Biological Conservation 204 (2016) 1–5

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/bioc

Editorial

Addressing knowledge gaps in reptile conservation

Reid Tingley [a,*], Shai Meiri [b], David G. Chapple [c]

[a] School of BioSciences, The University of Melbourne, Parkville, VIC 3010, Australia
[b] Department of Zoology, Tel Aviv University, Tel Aviv 6997801, Israel
[c] School of Biological Sciences, Monash University, Clayton, VIC 3800, Australia

ARTICLE INFO

Article history:
Received 12 July 2016
Accepted 18 July 2016
Available online 26 July 2016

Keywords:
Conservation
Data deficient
Extinction
IUCN
Prioritization
Threat

ABSTRACT

Reptiles are the most species-rich group of terrestrial vertebrates, yet we lack a comprehensive understanding of their extinction risk. Only 45% of described reptile species have been assessed by IUCN to date (4648 of 10,400 species); of these, 20% (945 species) are threatened with extinction, and 19% (867 species) are Data Deficient. The goal of this special issue is to improve our understanding of reptile conservation needs and extinction risk by (i) investigating patterns and drivers of extinction risk and data deficiency at a global scale; (ii) identifying and addressing taxonomic and regional gaps in our understanding of extinction risk and data deficiency; and (iii) drawing upon detailed case studies to highlight conservation approaches to mitigate extinction. By doing so, the special issue will guide future conservation efforts toward the taxa and regions in greatest need of assessment, and toward risks requiring immediate mitigation. We conclude with potential avenues for future research, including the need to address regional knowledge gaps, conduct macroecological and retrospective analyses of extinction risk, and implement targeted monitoring of conservation intervention outcomes.

© 2016 Elsevier Ltd. All rights reserved.

1. Narrowing the taxonomic gap in extinction risk research

Our understanding of geographic patterns and drivers of extinction risk is largely derived from studies of birds, mammals, and to a lesser extent, amphibians. The IUCN Red List of Threatened Species has been instrumental in this regard, providing near complete coverage of birds and mammals, and of ~83% of all described amphibians (Meiri and Chapple, 2016). In contrast, our grasp on the conservation status of reptiles remains vastly incomplete. Reptiles represent a significant proportion of terrestrial biodiversity, and global declines have long been suspected (Gibbons et al., 2000; Huey et al., 2010; Reading et al., 2010); yet only 45% of the 10,400 recognized reptile species have been assessed by IUCN (Uetz and Hosek, 2015). Those species that have been assigned a Red List status have been primarily listed on the basis of geographical range size (Criterion B), due to insufficient data on population trends. This lag in our understanding of reptile extinction risk has meant that reptiles have largely been neglected by previous global conservation prioritizations.

Böhm et al. (2013) addressed this taxonomic gap by conducting the first global analysis of the conservation status of reptiles. However, this analysis only considered 1500 randomly selected species (14% of all species globally), 21% of which were classified as 'Data Deficient'. Nonetheless, this initial assessment has become highly influential (cited 213 times as of 12/07/2016, according to Google Scholar), increasing awareness of the plight of reptiles globally, and sparking new research into patterns and drivers of reptile extinction risk (e.g., Ducatez et al., 2014; Jenkins et al., 2014; Böhm et al., 2016a; Tingley et al., in press).

This special issue builds on the momentum created by these recent contributions, by bringing together 14 papers on reptile extinction risk ranging from local and regional studies to broad-scale, global analyses. In approaching potential contributors for the issue, we specifically targeted taxa and regions that contained disproportionate levels of threat and/or data deficiency (Fig. 1), as well as key threatening processes (e.g., invasive species, climate change, trade) and conservation interventions (e.g., translocation, reintroduction). As a result, the special issue addresses several shortcomings in our understanding of reptile extinction risk, namely: (i) the majority (~55%) of all described species have not been evaluated by IUCN (Meiri and Chapple, 2016); (ii) 19% of all assessed species are Data Deficient (IUCN, 2015); and (iii) assessment gaps, extinction risk, and data deficiency are greater in tropical regions (Fig. 1), and among particular taxa (e.g., Amphisbaenids) and natural-histories (e.g., fossorial species) (Böhm et al., 2013; Meiri and Chapple, 2016). It is our hope that the special issue will help narrow these gaps by identifying taxa and regions for which conservation assessment is urgently needed, and by highlighting new approaches to inform assessment and action.

2. Summary of the special issue on reptile extinction risk

This special issue is organised under three broad themes, which we briefly summarise below: (i) global patterns and processes of extinction

* Corresponding author.
E-mail address: reid.tingley@unimelb.edu.au (R. Tingley).

http://dx.doi.org/10.1016/j.biocon.2016.07.021
0006-3207/© 2016 Elsevier Ltd. All rights reserved.

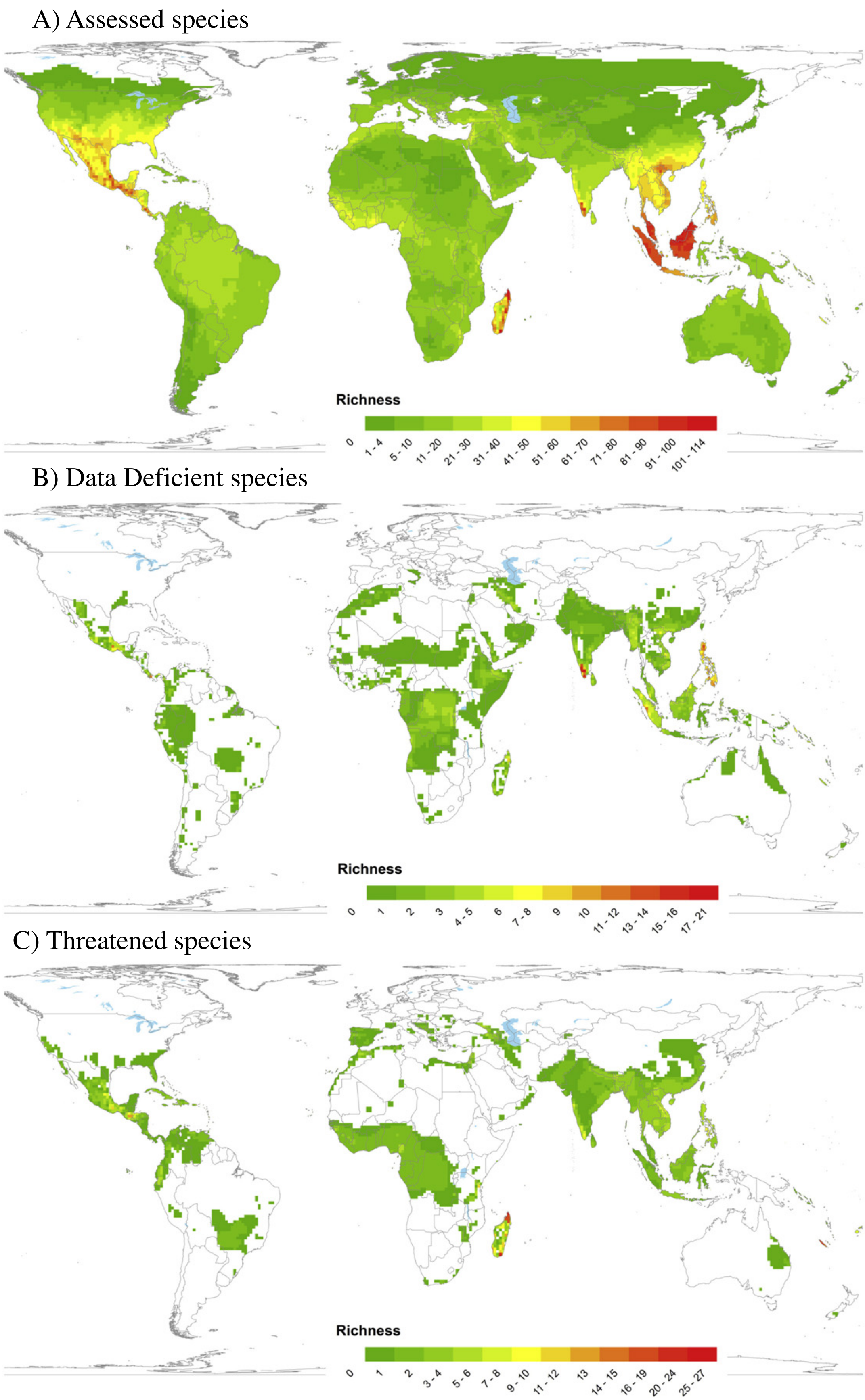

Fig. 1. Richness of reptile species assessed by IUCN (A), richness of Data Deficient reptile species (B), and richness of threatened (i.e., Vulnerable, Endangered, or Critically Endangered) reptile species (C).

risk; (ii) taxonomic and regional knowledge gaps; and (iii) conservation interventions.

2.1. Extinction risk: global patterns and processes

The first theme is comprised of five papers that examine geographic patterns and drivers of extinction risk at a global scale. The issue starts with a paper by Meiri and Chapple (2016), who ask whether lizard species assessed by IUCN are a random subset of all lizard species globally. Their analyses reveal significant biases with respect to taxonomy, life-history, ecology, and geographic origin. For example, the authors show that Australia has the lowest percentage of assessed species (15%), followed by the Neotropic, Oriental, and Afrotropic realms. Under-assessed species also shared particular traits, including smaller body sizes and clutch sizes, an oviparous mode of reproduction, and smaller distributional and elevation ranges. These findings will help target taxa and regions in greatest need of conservation assessment.

One of the major impediments to reptile conservation is that 19% of all reptile species assessed using IUCN Red List Criteria have been classified as Data Deficient (21% of species in the subset considered by Böhm et al., 2013), due to a lack of appropriate data. Bland and Böhm (2016) interrogate this issue by reviewing the causes of data deficiency in the 1500 reptile species assessed by Böhm et al. (2013). To help guide assessment efforts, they also develop machine learning models to predict the potential extinction risk of these Data Deficient species. Interestingly, Bland and Böhm (2016) find that the percentage of Data Deficient species predicted to be threatened (~19%) is the same as the percentage estimated in data-sufficient species (Böhm et al., 2013), and that spatial conservation priorities are robust to data deficiency. They also highlight the need for new Global Reptile Assessments to validate and refine models of extinction risk.

Böhm et al. (2013) found that extinction risk was not evenly distributed among reptile families. In this issue, Tonini et al. (2016) go one step further, using a phylogeny of Lepidosaurs (lizards, amphisbaenians, snakes, and the tuatara) to investigate whether threatened Lepidosaurs are clustered within particular lineages. They find significant phylogenetic clustering in extinction risk (with e.g., geckos, iguanas, and chameleons being particularly at risk), suggesting that Lepidosaur species that share particular ecological, geographic, or biological attributes are more prone to extinction. This may be useful in identifying extinction risk of closely-related species. Tonini et al. (2016) also suggest that future extinctions may not result in a disproportionate loss of evolutionary distinctiveness.

This contribution is followed by a paper by Böhm et al. (2016b), who conduct the first global assessment of climate change vulnerability for 1498 reptile species, using species-specific traits relating to climate change sensitivity, adaptability, and exposure. The authors find that the distributions of climate change-vulnerable species do not significantly overlap with those of threatened species, highlighting the need to incorporate future threats in extinction risk assessments. Additionally, the authors highlight shortcomings of current climate change vulnerability assessments caused by data gaps and incomplete knowledge concerning the link between traits and climate change vulnerability, and suggest approaches to close those gaps.

Species-level prioritisations, such as those presented by Meiri and Chapple (2016); Bland and Böhm (2016); Tonini et al. (2016), and Böhm et al. (2016b), can provide an efficient means to allocate assessment and conservation efforts (Bland et al., 2015) but typically ignore social and cultural values. Roll et al. (2016) take the first step toward addressing this issue by examining characteristics that make certain reptile species of greater cultural (and hence conservation) significance. Their results, based on Wikipedia page views, suggest that large, venomous, widespread, and threatened species that have been first described a longer time ago attract the greatest attention, and thus may receive greater conservation support from the public.

2.2. Addressing taxonomic and regional knowledge gaps

The second theme of the special issue takes a more targeted approach aimed at increasing our knowledge of threat status and key threatening processes in extinction-prone and Data Deficient taxa and regions. Böhm et al. (2013) found that tropical regions host high proportions of threatened and Data Deficient species, while Meiri and Chapple (2016) found that they host a large proportion of lizard species that have never been assessed by IUCN (Fig. 1A). Five papers in this special issue address this regional bias.

Fossorial reptiles are perhaps the least known in terms of both their biology and conservation needs. By investigating extinction risk in Brazilian worm lizards, Colli et al. (2016) simultaneously address knowledge gaps in taxonomy (globally, 48% of assessed worm lizards are Data Deficient and 73% remain unassessed), life-history (21% of assessed fossorial species are Data Deficient and 63% are unassessed), and geography (24% of assessed Neotropical squamates are threatened, 22% are Data-Deficient, and 67% are unassessed; IUCN, 2015; S. Meiri, unpubl. data). Colli et al. (2016) find that worm lizard species that have been described more recently have smaller body sizes and geographical range sizes, and that sampling intensity is biased largely toward accessible areas and large population centres. As a result, the authors conclude that Brazilian worm lizard diversity has been grossly under-estimated.

The next two contributions that address regional gaps in our understanding of reptile extinction risk focus on perhaps the least-studied region globally: the Afrotropics (Meiri, 2016). Twenty-five percent of Afrotropical species assessed by Böhm et al. (2013) are threatened. In this issue, Tolley et al. (2016) assess taxonomic and regional conservation priorities, and find that, in many regions of Africa (e.g., the Horn of Africa, Central and West Africa), agriculture emerges as the greatest threat (see also Meng et al., 2016). That said, Tolley et al. (2016) also point out that most African reptiles are too poorly known for their conservation status to be assessed adequately, with a lack of sampling effort greatly limiting knowledge of species, let alone their conservation status. They nonetheless find that several taxa, such as amphisbaenids, chameleons, and turtles, have a much higher percentage of threatened species than expected – and that the reptile faunas of several countries in equatorial Africa are at greatest risk. The second paper on Afrotopical species (Meng et al., 2016) begins to address the gap identified by Tolley et al. (2016), by systematically evaluating the threat status and climate change vulnerability of Tanzanian reptile species, using IUCN criteria. Their assessment suggests that 13% of Tanzanian reptiles are threatened, whereas 11% are Data Deficient. These figures are below the global average, potentially reflecting the fact that Tanzania is one of the better-studied African countries (Tolley et al., 2016). The authors also identify several regions and habitats that are under greatest threat, and point out globally-threatened and climate change vulnerable species that are poorly covered by existing protected areas. Interestingly, the findings of Meng et al. (2016) echo those of Böhm et al. (2016b), in that climate change vulnerable species in Tanzania are not necessarily the same as those that are currently listed as threatened by IUCN.

The final paper that addresses regional knowledge gaps is a study from tropical Australia (Rosauer et al., 2016). Meiri and Chapple (2016) show that IUCN has vastly under-assessed Australian lizards. One reason for this geographic disparity is the poorly known taxonomy and rapid rate of species discovery and description among Australia taxa (Meiri and Chapple, 2016). In a case study of ten lizard genera distributed across northern Australia, Rosauer et al. (2016) use phylogeographic methods to show that actual lizard diversity is far greater than current taxonomy would indicate. But this deficit in current taxonomy may not be an impediment to conservation planning if, as Rosauer et al. (2016) illustrate, phylogeographic methods can be used to map hotspots of unprotected phylogenetic endemism, and thus to identify priority areas for conservation, without the need to first resolve taxonomic uncertainties.

Finally, Maritz et al. (2016) interrogate an important taxonomic gap in our understanding of reptile extinction risk by examining spatial and taxonomic conservation priorities for the world's vipers – a group that is significantly over-represented among threatened reptile families (Böhm et al., 2013; Tolley et al., 2016). Maritz et al. (2016) present three indices (reactive, proactive and combined) that can be used to map spatial conservation priorities, and in the case of vipers, these areas largely overlapped at the global scale with species richness. The authors also identify regions and species for which further research and assessment is sorely needed.

2.3. Conservation interventions

The concluding theme of the special issue contains papers that focus on conservation actions to mitigate four key drivers of reptile extinction, namely: over-harvesting, invasive species, habitat loss and fragmentation, and global climate change (Gibbons et al., 2000). Auliyai et al. (2016) review data on the global reptile pet trade, and present detailed regional case studies, to examine the contribution of trade to the over-harvesting of wild populations. The authors find that The European Union plays a significant role in reptile trade, with over 20 million individuals imported over a 10-year period. Auliyai et al. (2016) suggest that regulations and enforcement in several countries are insufficient to prevent unsustainable and illegal trade, and make recommendations to address this issue. Meng et al. (2016) also identify trade as a significant threat to Tanzanian reptiles.

On many islands, such as New Zealand, invasive species are the primary threat to reptile biodiversity (Case et al., 1998; Böhm et al., 2013). Towns et al. (2016) review conservation translocations of New Zealand lizards to offshore islands free of invasive mammals, and review the criteria by which these translocations have been evaluated. The authors show that most translocations have involved a relatively small number of individuals, restricting 'success' and enhancing the possibility of demographic and genetic issues. But with modifications, translocations hold great promise as a management tool to increase range size, and thus improve the conservation status of threatened reptiles.

The special issue concludes with two case studies that evaluate conservation actions for threatened freshwater turtles. Reptile species that inhabit freshwater environments are particularly threatened (Böhm et al., 2013), and 59% of all assessed turtles are at risk of extinction (van Dijk et al., 2014). Canessa et al. (2016) evaluate the success of a captive breeding and reintroduction program for the freshwater turtle *Emys orbicularis,* which is threatened by invasive species and habitat loss and fragmentation. Using empirical data on vital rates of reintroduced individuals, the authors demonstrate how such monitoring data can be used to reduce uncertainty in predictions of persistence and modify management decisions accordingly. In a second case study, Mitchell et al. (2016) review conservation translocations of reptile eggs in the context of global climate change, and illustrate the power of mechanistic microclimate models to identify sites for assisted colonization of a Critically Endangered freshwater turtle (*Pseudemydura umbrina*). Their results demonstrate that translocation sites with optimal hydroperiods for free-living life stages (juveniles and adults) are not necessarily ideal for embryos; only if female turtles select unshaded nest sites will candidate translocation sites be suitable for embryonic development under the current climate.

3. Future directions in reptile extinction risk research

The contributions to this special issue have made significant progress in narrowing the taxonomic gap in extinction risk research, but key challenges remain. Below we conclude with several issues that warrant further investigation.

3.1. Additional regional priorities

Many papers in the special issue identify Tropical Asia, Central America, Australia, and Africa as hosting significant levels of threat (Bland and Böhm, 2016; Böhm et al., 2016b; Maritz et al., 2016; Tonini et al., 2016; Fig. 1C) and under-assessment (Meiri and Chapple, 2016; Fig. 1A). Many of these regions also contain a disproportionate number of Data Deficient species (Böhm et al., 2013; Bland and Böhm, 2016; Fig. 1B). None of the contributions in the special issue specifically examined Tropical Asia or Central America, but further assessments are clearly needed in these regions, in addition to Africa and Australia. As highlighted by Meiri and Chapple (2016), region- and taxa-specific working groups, such as those implemented as part of the Global Reptile Assessment (GRA), should be urgently prioritised in these regions.

3.2. Macroecological analyses of extinction risk

For decades, macroecological studies of extinction risk have benefited from the disparate research and conservation attention that has been afforded to mammals and birds (Bonnet et al., 2002). Heightened awareness of global amphibian declines has begun to shift the focus away from endothermic vertebrates (Cooper et al., 2008; Sodhi et al., 2008; Howard and Bickford, 2014), but studies of reptile extinction risk remain comparatively rare. Nonetheless, recent contributions, fuelled by the increasing availability of data on threat status and life-history provided by the GRA, and working groups such as GARD (Global Assessment of Reptile Distributions; http://www.gardinitiative.org), are narrowing this taxonomic gap (Meiri et al., 2012; Tingley et al., 2013a, 2013b; Ducatez et al., 2014; Bland and Böhm, 2016; Böhm et al., 2016a, 2016b; Tonini et al., 2016; Tingley et al., in press). These analyses remain preliminary, however, in that they are based on a relatively small and potentially biased subset of the world's reptile fauna (Meiri and Chapple, 2016). Thus, future studies should seek to validate the findings of previous macroecological analyses as further IUCN assessments are completed. Fortunately, a rich history of macroecological studies of birds, mammals, and amphibians has provided valuable methodological and conceptual advances that will pave the way for the next generation of reptile extinction risk analyses, once more assessments become available.

3.3. Retrospective analyses

Contributions to the special issue propose a variety of indices for spatial and taxonomic prioritization. For example, Maritz et al. (2016); Rosauer et al. (2016), and Tonini et al. (2016) develop indices based on evolutionary distinctiveness, Tolley et al. (2016) and Roll et al. (2016) use sociological and economic parameters, and Meng et al. (2016) and Böhm et al. (2016b) prioritise on the basis of climate change vulnerability. An alternative approach is to develop models of risk, using threat data from species that have already been assessed by IUCN (Bland and Böhm, 2016). Future studies could evaluate the predictive ability of such approaches by comparing observed and predicted threat statuses, once further IUCN assessments are completed. This hindcasting approach has rarely been applied in the extinction risk literature (Tingley et al., 2013b; Bland and Böhm, 2016) but presents a potentially powerful test of the ability of different threat metrics to forecast extinction risk and spatial conservation priorities.

3.4. Monitoring the success of conservation interventions

Most of the case studies on conservation interventions in the special issue focused on translocation or reintroduction. For many species, particularly those threatened by climate change or invasive species that are difficult to eradicate, these may be the only viable actions. Yet our ability to evaluate the success of translocation as a management tool has been hindered by a failure to document outcomes adequately (Germano and Bishop, 2009; Germano et al., 2015). This knowledge gap applies to conservation interventions more broadly (but see Hoffmann et al., 2010, 2015); however, monitoring does not in itself lead to better conservation outcomes (Canessa et al., 2016). Thus, we advocate the use of adaptive management and decision-support tools, such as Value of

Information analysis (Canessa et al., 2015), to evaluate the success of conservation interventions and quantify the value of additional monitoring data.

4. Conclusion

This special issue was born out of our collective concern that reptiles remain under-assessed and consequently under-represented in conservation planning. Indeed, many global conservation prioritizations have neglected reptiles (reviewed in Brooks et al., 2006; Blundell and Burkey, 2007), or focused on a very small subset of reptile species (e.g., Rodrigues et al., 2004a, 2004b), due to inadequate data on threat statuses and distributions. Geographic patterns of reptile diversity can differ markedly from those of other vertebrate groups (e.g., Powney et al., 2010), and thus future studies should evaluate the extent to which including threatened reptiles in conservation planning shifts conservation priorities (Bode et al., 2008), once further IUCN assessments are completed.

Acknowledgements

We thank Dr. Karen Beard and Dr. Richard Primack for their editorial assistance, and all of the authors and reviewers who contributed to the special issue.

References

Auliyai, M., Altherr, S., Ariano-Sanchez, D., Baard, E.H., Brown, C., Brown, R.M., Cantu, J.-C., Gentile, G., Gildenhuys, P., Henningheim, E., Hintzmann, J., Kanari, K., Krvavac, M., Lettink, M., Lippert, J., Luiselli, L., Nilson, G., Nguyen, T.Q., Nijman, V., Parham, J.F., Pasachnik, S.A., Pedrono, M., Rauhaus, A., Córdova, D.R., Sanchez, M.-E., Schepp, U., van Schingen, M., Schneeweiss, N., Segniagbeto, G.H., Somaweera, R., Sy, E.Y., Türkozan, O., Vinke, S., Vinke, T., Vyas, R., Williamson, S., Ziegler, T., 2016. Trade in live reptiles, its impact on wild populations, and the role of the European market. Biol. Conserv. 204, 103–119.

Bland, L.M., Böhm, M., 2016. Overcoming data deficiency in reptiles. Biol. Conserv. 204, 16–22.

Bland, L.M., Orme, C.D.L., Bielby, J., Collen, B., Nicholson, E., McCarthy, M.A., 2015. Cost-effective assessment of extinction risk with limited information. J. Appl. Ecol. 52, 861–870.

Blundell, A.G., Burkey, T.V., 2007. A database of schemes that prioritize sites and species based on their conservation value: Focusing business on biodiversity. BMC Ecol. 7, 1–5.

Bode, M., Wilson, K.A., Brooks, T.M., Turner, W.R., Mittermeier, R.A., McBride, M.F., Underwood, E.C., Possingham, H.P., 2008. Cost-effective global conservation spending is robust to taxonomic group. Proc. Natl. Acad. Sci. 105, 6498–6501.

Böhm, M., Cook, D., Ma, H., Carr, M., Freeman, R., 2016b. Hot and bothered: using trait-based approaches to assess climate change vulnerability in reptiles. Biol. Conserv. 204, 32–41.

Böhm, M., Williams, R., Bramhall, H.R., McMillian, K.M., Davidson, A.D., Garcia, A., Bland, L.M., Bielby, J., Collen, B., 2016a. Correlates of extinction risk in squamate reptiles: the relative importance of biology, geography, threat and range size. Glob. Ecol. Biogeogr. 25, 391–405.

Böhm, M., et al., 2013. The conservation status of the world's reptiles. Biol. Conserv. 157, 372–385.

Bonnet, X., Shine, R., Lourdais, O., 2002. Taxonomic chauvinism. Trends Ecol. Evol. 17, 1–3.

Brooks, T.M., Mittermeier, R.A., da Fonseca, G.A.B., et al., 2006. Global biodiversity conservation priorities. Science 313, 58–61.

Canessa, S., Genta, P., Jesu, R., Lamagni, L., Oneto, F., Salvidio, S., Ottonello, D., 2016. Challenges of monitoring reintroduction outcomes: insights from the conservation breeding program of an endangered Turtle in Italy. Biol. Conserv. 204, 128–133.

Canessa, S., Guillera-Arroita, G., Lahoz-Monfort, J.J., Southwell, D.M., Armstrong, D.P., Chadès, I., Lacy, R.C., Converse, S.J., 2015. When do we need more data? A primer on calculating the value of information for applied ecologists. Methods Ecol. Evol. 6, 1219–1228.

Case, T.J., Bolger, A.D., Richman, A.D., 1998. Reptilian extinctions over the last ten thousand years. In: Fielder, P.L., Kareiva, P.M. (Eds.), Conservation Biology for the Coming Decade, second ed. Chapman & Hall, New York, pp. 157–186.

Colli, G.R., Fenkera, J., Tedeschia, L.G., Barreto-Limaa, A.F., Mott, T., Ribeiro, S.L.B., 2016. In the depths of obscurity: knowledge gaps and extinction risk of Brazilian worm lizards (Squamata, Amphisbaenidae). Biol. Conserv. 204, 51–62.

Cooper, N., Bielby, J., Thomas, G.H., Purvis, A., 2008. Macroecology and extinction risk correlates in frogs. Glob. Ecol. Biogeogr. 17, 211–221.

Ducatez, S., Tingley, R., Shine, R., 2014. Using species co-occurrence patterns to quantify relative habitat breadth in terrestrial vertebrates. Ecosphere 5, 152.

Germano, J.M., Bishop, P.J., 2009. Suitability of amphibians and reptiles for translocation. Conserv. Biol. 23, 7–15.

Germano, J.M., Field, K.J., Griffiths, R.A., Clulow, S., Foster, J., Harding, G., Swaisgood, R.R., 2015. Mitigation-driven translocations: are we moving wildlife in the right direction? Front. Ecol. Environ. 13, 100–105.

Gibbons, J.W., Scott, D.E., Ryan, T.J., Buhlmann, K.A., Tuberville, T.D., Metts, B.S., Greene, J.L., Mills, T., Leiden, Y., Poppy, S., Winne, C.T., 2000. The global decline of reptiles, déjà vu amphibians. Bioscience 50, 653–666.

Hoffmann, M., Duckworth, J.W., Holmes, K., Mallon, D.P., Rodrigues, A.S.L., Stuart, S.N., 2015. The difference conservation makes to extinction risk of the world's ungulates. Conserv. Biol. 29, 1303–1313.

Hoffmann, M., et al., 2010. The impact of conservation on the status of the world's vertebrates. Science 330, 1503–1509.

Howard, S.D., Bickford, D.P., 2014. Amphibians over the edge: silent extinction risk of data deficient species. Divers. Distrib. 20, 837–846.

Huey, R.B., Losos, J.B., Moritz, C., 2010. Are lizards toast? Science 328, 832–833.

IUCN, 2015. The IUCN Red List of threatened species. Version 2015-3.

Jenkins, R.K.B., Tognelli, M.F., Bowles, P., Cox, N., Brown, J.L., Chan, L., Andreone, F., Andriamazava, A., Andriantsimanarilafy, R.R., Anjeriniaina, M., Bora, P., Brady, L.D., Hantalalaina, E.F., Glaw, F., Griffiths, R.A., Hilton-Taylor, C., Hoffmann, M., Katariya, V., Rabibisoa, N.H., Rafanomezantsoa, J., Rakotomalala, D., Rakotondravony, H., Rakotondrazafy, N.A., Ralamboniarainy, J., Ramannamanjato, J.B., Randriamahazo, H., Randrianantoandro, J.C., Randrianasolo, H.H., Randrianirina, J.E., Randrianizahan, H., Raselimanana, A.P., Rasolohery, A., Ratsoavina, F.M., Raxworthy, C.J., Rabosmanitrandrasana, E., Rollande, F., van Dijk, P.P., Yoder, A.D., Vences, M., 2014. Extinction risks and the conservation of Madagascar's reptiles. PLoS One 9.

Maritz, B., Penner, J., Martins, M., Crnobrnja-Isailović, J., Spear, S., Alencar, L.R., Sigala-Rodriguez, J., Messenger, K., Clark, R., Jenkins, C., Soorae, P., Luiselli, L., Greene, H.W., 2016. Identifying global priorities for the conservation of vipers. Biol. Conserv. 204, 94–102.

Meiri, S., 2016. Small, rare and trendy: traits and biogeography of lizards described in the 21st century. J. Zool. http://dx.doi.org/10.1111/jzo.12356 (in press).

Meiri, S., Chapple, D.G., 2016. Biases in the current knowledge of threat status in lizards, and bridging the 'assessment gap'. Biol. Conserv. 204, 6–15.

Meiri, S., Brown, J.H., Sibly, R.M., 2012. The ecology of lizard reproductive output. Glob. Ecol. Biogeogr. 21, 592–602.

Meng, H., Carr, J., Beraducci, J., Bowles, P., Branch, W., Capitani, C., Chenga, J., Cox, N., Howell, K., Malonza, P., Marchant, R., Mbilinyi, B., Mukama, K., Msuya, C., Platts, P.J., Safari, I., Spawls, S., Shennan-Farpon, Y., Wagner, P., Burgess, N.D., 2016. Tanzania's reptile biodiversity: distribution, threats and climate change vulnerability. Biol. Conserv. 204, 72–82.

Mitchell, N.J., Rodriguez, N., Kuchling, G., Arnall, S.G., Kearney, M.R., 2016. Reptile embryos and climate change: modelling limits of viability to inform translocation decisions. Biol. Conserv. http://dx.doi.org/10.1016/j.biocon.2016.04.004.

Powney, G.D., Grenyer, R., Orme, C.D.L., Owens, I.P.F., Meiri, S., 2010. Hot, dry and different: Australian lizard richness is unlike that of mammals, amphibians and birds. Glob. Ecol. Biogeogr. 19, 386–396.

Reading, C.J., Luiselli, L.M., Akani, G.C., Bonnet, X., Amori, G., Ballouard, J.M., Filippi, E., Naulleau, G., Pearson, D., Rugiero, L., 2010. Are snake populations in widespread decline? Biol. Lett. 6, 777–780.

Rodrigues, A.S.L., et al., 2004a. Effectiveness of the global protected area network in representing species diversity. Nature 428, 640–643.

Rodrigues, A.S.L., et al., 2004b. Global gap analysis: priority regions for expanding the global protected-area network. Bioscience 54, 1092–1100.

Roll, U., Mittermeier, J.C., Diaz, G.I., Novosolov, M., Feldman, A., Itescu, Y., Meiri, S., Grenyer, R., 2016. Using Wikipedia page views to explore the cultural importance of global reptiles. Biol. Conserv. 204, 42–50.

Rosauer, D., Blom, M.P.K., Bourke, G., Catalano, S., Donnellan, S., Gillespie, G., Mulder, E., Oliver, P.M., Potter, S., Pratt, R., Rabosky, D.L., Skipwith, P.L., Moritz, C., 2016. Phylogeography, hotspots and conservation priorities: an example from the top end of Australia. Biol. Conserv. 204, 83–93.

Sodhi, N.S., Bickford, D., Diesmos, A.C., Lee, T.M., Koh, L.P., Brook, B.W., Sekercioglu, C.H., Bradshaw, C.J.A., 2008. Measuring the meltdown: drivers of global amphibian extinction and decline. PLoS One 3, e1636.

Tingley, R., Hitchmough, R.A., Chapple, D.G., 2013a. Life-history traits and extrinsic threats determine extinction risk in New Zealand lizards. Biol. Conserv. 165, 62–68.

Tingley, R., Hitchmough, R.A., Chapple, D.G., 2013b. Analyses of extinction risk are an important part of the conservation process — reply to Monks. Biol. Conserv. 168, 224–225.

Tingley, R., Mahoney, P.J., Durso, A.M., Tallian, A.G., Moran-Ordonez, A., Beard, K.H., 2016. Threatened and invasive reptiles are not two sides of the same coin. Glob. Ecol. Biogeogr. (in press).

Tolley, K.A., Alexander, G.J., Branch, W.R., Bowles, P., Maritz, B., 2016. Conservation status and threats for African reptiles. Biol. Conserv. 204, 63–71.

Tonini, J.F.R., Beard, K.H., Ferreira, R.B., Jetz, W., Pyron, R.A., 2016. Fully-sampled phylogenies of squamates reveal evolutionary patterns in current threat status. Biol. Conserv. 204, 23–31.

Towns, D.R., Miller, K.A., Nelson, N.J., Chapple, D.G., 2016. Can translocations to islands reduce extinction risk for reptiles? Case studies from New Zealand. Biol. Conserv. 204, 120–127.

Uetz, P., Hosek, J., 2015. The Reptile Database. http://www.reptile-database.org (accessed August 13, 2015).

van Dijk, P.P., Iverson, J.B., Rhodin, A.G.J., Shaffer, H.B., Bour, R., 2014. Turtles of the world, 7th edition: annotated checklist of taxonomy, synonymy, distribution with maps, and conservation status. In: Rhodin, A.G.J., Pritchard, P.C.H., van Dijk, P.P., Saumure, R.A., Buhlmann, K.A., Iverson, J.B., Mittermeierw, R.A. (Eds.), Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelon. Res. Monogr. 5, pp. 329–479.