Introducing *Elinor* for monitoring the governance and management of area-based conservation

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Abstract

Monitoring the governance and management effectiveness of area-based conservation has long been recognized as an important foundation for achieving national and global biodiversity goals and enabling adaptive management. However, there are still many barriers that prevent conservation actors, including those impacted by governance and management systems and/or implementing conservation activities and programs, from gathering and using data on governance and management to inform decision-making across spatial scales and through time. Here, we explore current and past efforts for assessing governance and management effectiveness and the barriers that different actors have faced in using the resulting data and insights to inform conservation decision-making. To help

overcome these barriers, we introduce Elinor, a free and open-source monitoring tool that builds upon the work of Nobel Prize winner Elinor Ostrom, to facilitate the gathering, storing, sharing, analyzing, and use of data on environmental governance and management across spatial scales and for areas under different governance and management types. We discuss the process of co-designing and piloting Elinor with conservation scientists and practitioners, and introduce the main components of the assessment and the online data system. We situate Elinor within the context of existing approaches for assessing governance and management, and demonstrate how Elinor complements existing approaches by (1) addressing both governance and management in a single assessment for different types of area-based conservation, (2) introducing flexible options for data collection, and (3) integrating a data system with an assessment which can support data use and sharing across different spatial scales. We conclude by recognizing the challenges conservationists will continue to face when using governance and management data to inform decision-making and offer tangible solutions that can help navigate these in support of more effective, inclusive, and durable area-based conservation.

1. Introduction

With the accelerating pace of global change, there is an urgent need to understand if, how, and under what conditions area-based conservation can deliver effective, equitable, and durable conservation outcomes. Environmental governance (the institutions, structures, and processes that shape environmental decision-making) and management (the resources, plans, and actions that result from the functioning of governance) (Bennett and Satterfield 2018; Lockwood et al. 2010) are known to influence the biodiversity and social outcomes of conservation (Armitage et al., 2012; Coad et al. 2019; Gill et al. 2017). Accordingly, multiple tools and approaches for assessing and monitoring environmental governance (e.g., Booker and Franks 2019; Detoeuf et al. 2020; Lockwood et al. 2010; Springer et al., 2021) and management effectiveness (e.g., Coad et al. 2013; Hockings et al. 2006;

Leverington et al. 2008; Pomeroy et al., 2004) have been developed. While these efforts have elevated the importance of both concepts, there are few examples of where governance and management data systematically inform the design, implementation, and adaptive management of area-based conservation (Coad et al. 2015). Addressing this issue is particularly important in light of the 30x30 target to protect 30% of the planet through area-based conservation by 2030, which was adopted in December 2022 under the Convention on Biological Diversity's Kunming-Montreal Global Biodiversity Framework (CBD 2022). Indeed, there have been repeated calls for nations to look beyond conservation coverage to equity and effectiveness of management and governance in tracking their progress towards this global commitment (e.g. Jonas et al. 2021, Gurney et al. 2023).

In this paper, we introduce Elinor, a free, open-source tool designed to facilitate the gathering, storing, sharing, analyzing, and use of data on both environmental governance and management across spatial scales and areas under different governance and management types. Named after Elinor Ostrom, the Nobel Prize winner who studied how communities and groups can effectively manage shared resources, this tool brings elements of Ostrom's theories (Ostrom 1990, 2009) together with emerging insights on environmental governance (Bennett and Satterfield, 2018) and management effectiveness (Stolton et al., 2021). In this paper, we begin by exploring the existing theories and tools that are currently used to assess the governance, management, and equity of protected and conserved areas, including other effective conservation measures (OECMs), (hereafter, *area-based conservation*). We then describe the process for developing Elinor and present the different ways users can collect and store assessment data. We demonstrate how Elinor complements existing tools and approaches by integrating governance and management effectiveness in a single assessment, its relevance for different governance types, its flexibility in data collection, and its integration of an assessment tool with a collaborative database and decision support tool. We also highlight how the standardized, yet flexible, approach of Elinor can support assessing and comparing sites among

regions and over time. We conclude by exploring the challenges and opportunities for monitoring governance and management for area-based conservation.

2. Current approaches to assessing the governance and management of area-based conservation

Many tools and approaches have been developed by conservation NGOs, governments, and academics to assess environmental governance and management effectiveness over recent decades (see Table 4 below). These different approaches have similar but distinct goals, including supporting conservation monitoring, adaptive management, empirical and synthetic research (Coad et al. 2013), third-party certification, and/or meeting social safeguards and donor requirements for project implementation (Hockings et al., 2019; Leverington et al. 2010). Most existing tools used in the conservation community focus on assessing either governance *or* management (Meehan et al. 2020), and learning is limited by the fact that the same tools are rarely applied across multiple-sites repeatedly through time (Zafra-Calvo and Geldmann 2020). In this section, we briefly summarize existing efforts, how they have manifested in practice, and the opportunities and limitations for leveraging these existing efforts for the long-term monitoring of governance and management.

In 2006, the Global Database on Protected Areas Management Effectiveness (GD-PAME) was developed as a research database to compile evaluations of protected area management effectiveness. As of 2020, such evaluations had been conducted in only 18.29% of the world's protected areas (UNEP-WCMC, UNEP, IUCN 2021). Additionally, at least 78 different evaluation methodologies were reported in the GD-PAME as of April 2023, most of which are based on the International Union for Conservation of Nature World Commission on Protected Areas framework for protected area management effectiveness, which emphasizes measuring context, planning, inputs, processes, outputs, and outcomes (Hockings et al. 2006; Bialowolski et al. 2023).

First developed in 1990 and used in at least 126 countries, the Management Effectiveness Tracking Tool (METT) was one of the first assessment tools associated with the GD-PAME (Stolton et al. 2021). It was designed to track management progress over time within an individual protected area) and to identify actions to address management weaknesses (Stolton et al. 2019). Many organizations and governments have since created their own versions of the METT to track protected area performance (e.g., Kementerian Lingkungan Hidup dan Kehutanan 2018). Some conservation NGOs have also adapted METT to assess locally-managed and co-managed areas. While it was not originally intended to support comparisons of management effectiveness across different sites (Stolton et al. 2019), METT assessment data have been used by scholars to understand the status and trends of management effectiveness among protected areas regionally and globally (e.g., Geldmann et al. 2015; Gill et al. 2017).

Whereas METT assesses management, many research efforts focused on environmental governance have roots in academia (Partelow et al. 2020). One approach, led by Elinor Ostrom and colleagues, involved the development of eight design principles associated with the long-term sustainability of common-pool resource (CPR) governance (Ostrom 1990). Based on this work, a number of initiatives and databases were subsequently created to enable the consistent measuring and storing of governance data, primarily for research, rather than policy and practice, purposes (e.g. Chhatre and Agrawal 2009; IFRI 2013; Joshi et al. 2000; Lam 1998; Poteete and Ostrom 2004; Schlager, 1994; Schlager et al., 1994; Shivakoti and Ostrom 2002). More recent academic environmental governance research has expanded beyond Ostrom's work to explore equitable governance, the role of knowledge co-production, and adaptation and learning (e.g., Armitage, De Loë, and Plummer 2012; Borrini-Feyerabend and Hill 2015; Lockwood et al. 2010). In particular, there has been increasing attention given to evaluating the extent to which the governance systems in which conservation interventions are embedded are effective, equitable, responsive, and robust (Fidler et al. 2022; Bennett and Satterfield 2018; Partelow et al. 2020).

Outside academia, conservation practitioners increasingly recognize the importance of governance for area-based conservation (Bennett et al. 2021; Borrini-Feyerabend and Hill 2015; Maini et al. 2023). This recognition has led to a proliferation of policies, principles, frameworks, and tools that emphasize equitable and effective governance (Gurney et al. 2021), including the Natural Resource Governance Framework (Springer et al., 2021), the IUCN Green List (Hockings et al., 2019), the governance assessment for protected areas (GAPA; Booker and Franks, 2019), and the site-level assessment of governance and equity (SAGE; Pinto 2021). The design of many of these tools, and others, have been informed by CPR theory and more recent academic work and gray literature on environmental governance, which has enabled researchers and practitioners to both evaluate area-based conservation effectiveness (e.g. Fidler et al. 2022) and monitor the status and trends of environmental governance over time (Detoeuf et al. 2020; Glew et al., 2012; Gurney et al. 2019).

3. Barriers to using governance and management data in conservation decision-making

Existing efforts to assess governance and management have been instrumental in elevating the importance of, and further developing these concepts in policy and practice. However, many barriers still prevent the use of long-term data on governance and management in important conservation decisions, such as funding allocations, program design, policy development, and site-level adaptive management. These barriers include: 1) capacity and resource barriers for implementing and sustaining monitoring, 2) technical barriers surrounding the infrastructure and tools for collecting, storing, analyzing, and sharing data across contexts and over time, and 3) the barriers that prevent the use governance and management data in day-to-day and strategic conservation decision-making contexts.

3.1 Capacity and resource barriers

Conservation actors (particularly within NGOs, governments, and who lead site-level management) often have limited time and capacity for learning and implementing new tools and sustaining their use over time (Geldmann et al. 2021). This limited capacity is often rooted in the competing demands in conservation, often driven by funding and shaped by the limited expertise and training in governance concepts and assessments. Assessing governance and management also requires time (of facilitators and participants), capacity, and financial resources (Borrini-Feyerabend et al. 2013; 2015). Many of the existing tools (e.g., Franks and Pinto 2021; Stolton et. al., 2021) suggest allocating 2-3 days to complete an assessment for one site and encourage participation from a diverse set of actors, which requires participants' willingness to invest their time and for conveners, to invest financial resources to support bringing people together. Developing, implementing, and interpreting findings from these assessments often requires specific skills (e.g., facilitation and qualitative social science research) and expertise (e.g. knowledge of environmental governance theory and management effectiveness), which can also take time to cultivate if capacities do not currently exist. While many existing tools emphasize the importance of qualitative data for making sense of management and governance trends, qualitative data are not often gathered in practice given limited capacity, and sometimes interest in, social science research and analysis in conservation implementing agencies (Claus 2022).

Even when there is capacity and financial resources for assessments, monitoring governance, particularly equitable dimensions of governance, is often not prioritized; evidenced in recent reviews on water resource management (Pires et al. 2017) and marine protected areas (Meehan et al. 2020). Monitoring governance and management can be highly sensitive for some conservation actors, particularly within government agencies that often manage conservation areas. When assessments uncover weaknesses in governance and management, results can reflect poorly on those responsible for overseeing or implementing area-based conservation, which can also reduce the incentive to engage meaningfully in participatory assessments that track changes in governance and management over time.

3.2 Technical barriers that hinder data storage, sharing and use

Current, successful long-term monitoring programs in conservation often rely on data generated through automated observations of readily observed parameters (e.g., on habitat coverage or ecosystem pressure through remote sensing, via platforms like Global Fishing Watch and Global Forest Watch). Generating governance and management data cannot be automated in the same way, and requires inputs from knowledgeable actors via different social science methods. This means that governance and management data may be influenced by different understandings of the situation and the perceptions of the data recorder or observer. In addition, PAME assessment tools are generally either designed for or, in the case of the METT, adapted to the needs of different programs and places, which has led to different types of data being collected, and different indicators being used. This makes it difficult to synthesize data from different sites, which is needed for cross-site, regional, and global learning, and ultimately improving governance and management at scale (Coad et al. 2015; Fidler et al. 2023). Third, even when governance and management data are collected using the same protocols, data are often stored in different ways, which can limit the capacity for synthesis. Inevitably, data on governance and management are often qualitative, which is difficult to synthesize across scales yet critical for making sense of changes and trends over time (Macura, Secco, and Pullin 2015). As discussed in 3.1, there are often sensitivities around governance and management assessments, which can also limit the willingness to or capacity for conservation practitioners and researchers to share data on governance and management. Sustaining collaborative, co-designed processes that can effectively address some of these issues takes time, funding, sustained partnerships, and expertise (Ahumada et al. 2020; Mahajan et al. 2022).

3.3 Limited use of evidence in conservation decision-making

Despite a growing recognition of the importance of monitoring governance and management, there is still limited public or private investment in tools, capacities, and processes that can enable

conservation actors working in different contexts (e.g., government, NGOs, community-based associations and institutions) to use data in decision-making to inform strategic and adaptive management. For example, it is increasingly recognized that co-design processes and co-producing knowledge can foster more credible, salient, and useful evidence for decision-making (Bandola-Gill et al. 2023; Cash et al., 2003; Norström et al., 2020; Trischlet et al. 2019; van Kerkhoff and Pilbeam 2017), yet a majority of the longitudinal studies on environmental governance and management (e.g., Geldmann et al. 2015) are not co-designed with conservation decision-makers. Barriers that operate at an individual, organizational, and systematic level also limit the capacity for evidence-informed decision-making more broadly: For example, individual biases may limit an individual's capacity or willingness to engage with new insights that challenge their beliefs and values, or organizational monitoring and evaluation systems may prioritize demonstrating positive results over fostering learning (Mahajan et al., 2023). Conceptually, linking data on governance and management to outcomes still faces challenges. While research frameworks that link social and ecological outcomes to governance exist (e.g. Mascia et al. 2017; Mahajan et al., 2021), using these frameworks in practice is still limited. These disconnects between research and practice further limits the capacity for many governance and management assessments to inform decision-making (Macura et al., 2015; Osuka et al. 2020).

4. Introducing Elinor

The Elinor assessment tool and data system is designed to help conservation actors (inclusive of researchers and practitioners) gather, store, share, analyze, and use data on governance and management. Elinor was initially conceived to build on existing practices within conservation NGOs with the goal of streamlining how existing governance and management tools were being used, and to create a data platform to facilitate data sharing and use. Elinor was designed for use in a diversity of

conservation areas – including protected areas, OECMs, and other areas under Indigenous and/or local governance and management. Recognizing this diversity, the unit of analysis is set by tool users to match user needs hereafter is referred to as a 'managed area' or MA. The assessment is designed to collect quantitative and qualitative data through 35 questions designed to assess ten attributes of governance and management (see Table 1). The data are stored in an online data platform accessible at elinordata.org.

4.1 Developing the Elinor assessment

The Elinor assessment was initially designed to combine Elinor Ostrom's design principles for governance and the METT. Designing the assessment was iterative and collaborative: Given the widespread use of the METT assessment, the first draft of Elinor was developed using a subset of questions from the METT that we perceived as most critical for adaptive management and management effectiveness and a set of governance questions generated from Ostrom's eight principles for effective and long-lasting common property institutions. Recognizing the time constraints faced by conservation practitioners to fully engage in co-developing the assessment, we solicited two rounds of feedback with over 50 conservation actors on draft assessments (including NGO practitioners and researchers, many who are co-authors). We then completed pilots in four countries and an ethics assessment before finalizing the current version of the Elinor protocol (2023.1). See Figure 1 and Part 1 of the Supporting Information (SI) for more details on the development process.

<FIGURE 1>

The final assessment includes two main sections. The first section collects background information on the MA, including who was engaged in data collection, where and when the MA was established, its governance type (i.e. national protected area, co-managed area, Indigenous land, etc.), and additional data about the management objectives and rights of people living in and around the area. (See SI, Table 4A). This section also allows users to upload management plans and spatial information about the MA s (e.g. a shape file of a collaborative fishery management area, see Figure 2a), and to input the MAs' Associated ID from the World Database on Protected Areas, if applicable (note that MA shapefiles may be downloaded from WDPA and the uploaded to Elinor, but Elinor does not directly communicate with WDPA). The second section collects management and governance data, and contains 15 management questions adapted from the METT and 20 questions on the effectiveness, sustainability, and equitable nature of governance (Table 1). The 35 questions are nested under 10 broader 'attributes' to ease data interpretation and use. Questions on governance effectiveness and sustainability draw from Ostrom's design principles. Questions on equity in governance focus on the inclusion of gender and vulnerable groups in decision-making, access to natural resources, and benefit-sharing. Each question has four response options, following a scale of least to most desirable scenarios (mirroring the 4-point scale used in METT assessments, Table 2). Guidance is provided for each question to clarify the question's purpose and includes a rationale, an explanation of key terms, and suggested sources of information to consult when answering the question (see elinordata.org). While users must answer all questions within the attributes they select, they are allowed to skip attributes that are not applicable to their respective MA. Users can also provide additional information explaining their response in a qualitative text box that accompanies each question. This text box further allows them to describe any nuance not allowed by the standardized questions and responses, such as compound questions, which were included to reduce the assessment's length. Should users find understanding or answering these questions difficult, the

system encourages them to contact the developers, who maintain running lists of issues that are considered when Elinor goes through a version review.

<TABLE 1>

<TABLE 2>

4.2 Pathways for data collection

Elinor provides users with two options for collecting data: 1) via a desk-based exercise carried out by practitioners such as MA managers or an NGO staff knowledgeable about the governance of a MA; or 2) via a focus group discussion with a representative set of actors knowledgeable about and affected by governance and management in the MA (e.g., local community members, park managers, traditional or local leaders). Users are encouraged, when possible, to utilize the focus-group methodology to incorporate diverse perspectives, but it is well recognized that this pathway may not be an option in all contexts given capacity and resource constraints. Elinor limits data collection methods to these two options to encourage transparency on how the data was collected, and to balance flexibility of use and the importance of engaging multiple perspectives. The data storage system allows users to indicate which data collection method was used, and who was included in the assessment (e.g., NGO staff, managers, adjacent community members, community leaders) to ensure that data are interpreted and used with the recognition of whose perceptions are represented in the assessment.

<TABLE 3>

The two approaches differ in terms of the time, resources, and participants needed to conduct the assessment, and the types of conclusions data users can draw from the assessment (see Table 3). They also differ with regard to the types of biases that each approach could introduce. For desk-based assessments, it is likely that data will be subject to observer bias, with conservation practitioners or conservation managers potentially overestimating the success of governance and management (Cook et al., 2014; Cook and Hockings 2011). There may be additional biases introduced in the governance questions, as many questions ask about the experience of rights-holders and other actors impacted by governance systems. To reduce bias in desk-based assessments, the Elinor protocol encourages users to complement their assessment with additional data, including reviewing relevant documents like stakeholder reports or management plans, and offers guidance per question on what complementary data may be most helpful. To reduce biases in the focus groups discussions, the Elinor protocol provides users guidance on how to sample respondents to increase the likelihood of capturing the full diversity of perspectives (e.g. stratified random sampling across different areas or subgroups) and how to organize the discussions to ensure all perspectives are heard (e.g. separating respondents by gender, ethnic groups/castes, landowner/tenants, or other key identities that may influence their responses or willingness to respond).

4.3 Developing the data system

An online data system designed to support storing, sharing, analyzing and using Elinor data was co-developed by an interdisciplinary team of applied social scientists, data scientists, and software developers and informed by user-centered feedback from conservation NGO staff. Ensuring ease of use and access, secure and clean data storage, and data integrity were the priority issues that shaped

the development process, prioritized based on the design team's past experience in developing shared data systems (particularly datamermaid.org).

The Elinor web application uses a decoupled architecture with separate backend and frontend components that communicate via an Application Programming Interface (API). The API is a Django REST Framework application using a PostGIS-enabled PostgreSQL database (postgresql.org), while the front-end is a Vue Javascript application (vuejs.org). While the tool is currently only available through a web browser (requiring users to be online to enter data), this architecture creates many possibilities in the future for data entry and access through other clients like mobile apps or integrating with other data platforms. This provides for ease of scaling, upgrades, and security management. Capabilities that enable users to collect data offline and upload data to the online system are also under development. Based on a cloud platform, users can access data from anywhere, making it easy for collaborative research, analysis, and visualization. To encourage continuous co-creation, the application is free and open source which enables developers to contribute to the code base to bring in new functionalities.

Security and data privacy also informed development. Minimal personal identifiable information (name, email address, institution) is collected only to the extent that is required to operate the system, and users have the ability to erase this personal data from the system as they need. No personal information is shared with third parties. To protect data sovereignty, once assessments are finalized, users have the ability to choose whether their assessments are public or kept private and only accessible to them and their chosen collaborators. Additionally, a robust security structure is employed which includes both internal and remote backup to ensure there is no data loss. To improve accessibility, the tool has been developed with the provision for supporting multiple languages and the interface and protocol will be translated into various languages for ease of use globally. At the time of

publishing, the Elinor protocol is available in English, Spanish, Swahili, Portuguese, and Bahasa Indonesia.

4.4 Developing data outputs and visualizations

Data users and their needs were central to the design of data visualization features and outputs from elinordata.org. The cloud system underpinning Elinor allows users to back up their data and to download the raw data for each assessment as granted by the permissions set by the data owner. This enables collaboration and sharing either publicly or within closed groups while minimizing the risk of data loss. The current architecture also allows users to access the output from various platforms such as web and analysis software through the application programming interface (API), which can facilitate the integration of different datasets from different API platforms that may collect, for example, complementary ecological data (e.g., datamermaid.org).

To inform the development of semi-automated reports from elinordata.org, aggregate and site-level reports were manually developed by a team of social scientists and NGO practitioners using data from 2 pilots (Tanzania and Indonesia). A series of discussions between the development team and conservation practitioners working at the site level in both countries helped elucidate the most important information to include in the reports for different target audiences of the data. The manually produced reports and subsequent feedback were used to inform the layout and design of the semi-automated modules in elinordata.org that allow users to download a decision-oriented summary and visual of the assessment data (see Figures 2a & 2b for illustrative examples). The reporting module currently allows data to be aggregated and visualized at the MA level and soon will allow users to aggregate shared data at other scales defined by and relevant to users (e.g., a subnational or

transboundary region, nationally, or globally). MA site-level reports include an overview and data summary, with data aggregated and scored by attribute and at the level of the MA.

Each question is assigned a score of 0-3 (depending on the response option chosen by participants, with 0 being the least desirable and 3 being the most desirable). The attribute score is calculated as a percentage of all possible questions scores within that attribute and multiplied by 10 for easy interpretation. The 10 attribute scores are added to create a score for the MA out of 100. Thus, all question scores are equally weighted when calculating their respective attribute score, and all attribute scores are equally weighted when calculating the total score. Importantly, when users decide that one or more attributes are not applicable to their MA and do not enter responses for those attributes, the calculation for total MA score will adjust accordingly to reflect a total score out of 100. This provides a simple, transparent and flexible way to monitor and track high-level trends in MA governance among sites, and does not preclude others from developing their own customized indicators for attributes or MA governance based on different combinations of questions. The flexibility to omit attributes that users deem not relevant or feasible for their context was intended to facilitate user uptake, but we recognize this could limit how total MA scores can be used.

Total MA scores are assigned an assessment category (Plan, Build, Strengthen, Maintain) to enable action-oriented use (see legend in Figure 2a). The site-level reports that the system currently generates show all levels of scores (i.e. indicators, attributes, and total) to ensure that users can see how each level's score contributed to the next. In the future, different outputs will be available at an aggregate level that can enable users to interact with data in different ways. For example, users will be able to view average attribute scores for a custom selection of MAs (see Figure 2b) or explore the status of single attributes across multiple MAs. With potential inconsistencies on which attributes are included in total MA scores, using attribute scores to contextualize differences can provide a more nuanced understanding as to why governance and management may differ across sites.

<FIGURE 2>

5. Discussion

5.1. Elinor complements existing governance and management assessment approaches

Elinor integrates high-level questions on governance and management effectiveness in a single assessment and is supported by a decision-oriented data system actively designed to support data use, data sharing, and adaptive management across spatial scales. The focus on shared, high-level indicators (by attribute) and an underlying data system builds on past approaches to assessing governance and management to enable (1) gathering and analyzing trend data through time, and (2) cross-site comparison and learning (see Table 4 which compares Elinor to existing tools). In doing so, Elinor helps to overcome some of the existing barriers to using governance and management data in conservation decision-making (see Section 3). As a simple, relatively quick, and easy to use system that is accompanied by clear protocols and guidance, Elinor helps to address capacity and resource barriers that have limited the uptake of previous tools. Because it is implemented within a free, open-source, and secure data system that facilitates both site-level learning and cross-site comparisons, Elinor also helps to address technical barriers to data storage, access, and maintenance. Last, Elinor's collaborative development process which centered the needs of future users make it more likely to produce relevant evidence that is directly useful to practitioners and policymakers who make decisions about area-based conservation.

<TABLE 4>

In addition to supporting site-level managers, NGO staff, and higher-level agencies who support governance and management, Elinor could be used by academics to implement practice-relevant research and share data with practitioners and managers via the system's data sharing and visualization features. Elinor also includes several high-level measures on equitable governance, a noticeable gap in existing PAME tools (Meehan et al. 2020; Moreaux et al. 2018). The process for developing Elinor (see section 4.1 and SI) gave equal consideration to governance and management, prioritizing key issues deemed important from both academic (e.g., Bennett and Satterfield 2018; Ostrom 1990) and practitioners' perspectives (e.g. Stolton et al., 2021; Springer et al., 2021). Elinor's approach to data collection - namely the choice between a desk-based and focus-group option - introduces flexibility to potential tool users and may also enable increased uptake, including places with limited financial resources and time for monitoring.

Elinor may not be suitable for all area-based conservation contexts. It is important to note that Elinor was not designed to replace existing, effective monitoring systems tailored to place, especially those that assess and/or are designed by Indigenous Peoples and local communities for the areas they govern. In these contexts, should there be interest, Elinor could be used to complement place-based systems to facilitate knowledge sharing and regional learning and/or reporting. Second, whilst Elinor's strength lies in equal focus on governance and management, it trades off depth for breadth and does not provide the in-depth insights that tools or research focused on only governance or management are able to. For example, the full SAGE assessment uses a multistakeholder process to assess governance and equity issues at different levels of organization, offering a more nuanced exploration of equitable governance from different perspectives. SAGE also focuses more on actions that conservation stakeholders can take at the time of the assessment and prioritize which issues to address first based on stakeholders' needs (Franks and Pinto, 2021). The METT, which explores

management effectiveness in greater detail, is also required by certain funders in area-based conservation projects and programs (Craigie et al. 2015). However, as Elinor adopted many of the questions from METT, there are opportunities for the two tools to be used synergistically. For example, data collected using the METT assessment could be used to inform a desk-based Elinor assessment, and/or could be complemented with governance questions currently missing from the METT.

5.2. Using Elinor data to support policy and practice

Elinor has the potential to make data on governance and management more accessible to conservation actors working to enable effective area-based conservation at local, national, and global levels. By combining concepts from governance theory and management effectiveness with simplified questions and guidance, Elinor offers a low-cost way for users (e.g., NGO practitioners and monitoring and evaluation staff, site managers) to regularly engage with the concepts of governance and management through periodic monitoring. Similarly, Elinor can help target users of the data outputs (e.g., conservation portfolio managers working in government, non-profits, or multilateral agencies) to engage with governance concepts and reflect on what their current status and trends mean for appropriate conservation actions and investments. The collaborative process of developing Elinor with scientists and NGO staff and piloting the tool with community-based organizations brought a subset of future tool users into the tool's development process, which may improve the likelihood of its future use by target users. Additionally, the process helped create a more relevant, flexible, and easy to use tool to support conservation decision-making across different contexts, which increases its likelihood of persistent adoption (Rogers 2003). While Elinor was initially designed with NGO staff as the primary user, over time Elinor could be adapted to meet the needs of other conservation decision-makers such as leaders of community-led conservation organizations or government staff.

With its focus on user-friendly data outputs, Elinor has potential to bring governance and management data more actively into decision contexts. For instance, site-level managers within NGOs or governments working at the level of a single MA could use site-level summary data in existing communication forums with key constituents to have evidence-informed conversations about the trajectory of change in specific places and identify actions for improving governance and management based on trends over time. Staff with regional or national mandates in government or NGOs can use aggregate summaries to inform decisions around regional and national-level policies, programs, and funding. This will add particular value to transboundary conservation efforts, where different national monitoring systems may not be aligned with one another. However, we do recognize that realizing these goals will rely on users' willingness and capacity to share data.

With increasing emphasis on equitable governance in agreements made under the Convention on Biological Diversity (Gurney et al. 2023), Elinor could be valuably employed in monitoring protected areas and OECMs under Target 3 of the Kunming-Montreal Global Biodiversity Framework.[1] Although the sole headline indicator for Target 3 focuses on area alone (CBD 2022b), SAGE and PAME (which tends to be assessed through METT) are included as second-tier indicators. As discussed above, there are multiple ways that Elinor complements SAGE and METT assessments in measuring and monitoring the effectiveness and equity of management and governance. Further, Elinor could potentially support the screening process for OECMs given many of its assessment questions align with the criteria in the IUCN WCPA site-level tool for identifying OECMs (Jonas et al., 2023).

[1] Target 3 of the Kunming-Montreal Global Biodiversity Framework states: "Ensure and enable that by 2030 at least 30 percent of terrestrial, inland water, and of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures, recognizing Indigenous and traditional territories, where applicable, and integrated into wider landscapes, seascapes and the ocean, while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognizing and respecting the rights of indigenous peoples and local communities, including over their traditional territories."

Despite these opportunities, using Elinor to make evidence-informed decisions in conservation will continue to face many of the challenges that have hindered the use of governance and management data in the past. First, though the Elinor protocol encourages the use of multi-stakeholder focus groups to complete the assessment, how users take this guidance forward will shape whether or not data from Elinor will be subject to the same set of biases that many existing governance and management assessments (see Table 4) face, including strategic biases from protected area managers (Carbutt, 2013; Cook and Hockings 2011, Cook et al., 2014). While the data visualization features and guidance on data use have been designed to both increase transparency around how data was collected and raising awareness around potential biases, it is important that users of Elinor openly acknowledge and navigate these possible biases when using Elinor data. Like many governance and management assessment tools, Elinor collects perceptual data from focus groups participants or practitioners. While there has been some debate about the credibility of perceptual data for evidence-informed decision-making (Adams and Sandbrook 2013; Haddaway and Pullin 2013), it is increasingly recognized that perception data are central to understanding governance and management (Bennett 2016). For example, the *Resource Boundaries* attribute in Elinor asks both if boundaries are clearly defined and the extent to which those boundaries are known by relevant rights-holders and other actors. In addition, users can upload management plans and shapefiles of the boundaries. Together, these three lines of evidence provide complementary data on the clarity with which boundaries are defined and people's perceptions of them, all of which are important to effective and equitable environmental governance and management.

Second, ensuring that evidence on governance and management can play a role in decision-making processes will require efforts at individual and organizational levels. In particular, it will require systemic changes given the structures and norms that shape conservation decision-making within implementing agencies must shift to allow more time for engaging with evidence and learning at strategic decision points, at least during strategy reviews or at the start or end of funding cycles

(Mahajan et al., 2023). Governance and management data alone are also not sufficient for most conservation monitoring and evaluation needs (Meehan et al. 2020), thus ensuring that data from Elinor can be brought together with knowledge and evidence on biophysical, ecological, and social outcomes in decision-making contexts will be critical for guiding decision-making on actions that could improve governance and management and biodiversity conservation (Mascia et al. 2017).

Third, while Elinor will help introduce governance and management concepts to more conservation practitioners, holistic training and capacity development will be needed to sustain the use of Elinor over time. Future plans for Elinor include developing accessible, online training materials in multiple languages on both the concepts of governance and management and how to facilitate, analyze, and use assessment data, yet sustaining the platform itself and supporting resources will require sustained financial commitments from governments, funders, and conservation organizations. In particular, there is a need to better embed and support interdisciplinary social science capacity in conservation organizations globally to sustain capacity for assessing governance and management over time (Bennett et al. 2017; Claus 2022). Experimenting with how Elinor can support conservationists in different roles and settings in meeting their own goals (e.g., using Elinor as a platform to facilitate knowledge sharing internally at organizations or between different conservation actors) might help to (a) identify incentives to enable its usefulness for monitoring and learning and (b) diffuse Elinor, and broader interest in monitoring, evaluation, and learning, by demonstrating its added value (Rogers 2003). In the short term, we recognize that Elinor will likely have greater uptake in the NGO-community given the co-design process was focused on NGO staff and researchers. We hope in the future to engage more diverse conservation actors (e.g., government staff, park managers, community leaders) in using and adapting Elinor to ensure it can evolve to meet the needs of the broader conservation community. Currently, Elinor is not a requirement for monitoring within any organization or nation, but if after further testing, Elinor proves to be a useful

approach, identifying where and if it should be a requirement for monitoring area-based conservation could facilitate broader uptake.

Finally, the theory and practice of governance and management will vary from place to place and may change throughout time. Developing standardized and long-term monitoring systems always requires navigating these changing dynamics, and should the Elinor assessment need to evolve, new questions will be phased in to complement, and not replace, existing questions as to not compromise long-term monitoring data. If, however, certain questions or attributes are deemed unnecessary by a majority of users over time, they will be phased out and data on these indicators will be archived using a standard system for naming, numbering, and documenting changes to versions of the assessment protocol.

5.3. Co-designing systems for evidence-informed conservation

The process of developing the Elinor tool and data system highlighted challenges, opportunities, and practical lessons for co-designing assessments and data platforms in conservation.

Elinor was initially conceived by NGO scientists (the first and last author) in response to challenges harmonizing place-based monitoring systems with national and global policy and practice agendas. The process for developing Elinor was designed to be collaborative, particularly between conservation NGO staff who have portfolio-level roles and local staff who lead place-based conservation implementation. While it took approximately three years to co-design Elinor, centering place-based practitioners' role and needs helped ensure the tool was fit-for-purpose and created more ownership over the tool by future tool users. Involving academics in the tool's design process also helped ensure the tool remained grounded in emerging insights from social science research on governance, management, and equity. This transdisciplinary approach helped the core team navigate difficult questions on scope, methodology, and data storage in the early days of the tool's

development. For example, the decision on how to store data (open-source or private) was influenced by continuous discussions with tool users, given the sensitivities that surround environmental governance in different national contexts. Importantly, the co-design process also helped identify ways users wanted to use the data collection process and its resulting outputs to meet their conservation goals, which influenced the development team's decision to prioritize functionality for site-based outputs over global outputs in the short term. Co-designing the tool with portfolio and project managers also helped to ensure that funding was available to support important aspects of the tool's development.

The development process surfaced many of the challenges that Elinor and other collaborative tools and data platforms will continue to face. While Elinor's intent was to be co-designed, time limitations prevented the process from being truly co-owned by all those involved in the design process. Given the number of individuals consulted during the process and the limitations to bringing everyone together at the same time (due to location, budget and time constraints), the core development team had to make important decisions on behalf of the group based on feedback, especially when feedback from different participants was contradictory. Due to the same limitations, and particularly the travel constraints related to COVID-19, the collaborative design process did not involve representatives of groups who are affected by the area-based conservation projects that Elinor aims to monitor. Because these representatives were not involved, Elinor's indicators reinforce the use of Western academic and managerial knowledge over local and Indigenous ways of knowing in conservation decision-making. This reinforcement not only carries implications for the political questions of what knowledge guides conservation efforts, but also may impose limits on the extent to which both Elinor fits different social-ecological contexts (Muhl et al., 2022) and promotes the self-determination of those affected by area-based conservation (Kourantidou et al., 2020). Though novel in its transdisciplinary design and emphasis on governance, management, and equity, future monitoring tools would benefit from dedicated reflection on how an inclusive co-design process that

engages with diverse knowledge and priorities of rights-holders and other actors can balance inclusion with real-world time constraints that conservation actors face on all scales (Mahajan et al., 2022).

The data platform itself will also continue to face challenges. While working closely with project and program managers helped secure some financing for Elinor, there is currently no financing model that can ensure the platform can persist beyond philanthropic funding, which may not be sustainable. A sustainable business plan, which enables the platform to generate revenue (e.g., via providing software services, regular partner contributions, or bilateral or interest-generating financial instruments), is recognized as critical for sustaining collaborative data platforms, and challenging to balance with the need to keep it free to users (Ahumada et al. 2020). We also expect that there will continue to be tensions around sharing and interpreting data: For example, tensions may arise when different stakeholders perceive governance and management status and trends differently. Powerful stakeholders, such as conservation funders or governments, may interpret governance and management data without context, and make decisions about, for example, funding allocations without a full understanding of what is causing changes in governance and management throughout time. There may also be tensions around the use of Elinor assessment data in scientific publications and reports, though collaboration principles that outline how users can ethically share and use data have been developed to mitigate this risk (see SI and elinordata.org). See Table 2 in Cox et al. 2021 for additional examples.

6. Conclusion

Equitable governance and effective management are critical for ensuring that area-based conservation is enduring and provides social and biodiversity benefits (CBD, 2022). By bringing together emerging insights from the social sciences, data sciences, and practical experiences in governance, management

effectiveness, and monitoring, Elinor has the potential to help mainstream the use of governance and management data in support of effective and equitable conservation. In the future, integrating Elinor data with other types of knowledge and evidence (e.g., locally appropriate governance and management assessments, social and ecological monitoring data, Indigenous and local ecological knowledge) can help ensure Elinor supports a holistic approach to evidence-informed conservation. In particular, understanding how the governance and management of area-based conservation shapes its social and ecological outcomes will be critical for ensuring conservation actions are effective, equitable and durable (Mahajan et al. 2021; Mascia et al. 2017). Elinor and similar data platforms that encourage standardized approaches for monitoring (where appropriate and possible) have the potential to play a vital role in answering these critical questions across spatial scales. Collaboratively testing and adapting Elinor based on real-world experience will help ensure Elinor meets the changing needs of conservation scientists and practitioners. Elevating the role of governance and management in conservation is a critical undertaking, and we hope Elinor can become a valuable platform for realizing conservation's important mission of improved, inclusive stewardship of life on Earth.

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Table 1. Questions from the Elinor assessment tool, Version 2023.1, nested into 10 attributes for data analysis and use. Questions marked with one asterisk indicate questions taken directly or adapted from the METT version 4, two asterisk questions indicate which ones were adapted from Ostrom's 8 design principles, questions without an asterisk were created by the development team based on reviewer feedback.

ATTRIBUTES	QUESTIONS
1. Resource boundaries	(Q1) Is the boundary known by all rights-holders and other actors?** (Q2) Is the boundary clearly defined?**

ATTRIBUTES	QUESTIONS
2. Enforcement	(Q3) How often are the penalties for breaking resource use rules administered?** (Q4) To what extent do penalties for breaking rules for the use of resources depend upon the nature, severity, or frequency of the infraction?**
3. Capacity for adaptive management	(Q5) Are systems in place to monitor and document ecological conditions in the MA?** (Q6) Are systems in place to monitor and document the social conditions of communities in and/or adjacent to the managed area (MA)?** (Q7) Are systems in place to monitor and document impacts of climate change?* (Q8) Do those responsible for managing the MA integrate different types of knowledge (scientific, experiential, local, and traditional) into management decisions?* (Q9) Are the results of monitoring, research, and evaluation routinely incorporated into decisions and/or policies related to MA management? (Q10) Is the MA consciously managed to adapt to climate change?*
4. Operational capacity	(Q11) Do those responsible for managing the MA (e.g., staff, community associations, management groups) have the capacity to enforce the rules and regulations?** (Q12) Are there enough people employed or engaged to manage the MA?* (Q13) Do those responsible for managing the MA have sufficient capacity (e.g., information and adequate skills) to fulfill management objectives?* (Q14) Is the current budget or funds used to support MA activities sufficient?* (Q15) Is the budget or funding secure?* (Q16) Is the equipment sufficient for management needs?*
5. Inclusive and equitable management	(Q17) To what extent are rights-holders and other actors affected by the rules of the MA able to play a role in making changes to the rules?** (Q18) Do women or other vulnerable groups living in the local community have clearly defined rights to natural resources within the MA?

ATTRIBUTES	QUESTIONS
	(Q19) Is there an effective strategy or approach for ensuring benefits from the MA are shared equitably among rights-holders and other actors? (Q20) Do networks exist that develop social relations and support mutual learning among rights-holders and other actors? (Q21) Is the information on climate change being used to inform strategies to build community resilience to climate change?
6. Clearly defined rights and decision making	(Q22) Are there formal or informal rules that clearly define who has what rights to harvest resources within the MA?** (Q23) Are there formal or informal mechanisms that clearly define who has what rights to develop rules for the use of resources within the MA?** (Q24) Are there formal or informal rules that clearly define the rights to exclude other groups from harvesting resources within the MA?** (Q25) Is there legislation in place to enable resource management by rights-holders and other actors?** (Q26) Are those with rights to access natural resources able to exercise their rights?**
7. Clear and congruent regulations	(Q27) Are rights to harvest or benefit from resources within the MA related to a person's contributions to the governance of the MA (in terms of time and/or resources contributed)?** (Q28) Do different levels of management exist within the MA that function as a coordinated unit?** (Q29) Are appropriate regulations in place to control natural resource-based activities in the MA?* (Q30) Is there a management plan for the MA and is it being implemented?*
8. Transparency and accountability	(Q31) Are those responsible for the governance of the MA held to account if they do not perform their role?** (Q32) Do rights-holders and other actors receive information from MA authorities in a timely manner?

ATTRIBUTES	QUESTIONS
	(Q33) Do rights-holders and other actors have access to effective conflict resolution mechanisms?**
9. Perceived ecological outcomes	(Q34) To what extent do you feel the ecological outcomes are being achieved?*
10. Perceived social outcomes	(Q35) To what extent do you feel the social outcomes are being achieved?*

Table 2. Illustrative question from the Elinor assessment and the four response options. All 35 questions have similar response options, and range from a scale of least to most desirable scenarios, and a space to add open-ended context for each question.

Question 18. Do women or other vulnerable groups living in the local community have clearly defined rights to natural resources within the MA?	
What is this question asking?	Sometimes the rules and regulations that govern access to natural resources can either intentionally or unintentionally exclude certain groups of people. This question wants to know whether all groups of people - especially women and other vulnerable groups - are able to access natural resources within the MA. For example, in some communities rights to the local fishery are gendered, with women unable to access certain areas due to local norms prohibiting the mixing of men and women.
Information requirements	● Knowledge of the range of rights-holders and other actors involved with the MA. ● Access to information covering the rights of rights-holders and other actors e.g., a management plan/ legal documents / key informants with customary knowledge

Guidance	▪ This question is designed to measure the equitable governance of the natural resources amongst different rights-holders and actors ▪ Clearly defined means written in legal or management documents or verbally communicated through duty bearers. ▪ **Women or other vulnerable groups**: For the purpose of this question please consider the options below as they apply to the majority of women/vulnerable rights-holders and actors and include in the qualitative response any variation among them. Note: i) Not to be confused with rights-holders and other actors' level of awareness; ii) This question does not address/is not to be confused with the distribution of rights among rights-holders and interested parties.
o Women's or other vulnerable group's rights to natural resources are not clearly defined	
o Some rights to natural resources within the MA are clearly defined for women or other vulnerable groups	
o Most rights to natural resources within the MA are clearly defined for women or other vulnerable groups	
o Women's or other vulnerable group's rights to natural resources are clearly defined	
o Don't know	
Explanation	

Table 3. Two options for data collection using the Elinor assessment and their requirements, costs, strengths, and weaknesses. Estimated time was calculated based on experience with the three pilot surveys and is expected to decrease with increased familiarity with the survey

	Desk-based assessment (single stakeholder group)	**Multi-stakeholder focus group(s)**

Level of effort	Low	Medium to High
Estimated time*	1-3 hours	2-4 hours minimum for a focus group discussion or more depending on the size of group, in addition to preparation, travel time, and uploading offline data sheet into elinordata.org
Estimated cost	No additional cost beyond the time of the assessors	Varies by geography but includes costs such as transport, staff time, facilitator, translation, and possible compensation for participants' time.
Strengths	Low cost, simple, efficient as it leverages existing knowledge of an MA	Greater representation of stakeholder perspectives which increases the validity of the data, opportunity to engage with resource users on governance and management concepts, facilitates participatory monitoring and evaluation
Weaknesses	Different biases (e.g., social desirability bias; fear of failure) and potential consequences (e.g., funding implications) can shape responses; only captures one perspective; may reinforce dominant narrative on a MA; limited engagement with those affected by governance and management	Time consuming (for staff and participants); resource intensive; may stimulate conflict if divergent opinions on governance and management exist

Table 4. Comparison of Elinor with existing governance and management tools and approaches. Note "Original Purpose" denotes the reason for which the tool or approach was designed, not how it has been used subsequently.

Governance and management attributes	Ostrom's design principles	IUCN Green List	IUCN NRGF	SAGE	METT-4	Elinor
Resource boundaries	✓	✓		✓	✓	✓
Enforcement	✓	✓	✓	✓	✓	✓
Capacity for Adaptive management		✓	✓		✓	✓
Operational capacity		✓	✓		✓	✓
Inclusive and equitable management		✓	✓	✓		✓
Clearly defined rights and decision making	✓	✓	✓	✓		✓
Clear and congruent regulations	✓	✓	✓	✓	✓	✓
Transparency and accountability	✓	✓	✓	✓		✓
Perceived ecological outcomes		✓		✓	✓	✓
Perceived social outcomes		✓		✓	✓	✓
Devolution			✓			
Recognition and respect for all actors				✓		

Effective mitigation of negative impacts on communities				✓		
Management processes			✓		✓	
Management outcomes		✓			✓	
Sound design and planning		✓	✓			
Original Purpose	Theory development	Certification	Site-level assessment	Site-level assessment	Site-level assessment/ Monitoring over time	Monitoring over time
Duration of assessment (days)	Varies	Months to years	Varies	3	3	<1
Number of assessment questions	Varies	50	51 criteria	53	38	35

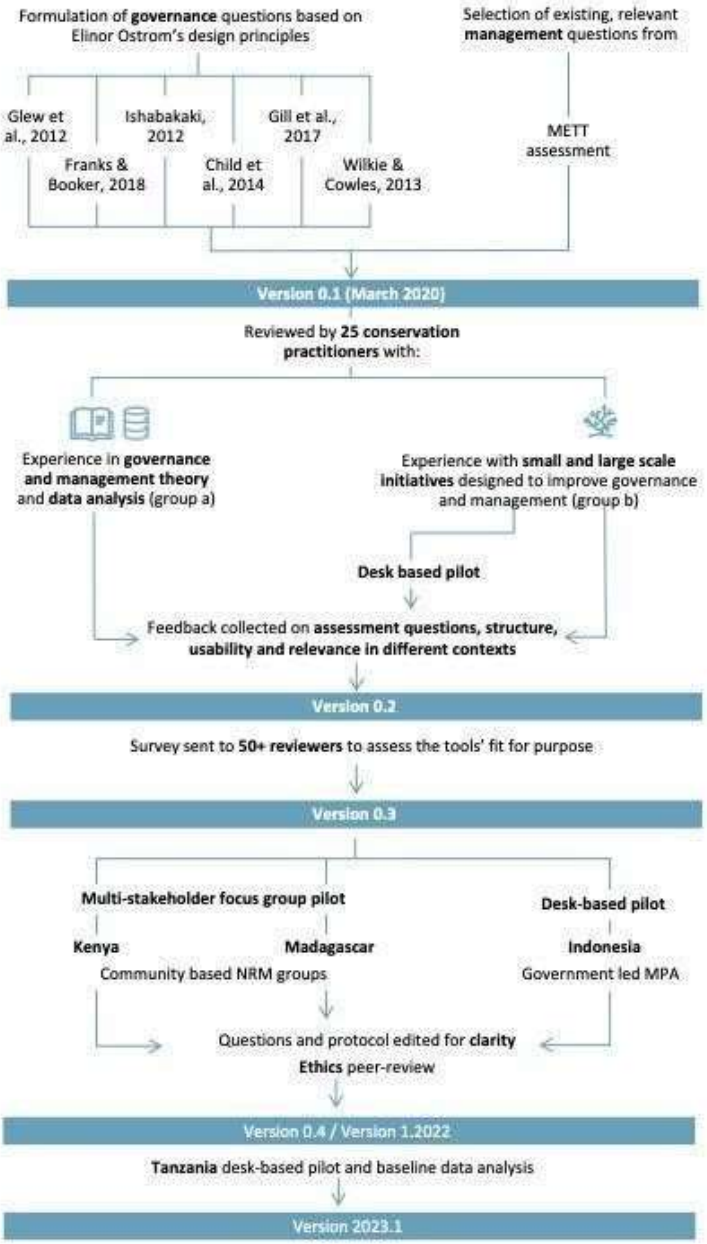

Figure 1. Process for developing the Elinor assessment tool. See supporting information for a detailed narrative describing the process.

Figure 2a.

Figure 2b.

Figure 2c.

Figure 2. Site-level (2a,b) and aggregate (2c) outputs from a desk-based pilot in coastal Tanzania. The pilot assessed five Collaborative Fisheries Management Areas (CFMA), and leveraged the knowledge of two NGO staff members knowledgeable about the areas. The staff members had recently facilitated the co-development of 5-year fishery management plans with CFMA members in all 5 sites, and used their knowledge and written plans from this process to inform the Elinor desk-based assessments. The assessments will serve as a baseline for the term to internally track governance and management in these sites, to support plans for future capacity development activities in the CFMAs. The first two panels (2a and 2b) show site-level outputs and highlight governance strengths and needs, along with contextual information (2a) and a full display of the assessment results showing scores at the question, attribute, and total levels, with associated Action Steps (2b). The third panel (2c) is an illustrative mock-up of what future aggregate level outputs will look like, as at the time of publishing, the aggregate site-level outputs were in the final stages of development.