The global distribution of tetrapods reveals a need for targeted reptile conservation

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Abstract

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The distributions of amphibians, birds and mammals have underpinned global and local

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conservation priorities, and have been fundamental to our understanding of the determinants of

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global biodiversity. In contrast, the global distributions of reptiles, representing a third of

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terrestrial vertebrate diversity, have been unavailable. This prevented reptiles' incorporation into

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conservation planning and biased our understanding of the underlying processes governing

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global vertebrate biodiversity. Here, we present and analyse, for the first time, the global

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distribution of 10,064 reptile species (99% of extant terrestrial species). We show that richness

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patterns of the other three tetrapod classes are good spatial surrogates for species richness of all

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reptiles combined and of snakes, but characterize diversity patterns of lizards and turtles poorly.

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Hotspots of total and endemic lizard richness overlap very little with those of other taxa.

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Moreover, existing protected areas, sites of biodiversity significance and global conservation

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schemes, represent birds and mammals better than reptiles. We show that additional conservation

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actions are needed to effectively protect reptiles, particularly lizards and turtles. Adding reptile

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knowledge to a global complementarity conservation priority scheme, identifies many locations

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that consequently become important. Notably, investing resources in some of the world's arid,

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grassland, and savannah habitats might be necessary to represent all terrestrial vertebrates

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efficiently.

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82   **Introduction**

83   Our knowledge of the distributions of a broad variety of organisms has improved greatly in the

84   past decade[1-3]. This has greatly aided our efforts to conserve biodiversity[4-6] and significantly

85   enhanced our grasp of broad scale evolutionary and ecological processes[7-12]. Nevertheless,

86   despite comprising one third of terrestrial vertebrate species, knowledge of reptile distributions

87   remained poor and unsystematic. This represented a major gap in our understanding of the global

88   structure of biodiversity and our ability to conserve nature. Historically, broad-scale efforts

89   towards the protection of land vertebrates (and thus also of reptiles) have been based

90   predominantly on data from plants, birds, mammals and to a lesser degree amphibians[13-15]. Here

91   we present complete species-level global distributions of nearly all reptiles: 10,064 known,

92   extant, terrestrial species for which we could identify precise distribution information. These

93   distributions cover the Sauria (lizards, 6110 species), Serpentes (snakes, 3414 species),

94   Testudines (turtles, 322 species), Amphisbaenia ('worm lizards', 193 species), Crocodylia

95   (crocodiles, 24 species) and Rhynchocephalia (the tuatara, one species).

96   This dataset completes the global distribution mapping of all described, extant, terrestrial

97   vertebrates (Fig. 1a), providing information that has been missing from much of the global

98   conservation planning and prioritization schemes constructed over the last twenty years[4]. We use

99   our reptile distribution data to: a) examine the congruence in general, hotspot, and endemism

100   richness patterns across all tetrapod classes and among reptile groups; b) explore how current

101   conservation networks and priorities represent reptiles; and c) suggest regions in need of

102   additional conservation attention to target full terrestrial vertebrate representation and highlight

103   current surrogacy gaps, using a formal conservation prioritisation technique.

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Results and Discussion

Species richness of reptiles compared to other tetrapods

The global pattern of reptile species richness (Fig. 1b) is largely congruent with that of all other terrestrial vertebrates combined ($r = 0.824$, e.d.f. $= 31.2$, p $\ll 0.0001$; Figs. 2a, S1, Table S1). However, the major reptile groups (Figs. 1c-e, 2b-c, S1, Table S1) show differing degrees of congruence with the other tetrapod taxa. The richness distribution of snakes (Fig. 1d) is very similar to that of other tetrapods (Fig. 2c) in showing pan-tropical dominance ($r = 0.873$, e.d.f. $= 30.2$, p $\ll 0.0001$). Lizard richness is much less similar to non-reptilian tetrapod richness ($r = 0.501$, e.d.f. $= 38.3$, p $\ll 0.001$, Fig. 2b). It is high in both tropical and arid regions, and notably in Australia (Figs. 1c, S1). Turtle richness is also less congruent with diversity patterns of the other tetrapods ($r = 0.673$, e.d.f. $= 55.2$, p $\ll 0.001$), and peaks in the south-eastern USA, the Ganges Delta, and Southeast Asia (Fig. 1e).

Snakes dominate reptile richness patterns due to their much larger range sizes compared to lizards, even though lizards are about twice as speciose (median ranges size for 3414 snake species: 62,646 km^2; for 6415 lizard species: 11,502 km^2; Fig. S2). Therefore snakes, disproportionally influence global reptile richness patterns[16,17] (Table S1, Fig. S1).

Hotspots of richness and range-restricted species

As with overall richness patterns, hotspots of richness (the richest 2.5%, 5%, 7.5% and 10% of grid-cells) for all reptiles combined, and of snakes, are largely congruent with those of other tetrapod classes. However they are incongruent with hotspots of lizard or turtle richness (Figs. 3; S3).

126   Congruence in the richness of range-restricted species (those species with the smallest 25% or

127   10% ranges in each group) between tetrapod groups is lower than the congruence across all

128   species[1] (Table S1). Endemic lizard and turtle distributions are least congruent with the endemics

129   in other tetrapod classes (Table S1). Global hotspots of relative endemism (or range-size

130   weighted richness, see Methods) for reptiles differ from those of non-reptilian tetrapods (Fig.

131   S4). Island faunas in places such as Socotra, New Caledonia and the Antilles are highlighted for

132   reptiles, while hotspots of endemism for non-reptilian tetrapods are more often continental.

133   ***The utility of protected areas and current priority schemes in capturing reptile richness***

134   Reptiles, like amphibians, are poorly represented in the global network of protected areas (Table

135   S2; Figs. S5, S6). Only 3.5% of reptile and 3.4% of amphibian species distributions are

136   contained in protected areas (median species range overlap per class, with IUCN categories I-

137   IV), compared with 6.5% for birds and 6% for mammals. Within reptile groups, strict protected

138   areas (IUCN Category I) overlap less with lizard ranges than with other reptile groups but there

139   are no important differences between taxa for the more permissive protected area types (Table

140   S2; Fig. S5). Amphibians have the highest proportion of species whose ranges lie completely

141   outside protected areas, when compared to the other tetrapod groups. Lizards, also fare poorly

142   and have the highest proportion of species outside protected areas when compared to the other

143   reptile groups (Fig. S6a). Turtles have the lowest proportion of species with at least 10% of their

144   range covered by protected areas (Fig. S6b). We suggest that these low overlaps may have been

145   caused by the inability to consider reptile diversity for direct protection, probably arising from

146   ignorance of their distributions.

147   We explored the coverage of all tetrapods in three global prioritisation schemes[13,14,18] and a

148   global designation of sites for biodiversity significance[15] that have recently used distribution data

149   to highlight regions for targeted conservation. These four global prioritisations/designations

150   cover 6.8%-37.4% of the Earth's land surface with 34-11,815 unique sites. Terrestrial vertebrate

151   groups have 68%-98% of their species with at least some range covered by these schemes (Fig.

152   S6c). However, reptiles and amphibians are sampled least well by these global schemes, and

153   within reptiles lizards have the lowest representation (Fig. S6c).

154   Fortunately, reptiles seem better situated in terms of conservation costs compared to other

155   tetrapods. The median conservation opportunity cost[19] (using the loss of agricultural revenue as a

156   proxy for land-cost) for reptiles is lower than that for other tetrapods ($F_{3,\ 31850} = 17.4$, $p < 0.001$;

157   Fig. S7). Within reptiles, the opportunity cost is lowest for lizards, and highest for turtles and

158   crocodiles, which could reflect their greater dependence on fresh-water habitats ($F_{3,\ 10060} = 88.4$,

159    $p < 0.001$; Fig. S7b).

160   ***Conservation priorities for all tetrapods, incorporating reptile distributions***

161   Our results suggest that reptiles, and particularly lizards and turtles, need to be better

162   incorporated into conservation schemes. We used relative endemism within a complementarity

163   analysis[20] to identify broad areas within which international and local conservation action should

164   reduce reptile extinction risk (Figs. 4, S8), and repeated this analysis to also incorporate

165   conservation opportunity costs[19] (Fig. S8d,e). Many previously identified priority regions[13,14],

166   have been retained with the addition of reptile distributions. These include northern and western

167   Australia; central southern USA and the gulf coast of Mexico; the Brazilian Cerrado; Southeast

168   Asia, and many islands.

169   Nevertheless, our analyses also reveal many regions, not currently perceived as biodiversity

170   conservation priorities for tetrapods. These priority areas are predominantly arid and semi-arid

171 habitats (see also Fig. S8f for mean rank change per biome, for prioritisation with and without

172 reptiles). They include parts of northern Africa through the Arabian Peninsula and the Levant;

173 around Lake Chad; in inland arid southern Africa; central Asian arid highlands and steppes;

174 central Australia; the Brazilian Caatinga, and the southern Andes. These regions have been

175 previously neglected as their non-reptile vertebrate biotas were more efficiently represented in

176 other locations. Our analyses show that those locations were poor spatial surrogates for reptile

177 distributions and that conservation efforts in our suggested locations may afford better protection

178 for reptiles while maintaining efficient representation of other vertebrates. We note that many of

179 these locations have low conservation opportunity costs so may be especially attractive for

180 conservation. Furthermore, the location of these areas is not primarily driven by conservation

181 opportunity costs. When these costs are incorporated into the analyses, very similar regions are

182 highlighted for special attention due to the inclusion of reptile distributions (Fig. S8d,e).

183 *Summation*

184 The complete map of tetrapod species richness presented here reveals important and unique

185 properties of reptile diversity, particularly of lizards and turtles (Figs. 1-3). At a regional scale

186 reptiles have previously been shown to be unusually diverse in arid and semi-arid habitats[21-23].

187 Here we reveal that this pattern is global, and further show reptile prominence in island faunas

188 (Figs. 2d, S4). Furthermore, we show that reptiles' unique diversity patterns have important

189 implications for their conservation. Targeted reptile conservation lags behind that of other

190 tetrapod classes, probably through ignorance[24-26]. The distributions provided here could make a

191 vital contribution to bridging this gap. Concentrations of rare species in unexpected locations

192 (Fig. 4) require explicit consideration when planning conservation actions. Highlighting such

193 locations for new taxa could be especially beneficial for resource-constrained planning,

194   especially where land costs are low. The lower global congruence with recognized diversity

195   patterns for reptiles should also serve as a warning sign, contrary to some recent suggestions[27],

196   for our ability to use distributions of well-studied groups in order to predict diversity patterns of

197   poorly known taxa. The distinctive distribution of reptiles, and especially of lizards, suggests that

198   it is driven by different ecological and evolutionary processes to those in other vertebrate

199   taxa[23,28]. The complete distributions of terrestrial tetrapods we now possess could greatly

200   enhance our ability to study, understand and protect nature.

201

202   **Methods**

203   Data collection and assembly was carried out by members of the Global Assessment of Reptile

204   Distributions (GARD) group, which includes all the authors of this paper. Regional specialist

205   group members supervised the integration of geographic data for all species from field guides

206   and books covering the terrestrial reptilian fauna of various regions, as well as revised museum

207   specimen databases, online meta-databases (including the IUCN, GBIF and Vertnet), our own

208   observations and the primary literature. We followed the taxonomy of the March 2015 edition of

209   the Reptile Database[29]. Source maps were split or joined on that basis. We used the newest

210   sources available to us. Polygonal maps - representing species extent of occurrence - were

211   preferred over other map types, as such distribution representations are those available for the

212   other classes that were compared to reptiles. Point locality data were modelled to create polygons

213   representing the extent of occurrence using hull geometries (see supplement). Gaps in reptile

214   distribution knowledge for particular locations or taxa were filled using *de novo* polygon and

215   gridded maps created by GARD members specializing in the fauna of particular regions and

216   taxa. These maps and all data obtained from online databases and the primary literature were

217 then internally vetted, in a manner analogous to the IUCN Specialist Group process. Further

218 details on data collection and curation, modelling of point localities and a full list of data sources

219 per species are available in the supplement. Overall we analysed distribution maps for 10,064

220 extant species, which represent 99% of the species found in the Reptile Database of March 2015.

221 For all analytical purposes we contrasted snakes with the paraphyletic 'lizards' (here defined as

222 lepidosaurs exclusive of snakes).

223 Polygonal representations of the extent of species' occurrences, such as we assembled and use in

224 our analyses, are fundamentally important to contemporary conservation planning[30]. The IUCN's

225 assessment of the extinction risk of individual species requires (and produces) such data, and

226 both they and many other organisations and researchers have used such data in aggregate and at

227 regional-to-global scales for several decades[31]. Like any representation of species distributions,

228 polygonal range maps can include errors both of omission and commission. Both kinds of

229 inaccuracy can lead to erroneous conclusions by unwary users and this has led to some

230 controversy over the use of polygonal range maps. Of course, all biogeographic representations -

231 specimen localities, SDM outputs, atlas data, polygonal maps and explorers' narratives - lie along

232 this omission: commission spectrum, and can equally be misused or found useless[32]. For global

233 prioritisation, we follow a comprehensive recent study[33] demonstrating the effectiveness of

234 polygonal range maps in highlighting priority areas, despite errors at the level of individual

235 species. We do, however, recognise that specimen data, if collected, curated and made available

236 (at a suitable scale) remains a gold standard for some uses[34].

237 Our grid-cell analyses were conducted in a Behrmann Equal Area projection of 48.25 km grid-

238 cells (~0.5° at 30°N/S). All analyses were repeated at a grid size of 96.5 km (~1° at 30°N/S) and

239   results were qualitatively unchanged. GIS and statistical analyses were carried out in R and

240   PostGIS.

241   Range size weighted richness (rswr) was calculated, for each cell, using the following formula:

242    $rswr_i = \sum_j q_{ij}$ *where* q_{ij} is the fraction of the distribution of the species j in the cell i.

243   We used 'Zonation'[20] to produce a ranked prioritisation amongst cells, assuming equal weight to

244   all species and assuming an equal cost for all cells. Cell value was the maximum proportion of

245   any species range represented in it. Cell priority was calculated by iteratively removing the least

246   valuable cell and updating cell values[20]. We analysed all tetrapod species combined and

247   tetrapods without reptiles separately, to reveal the change in rank importance induced by adding

248   reptile distributions (See supplement, Fig. S8). We repeated our prioritisation using per-cell

249   agricultural opportunity costs[19], and found via rank correlation that our priority regions are fairly

250   insensitive to the use of land costs (Figs. 4, S8).

Author contributions

AMB, RG, SM, UR conceived the study. RG, CDLO, UR designed the analyses. UR conducted the analyses. AF, SM, MN, UR complied, designed, and curated the dataset. RG, SM, UR wrote the paper. AA, AMB, MB, RB, BC, FCH, LC, GRC, LD, ID, TMD, AF, LLG, MH, YI, FK, AL, ML, EM, DM, MM, SM, CCN, MN, ZTN, GP, OSGP, DPD, UR, RS, OT, OTC, JFT, EV, PU, PW, YW provided, collated, and verified underlying data. All authors read and commented on the manuscript.

273 UR, AF and MN contributed equally to the paper. RG and SM contributed equally to the paper.

274 **Competing interests**

275 All authors declare no competing interests.

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279 **Data availability**

280 The reptile distribution data used in this study are available from the corresponding author on

281 reasonable request

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283 **References:**

284 [1] Grenyer, R. *et al.*, Global distribution and conservation of rare and threatened vertebrates.

285 *Nature* 444 (7115), 93-96 (2006).

286 [2] Orme, C.D.L. *et al.*, Global hotspots of species richness are not congruent with endemism

287 or threat. *Nature* 436 (7053), 1016-1019 (2005).

288 [3] Stuart, S.N. *et al.*, Status and trends of amphibian declines and extinctions worldwide.

289 *Science* 306 (5702), 1783-1786 (2004).

290 [4] Brooks, T.M. *et al.*, Global biodiversity conservation priorities. *Science* 313 (5783), 58-

291 61 (2006).

292 [5] Kremen, C. *et al.*, Aligning conservation priorities across taxa in Madagascar with high-

293 resolution planning tools. *Science* 320 (5873), 222-226 (2008).

294 [6]   Wilson, K.A., McBride, M.F., Bode, M., & Possingham, H.P., Prioritizing global

295   conservation efforts. *Nature* 440 (7082), 337-340 (2006).

296 [7]   Holt, B.G. *et al.*, An update of Wallace's zoogeographic regions of the world. *Science*

297   339 (6115), 74-78 (2013).

298 [8]   Schipper, J. *et al.*, The status of the world's land and marine mammals: Diversity, threat,

299   and knowledge. *Science* 322 (5899), 225-230 (2008).

300 [9]   Bates, S.T. *et al.*, Examining the global distribution of dominant archaeal populations in

301   soil. *ISME Journal* 5 (5), 908-917 (2011).

302 [10] Morueta-Holme, N. *et al.*, Habitat area and climate stability determine geographical

303   variation in plant species range sizes. *Ecology Letters* 16 (12), 1446-1454 (2013).

304 [11] Stuart-Smith, R.D. *et al.*, Integrating abundance and functional traits reveals new global

305   hotspots of fish diversity. *Nature* 501 (7468), 539-542 (2013).

306 [12] Tittensor, D.P. *et al.*, Global patterns and predictors of marine biodiversity across taxa.

307   *Nature* 466 (7310), 1098-1101 (2010).

308 [13] Mittermeier, R.A. *et al.*, *Hotspots Revisited: Earth's Biologically Richest and Most*

309   *Endangered Ecoregions*. (CEMEX, Mexico City, Mexico, 2004).

310 [14] Olson, D.M. & Dinerstein, E., The global 200: A representation approach to conserving

311   the Earth's most biologically valuable ecoregions. *Conservation Biology* 12 (3), 502-515

312   (1998).

313 [15] BirdLife International, Important Bird and Biodiversity Area (IBA) digital boundaries.

314   Version 2015 2 (BirdLife Intranational, Cambridge, UK, 2015).

315 [16] Jetz, W. & Rahbek, C., Geographic range size and determinants of avian species

316   Richness. *Science* 297 (5586), 1548-1551 (2002).

317 [17] Lennon, J.J., Koleff, P., Greenwood, J.J.D., & Gaston, K.J., Contribution of rarity and
318 commonness to patterns of species richness. *Ecology Letters* 7 (2), 81-87 (2004).

319 [18] Joppa, L.N., Visconti, P., Jenkins, C.N., & Pimm, S.L., Achieving the Convention on
320 Biological Diversity's goals for plant conservation. *Science* 341 (6150), 1100-1103
321 (2013).

322 [19] Naidoo, R. & Iwamura, T., Global-scale mapping of economic benefits from agricultural
323 lands: implications for conservation priorities. *Biological Conservation* 140 (1), 40-49
324 (2007).

325 [20] Moilanen, A. *et al.*, Prioritizing multiple-use landscapes for conservation: methods for
326 large multi-species planning problems. *Proceedings of the Royal Society of London B:*
327 *Biological Sciences* 272 (1575), 1885-1891 (2005).

328 [21] Pianka, E.R., The many dimensions of a lizard's ecological niche in *Lacertids of the*
329 *Mediterranean region*, edited by E.D. Valakos, W. Böhme, V. Pérez-Mellado, & P.
330 Maragou (Hellenic Zoological Society, University of Athens, Greece, 1993).

331 [22] Lewin, A. et al., Patterns of species richness, endemism and environmental gradients of
332 African reptiles. *Journal of Biogeography* (2016), doi: 10.1111/jbi.12848.

333 [23] Powney, G.D., Grenyer, R., Orme, C.D.L., Owens, I.P.F., & Meiri, S., Hot, dry and
334 different: Australian lizard richness is unlike that of mammals, amphibians and birds.
335 *Global Ecology and Biogeography* 19 (3), 386-396 (2010).

336 [24] Böhm, M. *et al.*, The conservation status of the world's reptiles. *Biological Conservation*
337 157 (0), 372-385 (2013).

338 [25] Meiri, S. & Chapple, D.G., Biases in the current knowledge of threat status in lizards, and
339 bridging the 'assessment gap'. *Biological Conservation* 2014A, 6-15 (2016.

340 [26] Roll, U. *et al.*, Using Wikipedia page views to explore the cultural importance of global

341 reptiles. *Biological Conservation* 204A, 42-50 (2016).

342 [27] Bode, M. *et al.*, Cost-effective global conservation spending is robust to taxonomic

343 group. *Proceedings of the National Academy of Sciences of the United States of America*

344 105 (17), 6498-6501 (2008).

345 [28] Hawkins, B.A. *et al.*, Energy, water, and broad-scale geographic patterns of species

346 richness. *Ecology* 84 (12), 3105-3117 (2003).

347 [29] Uetz, P. & Hošek, J., The Reptile Database, Available at http://www.reptile-

348 database.org/, (April 2015).

349 [30] Pouzols, F.M. et al., Global protected area expansion is compromised by projected land-

350 use and parochialism. *Nature* 516: 383–386 (2014).

351
352 [31] Scott, J.M. et al., Gap Analysis: a geographic approach to protection of biological

353 diversity. *Wildlife Monographs*, 123: 3-41 (1993).

354 [32] Maldonado, C. et al., Estimating species diversity and distribution in the era of Big Data:

355 to what extent can we trust public databases? *Global Ecology and Biogeography*, 24:

356 973–984 (2015).

357 [33] Maréchaux, I., Rodrigues, A.S.L. & Charpentier, A., The value of coarse species range

358 maps to inform local biodiversity conservation in a global context. *Ecography*, doi:

359 10.1111/ecog.02598 (2017).

360 [34] Cantú-Salazar, L. & Gaston, K.J., Species richness and representation in protected areas

361 of the Western hemisphere: discrepancies between checklists and range maps. *Diversity*

362 *& Distributions* 19: 782–793 (2013).

363 [35] Anselin, L., Local indicators of spatial association - LISA. *Geographical analysis* 27 (2),
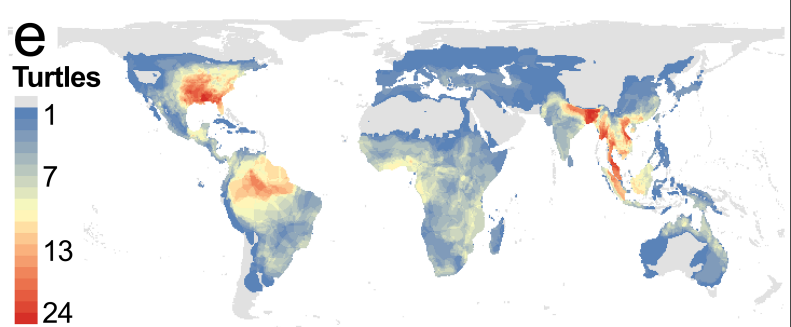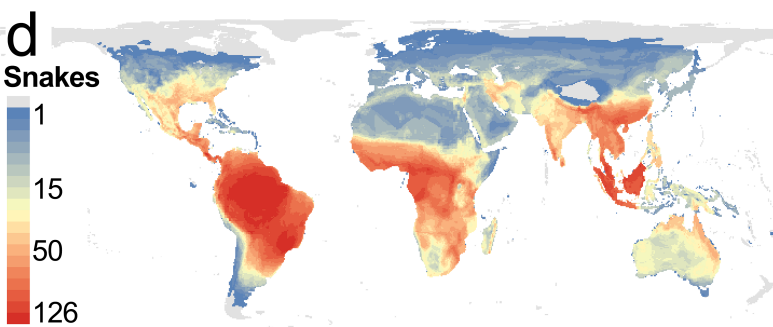
364 93-115 (1995).

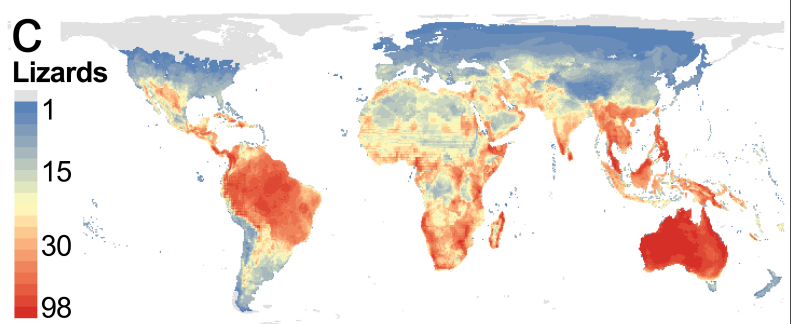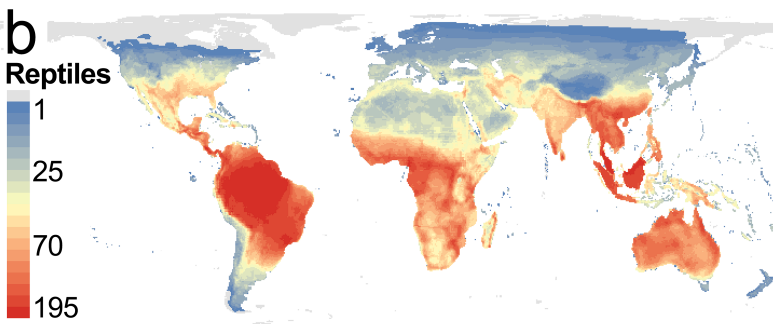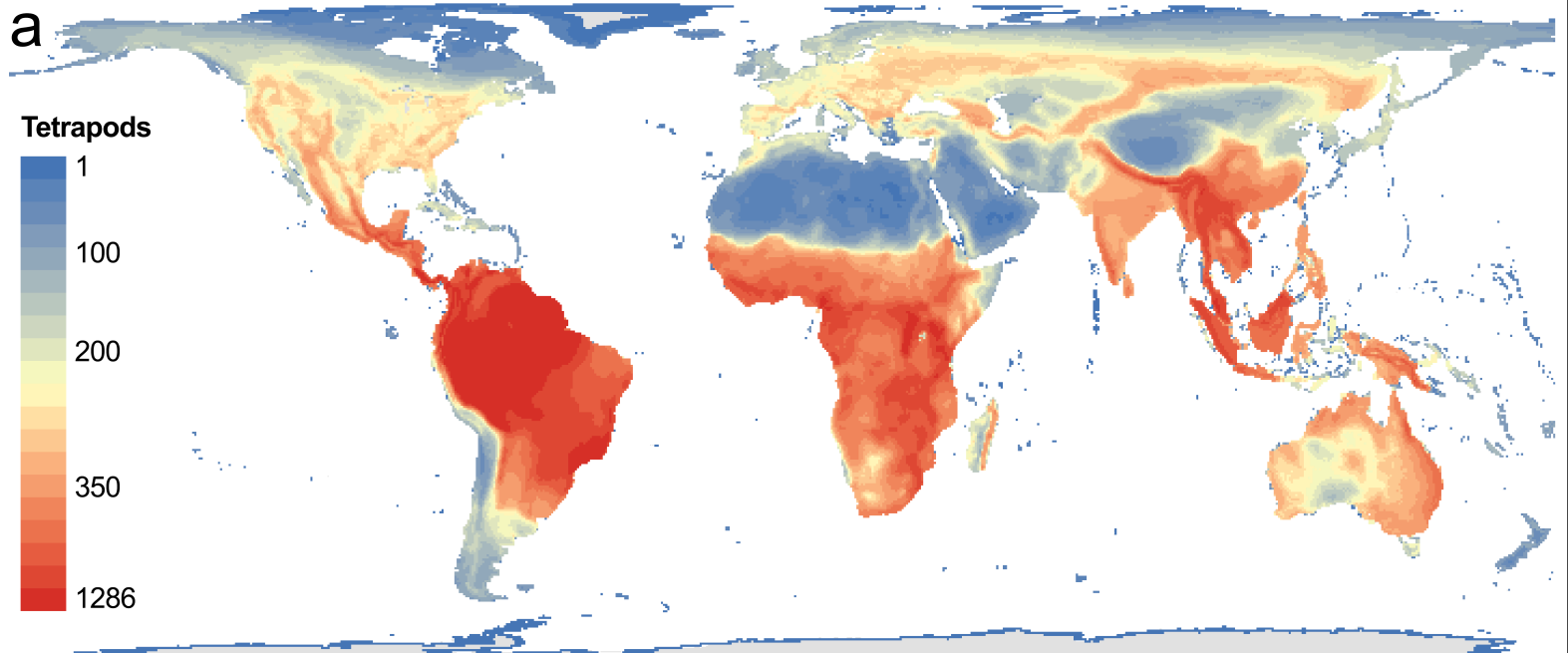365   **Figure captions**

366   Figure 1 – Terrestrial tetrapod species richness maps (0.5º grid-cell resolution). a) all tetrapods

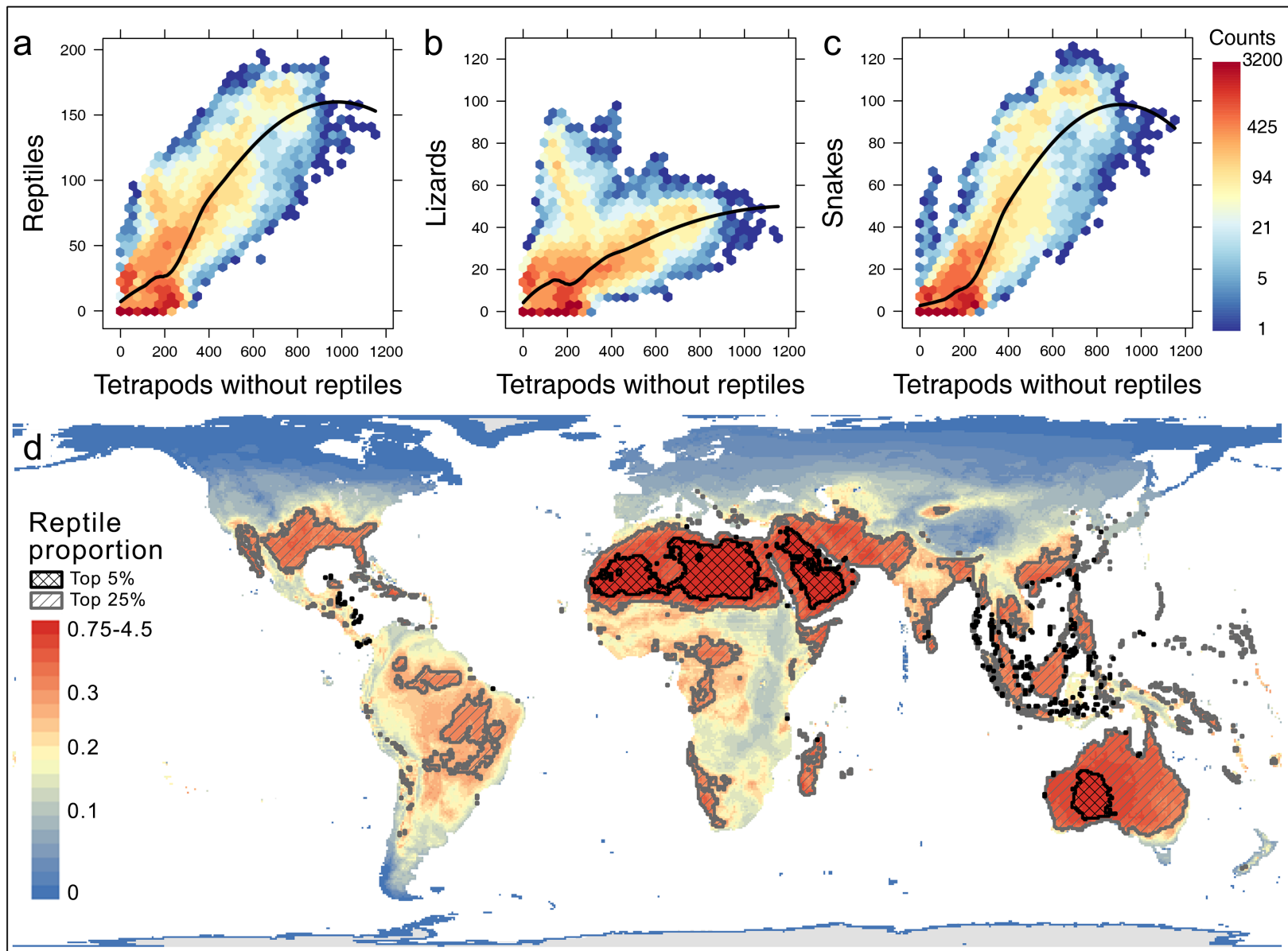367   including reptiles, b) all reptiles, c) 'lizards' d) snakes, e) turtles.

368   Figure 2 – Comparing reptile richness to other tetrapods. Hexagon scatter plots comparing

369   species richness values per grid-cell with binning (black line indicates a loess fit, α=0.6) of

370   tetrapods without reptiles, to a) all reptiles, b) 'lizards' and c) snakes. d) a map of the ratio of

371   reptile richness to non-reptilian tetrapod richness per grid cell (note the wide range of values for

372   the top category). Hatched regions designate areas where this proportion in the top 5% (black)
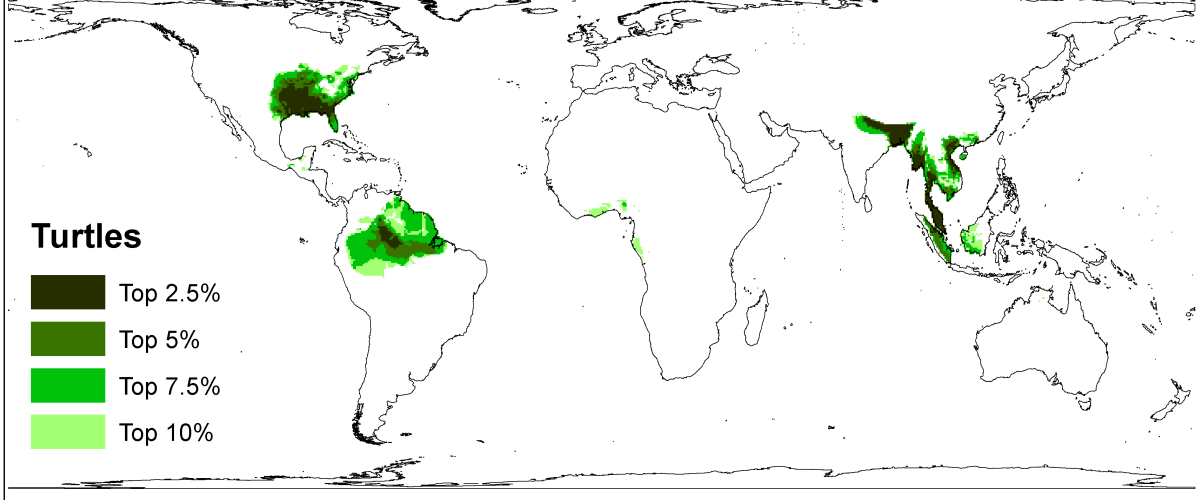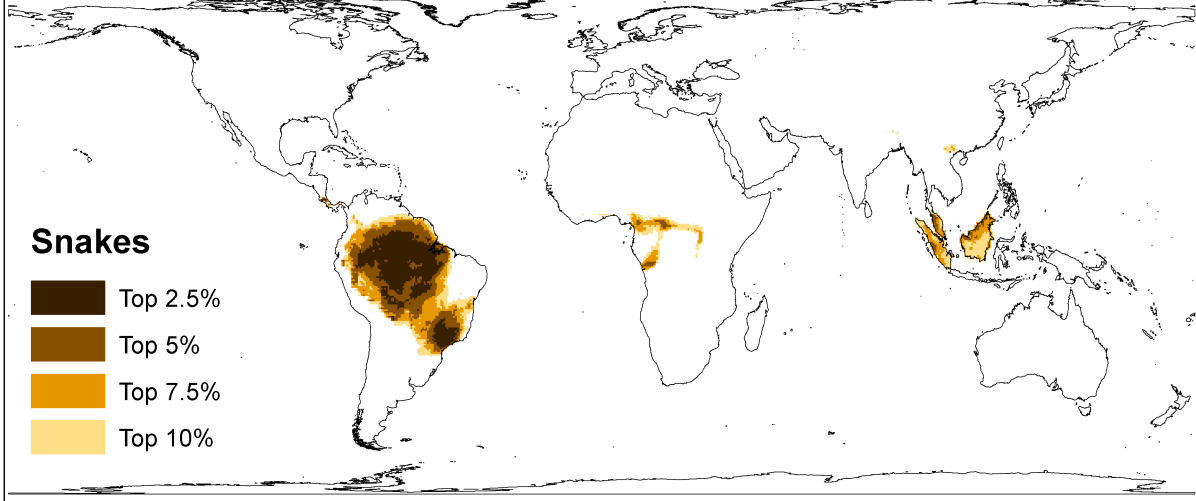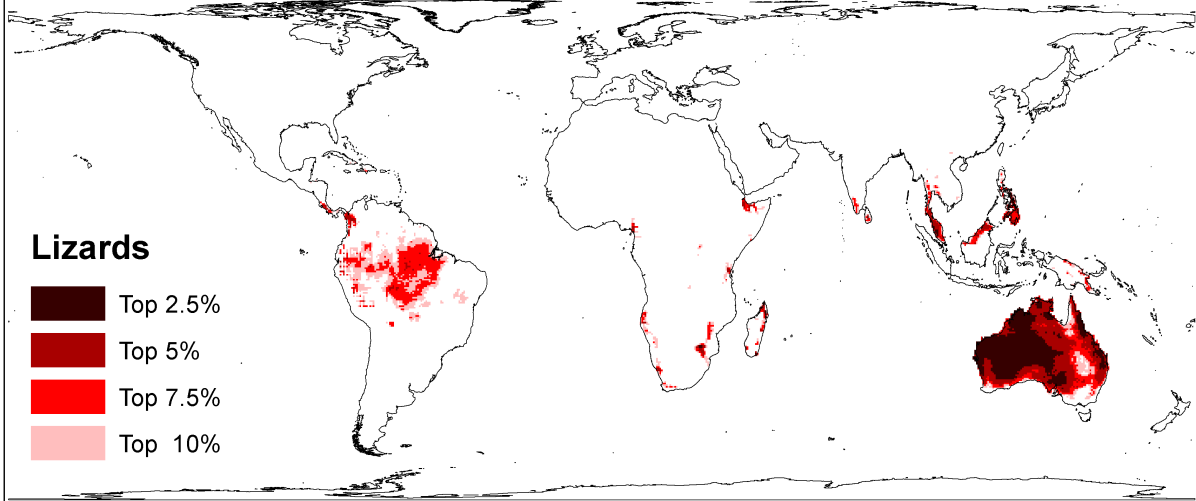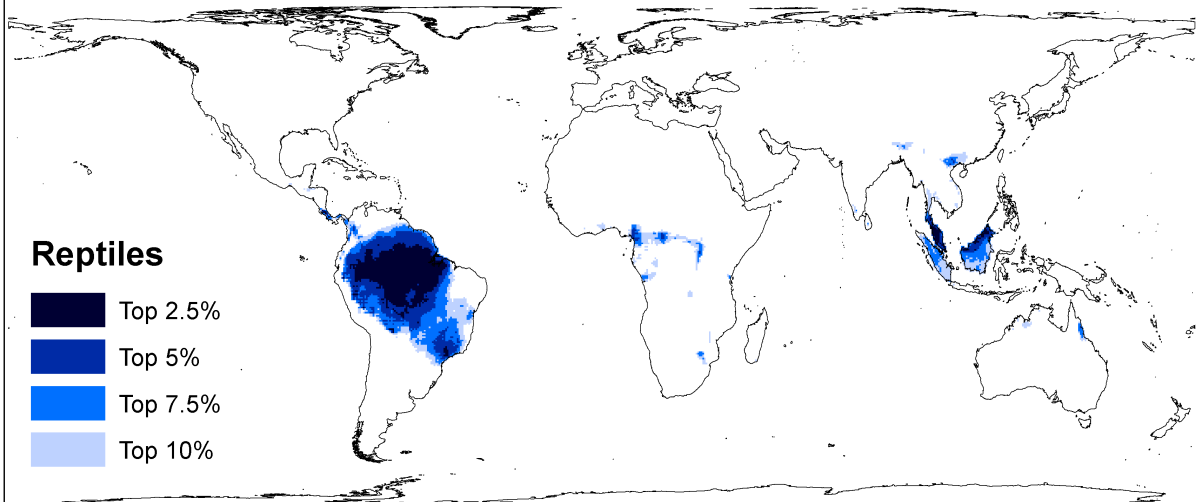
373   and 25% (grey).

374   Figure 3 –Species richness hotspots of reptiles and reptile groups. Those cells that are the 2.5%,

375   5%, 7.5%, 10% richest for a) all reptiles, b) 'lizards', c) snakes, and d) turtles.
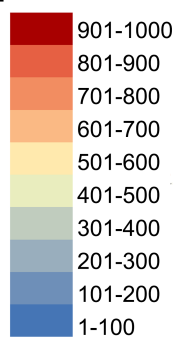
376   Figure 4 – Key areas for tetrapod conservation, highlighting regions that rise in importance for

377   conservation due to inclusion of reptiles. Cells were ranked in a formal prioritisation scheme[20],

378   based on complementarity when ranking cells in an iterative manner. Cells were ranked twice, I-

379   with all tetrapods, II- with all tetrapods excluding reptiles. a) Patterns per 0.5 degree grid-cell

380   where colours represent the priority ranks for the scheme which included all tetrapods (blue =

381   low, red = high). The cells that are highlighted with the bold foreground colours are those that

382   pinpoint those regions that gain in conservation importance due to the inclusion of the reptile

383   data. These cells were selected following these two rules (i) they were in the top 10% of increase

384   in rank, when subtracting the ranks of the analysis with reptiles from the ranks of the analysis

385   without them; and (ii) were part of statistically significant spatial clusters of rank changes (using

386   local Moran's I[35]). b) The mean change in rank between prioritizations with and without reptiles

387   (using the above method), per ecoregion (red- ecoregions that become more important due to the

388   inclusion of reptile information; blue – ecoregions becoming less important).

a Tetrapods
1
100
200
350
1286

b Reptiles
1
25
70
195

c Lizards
1
15
30
98

d Snakes
1
15
50
126

e Turtles
1
7
13
24

a

Reptiles vs Tetrapods without reptiles

b

Lizards vs Tetrapods without reptiles

c

Snakes vs Tetrapods without reptiles

Counts
3200
425
94
21
5
1

d

Reptile
proportion

Top 5%
Top 25%

0.75-4.5
0.3
0.2
0.1
0

Reptiles
- Top 2.5%
- Top 5%
- Top 7.5%
- Top 10%

Lizards
- Top 2.5%
- Top 5%
- Top 7.5%
- Top 10%

Snakes
- Top 2.5%
- Top 5%
- Top 7.5%
- Top 10%

Turtles
- Top 2.5%
- Top 5%
- Top 7.5%
- Top 10%

a Tetrapod cell prioritisation

- 901-1000
- 801-900
- 701-800
- 601-700
- 501-600
- 401-500
- 301-400
- 201-300
- 101-200
- 1-100

b Mean rank differences

- 0.083 - 0.450
- 0.037 - 0.082
- 0.015 - 0.036
- 0.001 - 0.014
- -0.011 - 0.000
- -0.021 - -0.012
- -0.032 - -0.022
- -0.045 - -0.033
- -0.067 - -0.046
- -0.377 - -0.068