Ten-year assessment of the 100 priority questions for global biodiversity conservation

Jucker, T., Wintle, B., Shackelford, G., Bocquillon, P., Geffert, J. L., Kasaor, T., Kovacs, E., Mumby, H. S., Orland, C., Schleicher, J., Tew, E. R., Zabala, A., Amano, T., Bell, A., Bongalov, B., Chambers, J. M., Garnett, E. E., Green, E. J., Guth, M. K., Hacket-Pain, A., Hinsley, A., Igea, J., Kunz, M., Luke, S. H., Martin, P. A., Lynam, W., Nunes, M. H., Ockendon, N., Pavitt, A., Payne, C. L. R., Plutshack, V., Rademacher, T. T., Robertson, R. J., Rose, D. C., Serban, A., Simmons, B. I., Corrigan, C., Emilson, E. J. S., Tayleur, C., Wordley, C. F. R., Mukherjee, N., Durán, A. P., Duvic-Paoli, L.-A., Emilson, C., Emilson, E. J. S. and Fonseca da Silva, J. (2018) Ten-year assessment of the 100 priority questions for global biodiversity conservation. Conservation Biology, 32 (6). pp. 1457-1463. ISSN 0888-8892 doi: 10.1111/cobi.13159 Available at https://centaur.reading.ac.uk/86623/

Conservation Biology

Research Note

Ten-year assessment of the 100 priority questions for global biodiversity conservation

Tommaso Jucker [1,2*†], Bonnie Wintle,[3,4] Gorm Shackelford,[5] Pierre Bocquillon,[6,7] Jan Laurens Geffert,[8,9] Tim Kasoar,[5] Eszter Kovacs,[8,10] Hannah S. Mumby,[5,11] Chloé Orland,[1] Judith Schleicher,[8,9] Eleanor R. Tew,[5] Aiora Zabala,[7] Tatsuya Amano,[3,5] Alexandra Bell,[12] Boris Bongalov,[1] Josephine M. Chambers,[8] Colleen Corrigan,[9,13] América P. Durán,[5,9,14] Leslie-Anne Duvic-Paoli,[7] Caroline Emilson,[15] Erik J.S. Emilson [1,15], Jéssica Fonseca da Silva,[1] Emma E. Garnett,[5] Elizabeth J. Green,[9] Miriam K. Guth,[9] Andrew Hacket-Pain,[16] Amy Hinsley,[17] Javier Igea,[1] Martina Kunz,[7] Sarah H. Luke,[5,18] William Lynam,[1] Philip A. Martin,[5] Matheus H. Nunes,[1] Nancy Ockendon,[5] Aly Pavitt,[9] Charlotte L.R. Payne,[5] Victoria Plutshack,[7] Tim T. Rademacher,[8,19,20] Rebecca J. Robertson,[5] David C. Rose,[5,21] Anca Serban,[8] Benno I. Simmons,[5] Catherine Tayleur,[5,22] Claire F.R. Wordley,[5] and Nibedita Mukherjee [5,23†]

[1]Department of Plant Sciences, University of Cambridge, Downing St, Cambridge CB2 3EA, U.K.
[2]CSIRO Land & Water, 147 Underwood Avenue, Floreat, WA 6014, Australia
[3]Centre for the Study of Existential Risk, University of Cambridge, Pembroke Street, Cambridge CB2 3QZ, Cambridge, U.K.
[4]School of BioSciences, University of Melbourne, Royal Parade, Parkville, VIC 3010, Australia
[5]Department of Zoology, University of Cambridge, Pembroke Street, Cambridge CB2 3QZ, U.K.
[6]School of Politics, Philosophy, Language and Communication Studies, University of East Anglia, Norwich Research Park, Norwich NR4 7TJ, U.K.
[7]Department of Land Economy, Cambridge Centre for Environment, Energy and Natural Resource Governance, University of Cambridge, 16–21 Silver Street, Cambridge CB3 9EP, U.K.
[8]Department of Geography, University of Cambridge, 20 Downing Place, Cambridge, CB2 1QB, U.K.
[9]UN Environment World Conservation Monitoring Centre, 219 Huntingdon Road, Cambridge CB3 0DL, U.K.
[10]Corvinus University of Budapest, Fővám tér 8, Budapest, 1093, Hungary
[11]Wissenschaftskolleg zu Berlin, Berlin, Germany, Wallotstraße 19, 14193 Berlin, Germany
[12]Ministerium für Umwelt, Energie, Ernährung und Forsten, Rheinland Pfalz, Kaiser-Friedrich-Straße 1, 55116 Mainz, Germany
[13]School of Earth and Environmental Sciences, University of Queensland, St Lucia, QLD 4067, Australia
[14]Luc Hoffmann Institute, c/o WWF International, Avenue du Mont Blanc, 1196 Gland, Switzerland
[15]Natural Resources Canada, Great Lakes Forestry Centre, Sault Ste. Marie, ON, P6A 2E5, Canada
[16]Department of Geography and Planning, School of Environmental Science, University of Liverpool, 4 Brownlow Street, Liverpool Merseyside, L69 3GP, U.K.
[17]Interdisciplinary Centre for Conservation Science, Department of Zoology, University of Oxford, 11a Mansfield Road, Oxford OX1 3SZ, U.K.
[18]Durrell Institute of Conservation and Ecology, School of Anthropology and Conservation, The University of Kent, Canterbury, Kent, CT2 7NR, U.K.
[19]Department of Organismic and Evolutionary Biology, Harvard University, 26 Oxford Street, Cambridge, MA 02138, U.S.A.
[20]School of Informatics and Cyber Security and Centre for Ecosystem Science and Society, Northern Arizona University, 1295 Knoles Drive, Flagstaff, AZ 86011, U.S.A.
[21]School of Environmental Sciences, University of East Anglia, Norwich Research Park, Norwich, Norfolk, NR4 7TJ, U.K.
[22]RSPB Centre for Conservation Science, The Lodge, Potton Road, Sandy, Bedfordshire, SG19 2DL, U.K.
[23]Centre for Ecology and Conservation, College of Life and Environmental Sciences, University of Exeter, Cornwall Campus, Treliever Road, Penryn, Cornwall TR10 9FE, U.K.

*email tommasojucker@gmail.com
†Both the authors contributed equally.

***Article impact statement**: Freshwater ecosystem conservation, role of social structures in human-environment interactions, and impacts of conservation interventions remain important knowledge gaps in efforts to conserve global biodiversity.*

Paper submitted January 13, 2017; revised manuscript accepted June 14, 2018.

Conservation Biology, Volume 32, No. 6, 1457–1463

DOI: 10.1111/cobi.13159

Abstract: *In 2008, a group of conservation scientists compiled a list of 100 priority questions for the conservation of the world's biodiversity. However, now almost a decade later, no one has yet published a study gauging how much progress has been made in addressing these 100 high-priority questions in the peer-reviewed literature. We took a first step toward reexamining the 100 questions to identify key knowledge gaps that remain. Through a combination of a questionnaire and a literature review, we evaluated each question on the basis of 2 criteria: relevance and effort. We defined highly relevant questions as those that – if answered – would have the greatest impact on global biodiversity conservation and quantified effort based on the number of review publications addressing a particular question, which we used as a proxy for research effort. Using this approach, we identified a set of questions that, despite being perceived as highly relevant, have been the focus of relatively few review publications over the past 10 years. These questions covered a broad range of topics but predominantly tackled 3 major themes: conservation and management of freshwater ecosystems, role of societal structures in shaping interactions between people and the environment, and impacts of conservation interventions. We believe these questions represent important knowledge gaps that have received insufficient attention and may need to be prioritized in future research.*

Keywords: horizon scanning, knowledge gaps, literature review, network analysis, priority setting, questionnaire, research agenda

Evaluación de las 100 Preguntas Prioritarias para la Conservación Mundial de la Biodiversidad Diez Años Después

Resumen: *En 2008 un grupo de científicos de la conservación recopilaron una lista de 100 preguntas prioritarias para la conservación mundial de la biodiversidad (Sutherland et al. 2009). Sin embargo, ahora casi una década después, nadie ha publicado en la literatura revisada por pares un estudio que estime cuánto progreso se ha logrado en el tratado de estas 100 preguntas de alta prioridad. Realizamos un primer paso hacia la reexaminación de las 100 preguntas para identificar los vacíos importantes de conocimiento que todavía permanecen. Por medio de una combinación de un cuestionario y una revisión de la literatura, evaluamos cada pregunta con base en dos criterios: relevancia y esfuerzo. Definimos a las preguntas de alta relevancia como aquellas que – de ser respondidas – tendrían el mayor impacto sobre la conservación mundial de la biodiversidad y cuantificamos el esfuerzo con base en el número de publicaciones revisadas que trataban sobre alguna pregunta en particular, lo cual usamos como un sustituto para el esfuerzo de investigación. Con este método identificamos un conjunto de preguntas que, a pesar de ser percibidas como muy relevantes, han sido el foco de relativamente pocas publicaciones en los últimos diez años. Estas preguntas cubrieron una amplia gama de temas pero abordaban principalmente tres grandes temas: conservación y manejo de los ecosistemas de agua dulce, el papel de las estructuras de la sociedad en la formación de las interacciones entre las personas y el ambiente, y los impactos de las intervenciones de conservación. Creemos que estas preguntas representan vacíos importantes de conocimiento que han recibido poca atención y probablemente tendrán que volverse una prioridad en investigaciones futuras.*

Palabras Clave: agenda de investigación, análisis de redes, cuestionario, escaneo del horizonte, establecimiento de prioridades, revisión de la literatura, vacíos de conocimiento

摘要: *2008年, 保护学家为全球生物多样性保护列出了100 个优先问题 (Sutherland et al. 2009) 。然而, 近十年后的今天, 还没有一篇同行评议的文章统计过我们在解决这100 个优先问题上取得的进展。我们初步地重新检验了这 100 个问题, 以确定目前存在的关键知识空缺。通过问卷调查和文献综述, 我们用相关性和努力程度这两个标准对每个问题都进行了评估。我们将 "高度相关的问题" 定义为, 如果得到回答, 将对全球生物多样性保护产生重要影响的问题; 努力程度则是用针对该问题的综述文章的数量作为研究投入的指标来进行量化。我们用这种方法确定了一系列在过去十年中被认为与全球生物多样性保护高度相关, 但却较少受到综述文章关注的问题。这些问题覆盖面广, 但主要涉及三大类主题: 淡水生态系统的保护和管理、社会结构对构建人与自然相互作用的影响, 以及保护干预措施的效果。我们认为这些问题代表了那些没有得到足够关注的知识空缺, 可能需要在未来的研究中优先考虑。* **【翻译: 胡怡思; 审校: 聂永刚】**

关键词: 文献综述, 水平扫描,知识空缺, 网络分析, 确定保护优先性, 问卷, 研究议程

Introduction

The ability to prioritize research in conservation science is critical to ensuring that available resources are used as effectively as possible to safeguard biodiversity. One approach to defining high-priority areas of research is to identify key questions which—if addressed—would contribute most toward advancing a given field. In recent years, this type of priority-setting exercise has become increasingly common in the environmental sciences. In the context of conservation science, Sutherland et al. (2009) were the first to compile a list of 100 questions of importance for the practice of conserving the world's biodiversity. As of July 2016, Sutherland et al. (2009) has

been cited 229 times, 70 of which did so specifically to justify research on topics highlighted in the paper (see Supporting Information). However, now a decade since these questions were first published, which ones should still be considered a high priority?

In an attempt to address this question, we conducted a preliminary assessment of how much progress has been made in addressing the 100 priority questions for global biodiversity conservation outlined in Sutherland et al. (2009). Through a combination of a questionnaire and a literature survey, we revisited the 100 questions with the aim of identifying which ones constitute key knowledge gaps that limit the effectiveness of conservation practices worldwide. Specifically, we asked which of the 100 questions were currently considered most relevant by conservation scientists and practitioners, which ones had researchers focused most of their efforts on, and which have featured less in the literature. In doing so, we sought to develop a framework through which priority questions from any field of research can be monitored and updated through time.

Methods

Compiling the Original 100 Questions

In 2008, a group of conservation scientists and practitioners convened for a workshop with the objective of outlining a set of key questions which—if answered—would have the greatest impact on conservation practices worldwide. Participants included representatives from both international conservation organizations and academic institutions based predominantly in western Europe and North America, but with strong working experience outside these areas. Through a series of group discussions and voting sessions, attendees converged on a list of 100 priority questions that featured in Sutherland et al. (2009) (see Supporting Information for a list of the 100 questions). For convenience, the questions were grouped into 12 broad themes: ecosystem function and services, climate change, technological change, protected areas, ecosystem management and restoration, terrestrial ecosystems, marine ecosystems, freshwater ecosystems, species management, organizational systems and processes, societal context and change, impacts of conservation interventions. We followed the above grouping structure, although Sutherland et al. (2009) suggested this is only 1 of several ways in which the 100 questions could be organized into themes.

Revising the 100 Questions

We evaluated each of the 100 questions on the basis of relevance and effort. Relevance was used to rank questions based on their potential to positively impact biodiversity conservation on a global scale. Highly relevant questions were those that if answered would have the greatest impact on global biodiversity conservation. Effort, instead, quantified how much research had been directed toward a particular question, for which we used number of review papers as a proxy. In this framework, questions that were deemed highly relevant but had relatively few associated review publications constituted knowledge gaps that limit the ability to effectively conserve biodiversity.

Relevance

Relevance scores for each of the 100 questions were obtained through a questionnaire. Respondents were presented with 10 randomly selected questions and asked to score each of these on a scale of 1 (low relevance) to 10 (high relevance). Respondents were also asked to identify how familiar they were with the topic of each question on a scale of 1 (no familiarity) to 10 (very familiar). We gathered information on each respondent's gender, career stage, and continent of origin. We distributed the survey globally among conservation scientists and practitioners via targeted mailing lists and on social media outlets with the Qualtrics web application (https://www.qualtrics.com). The questionnaire is available from http://cambridge.eu.qualtrics.com/jfe/form/SV_42wbtBiTo25ncH3. The survey was conducted anonymously and ethics clearance was obtained from the University of Cambridge before its launch.

We used structural equation models (SEMs) fit using the lavaan package in R (R Core Development Team 2016) to tease apart how relevance scores were associated with a respondent's gender, career stage and familiarity score. Based on this, when calculating mean relevance scores for each of the 100 questions, we weighted participant scores according to their degree of familiarity with the question (although almost identical results were obtained when using an unweighted measure of relevance). This implicitly assumes that respondents that are more familiar with a given topic are better placed to judge its relevance.

Effort

To gauge the degree of effort that has gone into addressing each of the 100 questions, we undertook a literature review. Given the large number and diverse range of topic covered by the 100 questions, we restricted bibliographic searches to review articles only. We reasoned that review papers would provide a good indicator that research on a given topic had matured enough to warrant a synthesis. Furthermore, a preliminary analysis of the bibliographic data we collected revealed a very strong correlation between number of review papers and primary articles returned by a given search (Pearson's correlation coefficient [ρ] = 0.97). Nonetheless, by focusing on review

papers alone we overlooked other equally important publication outlets (e.g., primary literature, grey literature, books or reports) and other meaningful metrics of effort (e.g., expenditure or number of funded projects). As such, ours should be viewed as a preliminary first step toward quantifying research effort for Sutherland et al.'s (2009) 100 questions.

The literature review was conducted using the Scopus search engine and followed a protocol that is outlined in full in Supporting Information. Briefly, we started by generating keyword searches for each of the 100 questions and running them through Scopus. Search outputs were then screened to only include review papers published since 2009. For each question, all review papers returned by the search were then classified as either pertinent or not to the question based on information contained in the title and abstract of the paper (although titles and abstracts may not always fairly represent the content of an article). For searches that returned >100 review papers, this assessment was based on a random subset of 100 reviews (details in Supporting Information). The total number of pertinent review papers identified through this process was used as a proxy for research effort for each of the 100 questions.

We determined the extent to which these effort scores were influenced by the time window across which searches were conducted, the choice of keywords selected for each question, and the subjective interpretation of which review articles to consider as pertinent to a particular question (details in Supporting Information). The majority of our keyword searches included 1 or more of the terms: *biodiv**, *species*, *conserv**, and *ecosyst** (see Supporting Information for a complete list of keywords used for each question). This constrained our search to review papers that explicitly linked a given topic and its application to conservation. However, many potentially relevant articles and reviews may have been overlooked in this process because authors did not recognize or emphasize that connection in the text.

Relating Relevance and Effort Scores to Identify Knowledge Gaps

We analyzed the relevance and effort scores calculated for each of the 100 questions to identify which ones are currently considered most relevant and highlight questions that have been the subject of relatively few review articles and therefore may constitute knowledge gaps that, if filled, could lead to the development of more effective conservation practices. Knowledge gaps were defined as questions that scored higher than average in terms of relevance and that had a lower than average effort score. We quantified how closely relevance and effort scores correlated across the 100 questions to explore whether questions that are deemed highly relevant by those that are familiar with the topic have also been the focus of a greater number of review articles. For these analyses effort scores were log transformed to better capture the right-skewed distribution of the data, following which both metrics were normalized from 0 to 1 to aid interpretation of the results. Data were analyzed at the individual-question level and at the aggregated-theme level (i.e., after grouping questions into their 12 themes).

Results

Relevance

A total of 222 respondents took part in the survey to score the 100 questions according to relevance. Of these, the majority were from Europe and the United States, although respondents from all continents except Antarctica took part in the survey (Fig. 1). Respondents were equally balanced among men (52%) and women (48%), and represented a diverse range of career stages (career length ranged from 1 to 40 years) (Fig. 1). structural equation models revealed that multiple factors contributed to shaping a person's perception of relevance, including gender, career stage, and familiarity with the topic (Fig. 2). The clearest pattern to emerge was that, on average, respondents tended to assign higher relevance scores to questions they were most familiar with (Fig. 2b). In turn, respondents that had been working in conservation the longest were more likely to express familiarity with the topic of a given question. However, compared with early-career participants, respondents who had been working in conservation for longer tended to attribute lower relevance to a given question. Although the gender of participants had little direct influence on their perception of relevance or familiarity of a given topic, participants who had worked in conservation the longest were predominantly male (Fig. 1). Of the top 10 ranked questions according to relevance scores, 4 belong to the climate-change theme (Supporting Information).

Effort

The literature survey returned a total of 23,611 review papers published since the beginning of 2009 that matched the selected keywords. For 45 of the 100 questions, literature searches returned >100 review papers. Because in these cases a subset of 100 review papers was selected at random for scoring, the total number of publications we assessed was 6934. Of these, 2142 were classified as pertinent to a particular question based on their title and abstract. Based on this, we estimated a mean of 53 pertinent reviews per question. When questions were ranked according to their effort score, 3 of the top 5 questions with the lowest effort scores were in the impacts of conservation interventions theme (Supporting Information).

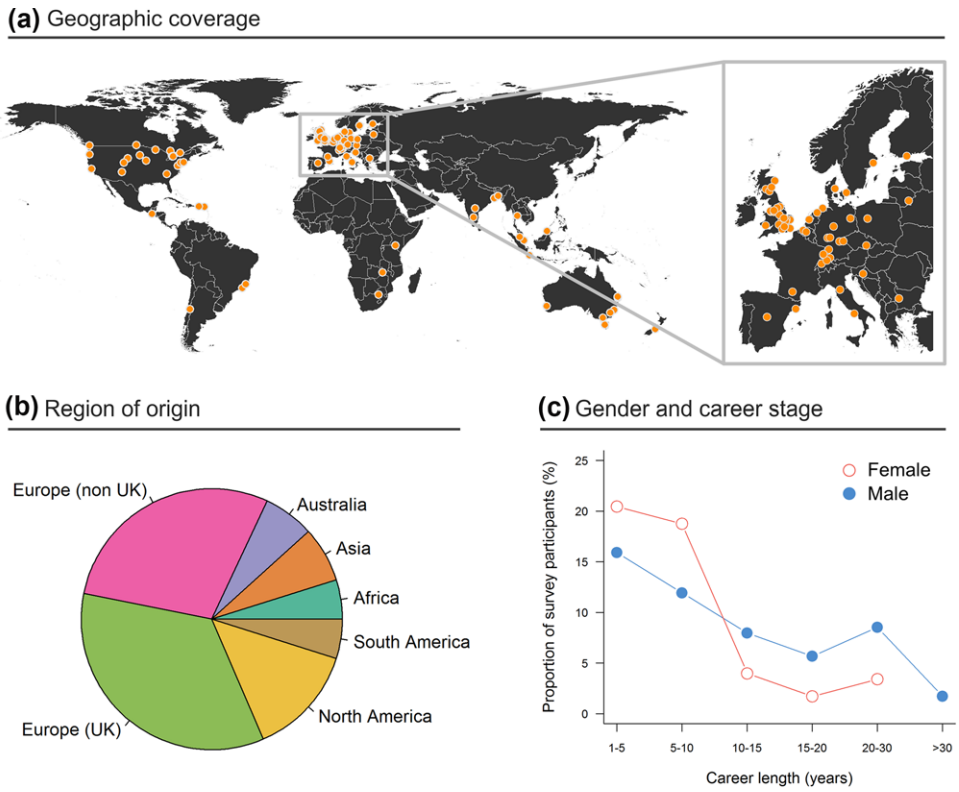

Figure 1. Breakdown of respondents who participated in the survey to assess the relevance of Sutherland et al.'s (2009) 100 priority questions for global biodiversity conservation by (a) geographic location, (b) continent of origin (for many respondents this differed from the geographic location where they took the survey), and (c) gender and career stage.

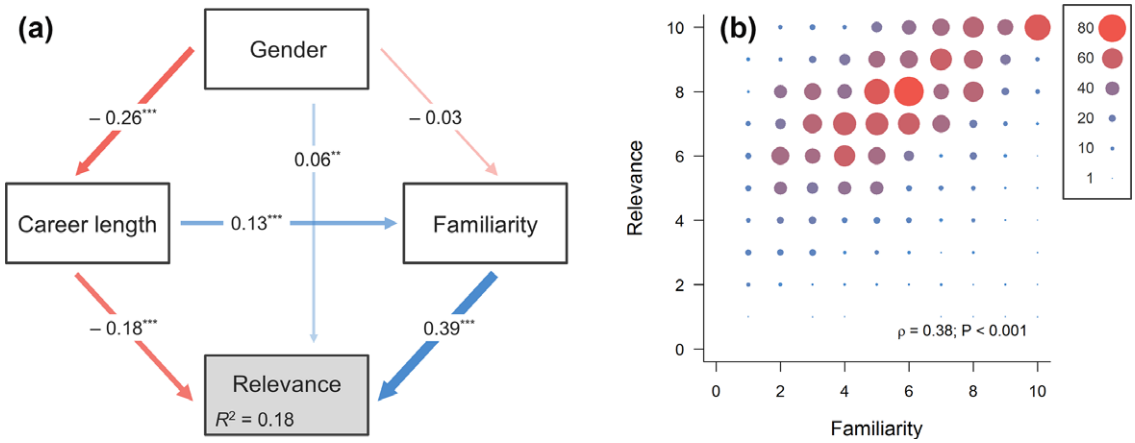

Figure 2. Results of the survey of conservation scientists asked to assess the relevance of Sutherland et al.'s (2009) 100 priority questions for global biodiversity conservation: (a) structural equation model that relates relevance scores (1, low relevance; 10, high relevance) to the respondent's familiarity with the topic of the question (1, low familiarity; 10, high familiarity), length of career (number of years spent working in conservation science), and gender (0, male; 1, female) (width of the arrows, proportional to the standardized path coefficient; significance: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$) and (b) relationships between relevance and familiarity scores across all 222 survey participants (size of the circles, reflects number of overlapping points; ρ, Pearson correlation coefficient between relevance and familiarity scores).

Knowledge Gaps

Questions and themes varied considerably in terms of both their relevance and effort scores (Fig. 3). Nonetheless, when looking across the 100 questions, a weak yet significantly positive correlation emerged between relevance and effort scores ($\rho = 0.29$, $p = 0.003$) (Fig. 3a). We identified 21 questions that met our criteria for knowledge gaps (Fig. 3b). When data were aggregated by theme, strong differences between groups emerged. For instance, questions in the technological

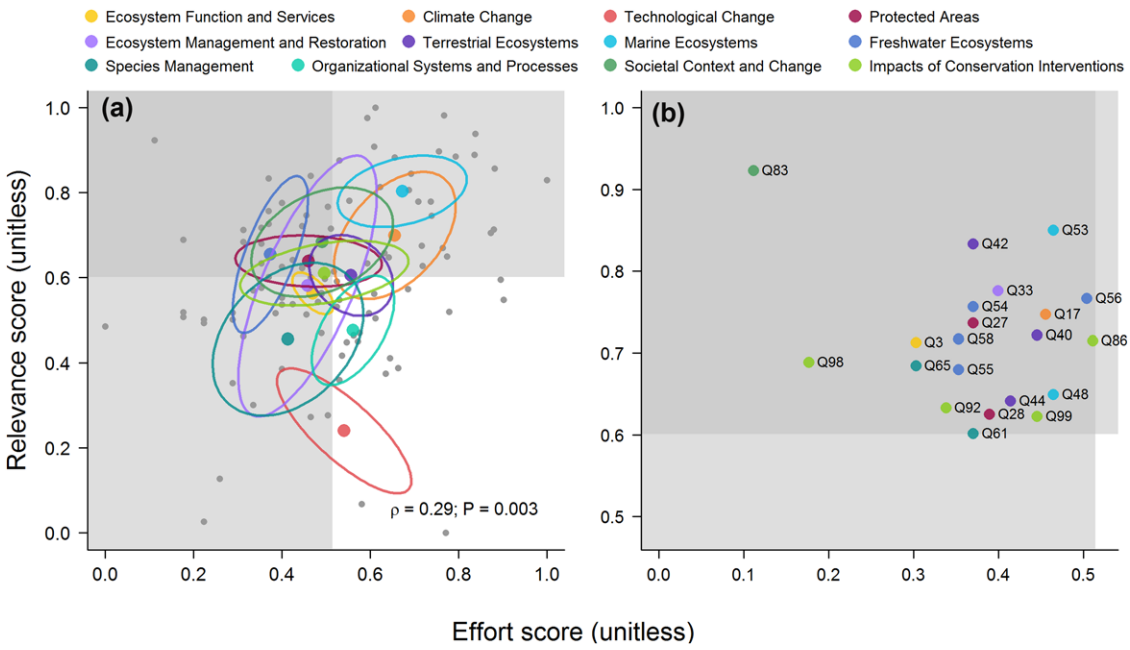

Figure 3. (a) Relationship between relevance and research-effort scores across the 100 questions in Sutherland et al. (2009) (small points, individual questions; large points, mean values for each theme; ellipses, 95% CIs; vertical shading, lower 50th percentile of effort scores; horizontal shading, upper 50th percentile of the relevance scores; ρ, Pearson correlation coefficient between relevance and effort scores). (b) Enlargement of the top-left sector of (a) that identifies questions with effort scores lower than the median but above the 50th percentile in terms of relevance, which we categorize as knowledge gap.

change formed a clear outlier, having received (on average) significantly lower relevance scores in the questionnaire compared with other themes. By contrast, the freshwater ecosystems theme scored among the highest in terms of relevance, despite that on average questions in this theme tended to have low effort scores. Similarly, questions from the societal context and change, protected areas, and impacts of conservation interventions themes also tended to have low effort scores given their perceived relevance. This is in contrast to questions from the climate change and marine ecosystems themes, for which high relevance scores were associated with equally high effort scores.

Discussion

We found considerable variation among the 100 questions in terms of their perceived relevance and the degree of research effort they have attracted (Fig. 3). Yet questions from the technological change theme emerged as a clear outlier—having scored significantly lower than average in terms of relevance on the questionnaire. This could be interpreted as a general perception among conservation scientists and practitioners that technological advances have little to contribute when it comes to achieving conservation outcomes. However, this seems unlikely to us, especially when considering how technologies, such as gene drives, eDNA, and drones, have gained such traction in conservation in recent years. A simpler explanation for the low relevance scores attributed to the questions in this theme may be that survey respondents were simply unfamiliar with the topics of these questions—which included nanotechnologies, genetically modified organisms, renewable energy and bioeconomy markets. Questions in the technological change theme scored by far the lowest in terms of familiarity in the questionnaire. Given that survey participants tended to assign higher relevance scores to questions they were most familiar with (Fig. 2), the fact that questions relating to technological change were perceived as being of low relevance to biodiversity conservation may therefore reflect a lack of awareness when it comes these topics.

Another pattern to emerge from our analysis was the tendency of questions within the freshwater ecosystems theme to score low in terms of research effort. Freshwater ecosystems are globally threatened by anthropogenic disturbance (Vörösmarty et al. 2010). The implications of jeopardizing the functionality of freshwater ecosystems are not lost on the conservation community, as questions pertaining to the conservation and management of these systems scored among the highest in terms of relevance in the questionnaire (Fig. 3). Despite this, research output

related to the conservation of freshwater systems was generally lower relative to that addressing similar issues in terrestrial and marine realms. This pattern was consistent with a post hoc analysis of the literature, which highlighted that during the past 5 years there have been 72% more publications addressing questions explicitly pertaining to the conservation of marine biodiversity compared with those tackling similar topics in freshwater ecosystems (assessed by recording the number of articles returned when searching for the terms "biodiversity and conservation" in association with either "marine" or "freshwater" in Scopus). In particular, compared with marine systems, we found fewer coordinated studies on the impacts of climate change on the biodiversity and hydrology of the world's freshwater systems.

A third theme that emerged when looking across questions with higher-than-average relevance scores and low numbers of associated publications is captured by a group of questions that broadly address how societal structures and processes influence interactions between people and the environment. Specifically, to us they suggest a need to better understand how education, development and economic growth shape the relationships between people and nature (questions 74, 82–84), as well as the importance of identifying the most effective strategies for building broad, long-lasting societal support for conservation interventions (questions 92 and 98). These issues are well summarized by question 83, which addresses the implications of increased human dissociation from nature for biodiversity conservation, a topic of research that despite being perceived as highly relevant by conservation scientists and practitioners who took part in the survey (Fig. 3) has only recently started to gain traction in the literature (e.g., Soga & Gaston 2016).

At the opposite end of the spectrum, our assessment also allowed us to identify a set of high-priority questions that have been relatively well studied. These questions fell under a variety of themes, but of the top 10 questions with the highest research effort scores, 4 were from the climate change theme. The fact that these questions have been the focus of a relatively large number of review publications to us reflects the severity of the threat posed by climate change to the world's biodiversity. However, it does raise the question of why certain topics are perceived as more relevant than others, and whether this in turn contributes to determining the high variability in research effort which we observe among the 100 questions.

Two key results from our study relate to this question. The first is a clear trend that emerged from the questionnaire, whereby respondents tended to attribute greater relevance to topics they were most familiar with (Fig. 2). The second is the fact that—on average—questions that were deemed most relevant are also those that have been the focus of the greatest number of review papers (Fig. 3a). Together, these findings pose important further questions. For instance, do these patterns emerge because researchers work hardest to address those problems that are genuinely most pressing or are researchers more likely to have been exposed to, become familiarized with, and work on topics that have been the focus of extensive previous research? Distinguishing between these and other scenarios is an important issue to resolve if prioritization exercises are to be used as an effective tool to guide the future direction of a field of research.

Acknowledgments

We thank the University of Cambridge Conservation Research Institute (UCCRI) and B. Vira, A. Harvey, and W. Sutherland, in particular, for supporting this project. Three anonymous reviewers provided constructive comments that helped us improve our paper. T.J. was funded by the Natural Environment Research Council (NE/K016377/1), as was B.I.S through the Cambridge Earth System Science DTP programme (NE/L002507/1). N.M. was funded through a Fondation Weiner-Anspach fellowship and the Dominic Scriven fellowship.

Supporting Information

Relevance and effort scores for each of the 100 questions (Appendix S1), literature review protocol (Appendix S2), sensitivity analysis of bibliographic searches and interrater agreement (Appendix S3), key assumptions and limitations (Appendix S4), and citation report for Sutherland et al. (2009) (Appendix S5) are available online. The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

Literature Cited

R Core Development Team. 2016. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna.

Soga M, Gaston KJ. 2016. Extinction of experience: the loss of human-nature interactions. Frontiers in Ecology and the Environment **14:**94–101.

Sutherland WJ, Adams WM, Aronson RB, et al. 2009. One hundred questions of importance to the conservation of global biological diversity. Conservation Biology **23:**557–567.

Vörösmarty CJ, McIntyre PB, Gessner MO, et al. 2010. Global threats to human water security and river biodiversity. Nature **467:**555–561.