1 Assessment of national-level progress towards elements of the Aichi Biodiversity Targets

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3 GRAEME M. BUCHANAN [1]*, STUART H.M. BUTCHART [2,3], GEORGINA CHANDLER[4], RICHARD D.

4 GREGORY [5,6]

5 1 RSPB Centre for Conservation Science, RSPB, 2 Lochside View, Edinburgh, EH12 9DH

6 2 BirdLife International, David Attenborough Building, Pembroke Street, Cambridge, CB2

7 3QZ, UK

8 3 Department of Zoology, University of Cambridge, Downing Street, Cambridge, CB2 3EJ, UK

9 4 RSPB, The Lodge, Sandy, SG19 2DL, UK

10 5 RSPB Centre for Conservation Science, RSPB, The Lodge, Sandy, SG19 2DL, UK

11 6 University College London, Centre for Biodiversity & Environment Research, Bloomsbury,

12 London WC1H 0AG, UK

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14 * graeme.buchanan@rspb.org.uk

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18 **Summary**

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20 Progress towards the Aichi Targets adopted through the Convention on Biological Diversity

21 has been measured globally via indicators linked to elements of targets (the 20 targets

22 consist of 54 elements), and nationally based on reporting by parties to the convention in

23 the 5th (2010 – 2014) and 6th (2014 – 2018) National Reports. Here we used selected

24 indicators that are readily available for each country to score national level progress

25 ('moving towards the target', 'little or no progress', or 'moving away from target') for 11

26 elements of eight Aichi Targets (1, 4, 5, 7, 11, 12, 19, 20). Across the selected indicators,

27 elements, and countries for which data were available, in 24.2% of cases countries were

28 moving towards the elements, for 22.3% they were moving away, and for 53.5% there was

29 little or no progress. This overall level of progress is similar to progress to targets as

30 reported in the 5th and 6th National Reports. National progress to three of the 11 elements

31 was positively correlated with progress to targets reported in the 5th National Reports,

32 while progress to none of the elements was correlated with progress reported in the 6th

33 National Reports. Progress to many of the elements considered was positively correlated

34 with better governance, and to a lesser extent GDP per capita, population density and

35 urbanisation. We suggest that post-2020 biodiversity targets should be designed taking

36 greater account of their measurability, and will require improved biodiversity monitoring,

37 both of which would facilitate more effective assessment of progress and enable more

38 insightful policy responses.

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1. Introduction

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42   To address the loss of global biodiversity, the world's nations agreed to a Strategic Plan in

43   2010 that supports the effective implementation of the Convention on Biological Diversity

44   (CBD; CBD 2010). The plan consists of five strategic goals that relate to addressing causes of

45   biodiversity loss, reducing pressures on biodiversity, improving the status of biodiversity,

46   enhancing the benefits to all from biodiversity, and enhancing implementation of the plan

47   itself (CBD 2010). Under the goals there are 20 targets, known as the Aichi Biodiversity

48   Targets (henceforth Aichi Targets), three of which were to be met by 2015, and the

49   remainder by 2020. The targets themselves are further divided into 54 elements, with each

50   target composed of one to six different elements (Green et al. 2019, IPBES 2019).

51   The Aichi Targets are global targets, but parties agreed to translate the Strategic Plan which

52   includes the Aichi Targets, into revised and updated national biodiversity strategies and

53   action plans (CBD 2010). Thus, the global Strategic Plan was implemented primarily through

54   activities at the national or subnational level, with supporting action at the regional and

55   global levels. Parties were free to interpret the global targets in a national context and

56   assess them against nationally appropriate metrics and indicators, but parties were required

57   to inform the CBD of national progress to the targets. The first submission from parties

58   relating to the Aichi Targets was in 2014, covering the period 2010 to 2014 (the 5th National

59   Reports; CBD 2014a). The CBD Secretariat evaluated each national report and each National

60   Biodiversity Strategy and Action Plan to score both the alignment of national plans with the

61   targets, and the progress made against each of the targets. Both scores, which are publicly

62   available online, were made on a five-point scale, and there was considerable variation

63   between countries on the level of progress made (CBD 2016a). The 6th National Reports

64 were due to be submitted by 31st December 2018 (CBD 2016b). By December 2019, 81 of

65 196 countries that are parties to CBD had submitted reports (https://www.cbd.int/reports/).

66 The scores for progress were made available online for the 6th National Reports and are

67 based on each country's self-assessment, without any interpretation by the CBD Secretariat.

68 In addition to national-level assessments, global progress towards the Aichi Targets has

69 been assessed by the four-yearly Global Biodiversity Outlook assessments (most recently

70 GBO4; CBD 2014b). GBO5 is currently scheduled for release in August 2020. GBO4 assessed

71 progress based on a set of global indicators developed and analysed by Tittensor et al.

72 (2014), supplemented by information from national reports and other sources.

73 Furthermore, the first global assessment of the Intergovernmental Science-Policy Platform

74 on Biodiversity and Ecosystems (IPBES) included a similar updated assessment of progress

75 towards the Aichi Targets (IPBES 2019, Butchart et al. 2019).

76 There has been no review of national progress towards CBD objectives based on multiple

77 indicators at a global scale, although Han et al. (2016) disaggregated data from four global

78 indicators for five countries in South America. Here, we used selected, existing indicators

79 developed by members of the Biodiversity Indicators Partnership (www.bipindicators.net),

80 from GBO4 (CBD 2014b, building on Tittensor et al. 2014), or Butchart et al. (2019), to

81 measure *national* progress towards elements of the Aichi Targets, linking indicators to

82 specific elements of the targets as defined by Green et al. (2019) and Butchart et al. (2019).

83 These indicators were based on objective, quantitative data. We only used indicators for

84 which available data were unambiguous (i.e. no further analysis or interpretation required

85 by users prior to use), available and comparable at a national scale, and available for at least

86 100 countries to allow comparisons to be made between countries. The selected indicators

87   allowed us to assess progress towards 11 of 54 elements, relating to eight of the 20 targets.

88   Specifically these were targets related to biodiversity awareness (Target 1), human

89   consumption and production (Target 4), habitat loss and degradation (Target 5), sustainable

90   agriculture, aquaculture and forestry (Target 7), protected and conserved areas (Target 11),

91   preventing extinctions (Target 12), scientific knowledge and its transferal and application

92   (Target 19) and resource mobilisation (Target 20). In each case we found indicators for just

93   one element of each target, except for protected and conserved areas (Target 11), for which

94   indicators for four elements were available. We compared progress from our indicators to

95   the 11 elements with progress towards the corresponding target from the 5th and 6th

96   National Reports.

97   The 5th and 6th National Reports indicate that there is considerable variation between

98   countries in progress being made towards the Aichi Targets, but assessments of correlates

99   of national level progress towards the Aichi Targets are rare. Assessment of correlates of

100   progress could give an indication of the social and political conditions associated with

101   progress to CBD goals. This in turn would inform the development of policies that increase

102   progress towards targets and allow for adaptive management of responses to CBD goals.

103   Multiple studies have reported that progress and attitudes to conservation and sustainable

104   use can be related to economy, governance, population density, and urbanisation (e.g.

105   Smith et al. 2003; Wright et al. 2007; Barnes et al. 2016; Waldron et al. 2017; Baynham-Herd

106   et al. 2018). Our extraction of objective, quantitative, indicators of national level progress

107   towards elements of targets enabled us to undertake a correlative analysis of factors that

108   might relate to progress. We compared all eleven indicators of progress towards target

109   elements at a national scale with national-level data for socio-political variables (economy,

110   governance, population density, and urbanisation), using previous studies to guide our

111   choice of variables (Burnham and Anderson 2002). Although correlative, this assessment

112   considered which variables were most strongly related to progress, informing future

113   research into factors that influence progress towards biodiversity targets, and enable more

114   insightful policy responses.

115

116   **2. Methods**

117   *2.1 Indicators of progress towards elements of Aichi Targets*

118   We reviewed previous global assessments of progress towards the Aichi Targets (Tittensor

119   et al. 2014, CBD 2014, Butchart et al. 2019) and indicators developed by members of the

120   Biodiversity Indicator Partnership (www.bipindicators.net) to identify existing indicators

121   that could be used to measure progress towards elements of targets by each country in a

122   comparable way. We selected the subset of the CBD recommended indicators that met the

123   criteria for our analysis. Specifically, we selected indicators for which data had been

124   produced in the same way across all countries, but which were available at a national level,

125   did not need further interpretation that could introduce ambiguity into assessments, and

126   were available for at least 100 countries. Table 1 presents the elements of the Aichi Targets

127   considered, the indicators used to assess national progress towards these, the number of

128   years for which data were available, and the data sources for each indicator. Data for

129   indicators on the number of Google searches for 'biodiversity' (1.1), forest area as a

130   proportion of land area (5.1), area of forest under Forest Stewardship Council (FSC) and

131   Programme for the Endorsement of Forest Certification (PEFC) forest management

132   certification (7.3), protected area coverage of land and inland waters (11.1), protected area

133   coverage of marine and coastal areas (11.2), mean percentage coverage of Key Biodiversity

134   Areas by protected areas (11.3), number of Protected Areas Management Effectiveness

135   Assessments (11.5), number of species occurrence records accessible through the Global

136   Biodiversity Information Facility (19.1) and official development assistance for biodiversity

137   (US$/yr) (20.1) were derived at a national level, while those for ecological footprint (4.1)

138   and Red List Index of species survival (12.2) were derived from an existing disaggregation of

139   global datasets.

140   We followed Green et al. (2019) and Butchart et al. (2019) in our numbering of elements of

141   targets (Table 1). Most indicators are relevant only to individual elements within each

142   target. For example, the indicator for the target on scientific knowledge and its transferal

143   and application (Target 19) relates to data uploaded and made available in GBIF. This

144   reflects the first element of the target (Target 19; element 19.1) on "The science base and

145   technologies relating to biodiversity, its values, functioning, status and trends, and the

146   consequences of its loss, are improved, widely shared and transferred", as records in GBIF

147   represent sharing of science data. This indicator is not relevant for the second element of

148   Target 19, which relates to application of knowledge. The only target for which indicators

149   were available for more than one element was the target on protected and conserved areas

150   (Target 11), for which data were available for four elements. Data from each of the chosen

151   indicators (Table 1) were divided into two time-periods. The period 2005–2010 inclusive is

152   considered the baseline and represents the period of before the Aichi Targets were agreed.

153   It is similar in length to the time for which the majority of post 2010 data were available.

154   The period from 2011 onwards represents the period after which the Aichi Targets were

155   agreed, in which we might have hoped to see improvement in indicator values attributable

156   to action stimulated by adoption of the targets. We used only indicators for which at least

157   four years of data were available for the two time-periods.

158

159   >> Table 1

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161   National data for Google searches for biodiversity (Element 1.1 of Target 1) were obtained

162   from Google trends through the R package gtrendsR (Massicotte et al. 2018) in R (R Core

163   Team 2018), searching on 'biodiversity', following CBD (2014b). Data on forest area as

164   proportion of land area (Element 5.1) came from https://www.globalforestwatch.org/map.

165   Data on growth in species occurrence records accessible through the Global Biodiversity

166   Information Facility (GBIF), relevant to assessing biodiversity knowledge and data availability

167   (Element 19.1), were extracted using rgbif (Chamberlain et al. 2017) in R (R Core Team

168   2018), searching by national ISO3 codes. For marine protected area coverage (Element

169   11.2), we considered only countries with a coastline, and for official development assistance

170   for biodiversity (Element 20.1), we only considered countries that received funds.

171   To test whether indicator values pre- and post-2010 were significantly different, we used a

172   Wilcoxon test in Proc NPAR1WAY in SAS 9.4, calculating exact p-values (SAS Institute 2016).

173   There were insufficient data to test for significantly different rates of change pre- and post-

174   2010. National-level progress for each indicator was categorised as *moving towards the*

175   *target* (significant change in a direction that indicated improvements for biodiversity), *little*

176   *or no progress* (no significant difference in indicator values) and *moving away from target*

177   (significant change in a direction that indicated deterioration for biodiversity). The direction

178   of progress was based on benefit for biodiversity rather than indicator values, as for some

179   indicators (e.g. for ecological footprint, Element 4.2), an increase in value would indicate

180   movement away from the element. We also calculated a median value across all indicators

181   for Target 11. To do so, we scored national progress for each of the four elements such that

182   moving towards the target was scored as 1, little or no progress as 0, and moving away from

183   target as -1.

184   The scores for progress for each target from the 5th National Reports were produced by the

185   CBD Secretariat using expert evaluation of the 5th reports submitted to the CBD by each

186   country (CBD 2016a). The scores for progress for each target from the 6th National Reports

187   were submitted directly by the countries themselves and obtained through

188   https://api.cbd.int/. The scores for progress were originally on a five-point scale, but to

189   facilitate comparison with the indicator scores we grouped these into three categories,

190   representing: *moving towards the target* (score 4 [on track to meet target] and 5 [on track

191   to exceed target]), *little or no progress* (score 2 [no real progress] and 3 [some progress but

192   insufficient to meet target]), or *moving away from target* (score 1 [moving away from

193   target]). A comparison of our measures with progress status from GBO4 (CBD 2014b) for

194   each element of targets that we considered found over 60% agreement for five of the seven

195   targets which had multiple elements, with 100% agreement for three of these targets (Table

196   S1).

197   Progress towards elements, as measured by indicators, was compared with progress to

198   targets in their entirety from the 5th National Reports and the 6th National Reports using

199   ordered ordinal logistic regression. We used Prog Logistic with binomial errors in SAS 9.4

200   (SAS Institute 2016). National Reports scores were the dependent variable, and the

201   indicator scores were the independent variable. Direction and significance of relationships

202   were recorded.

203

204   *2.2 Correlates of progress*

205   Progress towards elements and the Target 11 median were compared with national socio-

206   political variables to identify correlates of progress. We chose variables that have previously

207   been found to be associated with attitudes to biodiversity and progress to sustainable

208   development (e.g. Smith et al. 2003; Wright et al. 2007; Barnes et al. 2016; Waldron et al.

209   2017; Baynham-Herd et al. 2018). Specifically, we extracted covariates covering national-

210   level data for 2016 on GDP per capita

211   (https://data.worldbank.org/indicator/ny.gdp.pcap.cd), governance

212   (https://datacatalog.worldbank.org/dataset/worldwide-governance-indicators), population

213   density (https://data.worldbank.org/indicator/en.pop.dnst) and urbanisation

214   (https://data.worldbank.org/indicator/sp.urb.totl.in.zs). All covariates were standardised to

215   a mean of zero and standard deviation of one. Our analysis used ordered ordinal regression,

216   with an information theoretic approach to identify the importance of covariates. Models

217   were run in R (R Core Team 2018) using the "dredge" function of the MuMin package

218   (Barton 2018). The dependent variable was progress (moving towards target, little or no

219   progress, moving away from target). All possible combinations of covariates are considered,

220   and the models within 2 AICc points of model with the lowest AIC were considered best-fit

221   models. The prevalence of each covariate in these models was noted. If the null model was

222   within 2 AIC points of the model with the lowest AIC, we concluded that the covariates were

223   not useful for explaining variation in progress for that element.

224

225

226   **3. Results**

227   We were able to find data for at least one indicator spanning at least four years for each of

228   the pre-2010 and post-2010 periods for 11 elements of eight targets. The number of nations

229   for which data were available for each indicator varied between 123 and 193.

230   *3.1 Progress towards elements of Aichi Targets*

231   For Google searches for biodiversity (Element 1.1), the proportion of countries with little or

232   no progress or moving away from the target were similar (46.3% and 51.2% respectively),

233   while only three countries (2.4%) were moving towards the target. For ecological footprint

234   (Element 4.2), most countries (81.3%) were moving away from target, indicating that the

235   ecological footprint had increased post-2010; only 12 countries (7.0%) were moving towards

236   target. There was little or no progress for forest area as proportion of land area (Element

237   5.1) in the majority of countries (75.1%), and 19 countries (11.0%) were moving away from

238   target. For the majority of countries (67.5%), there was also little or no progress in the area

239   of forest under certification (Element 7.3), although 44 countries (28.6%) were moving

240   towards the target.

241   Target 11, on protected and conserved areas, had indicators for four elements. Indicators

242   for terrestrial (Element 11.1) and marine (Element 11.2) protected area coverage showed

243   that approximately half of countries had little or no progress (54.9% and 45.9%

244   respectively), while the other half were moving towards the target. No nations were moving

245   away from the target in relation to these elements. The majority of countries (59.5%) were

246   moving towards the target based on the indicator for protected area coverage of Key

247   Biodiversity Areas (Element 11.3), but the indicator for protected area management

248   effectiveness (Element 11.5) showed that there was little or no progress in the majority of

249   countries (86.5%).

250   The Red List Index (Element 12.2) showed that just three countries (Belarus, Poland and

251   very marginally Cape Verde) were moving towards the target, with the rest split

252   approximately evenly between little or no progress (45.1%) and moving away from the

253   target (53.3%). The indicator for growth in species occurrence records accessible through

254   GBIF (Element 19.1) showed that 72.1% countries had little or no progress, although 22.6%

255   were moving towards the target. For official development assistance for biodiversity

256   (Element 20.1), there was little or no progress for the majority of countries (43.6%),

257   although 37.3% were moving away from the target, while just 30 countries (19.0%) were

258   moving towards the target. Across all indicators, elements and countries for which data

259   were available, in 24.2% of cases countries were moving towards the elements, for 22.3%

260   they were moving away, and for 53.5% there was little or no progress.

261   The element with the highest percentage of countries moving towards target was

262   percentage coverage of Key Biodiversity Areas by protected areas (Element 11.3), although

263   Protected area coverage of land and inland waters (Element 11.1) was similar at around

264   50% of countries moving towards the target (Figure 1). The element with the highest

265   percentage of countries moving away was (Element 4.2) for which 81.2% of countries were

266   moving away, followed by Red List Index (12.2) for which 53.3% of countries were moving

267   away (Figure 2a).

268

269   >> Figure 1

270   >> Figure 2

271

272   *3.2 Comparison between progress to elements of Aichi Targets with 5th and 6th National*

273   *Reports of progress to Aichi Targets*

274   The percentage of signatory countries for which data were available for element indicators

275   was not significantly different from the percentage of targets for which data were available

276   for the 5th National Reports (Figure 3). Figure 4 shows regional variation in the percentage

277   of signatory countries for which element indicators or data from the 5th National Reports

278   were available. This result was replicated in all regions except Latin America and Caribbean

279   (z=3.97, P<0.001), Middle East and North Africa (z=9.55, P<0.001), and South East Asia

280   (Z=2.39, P=0.017).

281   Globally, the progress towards elements of targets based on our selected indicators was

282   broadly similar to progress towards entire targets reported in the 5th National Reports and

283   6th National Reports (Figure 2 a and b). Ordinal regression models identified relationships

284   between national progress towards elements based on the selected indicators and national

285   progress towards targets from the 5th National Reports for only Target 7 (Element 7.1) and

286   Target 11 (Elements 11.1, 11.2 and 11.5). In four of these cases, relationships were positive

287   (Table 2), suggesting some national-level agreement between the two assessments of

288   progress for these indicator / target combinations.

289

290   >> Figure 3, 4

291   >> Table 2

292

293   *3.3 Correlates of progress*

294   Progress towards eight of the 11 elements and the Target 11 median were correlated with

295   at least one of the socio-political variables we considered (Table 3). The exceptions were the

296   indicators for biodiversity awareness (Element 1.1), protected area effectiveness

297   assessments (Element 11.5) and number of species occurrence records accessible through

298   GBIF (Element 19.1), for which all the best-fit models were within two AIC points of the null

299   model (Table 3).

300   Governance was included in the majority of best-fit models for six of the remaining

301   elements and the Target 11 median (Table 3). There were positive relationships between

302   governance and progress for ecological footprint (Element 4.2), forest area (Element 5.1),

303   area of forest under sustainable management (Element 7.3), protected area coverage of Key

304   Biodiversity Areas (Element 11.5) and Target 11 median, indicating that there was a greater

305   likelihood of progress in countries with better governances. In contrast, countries with

306   lower levels of governance were more likely to have made progress towards terrestrial and

307   marine protected area coverage (Elements 11.1 and 11.2). Governance showed a negative

308   relationship with resource mobilisation (Element 20.1). This correlation, based on data from

309   only the countries eligible for Global Environment Facility funding, suggests that increased

310   overseas development funding was more likely in countries with lower governance. GDP per

311   capita was included in the majority of best-fit models for both ecological footprint (Element

312   4.2) and terrestrial protected area coverage (Element 11.1), meaning that progress for these

313   elements was less likely where GDP per capita was higher. Human population density was

314   included in the majority of best-fit models for three elements and Target 11 median.

315   Negative relationships for the Target 11 median and protected area coverage of KBAs

316   (Element 11.3), indicated that progress was less likely in nations where population densities

317   were higher, while positive relationships with terrestrial protected area coverage (Element

318   11.1) and Red List Index (Element 12.2), indicated that progress towards these elements

319   was more likely in nations with higher population densities. Urbanisation was included in

320   the majority of best-fit models for four elements and Target 11 median. Negative

321   relationships with terrestrial and marine protected area coverage (Elements 11.1 and 11.2)

322   suggested that progress was less likely in nations in which a greater proportion of the

323   population was urbanised. There was a positive relationship with the Target 11 median,

324   contrasting with these results. A positive relationship with official assistance for biodiversity

325   (Element 20.1) suggested that progress was more likely in more urbanised nations.

326

327   >> Table 3

328

329   **4. Discussion**

330   *4.1 Assessment of progress to the Aichi Targets*

331   There have been multiple assessments of global progress towards the Aichi Targets (e.g.

332   Tittensor et al. 2014, CBD 2014b, Butchart et al. 2019). All have concluded that while there

333   has been some progress towards some elements, we are not on track to meet any of the

334   Aichi Targets in full. At a national level, the only data available for multiple targets are based

335   on the 5th National Reports (CBD 2016a) from 2014 and the 6th National Reports for a

336   smaller number of countries. Given the 5th National Report progress data are based in part

337   on expert assessment of National Biodiversity Strategy and Action Plans, which vary

338   between countries, scores might not fully reflect the situation on the ground. Consequently,

339   the data in the 5th National Reports might not be comparable between countries either.

340   Additionally, CBD (2016a) presents scores for progress towards all elements of the targets

341   combined, despite the potential for considerable variation in progress towards each of the

342   separate elements of a particular target, as indicated by Tittensor et al. (2014) and Butchart

343   et al. (2019), and the elements of Target 11 presented in this study.

344   Our analyses of selected indicators showed that there has been little or no progress to most

345   elements in most countries (54.9% of all element-country combinations that we analysed).

346   There were encouraging signs though, with positive progress for 23.9% of element-country

347   combinations analysed, although this was only marginally higher than the percentage of

348   cases in which nations appeared to be moving away from the target for the elements we

349   assessed (21.2%).

350   The selected indicators that we used in this study were based on objective assessments of

351   data. However, they were available only for a minority of elements (11/54, 20%), and

352   targets (8/20, 40%). Consequently, they are not an assessment of overall progress of

353   countries to the Aichi Targets, but are an objective assessment of progress by countries to

354   specific elements of a subset of targets. The absence of indicators for all elements of targets

355   means that some caution should be used in interpreting the match between progress

356   according to our indicators and progress towards entire targets. The greater the proportion

357   of a target's elements for which we were able to identify indicators, the more likely it is that

358   the results of our indicator assessments accurately reflect progress towards the target as a

359   whole. For example, the target on mobilisation of financial resources (Target 20) has just

360   one element, meaning our assessment from an indicator may be more representative of

361   progress made towards the target, while the target on sustainable agriculture, aquaculture

362   and forestry (Target 7) has three elements, of which we were able to assess one.

363   The indicators mostly related to only one element per target, but the majority of the targets

364   for which we had indicators had only two elements, meaning we were able to measure

365   progress, at least through a proxy, for half of the target. In some cases, we were able to

366   measure more than this (e.g. four of six elements for Target 11 and all (one) element of

367   Target 20). Only for Target 7 were we able to measure progress for less than 50% of

368   elements (one of three). Each of the indicators captures only one dimension or aspect of

369   each element. For example, species' locality data stored in GBIF are just one component of

370   'knowledge…relating to biodiversity'. We were not able to assess the degree to which this

371   indicator matches trends for other components of knowledge, or other aspects of the target

372   element (relating to the science base, technologies, different dimensions of biodiversity,

373   and the application of this knowledge and technology). The high level of agreement of

374   progress to different elements of the same targets according to GBO4 (CBD 2016b) suggest

375   that our results are potentially indicative of progress to the other elements of targets.

376   Additional suitable indicators matching our criteria may be possible to generate from

377   available data for other targets and elements if there was no ambiguity in the interpretation

378   of data, and they were produced using the same methods across all countries.

379   Progress towards the elements of Target 11 presented a contrasting picture. The category of

380   progress derived from indicators of protected area coverage of sea and land was moving

381   towards the target because of consistent increases in the areal coverage of protected areas.

382   However, this increase does not necessarily mean the numerical targets of 'at least 10 per

383   cent of coastal and marine areas' and 'at least 17 per cent of terrestrial and inland water

384   areas…are conserved' will be reached by 2020. Our assessment of moving towards the

385   target is similar to the assessment of progress towards the entire Target made by CBD

386   (2016a). Progress in the number of management effectiveness assessments undertaken was

387   not correlated with progress towards the entire target in CBD (2016a). This is concerning

388   and echoes the global findings of Tittensor et al. (2014) CBD (2014b) and Butchart et al.

389   (2019), who concluded that there was greater progress towards terrestrial and marine

390   coverage of protected areas (on track to meet target) than the other five elements of the

391   target, which were scored as displaying poor or limited progress. This highlights the need for

392   multiple national-scale indicators that can be measured in an objective and repeatable way

393   and that cover the multiple elements of each target if we are to improve reporting accuracy

394   and produce globally comparable data on progress towards biodiversity targets.

395   The 5th and 6th National Reports by CBD indicated that there was substantial variation

396   between countries in the level of progress that they had made towards each of the targets,

397   but there has been no formal analysis of these data. Our results suggested that while there

398   was some progress towards the targets in some nations, this was insufficient for meeting

399   the Aichi Targets globally, supporting previous findings. The absence of concordance

400   between national progress based on indicators and that assessed by CBD (2016a) highlights

401   the uncertainty that can exist around measurements of progress towards targets at the

402   national scale.

403   Comparisons between the multiple assessments of progress towards the Aichi Targets need

404   to acknowledge differences in methods for collecting and analysing data. We compared

405   data from indicators relating to specific elements of targets, rather than the whole targets,

406   as assessed in the 5th and 6th National Reports. As noted above, the number of elements

407   varies between targets so progress towards individual elements of targets will vary in their

408   representativeness of progress towards the whole target. We looked at whether indicator

409   values differed before and after 2010 to assess if there had been any change in progress.

410   Thus, we were not looking at long term trends in indicators, unlike Tittensor et al. (2014)

411   and CBD (2014b). Consequently, our analysis indicators might suggest a country is moving

412   towards an element of a target, but it might not be on track to meet a numerical target

413   given for that element.

414   Additionally, the differences in the time periods covered by the different assessments (our

415   analysis of indicator data, the National Reports for CBD, Tittensor et al. (2014) and GBO4

416   (CBD 2014b)), together with the different approaches used to collate these data should be

417   considered. We compared data from selected indicators from pre- 2010 and post- 2010 and

418   noted the direction of any significant differences identified. The comparison of data from a

419   small number of years both pre- and post- 2010 inevitably reduces the power of any

420   statistical analysis. Consequently, we may have failed to detect instances where the

421   situation has improved since 2010. CBD (2016a) is based on expert scoring of National

422   Biodiversity Strategy and Action Plans submitted to CBD covering the period 2010 to 2014

423   and did not use statistical assessment of data. The analysis of Tittensor et al. (2014), CBD

424   (2014b) and Butchart et al. (2019) also differ in the time periods over which they assess

425   progress. Their analyses used trends in data to project forwards to 2020. For Tittensor et al.

426   (2014) and CBD (2014b), trends were often based on runs of data that started before 2006,

427   and finish at or before 2014.

428

429   *4.2 Correlates of progress*

430   Multiple studies have described correlates of progress towards biodiversity goals and

431   outcomes. These have identified a suite of correlated variables that relate to economic,

432   political, and demographic parameters (e.g. Smith et al. 2003; Wright et al. 2007; Barnes et

433   al. 2016; Waldron et al. 2017; Baynham-Herd et al. 2018). We examined whether progress

434   inferred from trends in our selected indicators was correlated with a suite of candidate

435   variables the selection of which was informed by the results of previous studies (Smith et al.

436   2003; Wright et al. 2007; Barnes et al. 2016; Waldron et al. 2017; Baynham-Herd et al.

437   2018). As with all correlative studies we cannot infer causation, and we only examine

438   progress towards a subset of elements and targets. Nonetheless we feel our analysis, which

439   uses previous studies to inform variable choice (Burnham and Anderson 2002) is

440   informative, with implications for the post-2020 global biodiversity framework that is being

441   developed. Studies of correlates of progress to Aichi Targets are rare, and our analysis

442   identifies relationships that would merit further research.

443   While we cannot exclude potential confounding effects, strength of governance was the

444   strongest predictor of positive progress towards elements. This is after considering other

445   potential explanatory covariates (specifically, GDP per capita, population density and

446   urbanisation) that have previously been found to be positively related to the success of

447   biodiversity conservation actions (e.g. Waldron et al. 2017). While not conclusive, this does

448   lend support to the importance of good governance in achieving conservation and

449   sustainable use objectives, and accords with previous studies (e.g. Smith et al. 2003; Wright

450   et al. 2007; Umemiya et al. 2010; Barnes et al. 2016; Baynham-Herd et al. 2018). Conversely,

451   Miller et al. (2013) reported that the amount of international biodiversity aid received by

452   countries between 1980 and 2008 was positively correlated with governance, something

453   that is at odds with our finding that resource mobilisation was higher post-2010 compared

454   with 2006-2010 in nations with lower governance. However, Miller et al. (2013) looked at

455   summed aid over a fixed period rather than considering trends in aid over time as we did

456   and considered an earlier time period (1980 – 2008), so direct comparison is difficult.

457   The negative relationships between governance and terrestrial and marine protected area

458   coverage might suggest that there has been progress towards this element despite

459   governance issues. Expansion in protected areas appears to have been achieved partly

460   through an increase in the area covered by 'paper parks' (e.g. Bruner et al. 2001), which are

461   designated but have little or no enforcement (Barnes et al. 2018). This highlights the need to

462   ensure that robust indicators are available for all elements of targets, and not just those

463   that are easier to measure. Previous studies have also found that governance can play a

464   more important role in conservation and sustainable use than wealth (e.g. Bayhnan-Herd et

465   al. 2018). This is particularly relevant for the CBD, given that funding from the Global

466   Environment Facility (relevant to Target 19) was more likely to have increased in nations

467   with poorer governance. While increasing resources towards the nations that have made

468   least progress towards targets could boost progress (Miller et al. 2013), governance also

469   needs to be considered in shaping future interventions for biodiversity.

470

471   *4.3 The post-2020 agenda*

472   In the development of a post-2020 global biodiversity framework, attention is focusing on

473   reviewing progress towards the Aichi Targets over the last decade, the formulation of a new

474   10-year framework including targets, and how progress towards them will be measured

475   (e.g. Visconti et al. 2019). There has been greater progress towards targets consisting of

476   elements that are more measurable, in addition to being more realistic, unambiguous and

477   scalable (Green et al. 2019). The current process for reporting progress is inclusive, as it is

478   based around national documentation and declaration of ambition and progress. However,

479   such assessments of progress may not allow robust comparison between countries. While

480   nationally designed indicators may have more weight in influencing national policy and

481   responses (Han et al. 2016), the value of disaggregated global indicators is their

482   comparability between countries. Currently there are few such global indicators. Although

483   we recognise that there are data available that could inform measurements of progress to

484   additional elements, our selection criteria resulted in the identification of indicators to

485   measure progress to only one-fifth of elements that make up the 20 Aichi Targets.

486   Indicators that are produced from readily accessible data and that can be easily verified and

487   compared between countries can provide increased transparency for the global community.

488   When linked to information on the actions that have been undertaken, the information

489   allows assessment of the success of failure of interventions. Review of this information

490   increases the level of accountability of countries to all, including funders of conservation

491   and sustainable development. If they are based on data that are collected frequently, they

492   can be rapidly updated, facilitating adaptive management. Such indicators are less subject

493   to delays in reporting; the deadline for submitting the 6th National Reports was December

494   2018, but only around 50% of nations had done so by December 2019. Adoption of linked

495   indicators that assess the implementation of actions as well as their outcomes (Sparks et al.

496   2011) would aid the identification of factors influencing the success of conservation and

497   sustainable development.

498   Collection of data for indicators, especially from the field, can be expensive, but well-

499   designed volunteer-based field surveys have proven to be a reliable and inexpensive

500   method for collecting robust data on species populations (Gregory et al. 2019). For example,

501   Wotton et al. (2020) estimate annual costs of c.30,000 US$/yr to operate a national bird

502   monitoring programme in Africa. Indicators based on data collected or collated without

503   need for field surveys, such as freely available satellite remote sensing data (as with forest

504   area as proportion of land area, element 5.1) or centrally collated (as with official

505   development assistance for biodiversity, element 20.1), can also be readily updated and

506   shared, facilitating rapid reporting. As new post-2020 targets are developed, it is essential

507   that attention is simultaneously given to indicators for monitoring progress towards these

508   targets. Frequent monitoring through linked indicators would increase understanding of the

509   issues affecting progress at the national scale, which in turn would facilitate knowledge

510   exchange between countries regarding which factors promote greater progress towards

511   specific elements of targets, ultimately benefiting biodiversity.

512

521

522   **References**

523   Barnes, M.D., Glew, L., Wyborn, C., Craigie, I.D., 2018. Prevent perverse outcomes from

524   global protected area policy. Nature Ecology & Evolution 2, 759–762.

525   Barnes, M.D., Craigie, I.D., Harrison, L.B., Geldmann, J., Collen, B., Whitmee, S., Balmford, A.,

526   Burgess, N.D., Brooks, T., Hockings, M., Woodley, S., 2016. Wildlife population trends in

527   protected areas predicted by national socio-economic metrics and body size. Nature

528   Communications 7, 1 – 9.

529   Barton, K., 2018 Package MuMIn. https://cran.r-

530   project.org/web/packages/MuMIn/MuMIn.pdf

531   Baynham-Herd, Z., Amano, T., Sutherland, W.J., Donald, P.F., 2018. Governance explains

532   variation in national responses to the biodiversity crisis. Environmental Conservation 45,

533   407-418.

534   Beresford. A.E., Eshiamwata, G.W., Donald, P.F., Balmford, A., Bertzky, B., Brink, A.B.,

535   Fishpool, L.D., Mayaux, P., Phalan, B., Simonetti, D., Buchanan, G.M., 2013 Protection

536   reduces loss of natural land-cover at sites of conservation importance across Africa. PloS

537   One 8, e65370.

538   Bruner, A.G., Gullison, R.E., Rice, R.E., Da Fonseca, G.A., 2001 Effectiveness of parks in

539   protecting tropical biodiversity. Science 291, 125-128.

540   Butchart, S.H.M., Di Marco, M., Watson, J.E., 2016 Formulating smart commitments on

541   biodiversity, lessons from the Aichi Targets. Conservation Letters 9, 457-468.

542   Butchart, S.H.M., Miloslavich, P., Reyers, B., Subramanian, S.M., Adams, C., Bennett, E.,

543   Czúcz, B., Galetto, L., Galvin, K., Reyes-García, V., Gerber, L.R., Gode, T.B., Jetz, W., Kosamu,

544   I.B.M., Palomo, M.G., Panahi, M, Selig, E.R., Singh, G.S., Tarkhnishvili, D., Xu, H., Lynch, A.J.,

545   Mwampamba, T.H., Samakov, A., 2019 Assessing progress towards meeting major

546   international objectives related to nature and nature's contributions to people. Chapter 3 In

547   Brondízio, E.S., Díaz, D., Settele, J., eds, Global Assessment Report of the Intergovernmental

548   Science-Policy Platform on Biodiversity and Ecosystem Services. Germany, Secretariat of the

549   Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services.

550   Chamberlain, S., Barve, V., Desmet, P., Geffert, L., McGlinn, D., Oldoni, D., Ram, K., 2017

551   Package rgbif. https://cran.r-project.org/web/packages/rgbif/rgbif.pdf

552   CBD 2010 The Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets

553   COP 10 Decision X/2. https://www.cbd.int/decision/cop/?id=12268

554   CBD 2014a COP 10 Decision X/10. https://wwwcbdint/decision/cop/?id=12276

555   CBD 2014b Global Biodiversity Outlook 4. URL

556   https://www.cbd.int/gbo/gbo4/publication/gbo4-en.pdf

557   CBD 2016a Analysis of targets established by parties and progress towards the Aichi

558   Biodiversity Targets. URL https://wwwcbdint/impact/assessment-table-2016-04-22-en.pdf

559   CBD 2016b National Reporting Decision CBD/COP/DEC/XIII/27. URL

560   https://wwwcbdint/doc/decisions/cop-13/cop-13-dec-27-enpdf

561   Di Marco, M., Butchart, S.H.M., Visconti, P., Buchanan, G.M., Ficetola, G.F., Rondinini, C.,

562   2016 Synergies and trade-offs in achieving global biodiversity targets. Conservation Biology

563   30, 189–195.

564   Green, E.J., Buchanan, G.M., Butchart, S.H.M., Chandler, G.M., Burgess, N.D., Hill, S.L.L.,

565   Gregory, R.D., 2019 Relating characteristics of global biodiversity targets to reported

566   progress. Conservation Biology 33, 1360-1369.

567 Gregory, R.D., Skorpilova, J. Voříšek, P., Butler, S., 2019 An analysis of trends, uncertainty

568 and species selection shows contrasting trends of widespread forest and farmland birds in

569 Europe. Ecological Indicators 103, 676-687.

570 Han, X., Josse, C., Young, B.E., Smyth, R.L., Hamilton, H.H., Bowles-Newark, N., 2017

571 Monitoring national conservation progress with indicators derived from global and national

572 datasets. Biological Conservation 213, 325-334.

573 IPBES, 2019 Summary for policymakers of the global assessment report on biodiversity and

574 ecosystem services.

575 https://wwwipbesnet/sites/default/files/downloads/spm_unedited_advance_for_posting_h

576 tn.pdf.

577 Massicotte, P., Eddelbuettel, P., 2018 Package 'gtrendsR'. https://cranr-

578 projectorg/web/packages/gtrendsR/gtrendsRpdf.

579 Miller, D.C., Agrawal, A., Roberts, J.T., 2013 Biodiversity governance and the allocation of

580 international aid for conservation Conservation Letters 6, 12-20.

581 R Core Team, 2018 R, A language and environment for statistical computing R Foundation

582 for Statistical Computing. https://wwwR-projectorg/.

583 Smith, R.J., Muir, R.D., Walpole, M.J., Balmford, A., Leader-Williams, N., 2003 Governance

584 and the loss of biodiversity. Nature 426, 67-70.

585 Sparks, T.H., Butchart, S.H.M, Balmford, A., Bennun, L., Stanwell-Smith, D., Walpole, M.,

586 Bates, N.R., Bomhard, B., Buchanan, G.M., Chenery, A.M., Collen, B., 2011 Linked indicator

587 sets for addressing biodiversity loss. Oryx 45, 411-419.

588   Strassburg, B.B., Kelly, A., Balmford, A., Davies, R.G., Gibbs, H.K., Lovett, A., Miles, L., 2010

589   Global congruence of carbon storage and biodiversity in terrestrial ecosystems.

590   Conservation Letters 3, 98-105.

591   Tittensor, D.P., Walpole, M., Hill, S.L., Boyce, D.G., Britten, G.L., Burgess, N.D., Butchart,

592   S.H.M., Leadley, P.W., Regan, E.C., Alkemade, R., Baumung, R., 2014 A mid-term analysis of

593   progress toward international biodiversity targets. Science 346, 241-244.

594   Umemiya, C., Rametsteiner, E., Kraxner, F., 2010 Quantifying the impacts of the quality of

595   governance on deforestation. Environmental Science & Policy 13, 695-701.

596   Waldron, A., Miller, D.C., Redding, D., Mooers, A., Kuhn, T.S., Nibbelink, N., Roberts, J.T.,

597   Tobias, J.A., Gittleman, J.L., 2017 Reductions in global biodiversity loss predicted from

598   conservation spending. Nature 551, 364-367.

599   Wotton, S., Eaton, M.A., Sheehan, D. Barasa Munyekenye. F. Burfield, I.J., Butchart, S.H.M.,

600   Moleofi, K., Nalwanga-Wabwire, D., Ndang'ang'a P.K., Pomeroy, D., Senyatso, K.J., Gregory,

601   R.D., 2020 Developing biodiversity indicators for African birds. Oryx 54, 62–73.

602   Wright, S.J., Sanchez-Azofeifa, G.A., Portillo-Quintero, C., Davies, D., 2007 Poverty and

603   corruption compromise tropical forest reserves. Ecological Applications 17, 1259-1266.
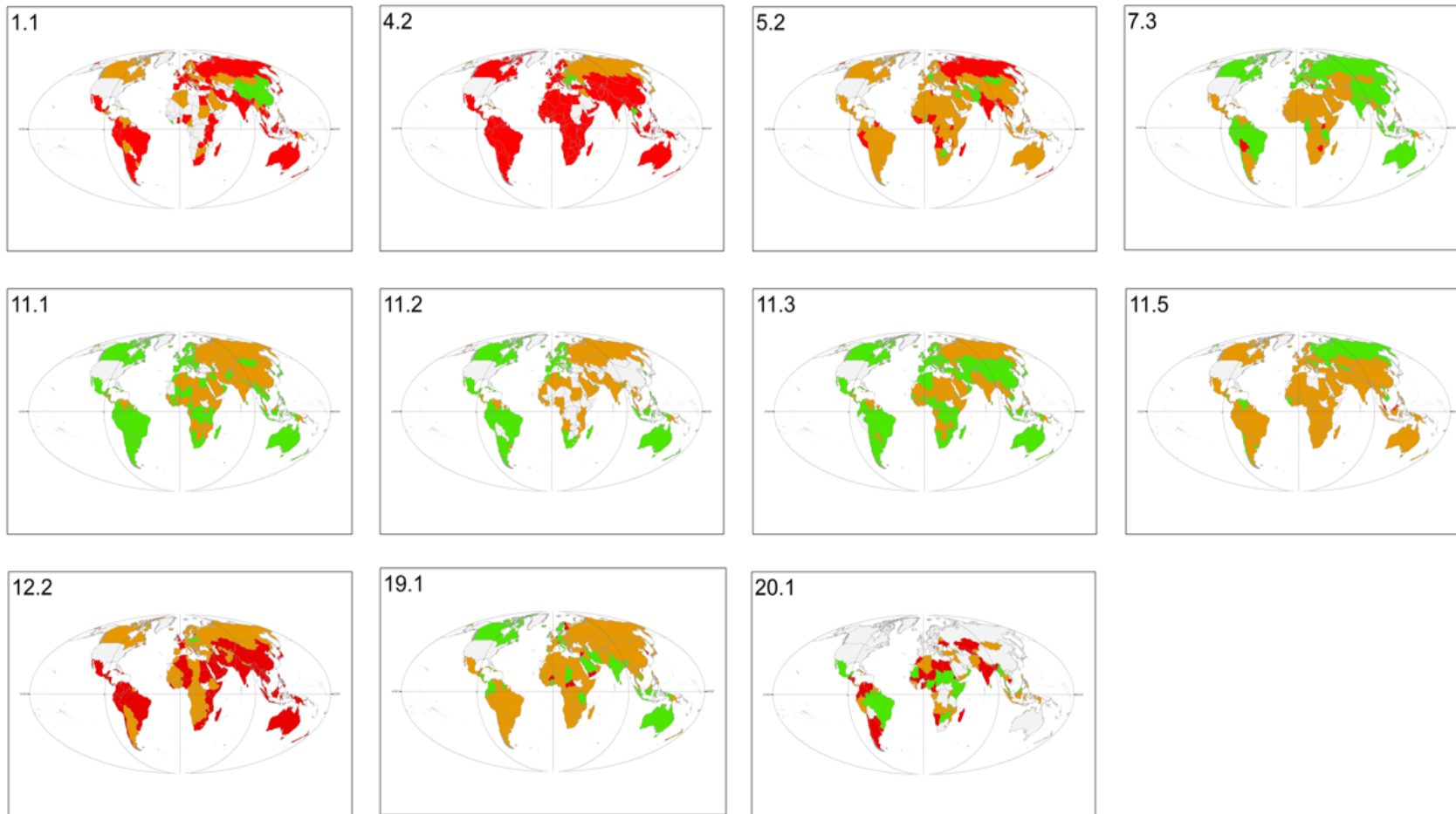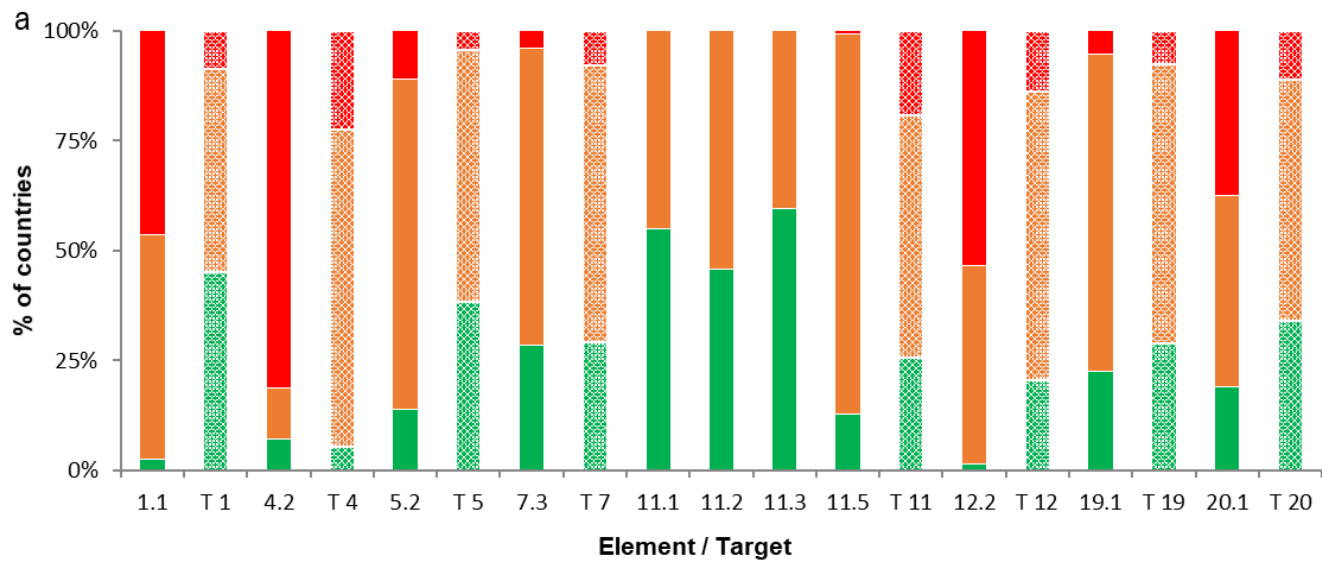
Figure 1. Distribution of countries in each category of progress based on our selected indicators for each Target element. Green indicates countries moving towards element, orange indicates little or no progress to element, and red indicates moving away from element.
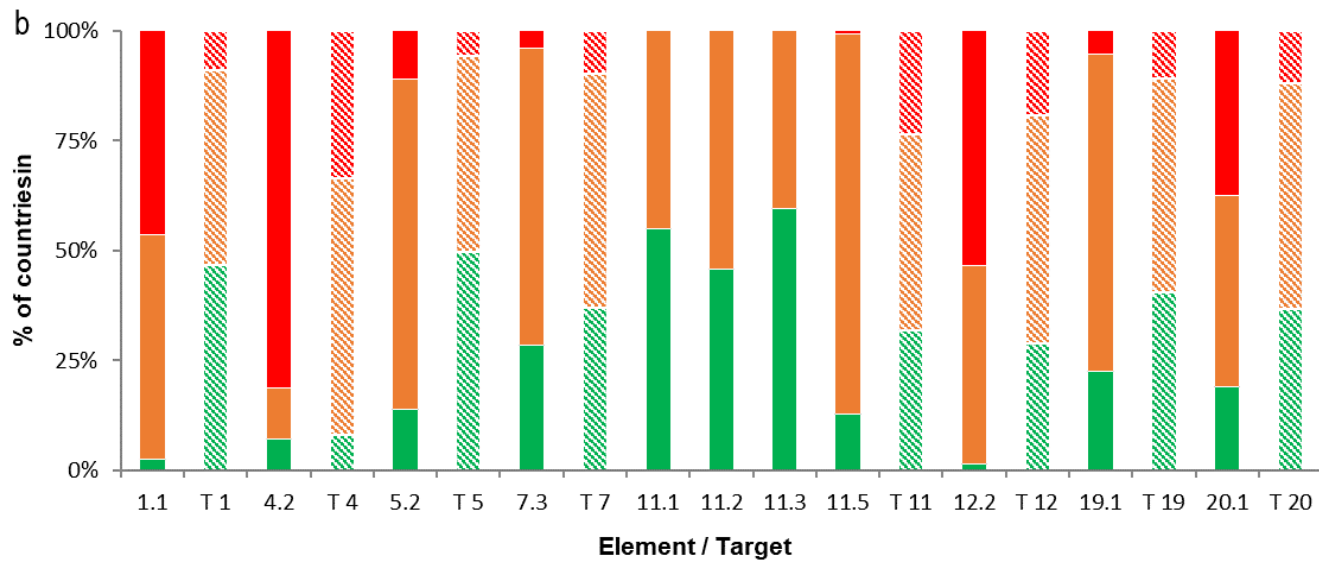
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Figure 2. Percentage of countries in each category of progress based on indicators for elements (solid bars) and (a) 5th National Reports (stippled bars) and (b) 6th National Reports (diagonal bars). Elements and Target numbers are given on the x axis (e.g. 1.1 indicates progress based

on our selected indicators for element 1 of Target 1, while T1 indicates progress based on 5th or 6th National Reports.) Green indicates coun-

tries moving towards element / target, orange indicates little or no progress towards element / target and red indicates moving away from
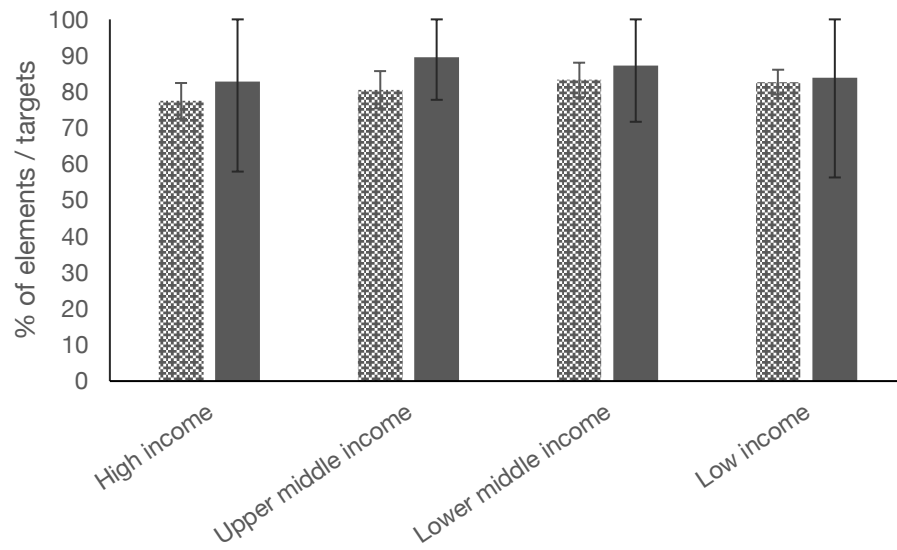
element / target.

Figure 3. Mean percentage of countries with available data to assess progress towards target elements (solid bars), and data for corresponding

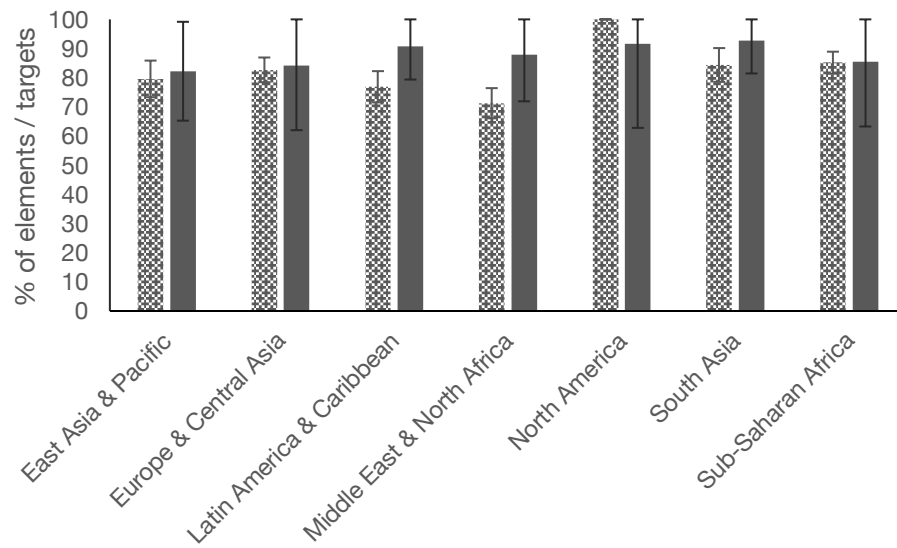targets from 5th National Reports (stippled bars), by income category.

Figure 4. Mean percentage of countries with available data to assess progress to target element (solid bars), and data for corresponding targets from 5th National Reports (stippled bars) by geographic regions.