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Centering equity, diversity and inclusion in environmental evidence synthesis: from awareness to action

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Abstract

Knowledge generated through evidence synthesis is an approach that decision-makers can take to inform policy and management decisions. Evidence syntheses, such as systematic reviews, provide quantitative and qualitative summaries of this evidence, using structured methods that make them comprehensive and repeatable. While such summaries can improve the applicability of scientific evidence and make it more accessible and useable for decision-makers, *who* engages in synthesizing evidence can be an important determinant of the results (e.g. legitimacy, validity and representativeness). Currently syntheses often focus on available, published literature, which can fail to represent the diversity of languages, experiences, and communities involved in producing high-quality evidence. Drawing on our diverse experiences in evidence synthesis we identified ways that principles of equity, diversity and inclusion (EDI) can be incorporated into the evidence synthesis process and outputs. We identify three core phases (pre-production, production, and post-production) that align with current synthesis processes, and where EDI concepts could be incorporated. We reflect on current synthesis structures and processes and highlight opportunities to incorporate new practices that will better reflect the true evidence base and minimize biases. We provide resources and examples of good practice to help guide authors. A growing awareness of the importance of EDI makes this an opportune time to rethink how review teams engage in evidence synthesis to ensure that the processes of evidence synthesis and their outputs are underpinned by practices of equity, diversity, and inclusion.

Keywords Evidence synthesis · Systematic reviews · Scoping reviews · Knowledge exchange · Environmental management · Conservation

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Background

Environmental management and conservation practitioners have made significant strides in adopting evidence-informed decision making (e.g., Karcher et al. [1]) to help address the increasing number and severity of human-caused environmental problems in the Anthropocene [2]. Influenced by the institutionalization of evidence-informed decision making [3, 4], primary and secondary research is increasingly applied to the complex, interconnected environmental and social problems facing decision-makers. Evidence syntheses, such as systematic reviews, are one method that is being increasingly adopted to inform decision-making [5]. Environmental evidence syntheses provide support for sound decision-making, ensure limited resources are used as efficiently as possible, and help identify knowledge gaps [6]. Ensuring that evidence syntheses are comprehensive, transparent, reliable [7], and performed ethically (i.e., in a 'good way' with the involvement of knowledge-holders and rightsholders [8]), is essential. Although often considered a 'gold-standard' for providing reliable evidence, failure to address biases within the process can compromise the validity of syntheses. Incorporating EDI into evidence syntheses can help address this risk.

A growing body of literature highlights that primary research is limited in the questions, problems and perspectives it represents [9–11]. For example, a review of top-publishing ecologists found persistent gender and geographic biases in published works since 1945; women represented only 11% of top publishing authors, while authors from the Global South were similarly under-represented, accounting for only 25% [12]. Feminist critiques of science have long highlighted the gaps in epistemic and ontological approaches that address power in natural and social science fields [13, 14]. Additionally, ecological studies are more often conducted in the Global North than South, which creates a bias in evidence across ecoregions [11, 15]. Indigenous scholars and ways of knowing have long been excluded from Western-based scientific forum and discussions that are commonly used for evidence synthesis [16, 17]. There is also often a larger focus on environmental management from a natural science, as opposed to a social-ecological perspective [18, 19]. As the impacts of environmental problems are not distributed equally across regions, communities, and individuals [20–22], bias can amplify disparities. Such biases result in systemic imbalances that define and limit our understanding of what problems exist, how they manifest, what is perceived as most important, and the potential range of possible solutions. Environmental problems are human problems [23] and as such, there is growing recognition that more inclusive approaches to science practices can generate better informed and more representative research findings [24–26].

Although evidence syntheses, such as systematic reviews and maps, are posited to be robust, reproducible, and objective methods to summarize the evidence-base and support management decisions, evidence synthesis processes have not been examined in as much detail in relation to equity, diversity, and inclusion (EDI[1]). In this paper, we follow the definitions, or principles, of EDI developed by the United Nations (UN) Working Group of Focal Points on Diversity, Equity, and Inclusion (see Glossary; [27]). We recognize that incorporating these concepts within the current structure of syntheses is aspirational, and an area where we currently fall short. For our purposes, EDI-conscious syntheses are conducted to meaningfully integrate all, or some, of these principles. This may mean considering who will be impacted by the results of a synthesis, how the review team can reflect multiple perspectives, how the synthesis process can support engagement, and how evidence, regardless of source, is incorporated. While EDI-related terms such as diversity are also commonly applied to ecosystems and other science-based knowledge systems, we limit our scope to the operationalization of EDI principles and participation in science-based syntheses more broadly.

[1] We use the acronym EDI (Equity, Diversity, Inclusion) throughout as it is commonly used. We acknowledge that other terms have been added as terminology and scope have evolved (e.g., justice, de-colonization, ability etc.). Although not explicitly included in the acronym, these other concepts are, and will continue to be, important parts of the conversation in evidence synthesis. We touch on many in this manuscript and acknowledge that there is a need to more fully explore these concepts. We encourage those developing evidence syntheses to continue work in these areas.

Current practices in evidence synthesis often focus on Western science (see Box 1) that is available as published literature [28, 29]. Articles included in syntheses are also frequently limited to English publications, reinforcing Anglo-centrism, producing knowledge that is valid only in certain contexts and risking the loss of important and relevant local knowledge [30, 31]. Additionally, evidence syntheses focus on digitalized items that are indexed online, leading to other evidence (e.g., older, more locally specific) never being incorporated into a synthesis using current processes. Unequal access to primary research (e.g., behind paywalls) means that some teams may not be able to conduct evidence syntheses, leading to inequalities in participation [32, 33]. Similarly, the cost of open access publishing may create barriers to publication for some researchers in under-resourced settings like small institutions or the Global South [34, 35], reducing the accessibility of primary research for inclusion in syntheses. Other barriers to participation in the evidence synthesis process may also exist; in medical syntheses women and authors from the Global South are under-represented among researchers [36]. It is likely that similar biases exist in environmental management and conservation evidence syntheses. Who creates the questions, funds research, and prioritizes what gets synthesized can have consequences as to how representative syntheses are.

Box 1 A note on knowledge practices in evidence synthesis

Using existing guidelines for evidence synthesis, the process of searching, collating, gathering data and analysis are based on inherently Western (or dominant) science approaches [37]. Standard evidence syntheses, with their valuation of Randomized Control Trials and Before-After Control-Impact (BACI-style) studies, use of online published literature, timelines connected to academic and government cycles and funding models, may make them antithetical to Indigenous and local knowledge practices. Indeed, even the language of 'evidence' and 'synthesis' can be problematic. This Western orientation can exacerbate issues of inclusion and representation of marginalized people and their ways of knowing even before the synthesis begins. The differences in underlying paradigms between Western-based and Indigenous research methodologies are well recognized [38] and are leading to the development of methodologies in evidence syntheses that are better in tune with different ways of knowing. For example, Leonard et al. [39], developed an Indigenous Literature Review Process to center Indigenous ways of knowing in the review process. The storytelling aspects of narrative syntheses may be one way to bring together multiple forms of knowledge [40]. Similarly, methods such as meta-ethnography could better represent different forms of knowledge in syntheses [41]. There are many questions to answer, and much work to be done in this space [42]. Doing this work will require rethinking how evidence syntheses can be done, and efforts are needed to rethink what makes a good or successful evidence synthesis.

For evidence syntheses to effectively support evidence-informed decisions while mitigating these biases, the guidelines underpinning evidence synthesis must actively consider equity, diversity, and inclusivity, as is being done in other fields of science. Specifically, evidence syntheses must include EDI principles in relation to the issues the reviews address and how they are understood, the knowledge they synthesize, and the process of synthesis itself. Beyond systemic changes needed to ensure equitable access to education, science publishing, and building diverse research and evidence-synthesis communities, there is a need to consider how different aspects of formal evidence synthesis can be refined to ensure that diverse evidence is contributing to decisions. These refinements will help ensure that decisions have the greatest potential to benefit all people (including underrepresented communities) and the environment. While it is relatively easy to identify problems within the field of science, there are gaps in the critical discussion of how to implement inclusive actions in the context of specific processes, which we address in this paper.

Much of evidence production and use falls outside the control of evidence synthesists (Fig. 1). Changes to science support and decision structures that incorporate EDI will benefit evidence syntheses by broadening the types of evidence available, but these systematic and fundamental changes need to be made at a much larger scale than can be achieved by individual teams. Here, we provide our perspective, as primary researchers, synthesists, and decision-makers (see *Positionality Statement*), on the current challenges and barriers to EDI in evidence synthesis processes. We highlight potential solutions to mitigate them, focusing on changes that can be within the influence of individual evidence synthesis teams, while highlighting areas where other groups (such as funders and publishers) can provide support. Recognizing that the necessary evolution of bringing EDI principles to bear on evidence synthesis has been differentially embraced within our community, the paper includes actions that some individuals and organizations may already be implementing as well as exploring issues and opportunities that have yet to be embraced.

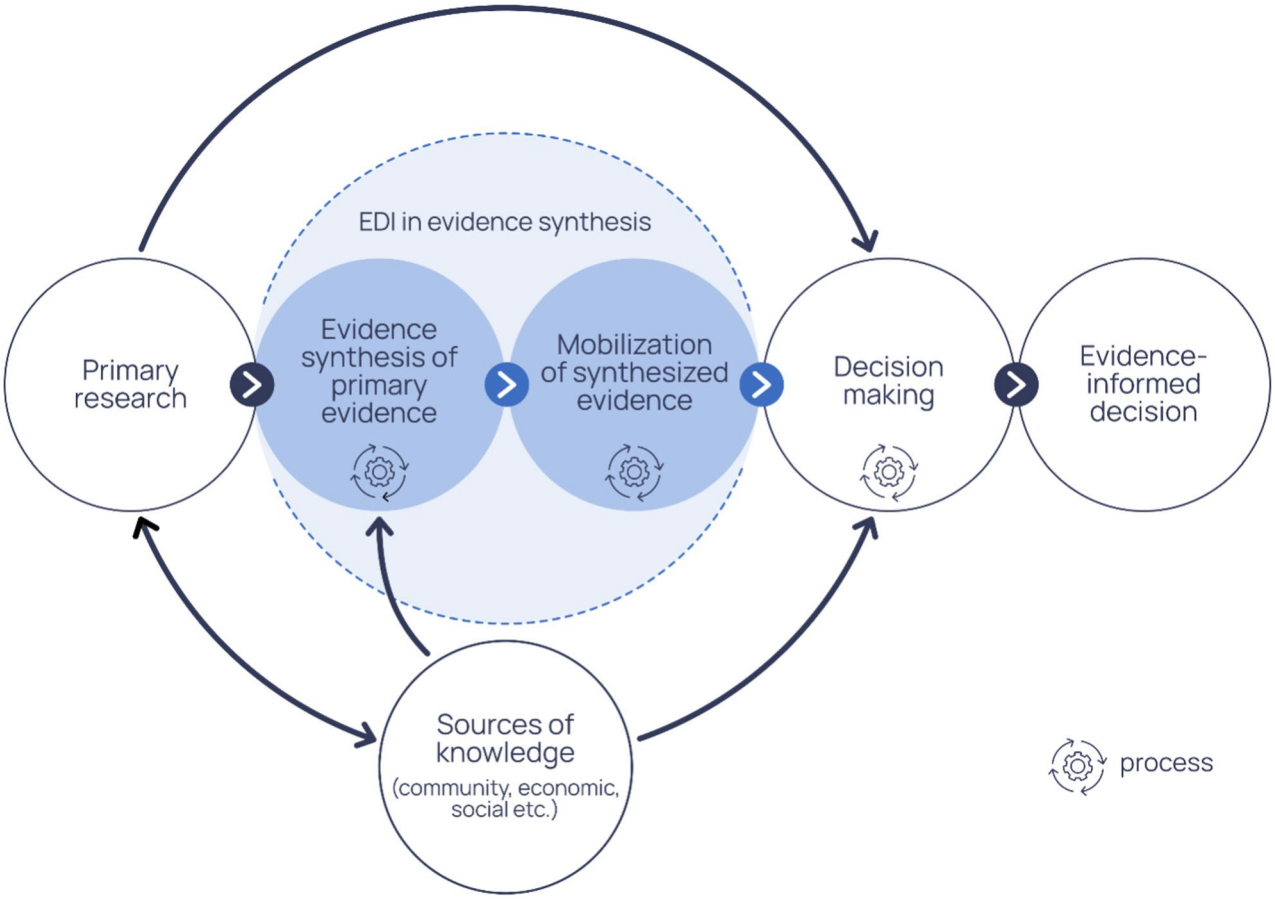

Fig. 1 Evidence synthesis is one component of the knowledge generation and decision-making process. All aspects of knowledge generation and decision-making can consider EDI, however guidance here for EDI in evidence synthesis (dashed line) focuses on the synthesis process and mobilization of synthesized evidence (blue). Information from primary research and other sources of knowledge feed into evidence syntheses, which in turn determines how this information will be mobilized. Many sources and types of knowledge inform the decision-making process, with the aim of producing an evidence-informed decision

Approach

To identify opportunities to incorporate EDI into environmental evidence syntheses, we assembled a diverse team of individuals from around the globe with experience in academia and government, and expertise in evidence syntheses. Team members work in various aspects of evidence synthesis, including methods development, conducting research, knowledge brokering, and evidence application. We reflected on our own lived experiences with EDI in evidence syntheses, recent recommendations from medicine [43, 44] and social science [45], and recent horizon scans for evidence syntheses [46]. Drawing on our experiential knowledge, we identified opportunities for incorporating EDI principles into the evidence synthesis process, adding new concepts where appropriate and relevant. To further build on these opportunities, we used searches of environmental justice, equity, inclusion, and diversity in conservation, and other biological, ecological, and conservation fields. We identified calls for changes to science practices overall, and assumed that the identified areas for improvement, and recommendations for science in general, would also apply to evidence syntheses.

We acknowledge that different groups of authors may emphasize different aspects of EDI based on their experiences and the contexts in which they work. We believe that the ideas presented here provide a useful starting point to bring these ideas to the fore, and we welcome ongoing debate and development of these ideas. Such

ideas may be relevant to those looking to incorporate EDI practices in their environmental evidence syntheses. To support those working to ensure EDI is incorporated into the evidence synthesis process, we identify evidence syntheses that can act as exemplars. Where we could not identify an example, we highlight this as an area for further examination and research, and attempt to include an example from the environmental and conservation literature at large.

Positionality statement

We are a diverse author group with backgrounds in the natural and social sciences, whose work crosses the boundaries between these two areas of research. We come from both the Global South and North and from a variety of environmental and conservation interests. We have experience in environmental resource management, academic research (both social and ecological, quantitative and qualitative), evidence synthesis, and policy development, with experience ranging from a few years to many decades. We draw on a variety of approaches to conduct research and approach questions along the theoretical and applied science continuum. The motivation of this work is to increase awareness of ways in which those who work in evidence synthesis may seek to engage with increasing equity, diversity, and inclusion principles in their work and in the composition of their teams, in the spirit of maximising the potential impacts of evidence syntheses.

Findings—incorporating EDI in evidence syntheses

There are three core phases—pre-production, production, and post-production—in the evidence synthesis process where review teams can work to incorporate EDI principles (Fig. 2). We identified specific EDI opportunities, with examples, guidance, and support from the literature, for each phase: pre-production (Table 1), production (Table 2), and post-production (Table 3). These core phases are consistent with those identified in current synthesis practices [47–49], although current guidelines usually start with question formulation, rather than steps such as ethics. Some steps, like positionality, reflexivity, and reflection, are not currently incorporated into major guidance documents for environmental evidence synthesis (but see Noyes et al. [50] for an example from qualitative evidence syntheses). Below, we briefly describe opportunities within each phase, highlighting current challenges and potential solutions to integrate EDI into synthesis efforts.

Pre-production

Team development

It is important that teams conducting and guiding evidence syntheses are representative of diverse perspectives and experiences. The inclusion of an advisory team made up of stakeholders helps ensure evidence syntheses are relevant to the context in which they will be used and provide reliable and unbiased results [51]. Other models that include members of the public through citizen groups may also bring in diverse perspectives (e.g., PERSPEX [52]). Variations of team structure that are specific to the question at hand help support diversity[2] and make syntheses socially inclusive [6]. Team building already considers a variety of skills and competencies (e.g., including topic experts, information and data specialists, and statisticians [53, 54]), but other aspects of diversity that can influence the process and outcomes of a synthesis are frequently overlooked. Different educational backgrounds (e.g., natural vs. social science), education levels, career stages, language proficiencies, genders, and citizenships, can be useful to build teams with more diverse outlooks and perspectives. It is important, especially for

[2] When considering how to develop a diverse team, it is essential to be aware that "diversity" is often (mis)used as an equivalent for 'underrepresented'. These are not synonymous; including a majority of Indigenous peoples - or any other dimension beyond ethnicity - on a team does not mean that a team is diverse.

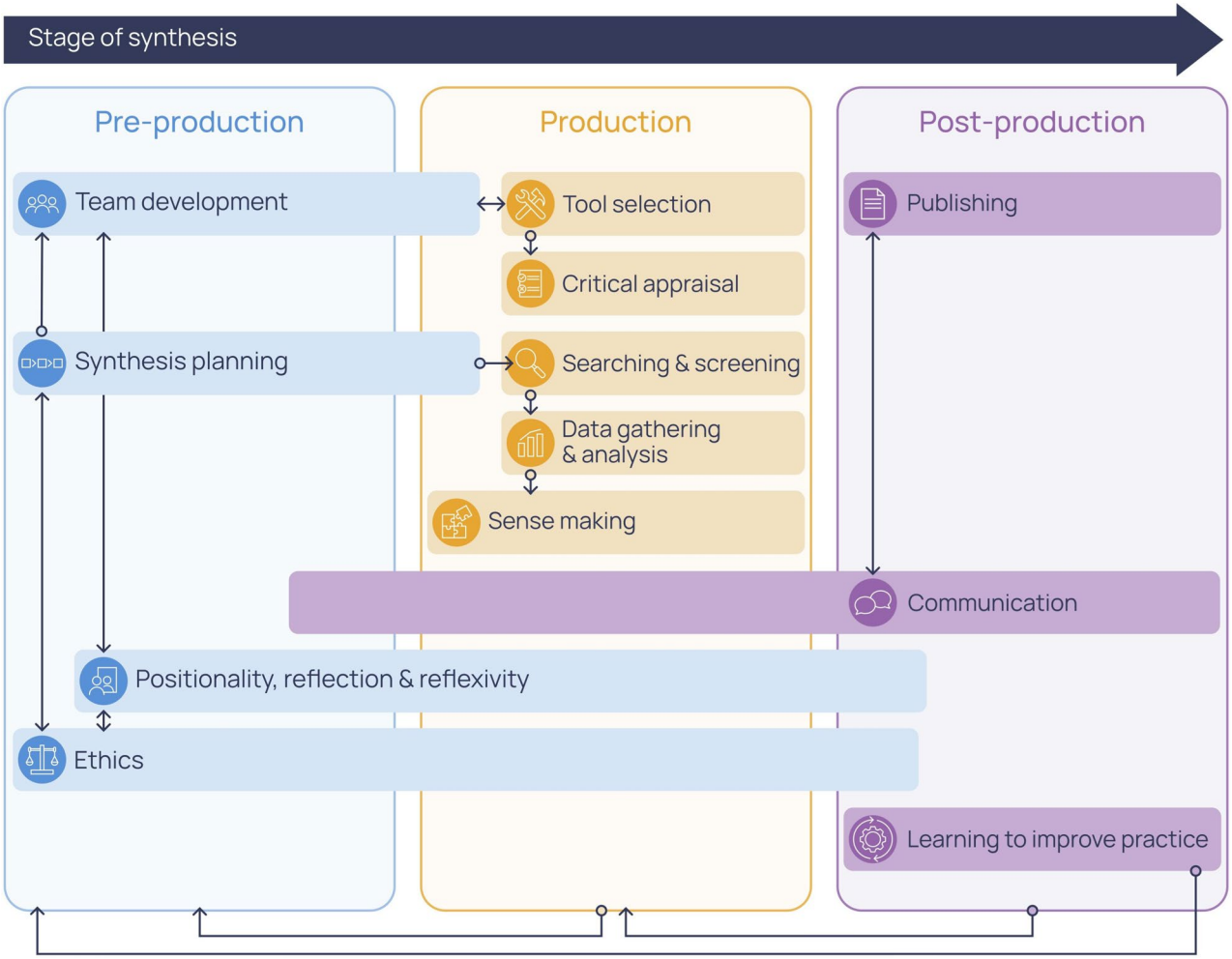

Fig. 2 Stage of review and where EDI should be considered. Considerations start with pre-production (blue), followed by those in the production stage (orange) and the post-production stage (purple). Some EDI considerations are discrete and occur within a single period, while others are overlapping and continuous, or should be repeated and revisited across all stages. Arrows indicate connections among process components, with EDI considerations in one part of the synthesis process influencing other components

environmental topics, to include team members with a variety of educational backgrounds, levels and career stages to ensure that a synthesis can be informed by the perspectives and knowledge of on-the-ground practitioners, managers, or other knowledge-holders, not just the perspectives of academics. Interdisciplinary research teams that bridge academic, sectoral, and social realms may be especially important when working to integrate diverse ways of thinking and types of knowledge [55]. Including individuals with training in different domains and knowledge systems could be beneficial; for example, understanding various ontologies (i.e., the study of being) and epistemologies (i.e., the study of knowledge) could help widen perspectives on types of research and approaches.

Each synthesis team will have to make decisions based on the context of their work and the question(s) being asked, but having an 'open community' that allows those conducting primary research and those doing syntheses to work together will lead to more diverse and inclusive reviews [56]. In all cases, team members should have opportunities for training to improve their understanding of EDI. Providing training specific to their understanding and needs will ensure that the processes put in place during the synthesis are understood by all team members.

Table 1 Activities and opportunities supporting equity, diversity and inclusion (EDI) in the pre-production phase evidence syntheses

Synthesis activity	Opportunity	Supports			Citation*
		Equity	Diversity	Inclusion	
Positionality, reflexivity & reflection	Think critically about who, why, and how research is conducted	*	*	*	[59–61]
	Consider knowledge gaps	*		*	[62]
	Include differing ontologies and epistemologies based on the question		*	*	[60]
	Provide a positionality statement		*	*	[130*, 131*]
	Describe the process of reflexivity		*		[57]
	Provide opportunities to reflect on the synthesis process throughout	*			[132*]
Ethics	Incorporate ethical considerations in a priori protocols	*			
	Submit evidence syntheses for formal ethics reviews (esp. for stakeholder involvement)	*			[65]
	Recognize intellectual credit	*		*	[8, 67]
	Scrutinize conflicts of interest	*			[68]
Team development	Include an advisory team of stakeholders		*	*	[6, 51]
	Consider representation of education, career stage, language proficiency, diverse abilities, gender, citizenship etc.	*	*	*	
	Create multi-disciplinary teams		*	*	[55]
	Build teams with different methodological training			*	
	Work together with primary researchers			*	[56]
	Seek training for all team members	*	*	*	[133]
Synthesis planning	Consider diverse questions, perspectives, and evidence	*	*	*	
	Use appropriate methods for questions			*	[69]
	Ensure stakeholder involvement	*		*	[68, 71]
	Create opportunities for knowledge gathering	*			[70]

*Citations with asterisk indicates exemplar from the synthesis literature

Positionality, reflexivity and reflection

While potentially done informally by many evidence synthesis teams, formally considering positionality, reflexivity and reflection are relatively rare in quantitative evidence syntheses of environmental topics. Positionality refers to how an individual's background and experience influence how they interact with and understand the world, while reflexivity is a process of self-examination of inherent motivations and influences [57]. Reflection can be used as a method to facilitate critical assessment of processes and outcomes that may have been introduced by unconscious bias on the part of the review team and improve practice [58]. Positionality, reflexivity, and reflection may be daunting prospects to incorporate into evidence syntheses, as the environmental evidence synthesis literature offers little guidance on how to include these processes. Introductory guides and frameworks on these concepts, and related concepts are available to support those undertaking evidence synthesis (e.g., Beck et al. [59]; Moon et al. [60]; Moon and Blackman [61]). Thinking critically about research itself, the context, the individuals conducting it and their experiences, helps ensure that syntheses are transparent about potential biases. It is also essential to consider individual perspectives and collective knowledge gaps [62]. Including diverse perspectives such as different ontologies and epistemologies, as well as different experiences (i.e., disciplinary, worked or lived experiences) can reduce the risk of bias within the context of the research question of interest. Providing a positionality statement can be a good way to start reflecting on these aspects within a team.

Table 2 Activities and opportunities supporting equity, diversity and inclusion (EDI) in the production phase evidence syntheses

Synthesis activity	Opportunity	Supports			Citation*
		Equity	Diversity	Inclusion	
Tool selection	Use tools to embed EDI into the synthesis	*	*	*	https://www.trialforge.org/trial-diversity/pro-edi/
	Use tools to increase access to primary research	*		*	[77]; https://unpaywall.org/
	Use translation tools to incorporate global evidence	*		*	[78]
	Use digital tools to reduce effort and time and make review process more equitable	*			[79]
	Use tools to support team members based on their individual needs			*	
	Select open-source tools or those developed by under-represented groups	*	*	*	
Searching & screening	Include different types of evidence		*	*	[85–87]
	Include multiple languages	*		*	[30, 134*]
	Work with local scientists and knowledge holders to increase cultural perspectives	*	*	*	[89, 90, 135*]
	Co-develop searches and inclusion criteria with stakeholders, rightsholders, and information specialists			*	[51, 85, 136*, 137*]
	Include local and traditional names	*		*	[90, 138*]
	Avoid harmful or out-dated language (outside of search terms).			*	[93]
Data gathering & analysis	Incorporate diverse forms of evidence		*	*	[94]
	Build in steps to assess diversity and representation in primary research		*		[95, 139]
	Embrace and incorporate processes for working with diverse knowledge systems	*	*	*	[42, 99, 140]
	Consider data ownership and usage	*			[100, 101]
	Gather EDI data from primary literature and consider during analysis	*	*	*	[45, 102*]
Critical appraisal	Assess if primary studies consider EDI	*	*	*	[74, 105, 141]
	Flag ethical issues within primary research included in syntheses	*			[106]
Sense-making	Provide opportunities for stakeholders to be involved			*	
	Make sure all are involved in constructive discussions			*	[107]
	Involve neutral voices when conversations are difficult	*		*	[108]
	Practice intellectual humility			*	[109]

*Citations with asterisk indicates exemplar from the synthesis literature

We provide a 'group-based' example (see *Positionality Statement* above), but individual positionality statements are also possible. Care should be taken to consider if all team members are comfortable sharing information about themselves [57] and that these are not treated as 'checklist' exercises [63]. Clearly describing the process of reflexivity will be essential for transparency [57]. Critical reflections, as done in social science, can also help ensure that the practice of evidence synthesis is done effectively with EDI in mind.

Ethics

As currently conducted, evidence syntheses rarely address ethical considerations beyond reporting methods in a thorough and transparent manner [64]. By ensuring that evidence syntheses adhere to ethical standards, authors

Table 3 Activities and opportunities supporting equity, diversity and inclusion (EDI) in the post-production phase evidence syntheses

Synthesis activity	Opportunity	Supports			Citation*
		Equity	Diversity	Inclusion	
Publishing	Incorporate Open Science/Open Data policies into your review	*			[110]
	Select journals that actively support EDI	*	*	*	[141]
	Advocate for inclusive citations processes	*		*	
	Work towards citation justice		*	*	[111, 113, 114]
	Expand authorship beyond the traditional roles	*		*	[115, 116]
	Use CRediT and include MeRIT for work	*			[117]
Communicating evidence	Create an engagement plan early with trusted partners			*	
	Collaborate with boundary spanners and knowledge brokers			*	[120]
	Use multiple formats and platforms	*		*	
	Use non-technical summaries to help maximize impact and access	*		*	[121, 142*] Also see https://www.ars.usda.gov/news-events/news/research-news/2022/genetically-modified-corn-does-not-damage-non-target-organisms/ For a public science article and https://environmentalevidence.org/wp-content/uploads/2022/12/CEE-PLS_Meissle-et-al.-2021_Genetically-modified-invertebrates_FINAL.pdf for a plain language summary of [142*]
	Consider creative communication options		*	*	[122– 124*, 143*] Also see: https://environmentalevidence.org/wp-content/uploads/2022/12/CEE-PLS_Meissle-et-al.-2021_Genetically-modified-invertebrates_FINAL.pdf for an example of a plain language summary for [143*]
	Translate to match local community needs	*		*	[45, 144*]
	Embed accessibility in communications	*		*	[125, 126]
	Communicate about the review team		*	*	

*Citations with asterisk indicates exemplar from the synthesis literature

can lay the groundwork for syntheses that effectively incorporate EDI. Ethical considerations fit into several aspects of the synthesis process. A priori protocols that lay out methods for how the ethics of the review will be addressed would help improve transparency and trust in future evidence syntheses. While not currently a requirement for most syntheses in environmental science, those that deal with Indigenous knowledge, or incorporate non-standard evidence types (e.g., interviews) may benefit from a formal ethics review [65]; this can be determined in consultation with ethics boards during planning. When rights-holders (i.e., those with constitutionally

protected rights and associated responsibilities) and stakeholders (i.e., those who take on one or more roles relating to an issue and for whom that issue has a certain level of priority; sensu Büschet et al. [66]) are involved in the provisioning of knowledge and interpretation of findings, ensuring that their knowledge ownership is respected, and their labour is recognized (e.g., through intellectual credit) is necessary [8, 67]. Ethics review can ensure that this is planned and conducted well. Author teams can also identify and scrutinise personal and financial conflicts of interest prior conducting a review to avoid introducing personal or institutional biases to the review process. Questions such as how funding organizations may influence the formation and results of a synthesis, and how these issues could be managed, are important considerations prior to initiating a synthesis [68]. There is a need to incorporate ethical considerations in evidence synthesis guidelines.

Synthesis planning

The process of planning an evidence synthesis, like a systematic review, is normally highly structured and lends itself well to the integration of EDI practices. Several aspects of well-planned evidence syntheses, such as the amount of detail about scope and limitations and the need to involve stakeholders, already address the need to consider diverse perspectives and include diverse evidence. There are many concepts within EDI, including considerations of justice, accessibility, and de-colonialism, among others, that authors planning a review could consider, dependent on the question being assessed, the knowledge systems involved, the working context of the review team, and historical, legal or cultural concerns. Considering EDI in review planning can help avoid conducting evidence syntheses in inappropriate contexts. In some situations, the team might have to decide that evidence synthesis is not a suitable or ethical approach for supporting decision-making. Typologies of questions and potential approaches to address them can assist in selecting methods [69]. Involving stakeholders in the planning process can ensure that the scope of the review is appropriate and that diverse experiences are incorporated as well as ensuring that primary outcomes are meaningful to affected populations [51]. Knowledge-gathering workshops can be important parts of the research plan and help ensure that diverse perspectives and different forms of evidence are not missed [70]. Planning the use of stakeholder mapping can also help ensure that stakeholder inclusion is robust [71]. Additional aspects of the synthesis process where EDI can be considered are described below but planning early and re-assessing throughout the process can lead to improved integration of EDI principles.

Production

Tool selection

Existing guidelines (e.g., from the Collaboration for Environmental Evidence; [47] and reporting standards [72] are some of the tools used to develop evidence syntheses that are reproducible and transparent. Because guidelines and standards are frequently updated, there is an opportunity for them to guide teams toward inclusive and equitable practices, if these concepts are incorporated in the future. Increasingly, tools are being made available to enable teams to embed EDI directly into their reviews through the types of questions asked and factors assessed. For example, syntheses in medicine and social sciences can use PRO EDI [73], PROGRESS-PLUS [31, 74], EQUALSS GUIDE Multiple [75] or the Evidence Synthesis Equity Companion (ESEC) tool [76]. We are unaware of similar tools in other domains such as the natural sciences. Tools can also help evidence synthesists who encounter inequalities in access to primary research (e.g., https://unpaywall.org/ [77]), making it possible for more researchers to be involved. Similarly, translation tools can help enable the inclusion of global evidence [78] and facilitate the involvement of more teams. Other digital tools can help facilitate the synthesis process by reducing effort and time [79]. Tools like screen readers, speech-to-text tools, or colour coding can make the process of synthesis more manageable and more equitably spread the work across team members with different abilities. Providing supports that meet individual team members' needs, considering universal design, and team

support structures can ensure that all team members can contribute and that no one is excluded or burdened based on their individual capabilities. Decisions about what tools to select can also be made with an EDI lens (particularly when considering the use of Artificial Intelligence (AI); Box 2). When equivalent tools are available (e.g., two similar screening support tools), teams may wish to consider using tools developed by under-represented groups, from organizations that have clear EDI statements, or that support marginalized communities through their organizational activities. These can be tangible steps to ensure that all aspects of an evidence synthesis consider EDI.

Box 2: A Note on Artificial Intelligence

Artificial intelligence (AI) will have huge impacts on how evidence syntheses are produced in the future. AI may have important places within the evidence synthesis process, such as supporting screening [80], language translation, or other aspects of the review process [81]. Work is currently underway to test how AI can be integrated into the synthesis process, and the impacts it has (for a current collection see: https://www.biomedcentral.com/collections/AISESEM and the work being done by the DESTINY project: https://destiny-evidence.github.io/website/). Challenges to using AI in evidence syntheses include the ethical concerns and potential biases these tools can create. Human biases and existing inequalities can be introduced and amplified within AI, especially if these biases are present within mainstream training databases or in the teams and environments in which the AI is developed [82]. Guidance for improving EDI in AI should be paired with that of evidence syntheses, however, much work is needed within the AI space before this can occur [83]. Synthesists will need to think carefully about the potential risks AI poses to EDI and explicitly report on how AI was used in their work [84].

Searching and screening the evidence

Ensuring evidence searches adequately represent the available knowledge on a topic is an essential component of evidence syntheses [47]. Current best practices suggest teams consider multiple sources [85], peer reviewed and non-peer reviewed literature [86, 87], and multiple languages [30]. These all have positive impacts on EDI goals and help ensure that multiple perspectives are incorporated, especially when paired with working with local scientists who can help increase the relevance, representation, and inclusion of cultural perspectives [88, 89]. Although many research groups involve advisory teams in the development of searching and screening criteria, further efforts to co-develop searches and inclusion criteria with stakeholders, rightsholders, and information specialists can help to capture additional perspectives [51, 85]. The inclusion of local or traditional names of species in search terms may expand the types of evidence found, while aligning with the need to recognize the value of these names [90]. Some types of evidence, such as qualitative research or indigenous knowledge, may not be found with common search processes and commonly used databases. Qualitative research collections or other textual documents can be missed if concerted efforts are not made to include them. As teams develop searching and inclusion criteria, they should be aware that pulling older but relevant articles may require the use of out-dated, harmful, or offensive language. For example, language surrounding invasive species has changed over time [91], and older terms can now be considered problematic (e.g., spongy moth's previous common name, 'gypsy moth' [92]). Including these terms within searches would be necessary to capture older documents and allow for assessments of change-over-time but could be considered discriminatory. Such cases may be required for comprehensiveness but thoughtful consultation, explicit acknowledgement of the reasons for their use, and avoiding these terms in other aspects of the synthesis can help reduce harm. Townsend et al. [93] provide useful recommendations for synthesists.

Data gathering and analysis

The processes of data gathering[3] and analysis are important areas for EDI integration. Synthesis processes have already developed ways to embrace quantitative, qualitative, and mixed methods, allowing diverse forms of

[3] We intentionally use the term 'data gathering' rather than 'data extraction' here, as extractive science processes have historically led to disproportionate benefits to scientists and little intellectual credit to communities [55]. By using the term 'gathering' we acknowledge that this process is collaborative with those who provided and produced the original (primary) evidence and shared their experiences and knowledge with those conducting the synthesis.

evidence to be incorporated [94]. Different types of analyses have helped showcase how diverse or representative the primary research is, helping to identify areas for improvement (e.g., research weaving [95], the interweave synthesis approach [96], and mixed methods [97]). During data gathering and analysis, recognizing that community members and practitioners possess valid knowledge could strengthen evidence. Developing methods to fully embrace diverse knowledge systems, such as Indigenous knowledge or stakeholder knowledge, is needed [42]. Currently, formally incorporating this knowledge within some aspects of evidence syntheses remains challenging [98], and different methods for synthesizing knowledge may be more appropriate [99]. Evidence syntheses rely on the availability of previously gathered knowledge and integrating different forms of knowledge, including oral records, will require synthesists to consider data ownership and usage to avoid negative consequences [100]. Operationalizing OCAP® (Ownership, Control, Access and Possession) and CARE (Collective benefit, Authority to control, Responsibility and Ethics) principles in all ecological research will assist with this [100, 101]. Finally, when deciding what to gather from individual pieces of evidence, considering which questions would have different results if there are differences at the demographic level (e.g., exposure to natural environments may differentially impact people of different genders [102]) could reduce biases. Demographics continues to be ignored during analysis; even in medicine, syntheses frequently do not report on aspects of the study such as sex or gender (or sometimes confuse the two) [103, 104]. Data gathering and analysis needs to specifically include this information to allow the conduct of more relevant analyses [45].

Critical appraisal

Testing for the reliability of individual studies within an evidence synthesis to adequately answer the review question is an essential step, since biases within individual studies can influence the overall outcomes of the review. Currently, critical appraisal assesses studies in terms of external validity (how generalizable a study is to the review question) and internal validity (the extent to which systematic error within a study is present) [47]. This helps to identify and test for issues within the primary literature. Incorporating EDI in critical appraisal may include: (1) assessing whether authors take equity, diversity, or inclusion into account during study subject selection; (2) whether they control for potential implicit bias through data anonymization; or (3) if they conducted reflexivity exercises during the research process [105]. Health equity is already being integrated into evidence syntheses in medicine through PROGRESS-Plus [31, 74]. Similar processes would benefit environmental evidence synthesis and critical appraisal, especially when socio-ecological questions are being addressed. Ethical issues that may be present within included studies, such as whether primary research followed ethical requirements for the study, could also be incorporated to ensure that unethical materials included in the evidence synthesis are flagged [106]; however, how to do so remains unresolved. Identifying biases that may result from neglecting EDI in primary research and expanding critical appraisal criteria to explicitly assess primary research through this lens can ensure that negative impacts are not magnified at the secondary research level. This may require specialized training for assessors, or consultation with experts on research ethics.

Sense-making

Once the evidence synthesis has been developed, putting the results in context is an important step to getting the results used in decision-making. Evidence synthesists already consider the implications of reviews for policy and research by highlighting knowledge gaps and clusters, bias in the evidence base, and generalizability. Highlighting the limits of a synthesis is essential, as is highlighting the potential biases that could be introduced by the team conducting the review and the stakeholders who are involved (e.g., reflexivity). Inviting stakeholders and rightsholders, on the basis of equity considerations, to participate and/or guide sense-making ensures that sense-making is inclusive and that diverse perspectives are represented. Evidence syntheses are frequently conducted on topics where scientific uncertainty exists requiring sense-making processes to be based on constructive discussions. Having these discussions can be difficult but structured facilitation, with set guidelines to provide

safe spaces for everyone involved, can ensure that everyone has an opportunity to contribute [107]. Facilitation does not necessarily need to be conducted by members of the research team. Neutral voices, such as professional facilitators or boundary spanners [108] brought in specifically for the sense-making process, can be beneficial to creating spaces where all involved are heard. This can have the added benefit of increased knowledge sharing. A willingness to 'self-distance' from the problem and practice intellectual humility [109] in order to re-assess team members' understanding of the topic and think critically about the results of the synthesis and how it can be applied in context are essential components of the sense-making process.

Post-production

Publishing

Many evidence syntheses already follow practices in publishing that support accessibility and trustworthiness, including selecting journals that support Open Science [110]. Authors frequently publish their datasets and ensure that results are available to all. Taking advantage of opportunities to publish a priori protocols through open access databases such as PROCEED or the Open Science Framework (https://help.osf.io/article/145-preregistration) also ensures that access is more equitable. These resources have the added benefit of decreasing barriers for researchers for whom publication costs are prohibitive. Authors can target journals that actively support EDI practices in publication and look for clear diversity statements, guidance for and promotion of inclusive language, and easy-to-access reports on EDI activities [43]. Other actions to make evidence syntheses more equitable and inclusive are possible. Many articles within a synthesis are only included within the database(s) and do not get cited within the main report. Efforts to give recognition to all articles within datasets are underway. For example, the British Ecological Society includes indexed references (within the main text) and indexed data sources (within the dataset); both result in citations for the authors of the original works.

Synthesist teams can also work towards citational justice by paying attention to whom they cite within the main text of a synthesis (while aiming for comprehensiveness in their databases) to decrease inequalities that arise from citing some groups (e.g., white men, English publications) over others [111, 112]. Proactively citing for representation and including a citation diversity statement are two potential ways to take action [113, 114]. EDI principles can also be supported by considering who is eligible for authorship [115]. Authorship can be expanded beyond the main team to include members involved in partnership development, translating knowledge across knowledge systems, or to non-human actors (e.g., Erren et al. [116]). Incorporating credit for work done within the manuscript itself, using methods such as MeRIT, can also ensure fairness and the representation of authorship [117].

Communicating evidence

Evidence synthesists undertake significant efforts to communicate the results of syntheses effectively, considering different learning styles and communication methods. Going beyond traditional modes of linear communication and using methods focused on the two-way exchange of knowledge supports potential end-users to build their capacity to draw on and use the outcomes of syntheses within their decision-making process [118]. Increasing the inclusion of EDI principles in communication and engagement efforts should involve early development of an engagement plan and the involvement of trusted partners throughout. Similarly, working with boundary spanners (*sensu* Bednarek et al. [108]), such as knowledge brokers, can effectively build capacity for the use of knowledge in decision-making, and improve participation and the diversity of those involved [119, 120]. The scientific community, the larger management community, and the public are all important audiences, and communication and engagement done in multiple formats and through multiple platforms will reach these audiences more effectively. Non-technical summaries, paired with full reports and other types of summaries can help maximize the impact of a synthesis [121]. Some forms of communication and/or engagement may not be relevant or accessible to all

audiences and tailored options that meet communities' needs are important (e.g., through environmental storytelling [122], or data visualizations like EviAtlas [123]).

Using creative techniques that go beyond standard written communications or presentations also has great potential to bolster EDI; healthcare has seen success with novel approaches, such as board games and podcasts, when engaging diverse groups [124]. Providing communications in several languages can also ensure that the findings are relevant to local communities and that everyone has an opportunity to interact with the scientific findings [45]. Many guides are available to help make science more accessible (e.g., Crameri et al. [125]; Kasdorf [126]), and their recommendations can be integrated into evidence synthesis engagement plans. Finally, to improve EDI processes for syntheses, it is important to communicate about the review team, not just the review itself; transparency about who did the work, their motivations, and what can and cannot be determined from the synthesis all help to increase trust [127].

Moving forward as a community

Moving towards more equitable, diverse, and inclusive evidence syntheses will require trial and error, and active champions within the community. We amplify recent calls to explicitly consider EDI in environmental evidence syntheses [46]. Considerations of EDI in evidence synthesis and the delivery of evidence-informed practice are much more developed in the health care and social science space than in the environmental space. This is largely because there are clearer direct consequences to human health when evidence or decisions do not consider EDI, and because systematic reviews are frequently done by smaller review teams in health than in environmental syntheses, making explicit consideration of positionality more essential. Yet, there are also clear connections between the environment and human health and well-being (e.g., the Sustainable Development Goals) emphasizing the need to fully embrace EDI in an environmental evidence context. Clearly, there is scope for more work in this space as it relates to the environment, including in areas such as environmental justice and other topics. It is time to rethink how we engage in environmental evidence generation, collation, and synthesis to ensure that resultant decisions are based on practices of EDI. This is particularly important now, when rapid AI developments may not be engaging in these practices.

Many of the concepts included here may be familiar to those already conducting evidence syntheses following published standards. Some things, like searching in multiple languages or having advisory and research teams with different experiences are already used to produce relevant syntheses. Teams conducting evidence syntheses should be encouraged that many of the processes they already have in place can have benefits for EDI. With some slight reframing and specific consideration through an EDI lens, these practices can have multiple benefits. There are also several available training tools already in place, such as training around OCAP [100] and CARE [101], and teams are encouraged to consider other training that offers guidance on similar aspects. Many of the activities that help support EDI may already be common for some teams; it will be important for these teams to share their experiences and perspectives on what went well and what did not so that continuous improvement can be made. We found several examples of EDI being integrated (and reported) effectively in environmental evidence syntheses (see Tables 1, 2 and 3).

To fully integrate EDI into evidence syntheses, efforts beyond the author team will be needed; changes leading to a more equitable, inclusive and just science system are required [128]. Organizations involved in developing guidance and standards for evidence syntheses can support EDI inclusion by providing recommendations for EDI and ethics requirements in their guidance documents. Technological advances will also support these endeavours. The evidence synthesis community will need to work collaboratively to develop methods and test the impacts of incorporating EDI and ethical considerations at different stages of the synthesis process. EDI principles can also be built into publication and reporting standards for environmental evidence syntheses (as has been done in medicine [44] and social sciences [45]), so that the steps taken within an evidence synthesis to support EDI are transparent. Integrating EDI into training plans will ensure that future evidence syntheses are started with an

EDI-conscious process. Efforts to ensure that evidence syntheses incorporate EDI principles will likely increase costs for engagement, additional planning, translation, and stronger communication strategies. Funding organizations should be aware of this and support these efforts.

Continuing to build an inclusive community for evidence synthesis will further EDI efforts [56]. Who becomes a scientist and generates evidence, the questions they ask, and their approach to scholarship, can significantly influence the evidence base [129]. Bolstering underrepresented groups across education, research, and publication systems will help ensure that evidence syntheses cover a diverse suite of questions and topics. Environmental evidence syntheses rely on evidence held by a broad community of knowledge keepers, scientists, and practitioners. Removing systemic barriers to engagement in all aspects of science will help build an evidence base that is more equitable, diverse, and inclusive, and lead to more representative evidence syntheses overall. With growing recognition that more diverse and inclusive approaches to science generate better and more representative research findings [24–26], contemporary evidence syntheses intended to support evidence-based environmental decisions must directly consider equity, diversity, and inclusivity, both in the literature they synthesize and the process of synthesis itself.

We acknowledge that incorporating all of the considerations identified here may not be possible for all teams or for all syntheses. Timelines are often short, or funding is limited, and it may not be possible to implement every suggestion we have made. Authors will need to be clear about what steps they took to incorporate EDI in their syntheses, doing their best to consider as many perspectives as possible, and being honest about what was not incorporated, and why. Including a description of EDI approaches used in a specific section of a synthesis can help improve overall transparency. Not all of the options listed above will apply to all evidence syntheses. While we think that every review can benefit from specifically considering EDI, no good quality synthesis should be ignored because of the lack of any one item suggested here. Evidence synthesis teams can feel empowered to plan reviews that work for them and meet their stakeholders needs while considering how to produce better outcomes. We encourage review teams to consider some of the opportunities identified here to produce more EDI-conscious syntheses. It will be essential to continue learning from past mistakes, updating processes, and thinking critically about how to improve.

Equity, diversity, and inclusion is a complex topic. Not all aspects of EDI relevant to environmental evidence syntheses could be covered here. However, we propose a useful framework for evidence synthesis producers and users considering EDI in their practices to advance more impactful research efforts. The anticipated benefits of doing so may include increased trust in the process and findings of evidence syntheses, decreased bias in their conduct and the questions they answer, evidence syntheses that are more accessible, and new opportunities to serve under-represented audiences and perspectives. For those just starting this journey, we recommend seeking out those with experience in this space, those who are already implementing good practices, and those who have important insights into how environmental evidence syntheses have impacted local communities or marginalized groups. Considering who we are as scientists, recognizing the biases and expectations we bring to the review, and how we can provide opportunities is essential. Our hope is that these suggestions help spur future conversations in EDI in environmental evidence syntheses and encourage the continuation of current efforts. We acknowledge that this is just a first step along the path to evidence syntheses that are more equitable, diverse and inclusive. There is still much to consider and much to learn.

Abbreviations

AI	Artificial intelligence
BACI	Before, After, Control, Impact study design
CARE	Collective benefit, Authority to control, Responsibility, and Ethics
CReDiT	Contributor Roles Taxonomy
EDI	Equity, Diversity, Inclusion
MeRIT	Method Reporting with Initials for Transparency

OCAP© Ownership, Control, Access, Possession
UN United Nations

Glossary

Diversity A workforce that is diverse from a variety of perspectives (including equitable geographical distribution and gender balance, as well as cultural, generational, and multilingual perspectives and the perspectives of persons with disabilities), and this diversity should be embraced in decision-making to strengthen the performance of the organizations [27]

Equity The process of being fair to all individuals and groups, by addressing present and historical inequality to work towards equality in outcomes. Equity may involve the use of temporary special measures to compensate for the historical and systemic bias and discrimination faced by marginalized groups. Systems, institutions, policies, and programming may be described as equitable or inequitable depending on their approach to addressing inequality. Generally speaking, equity is a means to the goal of equality [27]

Inclusion Inclusion is a dynamic state of feeling, belonging, and operating in which diversity is valued and managed to create a fair, results-based workplace. An inclusive workplace culture and environment fosters equitable opportunities to resources and opportunities for all staff and personnel. It also enables staff and personnel to feel that diversity is valued and managed to create a fair workplace where they feel safe, motivated and respected [27]

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Declarations

Competing interests SJC is a Senior Editor and Ruth Garside is an Associate Editor at Environmental Evidence. Neither author was involved in the review process for this article. All other authors declare that they have no competing interests.

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