

Insights from two decades of the Student Conference on Conservation Science

Authors: Jonas Geldmann^{1,2}, Helena Alves-Pinto^{3,4,1}, Tatsuya Amano^{5,1,6}, Harriet Bartlett^{1,7}, Alec P. Christie¹, Lydia Collas¹, Sophia C. Cooke¹, Roberto Correa¹, Imogen Cripps¹, Anya Doherty¹, Tom Finch⁸, Emma E. Garnett¹, Fangyuan Hua^{9,1}, Julia Patricia Gordon Jones¹⁰, Tim Kasoar¹, Douglas MacFarlane^{1,11}, Philip A. Martin^{1,12}, Nibedita Mukherjee¹, Hannah S. Mumby^{1,13}, Charlotte Payne¹, Silviu O. Petrovan¹, Ricardo Rocha^{1,14}, Kirsten Russell¹, Benno I. Simmons^{1,15,16}, Hannah S. Wauchope¹, Thomas A. Worthington¹, Rosie Trevelyan¹⁷, Rhys Green^{1,8}, and Andrew Balmford¹

Affiliations:

¹ Conservation Science Group, Department of Zoology, University of Cambridge, Downing St., Cambridge CB2 3EJ, UK

² Center for Macroecology, Evolution and Climate, Natural History Museum of Denmark, University of Copenhagen, Universitetsparken 15, 2100, Copenhagen E, Denmark.

³ Programa de Pós Graduação em Ecologia, Universidade Federal do Rio de Janeiro, CEP 21941-590 Rio de Janeiro, Brazil

⁴ Rio Conservation and Sustainability Science Centre, Department of Geography and the Environment, Pontifícia Universidade Católica, Rio de Janeiro 22453-900, Brazil

⁵ School of Biological Sciences, University of Queensland, Brisbane, 4072 Queensland, Australia

⁶ Centre for the Study of Existential Risk, University of Cambridge, 16 Mill Lane, Cambridge, CB2 1SB, UK

⁷ Department of Veterinary Medicine, University of Cambridge, Madingley Road, Cambridge, CB3 0ES, UK

⁸ RSPB Centre for Conservation Science, RSPB, The Lodge, Sandy, SG19 2DL, United Kingdom

⁹ Institute of Ecology, Peking University, Haidian Road, Beijing 100871, China

¹⁰ College of Environmental Sciences and Engineering, Bangor University, LL57 2UW, UK

¹¹ School of Psychological Science, University of Western Australia, 35 Stirling Hwy, Crawley WA 6009, Australia

¹² BioRISC, St. Catharine's College, Cambridge CB2 1RL, UK.

¹³ School of Biological Sciences, Kadoorie Biological Sciences Building, University of Hong Kong, Pok Fu Lam Road, Hong Kong SAR

¹⁴ "CIBIO-InBIO, Research Centre in Biodiversity and Genetic Resources, University of Porto, Vairão, Portugal

¹⁵ Department of Animal and Plant Sciences, University of Sheffield, Western Bank, Sheffield, S10 2TN, United Kingdom

¹⁶ Centre for Ecology and Conservation, College of Life and Environmental Sciences, University of Exeter, Penryn, UK

¹⁷ Tropical Biology Association, Cambridge, UK

Abstract

Conservation science is a crisis-oriented discipline focused on reducing human impacts on nature. To explore how the field has changed over the past two decades, we analyzed 3,245 applications for oral presentations submitted to the Student Conference on Conservation Science (SCCS) in Cambridge, UK. SCCS has been running every year since 2000, aims for global representation by providing bursaries to early-career conservationists from lower-income countries, and has never had a thematic focus, beyond conservation in the broadest sense. We found that the majority of projects submitted to SCCS were based on primary biological data collected from local scale field studies in the tropics, contrary to established literature which highlights gaps in tropical research. Our results showed a small increase

48 over time in submissions framed around how nature benefits people as well as a small increase in
49 submissions integrating social science. Our findings suggest that students and early-career
50 conservationists could provide pathways to increase availability of data from the tropics and address
51 well-known biases in the published literature towards wealthier countries. We hope this research will
52 motivate efforts to support student projects, ensuring data and results are published and data made
53 publicly available.

54

55 **Keywords:** Bias; Capacity building; Cross-disciplinarity; Early career; Field study; New conservation;
56 Student

57 **1. Introduction**

58 Conservation science focuses on understanding and reducing the negative impacts of human activities
59 on nature, and has, from its inception, been framed as a “mission-oriented discipline” (Soulé 1985). It
60 has its origins in biology and, as a result, its initial emphasis was on describing and explaining the
61 distribution of biodiversity as well as the ecological and evolutionary processes shaping the diversity
62 of life under human pressure. However, over the last few decades it has become increasingly clear that
63 understanding biological processes alone is insufficient in identifying robust solutions to reduce
64 pressures on nature and the environment (Balmford and Cowling 2006; Bennett et al. 2017; Kareiva
65 and Marvier 2012; Meine et al. 2006). This has led to the integration of the social sciences, economics,
66 and psychology to understand the role of people when addressing conservation problems (Mace 2014;
67 Martin et al. 2012b; Teel et al. 2018) and an interest in the motivations for conserving nature (Greenwald
68 et al. 2013; Kareiva 2014; Kareiva and Marvier 2012; Noss et al. 2013; Soule 2013).

69

70 Even though primary data are the foundation for conservation science and management (Tewksbury et
71 al. 2014; Wilson 2017), the proportion of published studies based on primary data collection has
72 decreased over the past two decades, though they still represent 70% of ecological studies (Ríos-Saldaña
73 et al. 2018). In addition, the conservation literature continues to exhibit considerable geographical bias
74 toward wealthier, often English-speaking countries (Amano and Sutherland 2013; Martin et al. 2012a)
75 and certain taxonomic groups (Clark and May 2002) and away from the tropics (Collen et al. 2008;
76 Mammides et al. 2016; Meijaard et al. 2015). These biases limit our ability to assess what conservation
77 actions work and where.

78

79 Analysis of trends in peer-reviewed articles can give an unrepresentative picture of the work being done
80 on the ground (Godet and Devictor 2018). Understanding the extent to which the peer-reviewed
81 literature is missing specific types of studies or research from certain parts of the world can help to
82 highlight publications gaps and improve the uptake of data and experiences outside the Western
83 dominated academic environment. One possible pathway to address the evidence gap and entrenched

84 biases is to analyze conference submissions. Conferences are an important part of academic culture and
85 student conferences especially provide early-career scientists with an opportunity to showcase and
86 discuss their ideas, projects, and fieldwork at a stage prior to publication. While not immune or without
87 possible biases of their own, conference submissions may be less vulnerable to some of the issues in
88 the peer-reviewed literature (e.g. positive-results publication bias, English language skills) and could
89 identify the disconnect between on-the-ground research and the published literature. This information
90 could help to utilize the full potential of the conservation research community.

91
92 In this study, we assessed the scope, data and methods of studies submitted for presentation at the
93 Student Conference on Conservation Science (SCCS) in Cambridge, UK using a database of >3000
94 applications. To our knowledge, SCCS is the oldest dedicated student conservation conference. Over
95 the 20 years it has been running, it has welcomed applications from bachelor, masters and PhD students.
96 It has never had a thematic focus but instead encourages submissions from across the diverse disciplines
97 of conservation science. It has consistently received applicants from around the world, in part thanks to
98 its provision of bursaries to those from lower income countries.

99
100 We classified these applications to explore patterns and trends over time in what conservation students
101 study, focusing on potential changes in framing, the types of studies conducted, the methods used, and
102 the integration of data and ideas from the social sciences. We were particularly interested in
103 understanding if the transition from conservation as a predominantly biological science to a more multi-
104 disciplinary one had changed the framing around the value of nature to people or the integration of the
105 social sciences.

106 **2. Material and methods**

107 We included 3,487 submissions for oral presentations (i.e. poster submissions were excluded) at SCCS-
108 Cambridge covering 15 individual years spanning the 18 years between 2002-2019. These are the years
109 for which we had access to all the original conference submissions, not only accepted submissions, to
110 ensure we captured the full scale of work undertaken and to avoid any selection bias by the conference
111 organisers. The years 2000, 2001, 2004, 2005, and 2006 were excluded due to missing data. Ethics
112 approval was obtained through the Human Biology Research Ethics Committee, School of Biological
113 Sciences, University of Cambridge (ref no.: PRE.2018.068). Conference submissions were anonymized
114 before being used to generate a database of submissions containing: 1) Row ID, 2) Nationality, 3)
115 Country of residence, 4) Stage in career, 5) Talk title, and 6) Talk abstract. E-mails were sent to all
116 applicants asking them to reply if they did not want to be included in the study. This led to the removal
117 of seven submissions.

118
119 The data extraction protocol and guidelines outlining the information extracted from each submission
120 were developed prior to reviewing the submissions (Table S1). The protocol was pilot tested on a subset

121 of submissions (n = 20) by a sub-group of reviewers and subsequently revised based on these
122 experiences. Two workshops were conducted prior to the data extraction to explain and discuss the final
123 protocol. In total, 25 of the paper's authors participated in the data extraction based on the information
124 in the submissions database. The conference-submissions were assigned randomly among all 25
125 reviewers, with each reviewer extracting data from approximately 140 abstracts. The year of submission
126 was removed to avoid biasing the data extraction.

127 **2.1 Data extraction**

128 For each submission (title and abstract), the reviewers extracted information on the applicant
129 (nationality, country of residence, career stage) as well as on 25 elements pertaining to the research
130 carried out by the student. The abstracts for 2002 and 2003 consisted of a title and an abstract with no
131 formatting requirements. For subsequent years the abstract was divided into four parts: 1) What
132 conservation problem or question does your talk address?, 2) What were the main research methods
133 you used?, 3) What are your most important results?, and 4) What is the relevance of your results to
134 conservation?. The 25 elements covered research locations (e.g. country, region); study type (i.e. field,
135 laboratory, modelling, remote sensing); and scale of study (e.g. local, national, multi-country) (see
136 Table S1 for the full list and definitions). Where possible, answers were assigned to predefined
137 categories (e.g. realm of study: terrestrial, marine, freshwater, coastal, or multiple). In addition,
138 reviewers used 'not sure' where the abstract did not allow a clear interpretation or 'not applicable'
139 where a particular question was not relevant.

140

141 Where one or multiple species were studied, we recorded the broad taxon using 16 categories: algae,
142 lichens, plants, fungi, arthropods, marine invertebrates, other invertebrates, fish, amphibians, reptiles,
143 birds, mammals, other, multiple, not applicable, and not sure.

144

145 For each conference submission each reviewer assessed whether the study primarily addressed
146 'Pressure', 'State', or 'Response' following the PSR-framework of the Organisation for Economic Co-
147 operation and Development (1993). For example, a study could examine the effect of protected areas
148 (response) in reducing hunting (pressure) on numbers of lions (state). This was done based on an
149 interpretation of the entire abstract. Where more than one category could apply, we used a hierarchical
150 approach to assign a single category to each submission, where 'response' superseded 'pressure' which
151 superseded 'state' - so the example above would be classed as a response study. The hierarchical
152 approach was used to reflect the conceptual thinking behind the PSR-framework, that conservation is
153 the human response to human pressures affecting the natural state of the world.

154

155 We extracted information on the extent to which human dimensions were included in the studies through
156 two questions. The first addressed whether the submission mentioned conservation benefiting people
157 and/or the importance of involving people in conservation decisions. It was not necessary for the study

158 to be primarily framed around the value of nature to people, only that the role of, or relevance to, people
159 was articulated. The second addressed whether the primary focus of the study was the value nature
160 provides to people.

161

162 We assessed whether submissions recorded biological data (e.g. species, habitats, genetics or any other
163 data derived from a biological system) and/or socio-economic data (e.g. livelihood issues,
164 economy/finances, attitudes, human behavior, or human behavior change). Additionally, we recorded
165 if the data was collected by the students themselves, or if the study included secondary data sources.

166

167 Finally, we recorded the methods for both biological (e.g. transects, camera-traps, remote sensing,
168 interviews) and socio-economic data collection (e.g. interviews, questionnaires). For biological
169 methods the original 20 categories (Table S1) were reduced to six: 1) field data, 2) genetic data, 3)
170 internet/literature search, 4) audio and camera recordings, 5) remote sensing, and 6) other.

171

172 Following data extraction, 359 (11.1%) submissions were selected for kappa analysis to test the inter-
173 reviewer variability in data extraction. This was done by randomly selecting 10% of the conference-
174 submissions of each reviewer to be re-reviewed by a different randomly selected reviewer. For the years
175 2002 and 2003 we assessed 20% of each year following the same procedure. Kappa analysis was
176 conducted on all questions individually and on overall agreement. Based on this, questions with a
177 Cohen's kappa score below 0.6 (weak agreement) were not included in the analysis (McHugh 2012).
178 The average Cohen's kappa for all included questions was 0.78 (S.E. = 0.07, min = 0.64, max = 0.87,
179 Table S2). Only the identification of main threat (Cohen's kappa = 0.21) did not meet this criterion,
180 potentially because the perception of threats in the field does not always align with the five main
181 categories used here and adopted from The Intergovernmental Science-Policy Platform on Biodiversity
182 and Ecosystem Services. The years 2002 and 2003 were assessed separately leading to the exclusion of
183 the Pressure-State-Response questions for those years (Cohen's kappa = 0.40).

184 **2.2 Analysis**

185 Prior to calculations of proportions, all empty fields, 'not applicable', and 'not sure' were removed.
186 Thus, the number of responses for each year varies across analyses. For questions where we assessed
187 proportional changes over time, we used beta-regression to model the proportion as the dependent
188 variable and year as a continuous independent variable. All analyses were carried out in R 3.5.1 (R
189 Development Core Team 2019).

190 **3. Results**

191 **3.1 Geographical and taxonomic focus**

192 We assessed 3,245 submissions after removing 235 that had been submitted but did not contain an
193 abstract and/or title. Over the 18-year period, the conference received applications from 128 countries;

211 The vast majority of studies were terrestrial (n = 2,393) followed by freshwater (n = 225), marine (n =
 212 177), multiple (n = 119) and coastal (n = 102). Across taxonomic groups, mammals were the most
 213 studied (n = 875), followed by plants (n = 470), birds (n = 432), fish (n = 121) and arthropods (n = 89),
 214 while potentially-important indicator groups, such as amphibians (n = 58), fungi (n = 10), and lichens
 215 (n = 2), were far less represented (Fig. 2).

216

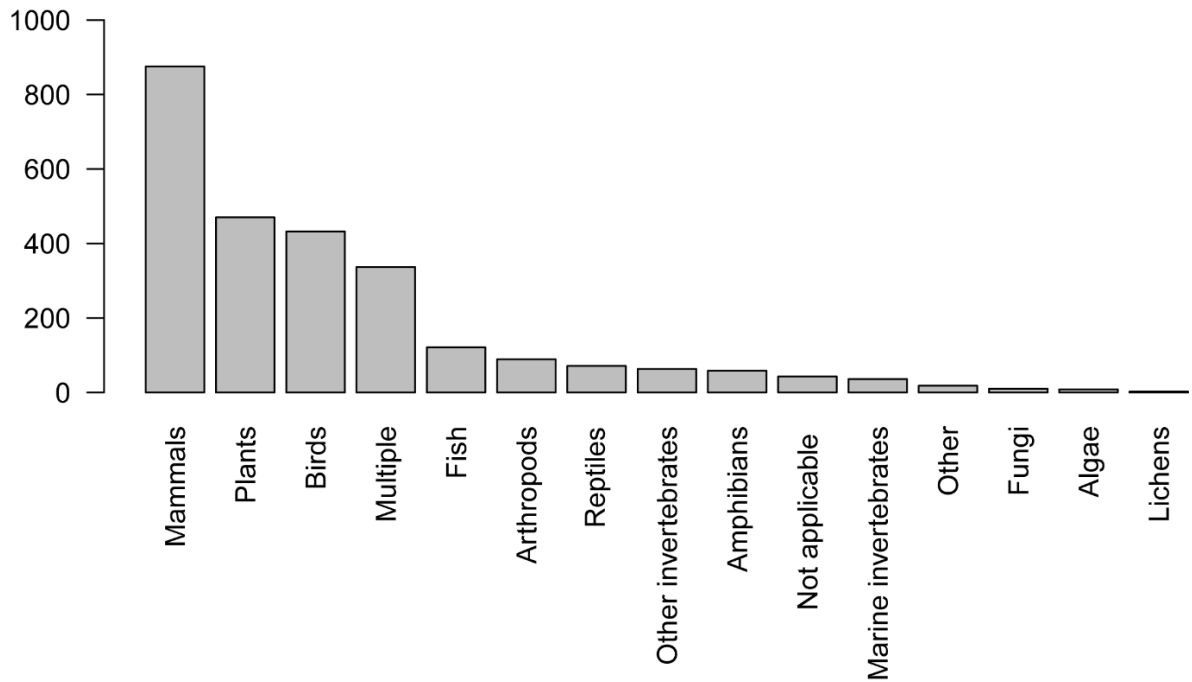


Figure 2. Taxonomic coverage across 2,489 conference sub-missions (excluding sub-missions with an ambiguous or no study taxon). Reviewers were explicitly asked to select the main species or higher taxonomic unit of interest. Where other species were described but were not the focus of the study, they have not been recorded.

217 **3.2 Framing**

218 On average, 38% (n = 1,003) of all studies focused on the state of nature, investigating patterns of
 219 biodiversity and processes, followed by 36% (n = 954) addressing pressure to biodiversity, and 26% (n
 220 = 671) addressing responses. No changes were observed between 2007 and 2019 in the proportions of
 221 state, pressure and response studies (Fig. 3a).

222

223 Of all the submissions, 31.3% (n = 983) mentioned the importance of conservation benefiting people
 224 and/or the importance of involving people in conservation decisions, with no change observed over
 225 time. While remaining relatively low, in absolute terms (mean = 11.8%) the number of submissions
 226 with a primary focus on the value of nature to people increased significantly (z-value = 2.62, p = 0.009,
 227 DF = 13) more than doubling from 2002 (estimate = 7.0%) to 2019 (estimate = 16.5%; Fig. 3b).

228

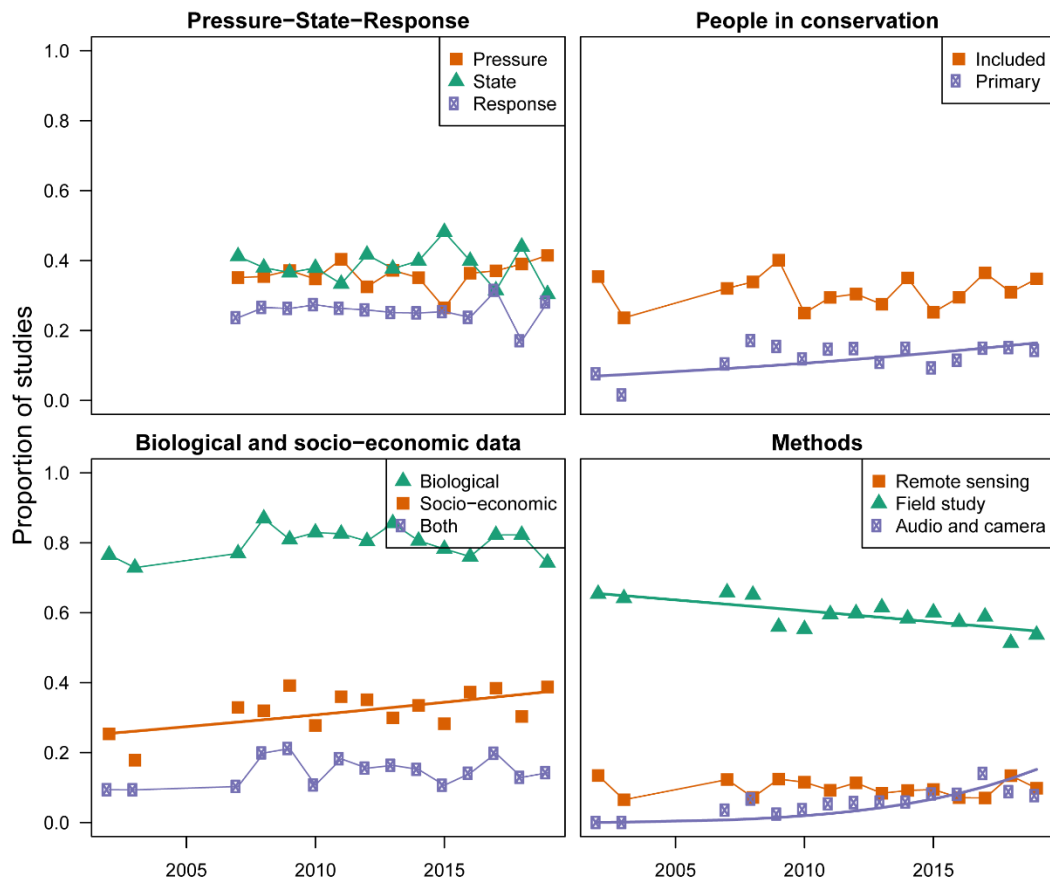


Figure 3. Change over time in the proportions of (a) studies that looked at pressure-state-responses, (b) studies that mentioned the importance of conservation to benefiting people and/or the importance of involving people in conservation decisions, or studies whose primary focus was to understand the values that nature provides to people, (c) studies that including biological data or socio-economic data, or both, and (d) studies using different methods. Studies that noted 'Not applicable', 'Not sure' or did not provide an answer for the questions involved were not included. Dots are connected where not significant relationship ($p \geq 0.05$) was identified while a regression line represents that a significant relationship ($p < 0.05$) was identified

229 3.3 Data and methods

230 Most submissions (80%, $n = 2,442$) contained biological data, while data on socio-economic aspects
 231 were less common (33%, $n = 998$). Only 15% ($n = 454$) reported both biological and socio-economic
 232 data in the submissions. For biological data and the combination of biological and socio-economic data,
 233 the proportions showed no change over time. However, the proportion of submissions including socio-
 234 economic data increased over time from 25.6% to 37.2% (estimate = 0.03, S.E = 0.01, $p = 0.004$, DF =
 235 13; Fig. 3c). Most of the data, both biological (66%, $n = 2,001$) and socio-economic 75% ($n = 852$),
 236 were collected by the students themselves. Eighty percent ($n = 2,457$) of the submissions contained a
 237 field-collection element (Table 1) with 74% ($n = 2,090$) of the submissions covering local-scale studies
 238 that looked at one or a few sites, and only 17% ($n = 475$) of studies investigating patterns at national
 239 level, 7% ($n = 186$) looking at multiple countries, and 2% ($n = 66$) conducting global analyses.

240

241 The methods used to collect biological data remained relatively constant over time and were dominated
 242 by field-based approaches, such as transects, plots and trapping (58.4%, $n = 1,691$). A decrease (from
 243 65.5% in 2002 to 54.8% in 2019) was observed in the use of traditional field-based methods (estimate

244 = -0.026, S.E = 0.006, $p < 0.001$, DF = 13), and there was an increase (from 0% in 2002 to 15.2% in
245 2019) in the use of audio and camera recordings (estimate = 0.21, S.E = 0.041, $p < 0.001$, DF = 13).
246 This suggests a change in approach toward more automated methods, rather than a decrease in field-
247 based data-collection (Fig. 3d).

248 **4. Discussion**

249 Our results show that the majority of submissions to SCCS between 2002 and 2019, were based on
250 primary biological data from local-scale field studies. These findings suggest a different trend to the
251 concerns raised in previous research: that there is a decrease in the proportion of field-based studies in
252 the peer-reviewed literature (Carmel et al. 2013; Ríos-Saldaña et al. 2018). Likewise, contrary to the
253 dominance of researchers from wealthier countries found by reviews of published papers (Amano and
254 Sutherland 2013), the majority of submissions to SCCS were from Asian and African nationals. These
255 two continents were even more prominent when looking at the countries in which people collected data
256 (Fig 1). For example, citizens from the UK represented the second largest group of applicants, but the
257 UK ranked 15th as a location for fieldwork.

258
259 The discrepancy, in terms of type and location of studies, between the published literature and
260 submissions to SCCS, highlights a potential barrier in the pathway from fieldwork to publication that
261 warrants further exploration. It is possible that conferences allow participants to present more creative
262 and less fully developed ideas that will be filtered out or modified once they get submitted to peer-
263 reviewed journals. Thus, conferences can play an important role in supporting and testing novel ideas
264 that might be harder to get through a review process. It is possible that this explains the discrepancy
265 between our findings, and studies of peer-reviewed papers that find a decrease in the proportion of field-
266 work based studies. Thus, it may be that though the proportion of field-based research is not decreasing,
267 field-based studies are being accepted less by journals. Furthermore, it suggests that the identified
268 knowledge and data gaps in the published literature for the tropics (Christie et al. 2019; Collen et al.
269 2008; Mammides et al. 2016; Meijaard et al. 2015), may not only be driven by the lack of research
270 effort and data-collection, but by publication bias. This is of particular concern given the significant
271 biodiversity importance of tropical areas (Brooks et al. 2006; Myers et al. 2000).

272
273 There is an urgent need to improve the uptake of studies from the tropics in the peer-reviewed literature
274 to ensure the availability of knowledge and data in conservation research and efforts. This will both
275 directly benefit the conservation community and ensure a greater diversity in the people and views
276 represented within conservation science. To achieve such improvements, it is important to support the
277 data-collection-publication pipeline in areas currently underrepresented in the published literature. This
278 may include reduced or waived publication fees (already applied by some journals), as well as language
279 support for non-native English speakers, which is a major barrier in the publication process (Amano et
280 al. 2016). In some cases, there might also a need for capacity building (Legg and Nagy 2006) and to

281 assist people in scientific writing. For example, in a capacity-building program in Africa run by the
282 Tropical Biological Association, a focus on how to write scientific articles resulted in 87 publications
283 (*Pers obs.* R. Trevelyan).

284

285 While the peer-review process is foundational for the publication of scientific studies, it is not the only
286 way to publish data. An increasing number of online data repositories allow for data sharing outside the
287 traditional publication pathway. Similar to the role of GenBank (NCBI Resource Coordinators 2017) in
288 molecular biology, such databases might help to publicize data currently unavailable in the public
289 sphere. However, to be successful, this should be linked to transparent standards (Poisot et al. 2019), a
290 formalized method of citing the data-collectors, and must be accompanied by the development of
291 appropriate and fair crediting mechanisms for data collectors by institutions and funding bodies. Data
292 can represent value, both monetary and cultural, thus where fieldwork is taking place outside the country
293 of the institution, the access to data should be accompanied by benefit-sharing (Baker et al. 2019). If
294 such mechanisms are not in place, data-sharing outside the peer-reviewed literature may not benefit
295 data-collectors in the developing world but rather lead to exploitation of field efforts by other
296 researchers.

297

298 Over the 18-year for which we had data, the number of submissions that focused on the value that nature
299 provides to people increased. This corresponds with the emergence within the conservation community
300 of a ‘nature for people’ framing (Mace 2014), which has profoundly influenced the strategies of some
301 of the world’s largest conservation organizations (e.g. Conservation International and The Nature
302 Conservancy; Kareiva et al. 2014). However, this narrative has been criticized as western-dominated
303 (Tallis and Lubchenco 2014) and as describing a polarization not actually found in the conservation
304 community (Sandbrook et al. 2019). In this light, it is interesting that while we observed a significant
305 trend over time, the proportion of SCCS submissions focused on the services and goods that nature
306 provides to people remained low. Thus, our results suggest that while the emphasis on people is a
307 component in conservation, it is by no means dominant. It is possible that our sample, with a majority
308 from lower-income countries, might be less influenced by this trend in conservation than in higher-
309 income regions. North America and Australia, which are among the largest contributors to peer-
310 reviewed journal articles in conservation science, were almost entirely absent in our sample (potentially
311 related to the distance to Cambridge, UK) while also being among the strongest proponents of a more
312 people focused conservation narrative (Tallis and Lubchenco 2014).

313

314 The submissions we assessed support suggestions that conservation science is broadening (Teel et al.
315 2018) by revealing an increase over time in the use socio-economic data. However, the proportion
316 remained relatively low across the 18 years. Additionally, the number of studies integrating both
317 biological and socio-economic data did not increase, with only around 16% of studies combining

318 biological and socio-economic data in the same study. This suggests that while conservation has become
319 increasingly multi-disciplinary, there is still considerable scope for further integration (also see
320 Guerrero et al. 2018). The call for integrating socio-economic perspectives into conservation research
321 is not new (e.g. Adams and McShane 1992), and it is increasingly recognized that both biological and
322 socio-economic perspectives are vital to conservation success (Martin et al. 2016). The continued
323 paucity of socio-economic considerations in conservation science that we observed highlights the need
324 to broaden the training of future conservation researchers. This requires university departments and
325 faculties to foster integration and to break down silos between disciplines and departments.

326

327 The majority of studies focused on describing biological states or human pressures, while only 26%
328 evaluated conservation interventions and solutions. Our results therefore mirror several papers that
329 highlight the lack of studies assessing the impact of conservation responses (Geldmann et al. 2013;
330 Schleicher 2018). While we recognize that an understanding and description of the state of nature and
331 the pressures it faces provides a foundation for developing effective responses, the under-representation
332 of studies assessing the impact of conservation efforts is concerning, given longstanding calls for
333 increasing evidence on the effectiveness of conservation interventions (Pullin and Knight 2001;
334 Sutherland et al. 2004). Assessing the impact of conservation responses is fundamental to improving
335 their effectiveness (Balakrishna 1999; Ferraro 2009) as well as measuring progress towards achieving
336 policy targets (Fisher et al. 2014). It is possible that the complexity of assessing conservation impact
337 (Baylis et al. 2016) is limiting the number of such studies undertaken by students, who are often
338 constrained by time and may lack the experience required to undertake complex impact assessments.
339 Additionally, students attending conferences may wish to present earlier parts of their projects, even if
340 this represents only a step towards the overall objective (i.e. submit the field stage if analysis isn't
341 completed). However, it is vital that conservation science increasingly addresses this knowledge gap
342 (Baylis et al. 2016; Miteva et al. 2012; Schleicher 2018) to better understand what works, when and
343 why.

344

345 By following 18 years of submissions from the longest running student conservation conference, our
346 study provides a unique temporal insight into the work undertaken by successive cohorts and early-
347 career conservation scientists. In including all submissions to give a talk, our sample is not biased by
348 the quality of submissions or by temporal shifts in the preferences of the selection committees but
349 represents the full diversity of students applying for SCCS. Nevertheless, our sample might not
350 represent the wider community as self-selection might exclude some from submitting. Conducting
351 similar analysis of other student and/or conservation conferences where similar long-term data exists,
352 would help to clarify these potential biases. As with published studies (Amano et al. 2016; Amano and
353 Sutherland 2013), countries (often former British colonies) where it is more common to communicate
354 in English were disproportionately represented and so the conference doubtless does not fully capture

355 a representative sample of all conservation studies. Moreover, the low proportion of marine studies
356 indicates that SCCS has tended to attract a lower proportion of those working on marine conservation,
357 perhaps due to the organizers having mostly terrestrial experience and networks. In general, conferences
358 can exacerbate such geographical and topical biases related to the organizer's areas of interest and the
359 location of the conference. This might also have influenced the submission to SCCS Cambridge and
360 thus how well suited this sample is for comparing to the wider academic conservation literature.

361

362 The dominance of field studies from the tropics in the conference submissions might not reflect a
363 dominance of field studies in general. Rather, it is possible that fieldwork in temperate zones is framed
364 more as ecological research without a conservation focus. Nevertheless, our study suggests that there is
365 an untapped resource in field studies and more tropical research being undertaken by students from
366 tropical countries than is suggested by the published literature.

367 **5. Conclusion**

368 Based on our findings we see an urgent need to make data generated by tropical fieldworkers more
369 widely available, and for increased efforts in examining the impact of conservation interventions. It is
370 important that any initiative focus on developing the capacity of and provide agency for the people
371 conducting the data-collection to help further their careers as independent researchers in their own right.
372 Our results also highlight that conservation science still needs to further integrate disciplines outside
373 biology. Only through combining understanding of both the natural world and human behaviour can we
374 successfully tackle the great challenges facing Earth's biodiversity, without jeopardizing the sustainable
375 livelihood of our own species.

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390 **Author statement:**

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