



The reliability of evidence review methodology in environmental science and conservation



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ABSTRACT

Given the proliferation of primary research articles, the importance of reliable environmental evidence reviews for informing policy and management decisions is increasing. Although conducting reviews is an efficient method of synthesising the fragmented primary evidence base, reviews that are of poor methodological reliability have the potential to misinform by not accurately reflecting the available evidence base. To assess the current value of evidence reviews for decision-making we appraised a systematic sample of articles published in early 2015 (N=92) using the Collaboration for Environmental Evidence Synthesis Assessment Tool (CEESAT). CEESAT assesses the methodology of policy-relevant evidence reviews according to elements important for objectivity, transparency and comprehensiveness. Overall, reviews performed poorly with a median score of 2.5/39 and a modal score of zero (range 0–30, mean 5.8), and low scores were ubiquitous across subject areas. In general, reviews that applied meta-analytical techniques achieved higher scores than narrative syntheses (median 18.3 and 2.0 respectively), as a result of the latter consistently failing to adequately report methodology or how conclusions were drawn. However, some narrative syntheses achieved high scores, illustrating that the reliability of reviews should be assessed on a case-by-case basis. Given the potential importance of reviews for informing management and policy, as well as research, it is vital that overall methodological reliability is improved. Although the increasing number of systematic reviews and meta-analyses highlight that some progress is being made, our findings suggest little or no improvement in the last decade. To motivate progress, we recommend that an annual assessment of the methodological reliability of evidence reviews be conducted. To better serve the environmental policy and management communities we identify a requirement for independent critical appraisal of review methodology thus enabling decision-makers to select reviews that are most likely to accurately reflect the evidence base.

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1. Introduction

Evidence reviews (defined in Table 1 and hereafter also referred to as reviews) in conservation and environmental science, as in other disciplines, are a vital tool to support decision making for researchers and decision-makers alike. Whereas more general literature reviews enable current states of knowledge to be summarised and trends and patterns across multiple datasets to be

identified, evidence reviews focus on specific questions of the size and direction of effect achieved through an intervention or the impact of an action (whether desired or not). The value of evidence reviews to end-users is strongly dependent on review objectivity (i.e. the review methodology reduces the susceptibility of findings to bias, individual judgement, or prejudice) and comprehensiveness (Chalmers, 2003; Pullin and Knight, 2001; Rothstein et al., 2013). These qualities also assist researchers in identifying gaps in knowledge and areas of controversy or uncertainty, and can help decision-makers undertake informed management and defend potentially controversial or expensive actions (Gough et al., 2012). Where these qualities are not present, reviews have the potential

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Table 1
Evidence synthesis and review terminology.

Term	Definition
Evidence review	An overarching term for articles that collate and summarise multiple primary studies related to a specific, policy-relevant question (Collaboration for Environmental Evidence, 2013).
Evidence synthesis	“A distinct element in the review process” that combines results from primary studies to derive findings from all available evidence. This “occurs once the evidence base has been accumulated and the data of interest extracted” (Pope et al., 2007).
Meta-analysis	“A set of statistical methods for combining the magnitude of the outcomes (effect sizes) across different data sets addressing the same research question”(Koricheva et al., 2013).
Narrative synthesis	A process which uses prose to summarise and draw conclusions from primary research and which may be supplemented by the reviewers' own experience. Some narrative syntheses may include limited quantitative analysis.
Systematic review	“A review of a clearly formulated question that uses systematic and explicit methods to identify, select and critically appraise relevant research, and to collect and analyse data from the studies that are included within the review. Statistical methods (meta-analysis) may or may not be used to analyse and summarise the results of the included studies” (Collaboration for Environmental Evidence, 2013).

to misinform and result in policies that have unwanted and unforeseen consequences and/or wasted research investment (Kirsch et al., 2008; Pullin and Knight, 2012), particularly if used as the single source of knowledge (although this will rarely be the case) or if selectively used by stakeholders with particular priorities. Avoiding such an eventuality imposes an obligation on those conducting evidence reviews to ensure their reliability and accurate reflection of the primary evidence base, and to transparently report review methodology to enable external assessment of reliability.

Evidence-based environmental policy is becoming a crucial element within wider societal debates on human impacts on the environment and future actions for environmental protection. Evidence may be used to inform policy from a number of sources including expert knowledge, experiential evidence, primary research, and review articles amongst others, each with their own potential biases and problems. For example, although expert knowledge may offer important guidance for non-specialists, experts can have biased opinions and their knowledge can lag behind published evidence (Ayyub, 2010). In addition, vested interests of multiple stakeholders can lead to selective use of evidence in political debates (e.g. Biber, 2012; Pielke, 2007; Sarewitz, 2004) giving an inflated impression of uncertainty of the science and reducing its potential to inform future policy. Similarly, while the decision-maker's own experiences or the experiences of others can provide valuable direction to decision-making, it may not be appropriate to generalise such experiences to different social, ecological or economic situations. Primary studies provide vital insight into the real-world application of, for example, a specific management intervention or conservation strategy under particular conditions, however increasing publication rates of primary literature (Larsen and von Ins, 2010; Li and Zhao, 2015; Pautasso, 2012) have resulted in ever-increasing evidence of variable quality for decision-makers to draw from. Effective and unbiased integration of published scientific evidence into policy and management is therefore impractical without evidence synthesis.

Based on our experience, we estimate that between 40 and 80 new review articles intending to inform decision-making were published each month (c. 480–960 per year) in the environmental peer-reviewed literature between 2012 and 2015. Multiple or overlapping reviews addressing the same basic issue or question are now commonplace (e.g. Claudet et al., 2008; Stewart et al., 2009) and misrepresentation of data within reviews resulting from conflicts of interest with funding organisations has been indicated (Wade et al., 2010). Perhaps more commonly, selection of primary data to support an adopted position or belief (so-called ‘policy-based evidence’) may be consciously or subconsciously employed by review authors (Biber, 2012; Pullin and Knight, 2012). While the

translation of evidence from science to policy is rarely linear and decisions are informed through other mechanisms as well as published literature (e.g. Sharman and Holmes, 2010; Wesselink et al., 2013 and references therein), misinformation and misrepresentation within reviews is likely to further undermine evidence-informed decision-making. There is consequently a need to develop ways in which the reliability of individual reviews can be evaluated and compared to determine the value of their contribution to the evidence base prior to their incorporation within the decision-making process. In addition, with so many reviews on environmental topics being published, it is valuable to have an overview of reliability that highlights both strengths in review conduct and opportunities for improvement.

The reliability of evidence reviews has been of concern in other sectors (e.g. Mulrow, 1987; Tranfield et al., 2003; vom Brocke et al., 2009) and, partly in recognition of this, systematic review methodology was developed in the health sector as a gold standard for collecting and synthesising evidence (Chalmers et al., 2002; Cook et al., 1997). This has subsequently been modified for other sectors (e.g. education and environment) to reflect the different methodological approaches employed. Systematic reviews follow strict guidelines (e.g. Collaboration for Environmental Evidence, 2013; The Cochrane Collaboration, 2011) designed to improve rigour and transparency, and to minimise biases to which more traditional reviews are susceptible. Subsequently a number of tools have been published for critically appraising and rating reviews against this best practice methodology (e.g. Guyatt et al., 2011; Shea et al., 2009; Woodcock et al., 2014). Within environmental science, most evaluations to date have focused on reviews within specific disciplines and that apply meta-analytical techniques (Huntington, 2011; Koricheva and Gurevitch, 2014; Philibert et al., 2012), identifying consistent weaknesses in conduct and reporting standards.

Based on environmental systematic review methodology, which is transferable to all reviews that use literature review techniques (Collaboration for Environmental Evidence, 2013), an assessment tool expressly intended for evaluating environmental evidence reviews has been developed (the Collaboration for Environmental Evidence Assessment Tool [CEESAT], Woodcock et al., 2014). CEESAT aims to evaluate review reliability by assessing methodological elements essential for objectivity, transparency and comprehensiveness to enable decision-makers to select reliable, unbiased reviews. Since systematic review methodology was introduced in the environmental sector a decade ago (Pullin and Stewart, 2006) its use has become more widespread (Haddaway et al., 2015). In this context, it is timely to take the opportunity to assess the current reliability of environmental evidence reviews.

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