

Contemporary authorship guidelines fail to recognize diverse contributions in conservation science research

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Abstract

1. Authorship should acknowledge and reward those deserving of such credit. Moreover, being an author on a paper also means that one assumes ownership of the content.
2. Journals are increasingly requiring author roles to be specified at time of submission using schemes such as the contributor roles taxonomy (CRediT) system, which relies on 14 different roles. Yet, there are many other aspects of research that are not adequately captured by the list of roles, particularly in applied environmental disciplines such as conservation science, environmental science and applied ecology.
3. The growing recognition that authorship should reflect contributions that extend beyond the usual data collection, analysis and writing provides the ideal backdrop for rethinking contributions in conservation science. Here we propose a more inclusive approach to authorship that recognizes and values diverse contributions and contributors using an expanded list of CRediT roles.

KEYWORDS

authorship, credit, fairness, collaboration, equity, diversity

1 | ON AUTHORSHIP

There are various schemes, expectations and sets of criteria that have been developed to provide guidance to those considering authorship decisions. Among the most common include those that rely on advice from the Committee on Publication Ethics (see https://publicationethics.org/files/Authorship_DiscussionDocument.pdf) or others that are specific to different publishers or journals. It is reasonably common to consider five types of contributions (i.e. idea

generation/design; data collection; data analysis; writing/editing; funding) with an expectation that authors have made contributions to at least two or three of these (see Grossman & DeVries, 2019 for review). Journals are increasingly requiring authors to specify roles according to those activities for all authors. Yet, there are many other aspects of research that are not adequately captured by this short list of roles, particularly in applied environmental disciplines such as conservation science, environmental science and applied ecology (herein referred to as conservation science).

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2 | RECOGNIZING AUTHOR CONTRIBUTIONS

Recognizing that there is a need for more transparency about the contributions of different team members and to better reflect the diversity of ways that authors may be involved in a paper, a relatively recent scheme has been created known as CRediT (Contributor Roles Taxonomy; discussed in Allen et al., 2014). CRediT is 'a high-level taxonomy, including 14 roles (see Table 1), that can be used to represent the roles typically played by contributors to scientific scholarly output. The roles describe each contributor's specific contribution to the scholarly output' (<http://credit.niso.org/>). A table is generated (usually included as supplemental material) for a given paper, outlining the ways in which all authors contributed to those 14 activities. Sometimes, the roles are instead described in a brief narrative. Readers (and editors) can thus access the author-specific details of contributions to the research and by extension, the paper. CRediT has been adopted by publishers including Cell Press (e.g. *Trends in Ecology & Evolution*), the Public Library of Science (e.g. *PLoS One*), Oxford University Press, Springer and Elsevier and is currently implemented by many journals.

3 | ON INCLUSIVE AUTHORSHIP FOR CONSERVATION SCIENCE

CRediT promotes inclusion and transparency by allowing a better identification of the ways in which team members have contributed to a paper. However, given the applied nature of conservation science, we contend that the conservation community remains poorly served by this tool (and other existing approaches that rely on fewer contributor roles). Conservation science is about people (Bennett et al., 2017) and the decisions they make rather than just about biology (Schultz, 2011). It is also inherently interdisciplinary (Dick et al., 2016). We have learned much in the past several decades about what leads to actionable knowledge that is used by decision makers (Cook et al., 2013; Nguyen et al., 2019), and it has become apparent that the process by which the research is conducted can be as important as its findings (Cooke et al., 2020; Norström et al., 2020; Simpson, 2004; Tuhiwai-Smith, 1999). To further complicate decisions about authorship, environmental research, if it ever was, is no longer recognized as being only the domain of those with advanced degrees. We are beginning to acknowledge the profound and far-reaching wisdom held by Indigenous peoples, fishers, hunters, bird watchers foragers, and so on – various rights holders and stakeholders – and their roles in research (Kimmerer, 2013; McElwee et al., 2020). Providing authorship to such individuals or even groups is a formal acknowledgement (reward) for their contributions and can help them feel a sense of pride and ownership. Failure to engage the right communities and partners in conservation research can undermine legitimacy of the process and the uptake of the findings (Norström et al., 2020).

In the context of conservation science, consider a project that involves comparing grassland restoration success in protected areas

that occur across a number of sites within National Parks and on Indigenous lands. There is much that has to happen before natural and social conservation scientists grab their quadrats or voice recorders and head into the field. Developing respectful, trusting and mutually beneficial relationships with non-academic government, practitioner, community and Indigenous partners can take years (Koster et al., 2012). In fact, when one truly embraces a community-based, participatory action research, or co-production approach, it may take years to identify research priorities before a project idea is formalized and research actually moves forward (Castleden et al., 2012). There may also be a need to develop data management/sharing protocols and obtain necessary ethical approvals (from institutions and/or communities themselves), depending on the nature of the research. If one fails to secure the necessary permits and permissions to access lands, the project simply cannot or should not happen. In that context, data collection, analysis and writing are entirely dependent on the aforementioned activities. In the CRediT system, all of those early but critical activities are collectively referred to as 'administration' and given the same weight and value as making sure that there is an adequate supply of pens and paper – when, in reality, the arduous, emotionally and intellectually demanding process of building relationships and administering the project should be recognized with authorship (Liboiron et al., 2017). Relationship building extends far beyond making connections – it is about bridging epistemic communities and traditions.

The CRediT approach is a major improvement on previous authorship guidelines. For example, it is transparent in that it clearly demonstrates the role of individual team members in a given paper. Since the role of individual contributors in papers is important for hiring, tenure, career advancement and awards (see Smith et al., 2019), having contributions clearly specified in papers provides a record of such contributions. Moreover, if irregularities are identified with, for example, the data, it is clear which author(s) was responsible for a given activity, something that has become increasingly important with retractions (Steen et al., 2013) and investigations into research misconduct (Clark et al., 2017). Importantly, CRediT extends beyond the usual four or five criteria that have historically been considered in deciding on authorship. While this is a key step forward, it remains that CRediT does not fully recognize many fundamental contributions to research in conservation science (see Table 1 for comments on existing CRediT role descriptions and additional roles we deem particularly relevant to conservation science). There will always be exceptions but given the importance of partnerships, community engagement and knowledge sharing in conservation science, these activities must be recognized as valued and indeed essential aspects of the research process. A peer-reviewed paper in conservation science (and more broadly in applied environmental sciences) is more than just words on a page – it is a culmination of extensive engagement, planning, design, fieldwork, communication and, often, management interventions with partners. The growing recognition that authorship should reflect contributions that extend beyond the usual data collection, analysis and writing (see Brand et al., 2015; Holcombe, 2019; Liboiron et al., 2017) provides the ideal backdrop for rethinking contributions in conservation science.

TABLE 1 Existing and possible expanded CRediT taxonomy (adapted from <http://credit.niso.org/>)

Term	Definition	Conservation science refinements
Conceptualization	Ideas; formulation or evolution of overarching research goals and aims	This can include practitioner partners whose input has helped to formulate research questions or determine overall direction of a project
Methodology	Development or design of methodology; creation of models	Field methods are often designed with the input of local communities or fieldwork assistants, often leveraging local skills and infrastructure.
Software	Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components	This is of particular value when it is open source, and useable in future projects.
Validation	Verification, whether as a part of the activity or separate, of the overall replication/ reproducibility of results/experiments and other research outputs	For conservation social science projects that are participatory, the analysis of the research is often verified with participants or a community partner; May also involve validating data quality http://cure.web.unc.edu/resources/data-quality-review/
Formal analysis	Application of statistical, mathematical, computational or other formal techniques to analyse or synthesize study data	Formal recognition that this may include qualitative and participatory methods and involve iterative attempts to interpret results in different contexts
Investigation	Conducting a research and investigation process, specifically performing the experiments, or data/evidence collection	May include those conducting (and in some instances even participants where warranted) interviews, surveys, focus group sessions or other human dimensions components
Resources	Provision of study materials, reagents, materials, patients, laboratory samples, animals, instrumentation, computing resources or other analysis tools	May include sharing intellectual resources, local knowledge and experiences
Data curation	Management activities to annotate (produce metadata), scrub data and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later reuse	For knowledge arising from Indigenous peoples and other rights holders and stakeholders, it may be necessary to assemble and archive data in specialized community archives
Writing: Original draft	Preparation, creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation)	
Writing: Review and editing	Preparation, creation and/or presentation of the published work by those from the original research group, specifically critical review, commentary or revision – including pre- or post-publication stages	
Visualization	Visualization, preparation, creation and/or presentation of the published work, specifically visualization/ data presentation	May include graphic design or other artistic activities that help to engage readers and draw connections between the research and people
Supervision	Oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team	
Project administration	Management and coordination responsibility for the research activity planning and execution	This is vague and in conservation science extends well beyond basic administration (see examples below of several activities such as securing permissions and permits that could be considered administration but are undervalued in that context)
Funding acquisition	Acquisition of the financial support for the project leading to this publication	Securing in kind contributions (although difficult to quantify) may be more important than cash when engaging in conservation research
Co-production (or co-creation-co-assessment or co-evolution)	Research conducted collaboratively, inclusively and in a respectful and engaged manner – from the identification of research needs to study design, data collection, interpretation and even application –with the idea of creating actionable science and benefits to the partners involved	

(Continues)

TABLE 1 (Continued)

Term	Definition	Conservation science refinements
Partnership development and consultation	Relationship building to establish mutual respect and trust needed to engage in partnership research; In the case of Indigenous research, this may include creating ethical space for sharing and learning; may include consultation on research questions and approaches	
Securing permissions and permits	Obtaining necessary permissions (e.g. from land owners, rights holders), permits (e.g. scientific collection, research ethics, animal care) and data sharing agreements	
Project sunset	Sharing findings with partners and community members involved in research; removing equipment and remediating any damage; thanking partners	
Community science	Community members (i.e. citizens, immigrants) involved in data collection	
Team building	Assembling diverse and interdisciplinary team that is inclusive of necessary perspectives	
Training	Providing team members with necessary training to enable them to engage in respectful and effective partner and community engagement; Includes necessary safety planning and training to mitigate risks; may include specialized training on animal handling, species identification, or other methods	
Bridging and brokering	Making connections across academic and non-academic communities; actions involved in facilitating communication and translation across epistemic communities (different knowledge traditions)	

Bolded terms indicate ones that we have added to the taxonomy to better reflect and value contributions in conservation science. We have also provided comments on how existing terms (i.e., those 14 contributor roles developed by CRediT) can be refined to be more relevant to conservation (see third column).

There have already been calls for community (citizen) scientists (see Ward-Fear et al., 2020) and Indigenous communities (see Castleden et al., 2010; Koster et al., 2012) to be recognized as co-authors. This should be extended to include others such as key knowledge holders, community partners, practitioners and decision makers whenever they have made significant and meaningful contributions to the research process or products. This notion is captured eloquently and poignantly by Ward-Fear et al. (2020):

Failing to recognize Indigenous traditional owners because they cannot qualify for academic authorship... could be perceived as discriminatory. The general point is clear: one subculture (professional scientists) has created authorship rules that aim to prevent ethical breaches, but their often-narrow scope can marginalize important contributors (e.g., citizen scientists, Indigenous organizations).

Rethinking and valuing different forms of contributions is itself a means of beginning to address environmental injustices that intersect with or even underlie contemporary conservation challenges (Burke & Heynan, 2014; Vucetich et al., 2018).

In our view, it is critical that all individuals who are formal co-authors understand the content of a paper and be willing to accept responsi-

bility for it. Our goal here is not to blindly increase author lists but rather to clearly acknowledge those deserving of authorship and recognize that there are diverse ways to make essential contributions to a paper. The CRediT system can be modified to better value and recognize key aspects of conservation research and key contributors. Indeed, this has recently been proposed in other fields (e.g. health) where contributor role ontologies (i.e. terminology and frameworks) are being developed to provide a structured representation of contribution roles in research and scholarship for both individuals and organizations beyond those listed in the CRediT taxonomy (see Patience et al., 2019, for a list of 25 roles; Vasilevsky et al., 2021, for a list of over 50 roles). We also note that this can be done independently from the CRediT system or other formal structures such as the frameworks just described. For example, journals can change their author guidelines to explicitly list these activities as ones that could be considered when determining who has earned authorship. Similarly, authors can adopt CRediT or a similar inclusive approach even where a journal or publisher has not done so. This can also be pursued by institutions (e.g. universities or research institutes) that could require use of detailed contribution statements (Grossman & De Vries, 2019). Although the CRediT system is one way to promote inclusivity in authorship and publications, we must also recognize the entrenched cultural norms and expectations that are imparted onto new researchers about authorship and promotions. Mentors, supervisors and senior researchers in

conservation science must play an important role in adopting and promoting greater inclusivity in their approaches while also ensuring that they are deserving of co-authorship and being willing to step back when they are not.

Discussions about authorship are often challenging. This is in part due to the fact that authorship norms and expectations in a given discipline, department or even lab, have cultural foundations (da Silva & Dobránszki, 2016; Elliott et al., 2017). For example, most researchers adopt the approach they experienced as trainees. These cultural norms extend into the domain of employment competitions, tenure, promotion and awards – often formalized in labour agreements. As such, moving to a model that is entirely different will inherently face challenges. Nonetheless, it is time for change and conservation science is one domain where change is needed. Having such discussions early in the research process (i.e. idea generation) is useful for reducing likelihood of conflict (Grossman & De Vries, 2019).

Determining who is deserving of authorship is a dynamic social process (Youtie & Bozeman, 2014) that requires answering difficult questions. For example, what constitutes a sufficient contribution to earn authorship – is it one activity or three? Does including many authors on a paper risk diluting the contributions of lead or middle authors who assumed greater responsibility in bringing a paper to fruition – a common discussion in the medical sciences (Benninger, 2001)? Such questions often have no definite answer, but they can be resolved by transparently and comprehensively reporting each author's role – in some instances, formal quantitative mechanisms can even be used to assign authorship (e.g. Digiusto, 1994). We want to be clear: we are not advocating for adding authors for the sake of adding authors nor are we suggesting that anyone with a tangential connection to a project deserves authorship. Above, we noted how, in some instances, community members, practitioners or rights holders may/should earn authorship. However, that does not mean attributing authorship to all volunteers contributing observations to big data repositories (e.g. Ebird), or to all workshop participants that helped generate research ideas, which are then executed over the next decade. There is still an important place for such contributions to be recognized and described in detail in a paper's acknowledgements section. We also note recent recommendations to list both authors and contributors on a paper (Brand et al., 2015), an innovative approach that could interface with the CRediT system we discuss above.

4 | CONCLUSION

The scientific paper of today is evolving rapidly (Sopinka et al., 2020), and a largely forgotten element has been rethinking authorship. Fears about gratuitous authorships, particularly in medical and health care sciences (Brand, 2012; Flanagan et al., 1998), yet what is equally insidious is failure to include local partners in the interpretation of results, preparation of project outputs or recognition of those individuals who make essential contributions that extend beyond analysing data and putting text on the page. There is increasing recognition

that co-authorship represents a 'plausible proxy for collaboration' with sharing of authorship denoting both recognition and a concrete form of project involvement (Lăzăroiu, 2020). There is a clear role for project leaders to create the space required so that interested collaborators can contribute to project roll out in ways that justify co-authorship. The conservation science community of today is at a crossroads (Tallis & Lubchenco, 2014) as we confront racist and otherwise oppressive histories across spheres/disciplines/scales and currently have an opportunity to bring this important dialogue to the fore of our field in thinking about who is considered as co-authors and experts on a given subject. It therefore follows that it is time to revisit authorship criteria to better acknowledge the diverse ways in which different individuals contribute to conservation science research. There are many ways in which to reconsider what constitutes authorship (see Grossman & De Vries, 2019), but we submit that adopting a modified version of CRediT (see Table 1 for example) in conservation science journals would go a long way towards a more inclusive approach to authorship that recognizes and values diverse contributions and contributors (Allen et al., 2019). As CRediT becomes adopted more widely (see Holcombe et al., 2020), it is important to consider how it can be adapted and refined to better serve and value all members of the conservation science community. We hope this paper encourages more creative thinking and discourse on this important issue.

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