policy super-  
474 year" of 2020, when the international biodiversity conservation strategy will be revisited, then  
475 businesses could truly start to play a part in the new agenda for a sustainable future for the planet,  
476 which has biodiversity at its heart.

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589

**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.**

| <b>Conservation science approach</b>  | <b>1) Developing science-based biodiversity commitments <del>(goals and targets)</del></b>   | <b>2) Developing transparent and comparable biodiversity indicators</b>   | <b>3) Expanding and deepening corporate biodiversity action</b>   |
|---|--|---|---|
| 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) | – Develop <del>specific clear and robust goals commitments</del> that are relevant to business influence and impacts <u>on biodiversity</u> (e.g., using values-focused thinking and conceptual models in structured decision-making). | – Develop indicators to evaluate corporate commitments and activities (e.g., using objectives hierarchies and conceptual models in structured decision-making). | – 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)<br>– Prioritize areas for biodiversity action (e.g., systematic conservation planning)<br>– Guide the evaluation and reporting on the effectiveness of biodiversity actions in contributing to corporate biodiversity commitments (e.g., e.g., using statistical models in structured decision-making or adaptive management)<br>– Account for uncertainty in the effectiveness of a proposed action, and help determine the |

| Conservation science approach  | 1) Developing science-based biodiversity commitments <del>(goals and targets)</del>   | 2) Developing transparent and comparable biodiversity indicators  | 3) Expanding and deepening corporate biodiversity action   |
|--|---|---|--|
| 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"> <li>– Develop <a href="#">measurable clear and robust targets that are associated with goals, which account for biodiversity gains and losses</a> (e.g., following the principles of no net loss (NNL), or net positive impact (NPI)).</li> <li>– Develop meaningful spatial and temporal frame(s) of reference <a href="#">for commitments for targets associated with biodiversity goals</a> (e.g., baseline or counterfactual development)</li> </ul> | <ul style="list-style-type: none"> <li>– Develop indicators that can account for biodiversity gains/benefits and losses/impacts.</li> </ul> | <p>magnitude of activity to be implemented (e.g., using process models within management strategy evaluation)</p> <ul style="list-style-type: none"> <li>– To guide the avoidance, minimisation, restoration and offsetting of predicted biodiversity impacts from development (i.e., applying the mitigation hierarchy).</li> <li>– Ensure that any activities are new contributions to biodiversity conservation, when the activity undertaken is designed to offset negative impacts (i.e., demonstrating additionality)</li> <li>– 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).</li> </ul> |

| Conservation science approach   | 1) Developing science-based biodiversity commitments <del>(goals and targets)</del>  | 2) Developing transparent and comparable biodiversity indicators   | 3) Expanding and deepening corporate biodiversity action   |
|---|--|--|--|
| Protected Area Management Effectiveness Evaluation framework and associated modelling techniques (Hockings et al. 2006) | – <del>Clear and robust goals</del> <a href="#">Develop specific, measurable and time bound commitments</a> 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   |  | – Develop a suite of indicators that paint a picture of both pressures, biodiversity status (i.e., outcomes),  |  |

| Conservation science approach  | 1) Developing science-based biodiversity commitments <del>(goals and targets)</del> | 2) Developing transparent and comparable biodiversity indicators   | 3) Expanding and deepening corporate biodiversity action  |
|--|---|--|---|
| al. 2010; Nicholson et al. 2012)   |   | and management responses to address biodiversity declines.<br>– Testing the performance and sensitivity of indicators in relation to the business contexts within which they are applied |   |
| Composite indicator development (e.g., Burgass et al. 2017)  |   | – Develop indicators that can be aggregated from site to corporate level, which account for bias and uncertainty through the aggregation process.  |   |
| International biodiversity goals, e.g., CBD Aichi targets (CBD 2011) and the Sustainable Development Goals (United Nations 2016) |   |  | – 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. |

**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)

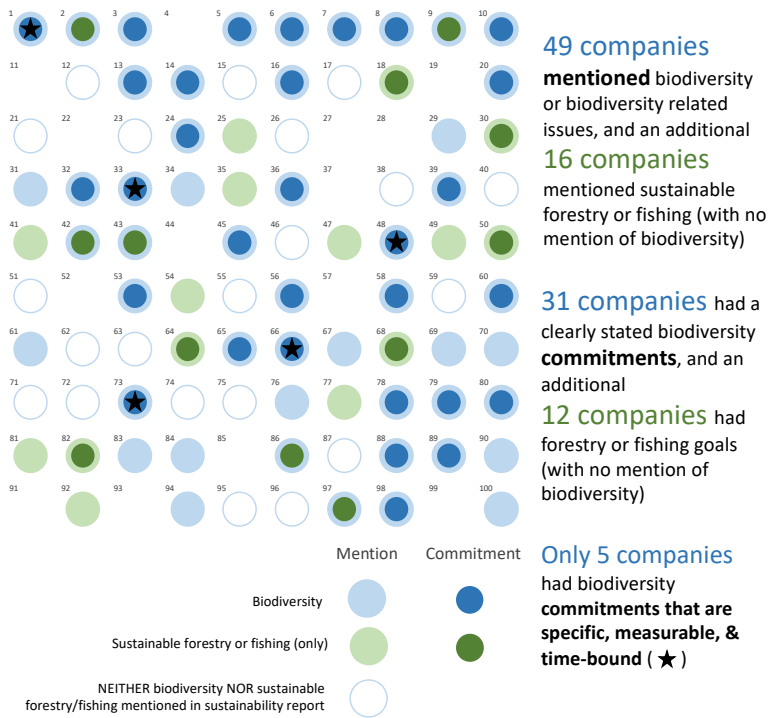


Total revenue = US\$12.6 trillion



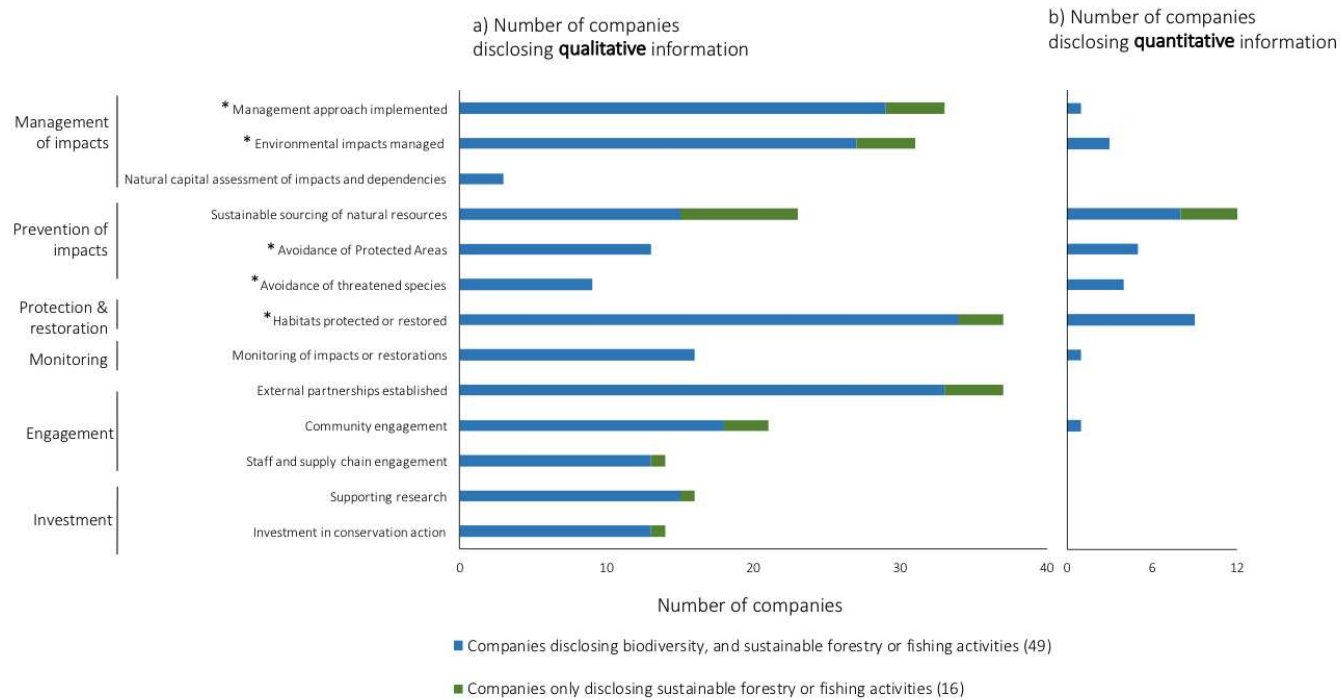
Total employees = 26.4 million staff

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



593 **Figure 1.** The Fortune 100 Global companies (with corresponding 2016 rankings), and their progress towards  
 594 incorporating biodiversity into sustainability reporting – through mentions and commitments relating to

595 biodiversity, sustainable forestry or fishery. Details regarding sector descriptions, headquarter locations, revenue and  
596 employee numbers can be found in SI Table 1 and the on the Fortune 500 Global website (Fortune 2016).



597

598 **Figure 2.** The number of companies disclosing a) qualitative biodiversity information about activities, and/or b) quantitative biodiversity information about activities.

599 Companies are differentiated as those that disclose biodiversity information (including sustainable forestry or fishing information; 49 companies; shown in blue) or those

600 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 (\*).