



Ensuring tests of conservation interventions build on existing literature

That scientific knowledge grows by building on previous understanding is familiarly expressed in English by Isaac Newton's phrasing of a much older idea, "If I have seen further it is by standing on the shoulders of giants." However, in science, we often do not always clamber as high as we could because we fail to consider previous work. Multiple factors beyond quality and relevance affect the likelihood of a scientific article being cited, including the author's status, country, and affiliation (Leimu & Koricheva 2005), number of authors (Neiminen et al. 2007; Sala & Brooks 2008), journal prestige (Tahamtan et al. 2016), length (Neiminen et al. 2007; Stanek 2008), language (van Leeuwen et al. 2001), geographical location of authors and readers (Nunez et al. 2019), direction and strength of the results (Neiminen et al. 2007), accessibility, and whether the article is a self-citation (Schreiber 2009). Furthermore, cited articles are not always used correctly. In ecology (Todd et al. 2007) and marine biology (Todd et al. 2010), 16–18% of citations offer either ambiguous or no support for an associated assertion. Even when articles are debunked, the original papers continue to be cited 17 times more than the rebuttal (Banobi et al. 2011).

We suggest that such failings distort knowledge. Few conservation practitioners cite original studies (Pullin et al. 2004; Sutherland 2004), although there is some evidence this is starting to change (Wainwright et al. 2018). Furthermore, most conservation scientists use previous literature selectively, leading to bias (Gossa et al. 2015). We checked the most recent issue of 5 major conservation journals and found 23 papers testing conservation interventions. Together, authors of these papers failed to cite at least 51 other studies, collected on www.conservationevidence.com that tested the same interventions in similar environments. Such underutilization exaggerates the originality of new findings and distorts impressions of existing knowledge and may result in actions being biased toward the single latest study.

Poor citation practices have distorted ideas (Smith & Banks 2017), such as that Darwin developed his theory of evolution by looking at Galapagos finches, despite not mentioning them in *The Origin of Species* (Sulloway 1983); that exotic ants in Madeira were responsible for the extinction of native ants, which never actually went

extinct (Wetterer 2006); and that black rats were important predators of Australian mammals, based on a study that found no significant effect of rats on native mammal numbers (Smith & Banks 2017). The failure to assess the existing evidence base fully can lead to an overemphasis on outlying, well publicized, or even discredited studies or those published in prestigious outlets. Effective policy and management rarely emerge from single, definitive experiments. Rather, reliable knowledge accumulates from diverse sources of evaluated evidence that persuade communities of professionals (Collins & Pinch 2012; Roche et al. 2019).

We can best understand how to employ interventions by evaluating how they have worked in a range of circumstances. For example, an article on the efficacy of streamer lines in reducing bycatch of seabirds should incorporate previous studies of streamer lines in different locations, with different species, and with different numbers of lines or types of line so as to provide a comprehensive picture of whether the action is generally effective or more effective in some situations than others. In this way, the giant is assembled, and future researchers can avoid pitfalls and target knowledge gaps. Reliability is important and conservation science should encourage studies that replicate interventions (Baker 2016).

One solution is the Conservation Evidence website (www.conservationevidence.com) (Sutherland et al. 2019), which was developed to collect, curate, and summarize tests of conservation interventions. It provides a means of checking the literature. Authors may summarize the existing literature by referring to the individual papers or, if the literature is extensive, make use of the review provided. We envisage a simple, routine check of Conservation Evidence and then addition of other relevant literature. Researchers can use it to check they have not missed key references and may reference the webpage to avoid adding references to their manuscript. Conservation Evidence focuses exclusively on conservation solutions, and does not, for example, collect papers describing threats or compile or summarize conceptual and theoretical papers for hypothesis generation and inference. It does not yet cover interventions for all habitats and taxa, and there may be relevant papers published

since a literature was synthesized by Conservation Evidence.




Other options for extracting the relevant literature include systematic reviews (especially those collated by the Collaboration for Environmental Evidence [www.environmentalevidence.org]); other specialist websites, such as the Resource database of the Society for Ecological Restoration (<https://www.ser-rrc.org/resource-database>) or the CABI Invasive species compendium (<https://www.cabi.org/isc>); standard literature searches (ideally with the search process specified); and the forthcoming Applied Ecology Resources (<https://www.britishecologicalsociety.org/publications/applied-ecology-resources/>), which will host a searchable and citable repository of gray literature.



Forty conservation-focused journals, whose lead editors are authors on this editorial (journal names are italicized in the list of author affiliations), are requesting that authors outline how they have placed the literature in context (e.g., by searching Conservation Evidence) by incorporating this in the submission process or in instructions to authors.

Asking authors who have tested interventions to explain how they have placed their paper in context will help ensure conservation science reduces the perils of cherry picking scientific evidence and will improve the design of future work. It will not provide a complete remedy to bias in conservation articles. Ideally, the impact of this measure will grow as the evidence base grows, so that we can have the extended vision that comes from standing on the shoulders of giants rather than the limited vision from standing on their toes.

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Article Impact Statement: Authors of conservation articles asked to include citations of existing evidence and to place studies in context of that evidence.

Literature Cited

- Baker M. 2016. 1,500 scientists lift the lid on reproducibility. *Nature News* **533**:452–454.
- Banobi, JA, Branch TA, Hilborn R. 2011. Do rebuttals affect future science? *Ecosphere* **2**:1–11.
- Collins, HM, Pinch T. 2012. *The Golem: what you should know about science*. Cambridge University Press, Cambridge, United Kingdom.
- Eysenbach G. 2006. Citation advantage of open access articles. *PLoS Biology* **4**:e157.
- Gossa C, Fisher M, Milner-Gulland E. 2015. The research-implementation gap: how practitioners and researchers from developing countries perceive the role of peer-reviewed literature in conservation science. *Oryx* **49**:80–87.
- Leimu R, Koricheva J. 2005. What determines the citation frequency of ecological papers? *Trends in Ecology & Evolution* **20**:28–32.
- Nieminen P, Rucker G, Miettunen J, Carpenter J, Schumacher M. 2007. Statistically significant papers in psychiatry were cited more often than others. *Journal of Clinical Epidemiology* **60**:939–946.
- Nuñez, MA, Barlow J, Cadotte M, Lucas K, Newton E, Pettorelli N, Stephens. 2019. Assessing the uneven global distribution of readership, submissions and publications in applied ecology: obvious problems without obvious solutions. *Journal of Applied Ecology* **56**:4–9.
- Pullin AS, Knight TM, Stone DA, Charman K. 2004. Do conservation managers use scientific evidence to support their decision-making? *Biological Conservation* **119**:245–252.
- Roche DG, Bennett JR, Provencher J, Rytwinski T, Haddaway NR, Cooke SJ. 2019. Environmental sciences benefit from robust evidence irrespective of speed. *Science of the Total Environment* **696**:134000.
- Sala SD, Brooks J. 2008. Multi-authors' self-citation: a further impact factor bias? *Cortex* **44**:1139–1145.
- Schreiber M. 2009. The influence of self-citation corrections and the fractionalised counting of multi-authored manuscripts on the Hirsch index. *Ann. Phys.* **18**:607–621. <https://doi.org/10.1002/andp.200910360>.
- Smith HM, Banks PB. 2017. How dangerous conservation ideas can develop through citation errors. *Australian Zoologist* **38**:408–413.
- Stanek KZ. 2008. How long should an astronomical paper be to increase its impact? Preprint [arXiv:0809.0692](https://arxiv.org/abs/0809.0692).
- Sulloway FJ. 1983. The legend of Darwin's finches. *Nature* **303**:372.
- Sutherland WJ, Pullin AS, Dolman PM, Knight TM. 2004. The need for evidence-based conservation. *Trends in Ecology & Evolution* **19**:305–308.
- Sutherland WJ, et al. 2019. Building a tool to overcome barriers in research-implementation spaces: the Conservation Evidence database. *Biological Conservation* **235**:93–101.
- Tahamtan I, Afshar AS, Ahamdzadeh K. 2016. Factors affecting number of citations: a comprehensive review of the literature. *Scientometrics* **107**:1195–1225.
- Todd PA, Yeo DC, Li D, Ladle RJ. 2007. Citing practices in ecology: can we believe our own words? *Oikos* **116**:1599–1601.
- Todd PA, Guest JR, Lu J, Chou LM. 2010. One in four citations in marine biology papers is inappropriate. *Marine Ecology Progress Series* **408**:299–303.
- Van Leeuwen TN, Moed HF, Tijssen RJ, Visser MS, Van Raan AF. 2001. Language biases in the coverage of the Science Citation Index and its consequences for international comparisons of national research performance. *Scientometrics* **51**:335–346.
- Wainwright CE, Staples TL, Charles LS, Flanagan TC, Lai HR, Loy X, Reynolds VA, Mayfield MM. 2018. Links between community ecology theory and ecological restoration are on the rise. *Journal of Applied Ecology* **55**:570–581.
- Wetterer JK. 2006. Quotation error, citation copying, and ant extinctions in Madeira. *Scientometrics* **67**:351–372.