CHAPTER SEVEN

Informing conservation decisions through evidence synthesis and communication

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7.1 Introduction

The volume of evidence from scientific research and wider observation is greater than ever. Approximately 2.5 million articles are published annually (Plume & van Weijen, 2014) and this rate is increasing at around 3–3.5% per year (Ware & Mabe, 2015). Conservation is no exception to this trend and the result is a rapidly expanding body of potentially useful information for decision-makers (Li & Zhao, 2015). While the expansion of research represents an important increase in knowledge generation, much of this information is scattered in fragments over increasingly diverse sources. This, along with the sheer volume, makes it harder for decision-makers to find, access and digest all of the relevant information on a particular topic, resolve seemingly contradictory results or simply identify a lack of evidence. Evidence synthesis is the process of searching for, and summarising, a body of research on a specific topic in order to inform decisions. The extent of relevant research may range from nothing, or one or two primary studies, to many hundreds. Despite the obvious potential value of synthesising findings from multiple studies (where two studies may be all that is needed to add value through

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synthesis), methods of rigorous evidence synthesis have been largely neglected until recently. We argue that it is time to place evidence synthesis as a central pillar of evidence-informed decision-making in conservation and environmental management.

As an enterprise, evidence synthesis is very broad and includes many and diverse methodologies, some more rigorous than others. For example, syntheses labelled as 'literature reviews' often lack standardised methodology, fail to report their methods and therefore lack transparency or the potential for repeatability (O'Leary et al., 2016). Additionally, these literature reviews do not deal with the risk of bias in either the primary research (e.g. poor-quality experimental design and conclusions that may not be supported by a given study) or the synthesis process (e.g. selective use of information). Meta-analysis approaches have become popular where significant amounts of quantitative data are available, but they are often biased in the way they select and include studies in their analysis (Koricheva & Gurevitch, 2014). In response to these problems, more rigorous methodologies, such as systematic reviews, have been developed. These were first used in the health sector through the work of the Cochrane Collaboration (Higgins & Green, 2011), and have subsequently been applied to conservation and environmental management by the Collaboration for Environmental Evidence (Pullin & Knight, 2009; Collaboration for Environmental Evidence, 2018).

In this chapter we make a case for rigorous evidence synthesis: we explain why these methods are appropriate, how they can benefit wider society and how evidence can be synthesised, shared and used as a public good. Although evidence synthesis can inform a broad range of decision-making contexts, we focus here on two major aspects of conservation where evidence might be useful. First, in measuring the direct and indirect impacts of human activity on the natural world, and second, the effectiveness of conservation efforts to mitigate those impacts.

7.2 The central role of evidence synthesis in informing decisions in conservation policy and practice

Many factors can contribute to making a decision. In contexts where social and political stakes are high, as is common for conservation policy, scientific evidence will likely only inform decisions, rather than act as the primary driving force behind them. Although evidence is sometimes crucial, it may equally be ignored or overruled by other factors, such as political context, infrastructure and capacity. Ideally, evidence synthesis should play a central role in providing reliable evidence and enabling the wider society to understand or challenge decisions that might affect them. Making decisions without considering all available evidence might perpetuate biases, increase the likelihood of taking a wrong or costly action, or lead to missed opportunities to achieve faster or more cost-efficient outcomes. In a democratic society, comprehensive and rigorous evidence synthesis and open communication makes 'sidelining' (i.e. deliberately ignoring evidence) and/or biased (i.e. selective) use of evidence by authorities more difficult without challenge and transparent justification.

Unfortunately, evidence synthesis is itself often 'bypassed' completely or manipulated to get the answer required (i.e. policy-based evidence) (Dicks et al., 2014). There may be significant resistance to the use of transparent evidence synthesis in the face of vested interests, and this may partly explain why organised and independent evidence synthesis receives so little attention or funding. Rigorous scientific evidence could also be seen as a threat to those with entrenched beliefs. Beyond outright opposition, complacency or inaccessibility of evidence might inhibit adoption of synthesis findings even when good intentions towards informed decision-making exist.

Fortunately, most decision-makers in conservation want practical advice that is grounded in the best available evidence (Cook et al., 2013). Leveraging syntheses and integrating their findings into decision-making processes requires an understanding of how and when evidence is necessary, and what level of confidence is needed to inform a decision. Such considerations will determine the choice of synthesis method(s), which should reflect practical needs to guide management decisions or future research. Syntheses can be used either to generate a new theory, conceptual framework or hypothesis (e.g. applying existing theory to a different context) or to test an existing hypothesis (e.g. evaluating the effectiveness of an intervention). In the context of effectiveness of interventions, evidence syntheses are relevant to decisions at several critical stage points in the life cycle of a programme or initiative: (1) initial scoping of a new topic early on in strategic planning (e.g. informing a new strategy on land use for a philanthropic foundation (Snilstviet et al., 2016)); (2) identification or validation of specific intervention designs (e.g. understanding how gender composition affects outcomes of resource management groups (Leisher et al., 2016)); (3) benchmarking of institutional outcomes against other programmes (e.g. investments in community forest management by the Global Environment Facility (Bowler et al., 2010)); (4) evaluation of overall effectiveness of an intervention across multiple contexts or applications (e.g. effects of property regimes in different biomes (Ojanen et al., 2017)). Understanding the purpose of the syntheses for informing the different stages of decision-making will ensure selection of a suitable method, appropriate engagement of stakeholders and relevant communication of findings.

Some evidence synthesis methods, such as systematic review, have been described as following the 'information deficit model' (Owens, 2000); that is to say, they follow the assumption that the simple production and push delivery of evidence that fills a gap will be sufficient to achieve uptake. However, this perception misrepresents the full process behind the methodology.

Systematic reviews can be socially inclusive, with extensive stakeholder contribution to formulating a question and approach, including setting the scope of the topic. This engagement attempts to ensure the findings of a review will fill a real and important synthesis gap (a knowledge need where sufficient primary research exists to allow synthesis) and respond to stakeholder demand. When engaging with stakeholders, a balance needs to be struck between involving them in the design of the review and independence from undue vested interest (Haddaway & Crowe, 2018). In the field of conservation, this balance is very much dependent on the nature of the question and the extent of vested interests (Kløcker Larsen & Nilsson, 2017). Many aspects of evidence synthesis are collective, with stakeholders having shared motivation to benefit from the findings. In other cases, evidence synthesis is conducted in contested areas, with stakeholders that hold opposing views and may be hostile to the process and its findings. In the latter case, it is important to have a process that allows consultation when appropriate but also provides independence when necessary. For example, for some key steps, such as initial formulation of the question, engagement with stakeholders is usually essential (Land et al., 2017), while other steps may need to be conducted free of such vested interests. To date, systematic reviews have engaged with a spectrum of stakeholders at different levels. Some reviews, for example those that are more academic or have specific commissioners (e.g. private goods reviews (Oliver & Dickson, 2016)), have only passively engaged stakeholders by informing or consulting them (typically only at the beginning of the review process), while others have employed more in-depth engagement, extending to co-design of review methods and scope (Land et al., 2017).

Alongside the purpose of syntheses, the level of confidence required to make a decision determines their method and scope. In some instances, where evidence of effectiveness is key, uncertainty in the evidence base hampers decision-making. In such instances one might ask 'How much evidence is enough?' or 'How much uncertainty is acceptable?' (Salafsky & Redford, 2013). The need for evidence synthesis in the conservation sector may also vary depending on aspects of spatial scale, complexity and controversy. For example, decisions regarding inexpensive and low-risk local-scale interventions (e.g. applied to improve biodiversity or habitat conditions in nature reserves) may benefit most from locally generated, rigorous evidence, or more commonly from primary research studies conducted in similar contexts. This evidence could be provided by a single, self-generated study (as in adaptive management), be internally generated by the relevant organisation, or come from collating evidence from similar case studies. In contrast, decisions regarding expensive, often large-scale, high-risk programmes (e.g. to eradicate poaching and illegal trade in wildlife), where stakeholders are likely to be global and might hold conflicting views, may benefit from an independent global-scale, multi-context evidence synthesis. This might require a rigorous analysis of what works, where and when and for whom, involving analysis of heterogeneity in outcome and identification of effect modifiers. Often within conservation, a broader set of evidence types (e.g. controlled trials, case studies, quantitative and qualitative research) is needed to fully capture the complexity of conservation contexts.

7.3 Key aspects of rigorous evidence synthesis and why they are needed

To be reliable, evidence syntheses should consider all available evidence and attempt to provide the most accurate and precise estimation of the truth. A suite of methodologies has been developed that maximises transparency and repeatability while minimising subjectivity, susceptibility to bias or influence of vested interest. The most widespread of these, systematic reviews and systematic maps, are well-documented secondary research methods that follow detailed guidance (e.g. Collaboration for Environmental Evidence, 2018) and use step-wise processes set out in an a-priori protocol to comprehensively identify and collate all available evidence (Table 7.1).

Systematic reviews in conservation and environmental management have most commonly aimed to answer specific cause-and-effect type questions, for example relating to the effect of a management intervention or exposure on a subject of concern. (e.g. 'What is the impact of a specific factor *x* on a subject *z*?'). In contrast, systematic maps collate and catalogue available evidence on a relatively broad subject, describing the nature of the evidence base and highlighting evidence clusters and gaps, along with methodological patterns in primary research (Collaboration for Environmental Evidence, 2018). Systematic maps can be used as an initial step of an *evidence synthesis pathway* to identify subtopics suitable for a systematic review and subtopics where there is insufficient evidence to make synthesis of primary data worthwhile. In such latter cases, which are common in conservation, the map may identify individual primary studies that provide useful evidence (for an example of a systematic review question generated from a map, see www.eviem.se/en/projects/SR15-Prescribed-forest-burning/).

Systematic reviews were originally developed in response to an absence of easily accessible and rigorous synthesis of available evidence. However, recent assessments have shown that non-systematic reviews that aim to inform environmental policy and practice are still prevalent, but have low methodological reliability, suffering from lack of transparency and methodological rigour, and are consequently highly susceptible to bias (Woodcock et al., 2014, 2017; O'Leary et al., 2016). Moreover, the term 'systematic review' is often used by authors (and not challenged by editors or peer reviewers) when the reviews are in no way systematic. The production of substandard and

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Table 7.1 *Overview of systematic evidence synthesis stages and the issues they address. For an explanation of bias see Collaboration for Environmental Evidence (2018) or Bayliss and Beyer (2015)*

Systematic review stage	Description	Defining features	Type of issue addressed
Review question identification and formulation (with stakeholder engagement)	Question is carefully identified and formulated with help of stakeholders	Social acceptance, relevance and legitimacy of the review process	
Protocol	Protocol outlines the intended method in detail. Protocol is peer-reviewed and published on an open-access platform	Public acceptance, peer review	Review bias, question creep
Searching for relevant literature	Comprehensive searches for grey and commercially published literature from a variety of sources	Comprehensiveness, repeatability (through transparency)	Publication bias
Eligibility screening	Careful screening of all identified articles according to pre-determined inclusion criteria	Consistency	Selection bias, review bias
Critical appraisal of study validity (optional for systematic maps)	A detailed assessment of the susceptibility to bias and generalisability of each study	Account for variability in internal validity and power of individual studies	Susceptibility to bias in individual studies and in study weighting by reviewers
Data coding and extraction	Transparent coding and, in case of systematic reviews, extraction of study finding	Consistency, repeatability (through transparency), minimising subjectivity	Selection bias

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Table 7.1 (*cont.*)

Systematic review stage	Description	Defining features	Type of issue addressed
Qualitative and/or qualitative data synthesis (not required for systematic maps)	Well-documented and comprehensive synthesis of qualitative and/or quantitative study findings	Comprehensiveness, repeatability (through transparency)	Selection bias, vote-counting, publication bias
Reporting and communication of review findings	Transparent reporting of the review results with extensive supplementary information	Repeatability (through transparency), avoiding overreach	Discussion bias

'fake' systematic reviews is increasing in all fields, from public health to environmental management and education (Haddaway et al., 2016; Ioannidis, 2016; Haddaway, 2017; Pussegoda et al., 2017); they are 'fake' in the sense that they lack necessary comprehensiveness, transparency and reliability (Haddaway, 2017). This further confuses the issue for potential readers, with only a handful of environmental journals requiring authors to follow accepted standards of conduct and reporting (see Collaboration for Environmental Evidence, 2018). A potential evidence user can use keywords like 'systematic review' in their search and have it return documents that claim to be such, when in fact they are not. The misuse of the term 'systematic review' can undermine efforts towards effective decision-making and is a key reason for establishing independent standards.

Stakeholders, including scientists, rarely have the time or training to differentiate between a 'true' systematic review and one that misses critical components of the method (resulting in increased risk of bias and lack of transparency) especially when published in an outlet such as a peer-reviewed journal. To enhance the uptake of more rigorous and reliable synthesis methodologies and maximise the potential of evidence to inform decisions, independent coordinating bodies have been founded in different sectors of society to provide guidelines and standards for evidence synthesis. In the field of medicine this process began in the 1990s with the establishment of the Cochrane Collaboration, which aimed to conduct systematic reviews in order to provide healthcare professionals with the best available evidence on the effectiveness of clinical interventions (Higgins & Green, 2011). The methods were transferred to the field of conservation and environmental management in the early 2000s (Pullin & Stewart, 2006) and are now under the coordination of the Collaboration for Environmental Evidence. These independent coordinating bodies provide guidelines for and training in the conduct of systematic reviews and systematic maps, as well as registering, endorsing and publishing such evidence syntheses. Syntheses registered through the coordinating bodies are scrutinised by methodology experts, guaranteeing a level of reliability and rigour (Collaboration for Environmental Evidence, 2018).

In circumstances where vested interests might potentially influence the outcome of an evidence synthesis, these independent organisations provide a framework and platform to assist the review team to achieve and demonstrate independence of the synthesis process. The framework allows for full engagement of commissioners and other stakeholders in formulation of the review question and planning of the review protocol, followed by independent peer review and publication of the protocol prior to the conduct of the review. In cases where conflict or the risk of undue influence from particular stakeholders is high, the review process should be conducted by an independent review team and the report submitted for independent peer review. Following this process, the review findings may be endorsed by the independent organisation.

7.4 New developments that address barriers to evidence synthesis and communication

There are persistent barriers to the conduct of environmental evidence syntheses and communication of their findings. First, the high resource costs required have been a major disincentive to producing high-quality syntheses, despite their critical value for effective conservation. Second, efficient and effective means of communicating results and facilitating their use for real-life decision-making scenarios are haphazardly applied. These barriers limit the ability of evidence synthesis to dynamically and adaptively respond to conservation challenges. However, new developments in big data and deep learning approaches are offering exciting opportunities to harness evidence syntheses and promote them to broader audiences.

Conducting rigorous evidence syntheses, such as systematic reviews, can carry both significant monetary and human resource costs (Dicks et al., 2014). These costs are particularly prohibitive for organisations with critical needs for evidence, but who have limited time and resources to engage in such synthesis efforts or even to glean needed information from lengthy synthesis reports (Elliott et al., 2014). Moreover, high costs make updating syntheses to create a dynamic evidence base with the most up-to-date knowledge effectively impossible using current technology (Garritty et al., 2010). Additionally, the window of opportunity for decision-making may be shorter than the time in which a credible synthesis can be completed. Thus, to be useful to conservation, evidence syntheses must be optimised to efficiently find, collate and communicate existing evidence (Boyack & Klavans, 2014).

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In a policy space where decision-making timelines are short and demands for rigorous, reliable evidence are high, methods assisted by advances in computing can support rapid evidence collation as well as increase cost efficiency (Shemilt et al., 2016). Computer-assisted approaches range from tools that manage data and streamline the synthesis process to tools powered by machine learning algorithms that allow rapid screening and extraction of evidence with reduced human intervention (Kohl et al., 2018). Promising computer-assisted approaches, including automatic term recognition, document clustering, automatic document classification and document summarisation (Frantzi et al., 2000; O'Mara-Eves et al., 2015) have been trialled in medical and health topics (Ananiadou et al., 2009) and are beginning to be tested in ecological topics (Westgate et al., 2015; Grubert & Siders, 2016; Roll et al., 2018).

These developments are encouraging for increased efficiency of the synthesis processes and potentially enabling dynamic syntheses that continuously update with new evidence as it becomes available. However, there are certain caveats and limitations that must be considered prior to widespread employment of computer-assisted tools. First, unlike medicine and fields such as economics, the semantics of conservation are highly heterogeneous and nonstandardised (Westgate & Lindenmayer, 2017), posing difficulties for both efficient and comprehensive searching, and reliable application of machine learning algorithms to sort and mine text for desired patterns. Second, thus far, the performance of these approaches remains largely untested empirically, particular for conservation and environmental topics. As the value of evidence synthesis methods is in their transparency and credibility, reliable data on the efficacy of different computer-assisted approaches are important for uptake and expansion. Third, many existing computer-assisted platforms are fee-based or require programming skills, limiting their utility to a broader field of users. To improve global ability to address pervasive environmental threats, we need to democratise access to the tools that can help decision-making worldwide, not solely in countries or among researchers with means.

7.5 Mainstreaming evidence synthesis for decision support

Efforts to engage in open science and collaborative practice between conservation and technology fields will require forming collaborative partnerships and fostering conversation between evidence producers, evidence users and data scientists, to build a cohesive and engaged community of practice to open channels of communication to all users (Joppa, 2015). This will allow the broader community to use existing efforts as a starting point and avoid reinventing the wheel and wasting already limited resources (Lowndes et al., 2017). Furthermore, collaborative partnerships and creative funding can foster the long-term sustainability of tools that can live on to serve users. Too often, tools and platforms are created in good faith but require maintenance and updating and lack the ongoing funding and personnel to do so. This is particularly important as tools are most useful when they can dynamically respond to user needs and emerging technologies. This is a critical stepping stone for breaking down barriers to understanding and using evidence synthesis methodologies, as without a dynamic toolbox, synthesis methods will reman aloof from the needs of a diversifying and widening audience.

Evidence synthesis conducted to Collaboration for Environmental Evidence standards generates systematic reviews and systematic maps that are theoretically accessible to all. Yet, simply because something is available does not mean that the potential user is aware of it, knows where to find it, or even how to make sense of it. This is particularly the case for those new to the concept of evidence synthesis. Indeed, many practitioners and policy-makers rely on past experience or consult colleagues, rather than make use of the full suite of evidence (Pullin et al., 2004; Young et al., 2016). These issues create a number of inherent challenges for those decision-makers seeking to be evidence-informed and also broader potential audiences, such as stakeholders and wider society.

One of the mantras of science communication is ‘know your audience’ (Wilson et al., 2016; Cooke et al., 2017) and to have impact, the findings of an evidence synthesis need to be effectively tailored and communicated to different groups of people in different ways and through different media. Communication efforts should, for example, be sensitive to the fact that different groups vary in their ‘trust’ of the science they encounter from different sources (e.g. academic journals, colleagues, social media) (Wilson et al., 2016; Cooke et al., 2017).

A study that surveyed the willingness of practitioners to use a synopsis of relevant literature on bird conservation found that participants were more likely to use the evidence to inform decisions if it was easily accessible and in a clearly summarised format (Walsh et al., 2014). Similar summaries are needed to complement evidence syntheses. These summaries may then need to be further refined and transformed into policy briefs. Policy briefs are often written through the cultural lens of a given organisation and a given issue, meaning that these are unlikely to be useful if prepared in a generic format. Sundin et al. (2018) recently proposed the use of storytelling as a tool to effectively communicate the results of evidence syntheses. This method could give meaning to the evidence and can be communicated through videos (e.g. see https://youtu.be/4uPowxn2skg), presentations or public forums (e.g. newspapers, magazines). Nevertheless, uptake of these methods in science communication is generally slow and also could still rely on poorly conducted syntheses (McKinnon et al., 2018).

There has also been a rise in various knowledge management platforms and data-visualisation tools to explore underlying data that support evidence synthesis (e.g. www.3ieimpact.org/en/evaluation/evidence-gap-maps/, or www.cedar.iph.cam.ac.uk/resources/evidence/). These platforms present data from synthesis projects using interactive features and intuitive visualisations. For example, the Evidence for Nature and People Data Portal (www.natureandpeopleevidence.org) allows users to filter data according to desired parameters – such as diving into a data set to examine a specific intervention or outcome or geographic region, and visualising resultant trends. Syntheses, and in particular systematic maps, can be multi-layered and complex, precipitating a need for an interface that is graphical and intuitive, allowing a broader audience to use it (Figure 7.1).

CONSERVATION INTERVENTION

Area protection	Land/water management	Resource management	Species management	Education & awareness	Law & policy	Livelihood incentives	Ext. capacity building	Sustainable use	Other	HUMAN WELL-BEING
247	213	278	91	34	149	248	80	22	9	Economic living standards
158	151	185	52	20	99	119	28	16	5	Material living standards
22	16	24	6	6	12	17	4	0	3	Health
49	43	68	23	41	30	56	17	5	5	Education
102	105	140	45	18	75	89	47	13	2	Social relations
45	29	33	21	5	19	16	13	3	1	Security & safety
133	162	202	58	31	134	109	54	16	6	Governance & empowerment
36	37	23	19	15	24	47	25	10	3	Subjective well-being
21	17	10	11	5	6	21	8	2	3	Culture/spirituality
1	3	3	1	1	2	2	1	0	0	Freedom of choice/action
0	0	4	2	0	2	3	0	1	0	Other

NO. OF STUDIES

0 50 100 150 200 250

Figure 7.1 An example of an evidence 'heat map' linking conservation interventions with human well-being outcomes. The map allows the user to assess the evidence base for gaps and gluts as well as clicking on each box to further examine the relevant studies (after McKinnon et al., 2016). (A black and white version of this figure will appear in some formats. For the colour version, please refer to the plate section.)

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If reported responsibly, these platforms and visualisations can play an important role in how stakeholders access evidence. A challenge for these approaches is to communicate that evidence syntheses are only estimates of the truth, which depend on the reliability of the evidence with which they were made. There is potential for evidence to be misinterpreted if the relative weight or reliability of a given element is misconstrued when visualised. Regardless of the output, it is important that authors of evidence syntheses communicate any uncertainty in the evidence and the risks associated with relying on studies that have high risk of bias.

Although it is laudable to communicate the findings of a topical evidence synthesis, additional efforts are also needed to communicate to practitioners the value of systematic reviews or maps, how they differ from other evidence synthesis methods and how they can be integrated with existing science advice and decision-making processes within different regions or institutions. Writing academic papers and delivering presentations at scientific conferences is unlikely to reach the typical practitioner, so creative approaches to outreach are needed to access and inform them.

Without use of rigorous evidence synthesis, policies and practice claiming to be 'evidence-informed' can be meaningless. For conservation and the environmental sector in general, the value of evidence synthesis has yet to be fully realised and we have the feeling that its time is yet to come. However, the recent methodological developments, awareness-raising and capacity development, together with new technologies for faster and more efficient conduct, suggest this time is not far away. Conservation is an interdisciplinary field and cannot remain for long in a state of relative evidence synthesis deficit in comparison with other sectors with which it seeks to be relevant. Although still marginalised, the methodology and infrastructure to build conservation's evidence base through rigorous synthesis now exist at a global level. A commitment to evidence-informed decision-making that recognises the central role of rigorous evidence synthesis is required by key actors in the sector if these potential benefits are to be achieved.

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