Received: 8 December 2021 | Revised: 25 January 2022 | Accepted: 12 February 2022

DOI: 10.1111/btp.13084

COMMENTARY

bioTROPICA ASSOCIATION FOR TROPICAL BIOLOGY AND CONSERVATION WILEY

How can academics contribute to biodiversity science?

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Associate Editor: Jennifer Powers

Handling Editor: Jennifer Powers

Keywords: community involvement in conservation, evaluation, knowledge to action pathway, university business model

1 | INTRODUCTION

Human actions have severely disrupted the earth's systems and impacted biodiversity. Species extinction rates are currently estimated to be ~1000 times above the rate that would have occurred without anthropogenic impacts (Ceballos et al., 2015; Dirzo et al., 2014; Pimm et al., 2014). Habitat degradation is the major cause of biodiversity loss, and ~60 million ha of biologically diverse tropical forest was lost from 2002 to 2019 (Chapman & Peres, 2021; Weisse & Gladman, 2020). To put this in perspective, an area of old-growth tropical forest larger than Madagascar was lost in 18 years. The earth's mean surface temperature has increased by 1.07°C as the result of human actions and warming will exceed 1.5°C before 2100 unless deep reductions in CO_2 and other greenhouse gas emissions occur (Zhongming et al., 2021).

Here, we ask the question "How can Academics Contribute to Biodiversity Science." This effort stemmed from a symposium on this topic at the 2021 ATBC meeting and the lively discussions that followed. We take two approaches. First, we consider some general principles that will help scientists engage in the most effective, ethically appropriate action to have long-term impact. Second, we present a set of general, practical suggestions of ways scientists can engage with broader systems to promote positive changes. Our suggestions are aimed at promoting system change that would facilitate high-quality tropical conservation research and its appropriate application. As many of the readers will be functioning in the academic system, we frame our suggestions in terms of three pillars of academic activities: research, teaching, and service. While we aim to present ideas that will be most helpful to academics in both tropical countries and those working in high-income nations and conducting research in the tropics, we trust that individuals within government, international conservation groups, and small Non-Government Organizations (NGOs) will be able to easily evaluate the value of our suggestions for their activities.

2 | PRINCIPLES

We present general ideas about conservation that we hope guide scientists to engage in the most effective ethically appropriate action that will have long-term impact. Unlike most academic fields, conservation science often seeks to promote societal change. As a result, conservation scientists regularly seek to produce science that

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can be effectively communicates to the public so that it can inform policy decisions and motivate action. This requires that the information produced be salient (relevant, actionable, and timely), credible (authoritative, believable, and trusted), and legitimate (developed via a process that considers the values and perspectives of all actors) in the eyes of researchers, local communities, policymakers, and agents that create action (Cook et al., 2013).

2.1 | Salient

For the information produced by the academic community to be of direct value for biodiversity conservation, it must be relevant, actionable, and timely. It is not uncommon for researchers to advocate for large investments to save very small, nonviable populations or ever for the protection of individuals that are at risk, but ignore the more relevant populations where conservation efforts can make long-lasting differences. This ignores the principles of ecological triage, which suggests that immediate relevant conservation action and resources should be directed to populations that are highly threatened but have a high probability of persistence (Hobbs & Kristjanson, 2003; Wilson et al., 2007).

We are in no way implying that purely academic science is not of great importance. However, the timeframe for the sorts of ideas they develop to be actionable will likely be long. A classic example of an academic theory that became of great importance to conservation concerns island biography theory (MacArthur & Wilson, 1967). This theory was advanced to explain that the level of species richness found on an island as the result of the interplay between extinction, colonization, and speciation. However, a decade after it was proposed, it became a critical component of understanding the effects of habitat fragmentation and became an important tool for reserve design (Hanski & Simberloff, 1997).

Producing salient information will mean that researchers will need to draw on information and skills outside of the biological sciences and collaboration and training in the fields of social science, economics, and political science will be needed (Robinson, 2006). New ways to broadly communicate information will be essential. For over a decade, the academic community has recognized the difficulties of bridging the gap between the generation of knowledge and its use to promote action (Bickford et al., 2012; Boreux et al., 2009; Dubois et al., 2020; Fabian et al., 2019; Farwig et al., 2017; Sunderland et al., 2009). Improving the knowledge to action pathways requires an assessment of the priority audiences (Balvanera et al., 2020), what actions are feasible to take from biological, social, and political perspectives (Parsons et al., 2015), what filters or biases actors bring to processing knowledge, who is seeking to influence the actions and for what reason, who are effective messengers (often not the scientists generating the knowledge), and what are the effective modes of communication (Goldberg et al., 2019; Jamieson et al., 2017; Kahan, 2013, 2015; Leiserowitz & Smith, 2017; Roser-Renouf et al., 2014).

2.2 | Credible

To ensure that the information is credible, conservation scientists must be scientists first and foremost and not merely activists. The information that scientists relay must be factual and as carefully presented as possible. If speculations are given, they need to be presented as such. For information to be credible, it often means that the research must be long term. For example, a central goal of conservation research is to understand the drivers of population change. This requires identifying a signal that is greater than stochastic variation caused by minor ecological or demographic variation, events that are largely stochastic (e.g., the appearance of a predator in an area), and sampling error associated with having only a few time points to estimate population change (Isbell, 1990; Strier, 2010). Furthermore, many endangered species have generation times from years to many decades (trees Swaine et al., 1987, birds Sæther et al., 2005, mammals Clutton-Brock & Sheldon, 2010), and it can take decades for their populations to recover from anthropogenic perturbations (Chapman et al., 2013; Jezkova & Wiens, 2016). Similarly, most conservation efforts require substantial time to detect an effect. Some efforts, such as conservation outreach targeting children, require decades before we would expect results. Finally, it is our experience that it can take at least a generation from the time that scientists document a serious issue and recommend a solution, to when policy is put into place to deal with the issue. This necessitates continuous, long-term ecological research and persistent engagement with policy makers and administrators.

Today, maintaining credibility is extremely important as the use of science by policy makers has declined dramatically in some countries and all too often the best available science is presented as "just another opinion" (Parsons et al., 2015). This is clearly evident with respect to statements made by politicians around the world regarding the value of masks and vaccinations for fighting the COVID-19 pandemic (Viglione, 2020). If the credibility of science is not maintained, the role of science in influencing policy will deteriorate.

2.3 | Legitimate

For the information that is produced by conservation scientists to be used to promote biodiversity conservation, it must be considered legitimate, not only by researchers, but in the eyes of local communities, policymakers, and agents that create action. This requires that the information be developed via a process that considers the values and perspectives of all actors. At the local level, researchers and practitioners are recognizing the need to involve the local communities (Guibrunet et al., 2021). The participation of local community members in both the design and implementation of conservation programs is not only viewed to improve the effectiveness of the programs (Tengö et al., 2014), but it is also considered the ethically correct approach (Adams & Hutton, 2007; Kothari et al., 2013). We view a critical step is to listen to the local people, understand their needs, their belief system, their knowledge base that is relevant to the conservation issue, and to have a meaningful empathy for their aspirations. This should often involve the co-production of research and conservation actions and considering diverse values of nature (Zafra-Calvo et al., 2020). Co-production is considered the deliberate collaboration between people to achieve common goals (Lemos & Morehouse, 2005; Norström et al., 2020). Understanding the linkages and feedbacks between people and ecosystems faces many challenges, but having such an understanding can greatly enhance the chances of success.

Once results have been obtained, it is only appropriate that the information be given back to the community, so they can evaluate its value and respond. Frequently, foreign scientists are criticized for not conveying their findings to local communities and thus not being inclusive in their approach (Blair, 2019; Erondu et al., 2021; Massey et al., 2021). The local use of social media provides an effective way to communicate research findings (C. Twining-Ward, J. Ramos-Luna, J. P. Back, J. Barakagwira, J. C. Bicca-Marques, M. Chanvin, N. Diko, J. Duboscq, P. Fan, G.-A. Carmen, J. F. Gogarten, S. Guo, G.-C. Diana, R. Hou, U. Kalbitzer, B. A. Kaplin, S. M. Lee, A. Mekonnen, P. Mungongo, H. Nautiyal, P. Omeja, V. Ramananjato, N. Raoelinjanakolona, O. Razafindratsima, C. Sarabian, D. Sarkar, J. C. Serio-Silva, R. Yanti, C. A. Chapman, unpublished data). Often researchers only fully understand their data after they have left the field and returned to their universities and performed detailed analysis. Returning to where the research was conducted can be difficult, impractical, and expensive, particularly for international students. But once systems are established to convey information through social media, these difficulties are largely removed. Such systems can be as simple as a list of appropriate WhatsApp contacts or a Facebook group. It will be important that these systems involve local leaders moderating posts, and when researchers post, they need appropriate ethical clearance.

3 | PRACTICAL SUGGESTIONS

Biodiversity is being rapidly lost due to human actions; thus, we present a set of very practical suggestions of ways scientists can engage with broader systems to promote positive change that will facilitate high-quality conservation research and its appropriate application. We make our suggestions along the three pillars of academic activities, but view that they are also relevant for individuals working in non-academic settings.

3.1 | Research

The use of science in policy making has declined dramatically in some temperate and tropical countries (Parsons et al., 2015). This calls for improvements in knowledge to action pathways. Frequently, the actions need to protect or restore biodiversity are already known, but little or no action is taken (Farwig et al., 2017). This is clearly illustrated by the fact that nearly 30 years ago the world's leading scientists outlined how humanity should adopt environmentally sustainable policies to avoid environmental disasters. Yet, these warnings remain largely unheeded (Ripple et al., 2017).

Developing effective relationships to promote communication is time consuming and difficult. Climate scientists have stated that it may not be realistic to expect climate scientists to devote this time given conditions of limited resources and poor institutional support (Bidwell et al., 2013). To a large part, these barriers are created and maintained because the nature of the academic incentive system (Chapman et al., 2019). While the scientific community is under substantial societal pressure to develop and share knowledge that can solve environmental problems (Lovejoy, 2009), universities and the academic culture provide few incentives to communicate knowledge to the public (Born et al., 2009). A survey of researchers in 29 countries documented that the largest percentage of respondents (34%) ranked scientists as the most important audience for their work, but 85% of these respondents viewed that peer-reviewed journals were ineffective in promoting conservation (Shanley & López, 2009). Furthermore, media engagement, production of training and educational materials, and popular publications were viewed as inconsequential for advancing scientific standing. Unfortunately, there is little evidence that the academic incentive system is moving toward rewarding communicating with practitioners, the public, and policy makers (Chapman et al., 2019).

There is a clear need for investigations into how to effectively communicate scientific information and bring about change. Graduate programs that offered instructions on how to effectively communicate to a variety of audiences could lead to significant advances. Effective communication by skilled mediators can help bridge the gap between science and policy (Bultitude et al., 2012). Improving the knowledge to action pathway will call for biologists to work as part of multidisciplinary teams and to form networks; skills that the next generation of conservation scientists will benefit from possessing.

To make progress, it is extremely valuable to learn from successes and failures. This requires carefully evaluation; yet, this is rarely done in conservation. Junker et al. (2020) reviewed thousands of conservation studies focusing on primates and found than less than 1% evaluated conservation effectiveness. Many of the studies that provided evaluations, implemented several interventions at once, lacked quantitative data, and failed to undertake post-implementation monitoring. Thus, we have learned little despite millions of dollars of conservation funds being spent.

3.2 | Teaching

Inevitably, conservation requires societal support. Thus, our collective opinion is that the biggest hurdle facing conservation is people having the will to protect our planet. Many people, be them city dwellers or members of local communities living next to protected areas, have a sympathetic attitude to conservation (Kirumira et al., 2019; Puri et al., 2021). In fact, Wainger et al. (2018) demonstrated that when people around the world were asked to commit money, respond to tweets, or express opinions in a survey, respondents revealed a willingness to protect and restore natural resources, regardless of their use of those resources. This willingness was not influenced by race, ethnicity, income, geographic location, age, or gender. Education programs of all types can nurture this sympathy for conservation and thus build support. Such programs should be in the local language, be accessible, consider gender roles and local culture, and should target people living near protected areas and those in urban centers as all these people vote and influence politicians (Razafindratsima & Dunham, 2015). The development of this sympathetic attitude to nature can lead to self-policing that prevents excessive exploitation of resources within protected areas (Rustagi et al., 2010; Sheil et al., 2017). Furthermore, involving people in the management of their own resources is simply the ethically appropriate thing to do.

The university education programs are the primary route with which the next generation of conservation scientists will emerge. Thus, it is important to value the day-to-day teaching and graduate/undergraduate supervision of academics. When we are not teaching future conservation scientists, instructors can motivate other types of students; these students will be the next oil company executives, politicians, consumers, and voters. Thus, through our teaching, we can motivate and empower the next generation.

3.3 | Service

Scientists operate in a system that is based on rewards and the nature of those rewards shape the fields future. Researchers exhibiting certain traits obtain the best positions, tenure, and grants, while those who do not have the preferred traits lose out, do not obtain the rewards, and have a reduced impact on the field. In providing service to our universities and institutions, scientists review grants and papers, evaluate people for tenure and promotion, and select who will be the next member of their research groups. As a result, scientists can change the nature of the reward system and thus influence the field's direction. Making such decisions requires carefully reflection.

As universities have progressively adopted business models, incentives for academics have become increasingly perverse (Alberts et al., 2014; Edwards & Roy, 2017). One change affecting conservation is the need to chase high metric scores, including H factors, altmetric scores, and the number of papers published in high impact factor journals. In some countries, grants are allocated partially based on the applicant's H factor or altmetric scores and researchers receive grant funding per paper published in high impact journals (Chapman et al., 2019; Chapman et al., In Press). In general, taking part in meaningful engagement with community members about conservation, conducting surveys of endangered species, communicating back to the community once the research is finalized, or continuing long-term monitoring does not help increase these metrics.

As part of the service to the university and the global scientific community, scientists engage in peer review. Thus, scientists can alter the basis on which rewards are given. For example, when writing evaluation letters for tenure and promotion packages, reviewers can clearly state the importance of an applicant's work with the community. Similarly, when reviewing papers, scientists can emphasize the importance of long-term monitoring. One means scientists can promote conservation research would be to change the way journals measure impact factors. This could involve recognizing scientific papers, not only on their citation frequency, but on their impact on policy, management, or specific conservation goal (Parsons et al., 2015). Conservation is not only about science, it involves accommodating people's needs, understanding and respecting indigenous people's rights and knowledge, communicating outside of academia, and dealing with politics and legal wrangling. We need means, likely metrics, to recognize and give credit to such achievements.

4 | CONCLUSIONS

It is clear that biodiversity is gravely threatened. Thus, conservation scientists face great challenges in contributing practically, meaningfully, and ethically to the preservation of biodiversity, but it is equally evident that there are reasons to be optimistic. In recent years, there has accumulated a great store of information and knowledge relevant for conservation efforts (Zhang et al., Submitted). Scientists have amazing new tools at their disposal. For example, we can monitor changes in forest cover on vast scales in near-real time (Hoekman et al., 2020), and it may be possible to survey animal populations by sampling the air for the DNA they leave behind (Lynggaard et al., 2021; Stokstad, 2021). What remains is for us to find ingenious ways to use this information and these tools to make significant advances and, most importantly, to find the will to enact the needed change.

ACKNOWLEDGEMENTS

We thank Patricia Balvanera for her participation in the panel, Claire Hemingway for spirited discussions, and Lucia Lohmann and Miguel Martinez for organizing the panel at ATBC2021 and for discussion on the ideas. Colin Chapman was supported by the Wilson Center while writing this paper. Raman Sukumar is supported by a JC Bose National Fellowship.

AUTHOR CONTRIBUTIONS

CAC led this effort but all authors contributed to its conceptualization, the ideas, and writing.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable as no data were created or analyzed in this study.

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