





METHOD

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 affected by governance and management systems from implementing conservation activities and programs and from gathering and using data on governance and management to inform decision-making across spatial scales and through time. We explored current and past efforts to assess governance and management effectiveness and barriers actors face in using the resulting data and insights to inform conservation decision-making. To help overcome these barriers, we developed Elinor, a free and open-source monitoring tool that builds on 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 consider the process of codesigning and piloting Elinor with conservation scientists and practitioners and the main components of the assessment and online data system. We also consider how Elinor complements existing approaches by addressing governance and management in a single assessment at a high level for different types of area-based conservation, providing flexible options for data collection, and integrating a data system with an assessment that can support data use and sharing across different spatial scales, including global monitoring of the Global Biodiversity Framework. Although challenges will continue, the process of developing Elinor and the tool itself offer tangible solutions to barriers that prevent the systematic collection and use of governance and management data. With broader uptake, Elinor can play a valuable role in enabling more effective, inclusive, and durable area-based conservation.

KEYWORDS

area-based conservation, biodiversity, database, decision-making, equitable governance, governance, management effectiveness, monitoring

Introducción de Elinor para el monitoreo de la gobernanza y la gestión de la conservación con base en zonas geográficas

Resumen: El monitoreo de la efectividad de la gobernanza y de la gestión de la conservación basada en zonas geográficas ha sido reconocido durante mucho tiempo como una base importante para alcanzar las metas nacionales y mundiales de la biodiversidad y permitir un manejo adaptativo. Sin embargo, todavía existen barreras que evitan que los actores de la conservación, incluidos aquellos afectados por los sistemas de gobernanza y gestión, implementen actividades y programas de conservación y recopilen y usen datos de la gobernanza y la gestión para informar las decisiones a lo largo de las escalas espaciales y a través del tiempo. Exploramos los esfuerzos hechos en la actualidad y en el pasado para evaluar la efectividad de la gobernanza y la gestión así como las barreras que los actores enfrentan al usar los datos y el conocimiento resultantes para informar la toma de decisiones de conservación. Para ayudar a derribar estas barreras desarrollamos Elinor, una herramienta de monitoreo gratuita y de software libre que parte del trabajo de la ganadora del Premio Nobel Elinor Ostrom, para facilitar la recopilación, almacenamiento, divulgación, análisis y uso de los datos sobre la gobernanza y la gestión ambiental en las escalas espaciales y para las zonas con diferentes tipos de gobernanza y gestión. Planteamos co-diseñar y pilotar Elinor con los científicos y practicantes de la conservación y usando los componentes principales del sistema de evaluación y de datos en línea. También planteamos cómo Elinor complementa las estrategias existentes al abordar la gobernanza y la gestión en una

sola evaluación a un nivel elevado para diferentes tipos de conservación basada en zonas geográficas, lo que proporciona opciones flexibles para la colecta de datos, e integramos un sistema de datos con una evaluación que soporta el uso y divulgación de datos en diferentes escalas espaciales, incluido el Marco Mundial para la Biodiversidad. Aunque los retos seguirán existiendo, el proceso de desarrollo de Elinor y la propia herramienta ofrecen soluciones tangibles a las barreras que previenen la colecta sistemática y el uso de datos de la gobernanza y la gestión. Con una mayor aceptación, Elinor puede tener un papel importante en el momento de hacer posible una conservación basada en zonas geográficas más eficaz, integradora y duradera.

PALABRAS CLAVE

base de datos, biodiversidad, conservación basada en zonas, efectividad de la gestión, gobernanza, gobernanza equitativa, monitoreo, toma de decisiones

在区域保护的治理和管理中引入Elinor

【摘要】 监测区域保护的治理和管理有效性早已被视为实现国家和全球生物多样性目标和实现适应性管理的重要基础。然而,保护行动者(包括受治理和管理系统影响的人们)在实施保护活动和计划,以及收集和利用治理和管理数据为跨时空尺度的决策提供信息的过程中,仍面临重重阻碍。本文探讨了当前和过去为评估治理和管理有效性所做的努力、行动者在使用产出数据时面临的阻碍,以及为保护决策提供信息的洞见。为了帮助克服这些阻碍,我们开发了Elinor这一免费开源监测工具,该工具以诺贝尔奖获得者Elinor Ostrom的研究成果为基础,旨在促进不同治理和管理类型区域跨空间尺度的环境治理和管理数据的收集、存储、共享、分析和使用。本文介绍了与保护科学家和实践者共同设计和试用Elinor的过程,以及其评估和在线数据系统的主要组成部分。我们还考虑了Elinor如何对现有方法进行补充,包括:在单一评估中高水平地处理不同类型区域保护的治理和管理问题,为数据收集提供灵活的选择,以及整合数据系统与评估来支持不同空间尺度的数据使用和共享,包括对《全球生物多样性框架》的全球监测。虽然挑战持续存在,但Elinor的开发过程和工具本身为克服系统性收集和使用治理与管理数据中面临的阻碍提供了切实的解决方案。随着Elinor被更广泛地采用,它将在实现更有效、更包容和更长期的基于区域的保护中发挥宝贵作用。**【翻译:胡怡思;审校:聂永刚】**

关键词: 基于区域的保护,生物多样性,数据库,决策,公平治理,治理,管理有效性,监测

INTRODUCTION

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 (institutions, structures, and processes that shape environmental decision-making) and management (resources, plans, and actions that result from the functioning of governance) (Bennett & Satterfield, 2018; Lockwood et al., 2010) affect biodiversity and social outcomes of conservation (Armitage et al., 2012; Coad et al., 2019; Gill et al., 2017). Multiple tools and approaches for assessing and monitoring environmental governance (e.g., Booker & Franks, 2019; Detoefuf 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. Although these efforts have elevated the importance of both concepts, there are few examples of governance and management data being used to systematically inform

the design, implementation, and adaptive management of area-based conservation (Coad et al., 2015). Addressing this problem is particularly important in light of the target to protect 30% of the planet through area-based conservation by 2030 (CBD, 2022a). There have been repeated calls for nations to look beyond conservation coverage to equity and effectiveness of management and governance in tracking their progress toward this global commitment (e.g., Jonas et al., 2021; Gurney et al., 2023).

We introduce Elinor, a free, open-source tool for gathering, storing, sharing, analyzing, and using data on 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 & Satterfield, 2018) and management effectiveness (Stolton et al., 2021).

TABLE 1 Comparison of the Elinor environmental governance and management assessment tool with existing governance and management tools and approaches.*

Governance and management attribute	Ostrom's design principle	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 and 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

Abbreviations: IUCN, International Union for the Conservation of Nature; METT-4, Management Effectiveness Tracking Tool version 4; NRGF, Natural Resource Governance Framework; SAGE, Site-Level Assessment of Governance and Equity).

*Original purpose denotes the reason for which the tool or approach was designed, not how it has been used subsequently.

We provide an overview of existing tools and approaches to assess governance, management, and equity of area-based conservation (i.e., protected areas and other effective area-based conservation measures [OECMs]). We describe how we developed Elinor to complement these tools and approaches, specifically considering the different ways users collect and store assessment data. We argue that Elinor's standardized, yet flexible, approach can support assessing and comparing sites over time and address many challenges and opportunities for monitoring area-based conservation governance and management.

CURRENT APPROACHES TO ASSESSING AREA-BASED CONSERVATION GOVERNANCE AND MANAGEMENT

Many tools and approaches exist to assess environmental governance and management effectiveness (Table 1). These approaches have similar but distinct goals, including supporting conservation monitoring, adaptive management, empirical

and synthetic research (Coad et al., 2013), third-party certification, and meeting social safeguards and donor requirements (Hockings et al., 2019; Leverington et al., 2010). Learning from existing tools is limited because most assess either governance or management (Meehan et al., 2020), and the same tools are rarely applied across multiple sites repeatedly (Zafra-Calvo & Geldmann, 2020).

In 2006, the Global Database on Protected Areas Management Effectiveness (GD-PAME) began compiling evaluations of protected area management effectiveness. By 2020, such evaluations had been conducted in 18.29% of the world's protected areas (UNEP-WCMC, UNEP, IUCN, 2021). At least 78 different evaluation methods had been reported in the GD-PAME as of April 2023 (UNEP-WCMC, 2023), most of which were based on the International Union for Conservation of Nature (IUCN) World Commission on Protected Areas framework, 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 in individual protected areas 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 the performance of protected, comanaged, and locally managed areas (MAs). Although not originally intended to compare management effectiveness across different sites (Stolton et al., 2019), METT data have been used for such analyses at regional and global scales (e.g., Geldmann et al., 2015; Gill et al., 2017).

Although 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 8 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 created to enable consistent measurement and storage of governance data, primarily for research purposes (e.g., Chhatre & Agrawal, 2009; IFRI, 2013; Joshi et al., 2000; Lam, 1998; Potete & Ostrom, 2004; Schlager, 1994; Schlager et al., 1994; Shivakoti & Ostrom, 2002). More recent environmental governance research has expanded beyond Ostrom's work to explore equitable governance and the role of knowledge coproduction, adaptation, and learning (e.g., Armitage et al., 2012; Borrini-Feyerabend & Hill, 2015; Lockwood et al., 2010). Attention to evaluating the extent to which the governance systems in which conservation interventions are embedded are effective and equitable has increased (Fidler et al., 2022; Bennett & Satterfield, 2018; Partelow et al., 2020).

Conservation practitioners increasingly recognize the importance of governance for area-based conservation (Bennett et al., 2021; Borrini-Feyerabend & Hill, 2015; Maini et al., 2023), which has led to a proliferation of policies, principles, frameworks, and tools that emphasize equitable and effective governance (Gurney et al., 2021). Many such tools are designed around CPR theory, practical experience, and subsequent academic and gray literature on environmental governance, including the Natural Resource Governance Framework (Springer et al., 2021), the IUCN Green List (Hockings et al., 2019), and the site-level assessment of governance and equity (SAGE) (Pinto, 2021). These tools and approaches enable researchers and practitioners to evaluate area-based conservation effectiveness (e.g., Fidler et al., 2022) and monitor the status and trends of environmental governance over time (Detoef et al., 2020; Glew et al., 2012; Gurney et al., 2019).

BARRIERS TO USING GOVERNANCE AND MANAGEMENT DATA IN 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, 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 limited capacity and resources for implementing and sustaining monitoring, technical barriers surrounding the infrastructure and tools for collecting, storing, analyzing, and sharing data across contexts and time, and lack of investment in applying governance and management data to day-to-day conservation decision-making.

Capacity and resource barriers

Conservation actors (particularly those in nongovernmental organizations (NGOs) and government organizations and site-level managers) often have limited time and capacity to learn, implement, and sustain the use of new tools (Geldmann et al., 2021). These limitations are often rooted in the competing demands in conservation and the limited training and expertise in governance concepts and tools. Assessing governance and management also requires time (of facilitators and participants), capacity, and financial resources (Borrini-Feyerabend et al., 2013; 2015). Many existing assessment approaches (e.g., Franks & Pinto, 2021; Stolton et al., 2021) require 2–3 days to complete for 1 site and participation from a diverse set of actors, which further necessitates time and financial investment. 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. Although 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 are capacity and resources for assessments, monitoring governance and equity is often not prioritized (Pires et al., 2017; Meehan et al., 2020). Such monitoring can be highly sensitive for some conservation actors, particularly in government agencies that manage conservation areas. Assessments uncovering weaknesses in governance and management can reflect poorly on those responsible for overseeing or implementing area-based conservation, which can discourage meaningful engagement, such assessments, and sharing results.

Technical barriers

Successful long-term monitoring programs in conservation often rely on data generated through automated observations of readily observed parameters (e.g., habitat coverage or ecosystem pressure through remote sensing, via platforms like Global Fishing Watch, 2023 and Global Forest Watch, 2023). Generating governance and management data cannot be automated in the same way and requires input from knowledgeable actors

via social science methods. This means that governance and management data may be influenced by differing understandings of the situation and the perceptions of the data recorder or observer. The PAME assessment tools are generally designed for or, in the case of the METT, adapted to the needs of different programs and places, which has led to the collection of different types of data and the use of different indicators. This makes it difficult to synthesize data from different sites and promote learning and adaptive governance and management at different scales (Coad et al., 2015; Fidler et al., 2023). Even when governance and management data are collected using the same protocols, synthesis is limited by data being stored in different ways.

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 allow conservation actors to use data when making strategic and adaptive management decisions. First, the sensitivities around governance and management assessments can limit the willingness to or capacity for conservation practitioners and researchers to share and use data on governance and management, despite the prevalence of research frameworks that link social and ecological outcomes to governance (e.g., Mascia et al., 2017; Mahajan et al., 2021). Second, while codesign processes and knowledge coproduction 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 & Pilbeam, 2017), most longitudinal studies on environmental governance and management (e.g., Geldmann et al., 2015) are not codesigned with conservation decision-makers. Barriers that operate at individual, organizational, and systematic levels 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). Sustaining collaborative, codesigned processes that effectively address some of these issues takes time, funding, sustained partnerships, and expertise (Ahumada et al., 2020; Mahajan et al. 2023). Without such processes, the scope for using governance and management data in decision-making is limited (Macura et al., 2015; Osuka et al., 2020).

INTRODUCING ELINOR

The Elinor assessment tool and data system is designed to help conservation actors gather, store, share, analyze, and use governance and management data. Elinor was conceived to streamline how governance and management tools are used in conservation NGOs and to create a data platform to facilitate

data sharing and use. Elinor was designed to apply to all types of area-based conservation, including protected areas, OECMs, and areas under Indigenous or local governance and management. Recognizing this diversity, Elinor allows users to define the MA, which is the unit of analysis, in a way that best suits their needs. Quantitative and qualitative data are collected through 35 questions designed to assess 10 attributes of governance and management (Table 2). Data are stored in an online platform accessible at elinordata.org.

The Elinor assessment was initially designed to combine Elinor Ostrom's design principles for governance and the METT. Its design was iterative and collaborative (Figure 1 & Appendix S1). Given the widespread use of the METT, the first draft of Elinor combined 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 8 design principles. We then solicited 2 rounds of feedback from over 50 conservation actors on draft assessments. After incorporating their feedback, we tested Elinor in 4 countries and conducted an ethics assessment (using Cornell et al., 2018) before finalizing the current version, 2023.1.

The latest version of Elinor includes 2 main sections. The first collects background information on the MA, including who was engaged in data collection, where and when the MA was established, MA governance type, and additional data on management objectives and rights of people living in and around the MA (Appendix S1). This section allows users to upload management plans, spatial information about the MA, and the MA's associated identification number from the World Database on Protected Areas, if applicable. The MA shapefiles may be downloaded from WDPA and uploaded to Elinor, but Elinor does not directly communicate with WDPA. The second section collects management and governance data through 15 management questions adapted from the METT and 20 questions on the effectiveness, sustainability, and equitable nature of governance (Table 2). 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 4 response options, following a scale of least to most desirable scenarios (mirroring the 4-point scale used in METT assessments) (Table 3). Guidance is provided for each question to clarify its purpose, including a rationale, explanation of key terms, and suggested sources of information to consult (see elinordata.org). Users must answer all questions within the attributes they select and are allowed to skip attributes that are not applicable to their MA. Users are asked to explain their responses in a qualitative text box that accompanies each question. This text box allows them to describe nuances not allowed by the standardized questions and responses, such as compound questions, which were included to reduce assessment length. Should users find understanding or answering these questions difficult, the system encourages them to contact the developers, who maintain running lists of issues to consider when Elinor is reviewed for version updates.

TABLE 2 Questions from the Elinor version 2023.1 environmental governance and management assessment tool nested within 10 attributes for data analyses and use.

Attribute	Question
Resource boundaries	Q1 Is the boundary known by all rights holders and other actors? ^a Q2 Is the boundary clearly defined? ^a
Enforcement	Q3 How often are the penalties for breaking resource use rules administered? ^a Q4 To what extent do penalties for breaking rules for the use of resources depend on the nature, severity, or frequency of the infraction? ^a
Capacity for adaptive management	Q5 Are systems in place to monitor and document ecological conditions in the MA? ^a Q6 Are systems in place to monitor and document the social conditions of communities in and/or adjacent to the managed area (MA)? ^a Q7 Are systems in place to monitor and document impacts of climate change? ^b Q8 Do those responsible for managing the MA integrate different types of knowledge (scientific, experiential, local, and traditional) into management decisions? ^b Q9 Are the results of monitoring, research, and evaluation routinely incorporated into decisions and/or policies related to MA management? ^c Q10 Is the MA consciously managed to adapt to climate change? ^b
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? ^a Q12 Are there enough people employed or engaged to manage the MA? ^b Q13 Do those responsible for managing the MA have sufficient capacity (e.g., information and adequate skills) to fulfill management objectives? ^b Q14 Is the current budget or funds used to support MA activities sufficient? ^b Q15 Is the budget or funding secure? ^b Q16 Is the equipment sufficient for management needs? ^b
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? ^a Q18 Do women or other vulnerable groups living in the local community have clearly defined rights to natural resources in the MA? ^c Q19 Is there an effective strategy or approach for ensuring benefits from the MA are shared equitably among rights holders and other actors? ^c Q20 Do networks exist that develop social relations and support mutual learning among rights holders and other actors? ^c Q21 Is the information on climate change being used to inform strategies to build community resilience to climate change? ^c
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? ^a 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? ^a Q24 Are there formal or informal rules that clearly define the rights to exclude other groups from harvesting resources in the MA? ^a Q25 Is there legislation in place to enable resource management by rights holders and other actors? ^a Q26 Are those with rights to access natural resources able to exercise their rights? ^a
Clear and congruent regulations	Q27 Are rights to harvest or benefit from resources in the MA related to a person's contributions to the governance of the MA (in terms of time and/or resources contributed)? ^a Q28 Do different levels of management exist within the MA that function as a coordinated unit? ^a Q29 Are appropriate regulations in place to control natural resource-based activities in the MA? ^b Q30 Is there a management plan for the MA and is it being implemented? ^b
Transparency and accountability	Q31 Are those responsible for the governance of the MA held to account if they do not perform their role? ^a Q32 Do rights holders and other actors receive information from MA authorities in a timely manner? ^c Q33 Do rights holders and other actors have access to effective conflict resolution mechanisms? ^a
Perceived ecological outcomes	Q34 To what extent do you feel the ecological outcomes are being achieved? ^b
Perceived social outcomes	Q35 To what extent do you feel the social outcomes are being achieved? ^b

^aAdapted from Ostrom's (1990) 8 design principles.

^bTaken directly or adapted from the Management Effectiveness Tracking Tool 4.

^cCreated by the development team based on reviewer feedback.

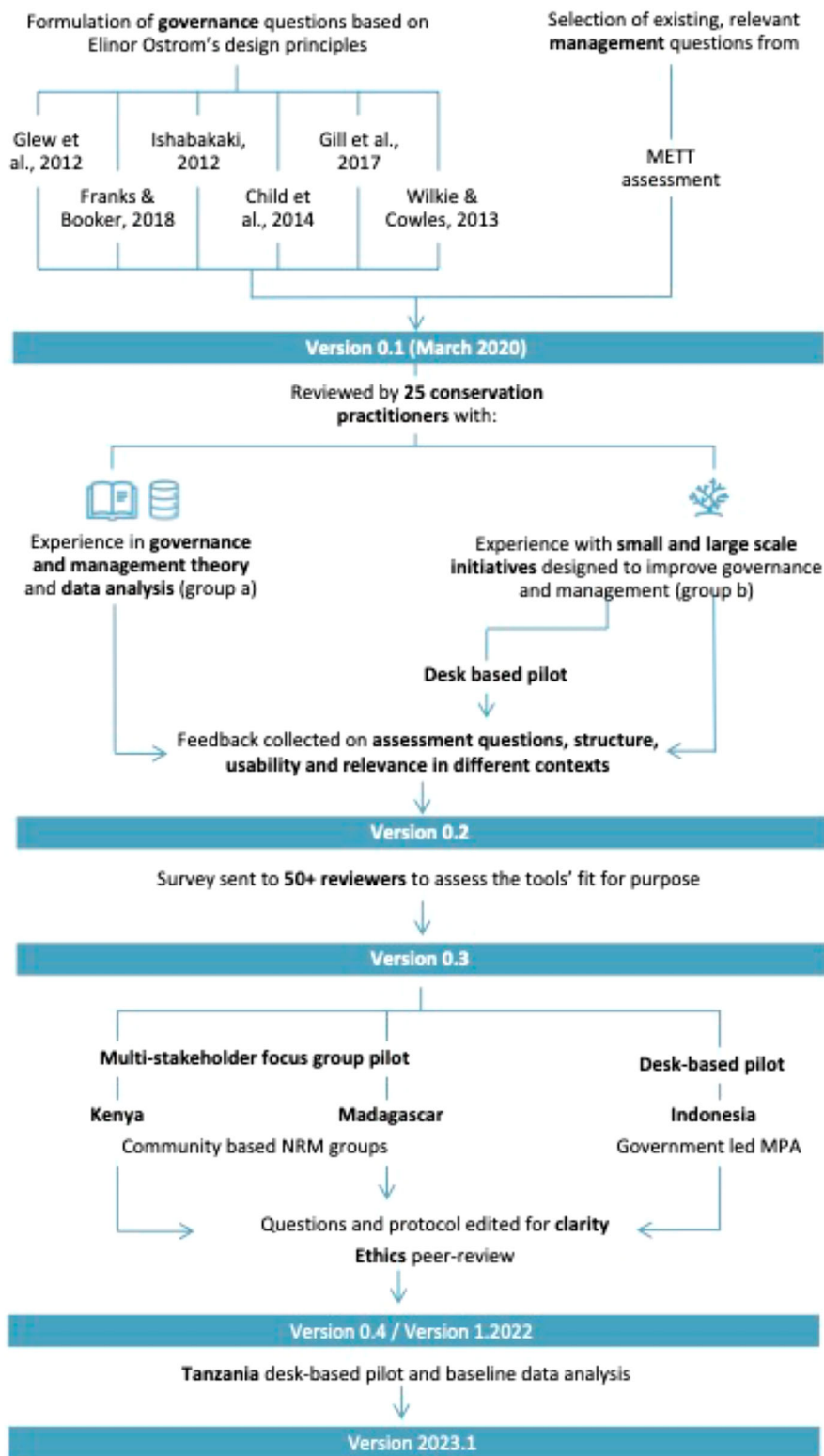


FIGURE 1 Process for developing the Elinor assessment tool. See Supporting Information for a detailed narrative describing the process (METT, management effectiveness tracking tool; MPA, marine protected area).

TABLE 3 Illustrative question from the Elinor assessment, question guidance, and the 4 response options.*

Question 18. Do women or other vulnerable groups living in the local community have clearly defined rights to natural resources in 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 in 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, for example, a management plan, legal documents, key informants with customary knowledge
Guidance	This question is designed to measure the equitable governance of the natural resources among different rights holders and actors. <i>Clearly defined</i> 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 and vulnerable rights holders and actors and include in the qualitative response any variation among them. Note: Not to be confused with rights holders and other actors' level of awareness. This question does not address this and is not to be confused with the distribution of rights among rights holders and interested parties.
Response options	Women's or other vulnerable group's rights to natural resources are not clearly defined. Some rights to natural resources in the MA are clearly defined for women or other vulnerable groups. Most rights to natural resources in the MA are clearly defined for women or other vulnerable groups. Women's or other vulnerable group's rights to natural resources are clearly defined. Don't know.

*All 35 questions have similar response options and range from a scale of least to most desirable scenarios, and there is a space titled "explanation" in which respondents can add open-ended context for each question.

Pathways for data collection

Elinor provides 2 options for data collection: a desk-based exercise carried out by practitioners, such as MA managers or an NGO staff member knowledgeable about the governance of the MA or a focus group discussion with actors knowledgeable about and affected by governance and management in the MA (e.g., local community members, park managers, traditional or local leaders). Focus groups are the preferred data collection method because they can incorporate diverse perspectives, but they may be difficult to implement without adequate capacity and resources. Elinor limits data collection to these 2 options to encourage transparency on how data were collected and to balance the flexibility of use with 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, community members), which should be accounted for when data are interpreted and used.

The 2 options differ in terms of the time, resources, and participants needed to conduct the assessment and in what conclusions users can draw (Table 4). They also differ in their biases. For desk-based assessments, 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 & Hockings, 2011). There may be additional biases introduced in the governance questions because many concern the experience of rights holders and other actors affected by governance systems. To reduce bias in desk-based assessments, users are encouraged to comple-

ment their assessment with additional data, such as stakeholder reports or management plans, and offer guidance on what complementary data may be most helpful. To reduce biases in the focus groups, Elinor provides guidance on how to sample respondents to increase the likelihood of capturing more diverse 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 important identities).

Data system

An online data system was codesigned to support storing, sharing, analyzing, and using Elinor data. The codesign process included an interdisciplinary team of applied social scientists, data scientists, and software developers and was informed by user-centered feedback from conservation NGO staff. Building on the team's past experience in developing shared data systems (particularly datamermaid.org), the codesign process prioritized ease of use and access, secure and clean data storage, and data integrity.

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 with a PostGIS-enabled PostgreSQL database (postgresql.org). The front-end is a Vue Javascript application (vuejs.org). Although the tool is currently only available through a web browser (requiring users to be online to enter data), this architecture

TABLE 4 Two options for data collection with the Elinor governance and management assessment tool and their requirements, costs, strengths, and weaknesses.

	Desk-based assessment	Focus groups
Level of effort	low	medium to high
Estimated time*	1–3 h	2–4 h 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 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 because it leverages existing knowledge of a managed area	greater representation of stakeholder perspectives, which increases validity of the data, provides 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 associated with a managed area; 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

*Estimated time was calculated based on experience with the 3 pilot surveys and is expected to decrease with increased familiarity with the survey.

creates many future possibilities for data entry and access through, for example, mobile apps or integration with other data platforms. This architecture eases scaling, upgrades, and security management. Capabilities that enable data to be collected offline and then uploaded to the online system are also under development. With the cloud platform, users can access data anywhere, facilitating collaborative research, analysis, and visualization. The application is free and open source, enabling developers to contribute to the code base to bring in new functionalities.

Security and data privacy also informed development. Personal information (name, email address, institution) is collected only to the extent that is required to operate the system, and users can erase this personal data from the system. No personal information is shared with third parties. To protect data sovereignty, once assessments are finalized, users can choose whether their assessments are accessible to the public or only to them and their chosen collaborators. A robust security structure with internal and remote backup protects against data loss. To improve accessibility, Elinor supports multiple languages, and the interface and protocol will be translated into various languages. At the time of publication, Elinor is in English, Spanish, Swahili, Portuguese, and Bahasa Indonesia.

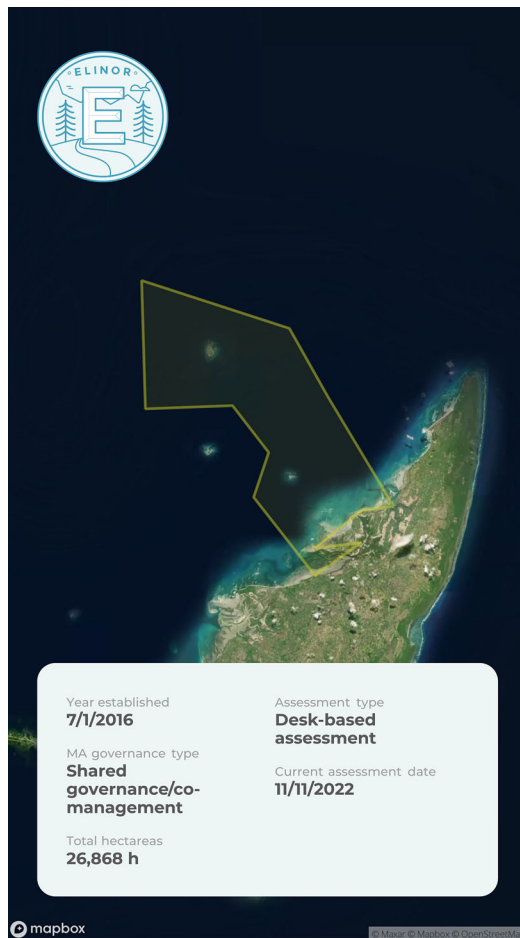
Data outputs and visualizations

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 download raw data for each assessment with permission from the data owner. This enables collaboration and sharing publicly or within closed groups while minimizing the risk of data loss. The current architecture allows users to access the output from various platforms, such as web and analysis software, through the API, which facilitates the integration of different data sets from different API platforms that may collect complementary data (e.g., datamermaid.org).

To inform the development of semiautomated reports from elinordata.org, aggregate and site-level reports were manually developed by social scientists and NGO practitioners with data from 2 Elinor pilots. 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. The manually produced reports and subsequent feedback informed the layout and design of the semiautomated modules in elinordata.org that allow users to download a decision-oriented summary and visual of the assessment data (Figure 2a,b). The reporting module allows data to be aggregated and visualized at the MA level and soon will allow users to aggregate shared data at other user-defined scales. 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; 0, least desirable; 3, most desirable). The attribute score is a percentage of all possible question scores within that attribute multiplied by 10 for easy interpretation. The 10 attribute scores are added to cre-



66 JOJIBAKI CFMA 2022

OUT OF 100 YEAR 2022

KEY GOVERNANCE STRENGTHS

- Resource boundaries
- Perceived social outcomes
- Inclusive and equitable management

Top-down legislation and bottom-up lobbying have ensured rights-holders and other actors have a voice in decision-making processes, including some vulnerable groups.

KEY GOVERNANCE NEEDS

- Clearly defined rights and decision making
- Capacity for adaptive management
- Perceived ecological outcomes

Use, but not exclusion, rights are clearly defined. A fishing license for one CFMA is valid in all. Fish catch is increasing, but mangroves continue to decline.

CONTEXT

JOJIBAKI, like other government recognized CFMAs in Tanzania, is governed through a co-management model that promotes the sustainable use of marine resources.

FIGURE 2 (a, b) Site-level and (c) aggregate outputs, (a) contextual information, and (b) assessment results (showing scores at the question, attribute, and total levels and associated action steps) in a desk-based test of the Elinor environmental governance and management assessment tool in coastal Tanzania. For illustration, (c) shows what future aggregate-level outputs will look like (at the time of publication, the aggregate site-level outputs were in the final stages of development). Five collaborative fisheries management areas (CFMAs) were assessed and knowledge of 2 nongovernmental organization staff members, who facilitated the 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 tracking of governance and management in these sites to support plans for future capacity development activities in the CFMAs.

ate 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. When users decide that 1 or more attributes are not applicable to their MA and do not enter responses for those attributes, the calculation for the total MA score is adjusted 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 customizing indicators for attributes or MA governance based on different combinations of questions. The flexibility to omit irrelevant attributes is intended to facilitate user uptake, but we recognize this could limit how total MA scores can be used.

Total MA and attribute scores are assigned to 1 of 4 action-oriented categories: plan, build, strengthen, or maintain (Figure 2). The site-level reports that the system 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 allows 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 (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 nuanced understanding as to why governance and management may differ across sites.

ELINOR AND EXISTING GOVERNANCE AND MANAGEMENT ASSESSMENT APPROACHES

Elinor integrates high-level questions on governance and management in a single assessment and is supported by a



FIGURE 2 Continued

decision-oriented data system that facilitates data use, sharing, and adaptive management across 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 gathering and analyzing temporal trends and cross-site comparison and learning (Table 1). In doing so, Elinor overcomes some of the existing barriers to using governance and management data in conservation decision-making. As a simple, relatively quick, and easy system, accompanied by clear protocols and guidance, Elinor addresses capacity and resource barriers that have limited the uptake of other tools. Implemented within a free, open-source, and secure data system that facilitates site-level learning and cross-site comparisons, Elinor also helps address technical barriers to data storage, access, and maintenance. Finally, Elinor's collaborative development process makes it more likely to produce relevant evidence for conservation decision-makers.

In addition to supporting those who contribute to area-based conservation governance and management, Elinor could be used by academics to implement and share practice-relevant research with practitioners and managers via the system's data sharing and visualization features. Elinor includes several high-level measures on equitable governance, a noticeable gap in existing PAME tools (Meehan et al., 2020; Moreaux et al.,

2018). Elinor's development process gave equal consideration to governance and management, prioritizing key issues deemed important from academic (e.g., Bennett & Satterfield, 2018; Ostrom, 1990) and practitioners' perspectives (e.g., Stolton et al., 2021; Springer et al., 2021). The choice between a desk-based and focus-group data collection introduces flexibility to potential users and may also increase uptake, including in organizations with limited financial resources and time for monitoring.

Elinor may not be suitable for all area-based conservation contexts. It was not designed to replace existing, effective monitoring systems tailored to place, but can complement such systems to facilitate knowledge sharing and regional learning and reporting. Elinor's strength lies in its equal focus on governance and management, but it trades off depth for breadth and lacks the deep insights that tools or research focused on only governance or management can obtain. For example, SAGE 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 prioritizes which issues to address first based on stakeholder needs (Franks & Pinto, 2021). The METT, which

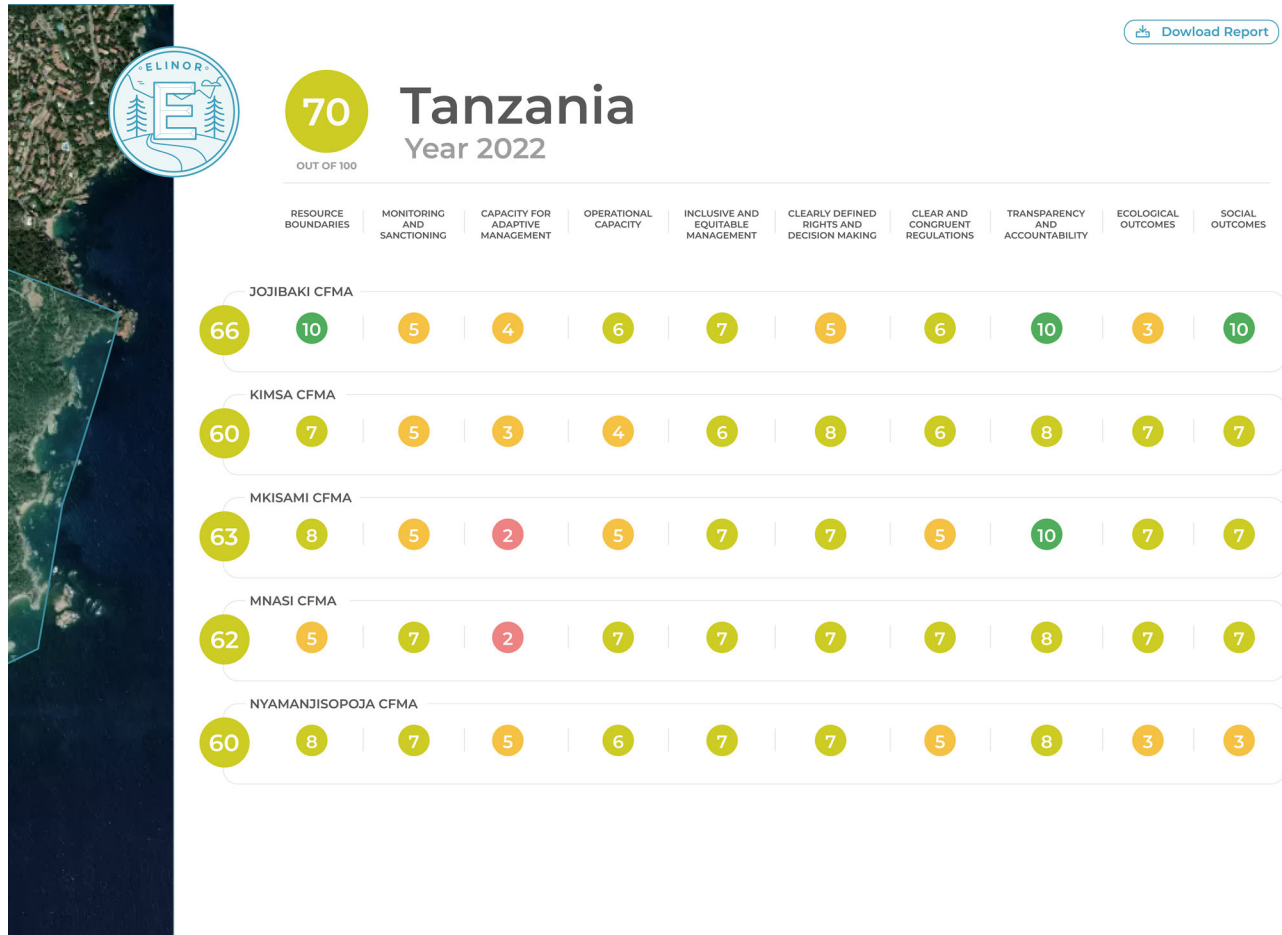


FIGURE 2 Continued

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

USING ELINOR DATA TO SUPPORT POLICY AND PRACTICE

Elinor could make data on governance and management more accessible to those 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 to regularly engage these concepts through periodic monitoring. Its data outputs further help users to reflect on what the current status and trends of these concepts mean for 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 for conservation decision-making in different contexts and increased Elinor’s likelihood of persistent adoption (Rogers, 2003). Although Elinor was initially designed with NGO staff as the primary users, over time Elinor could be adapted to meet the needs of other conservation decision-makers, such as community conservation leaders or government staff.

Elinor’s data outputs facilitate using governance and management data in decision contexts. For instance, site-level managers working at the level of a single MA could use site-level summary data in evidence-informed conversations with constituents about the trajectory of change in specific places and to identify actions for improving governance and management based on trends over time. Staff with regional or national mandates can use aggregate summaries to inform decisions around regional- and national-level policies, programs, and funding. By applying to multiple levels, Elinor particularly benefits transboundary conservation, where different national monitoring systems may not be aligned.

With increasing emphasis on equitable governance in agreements made under the Convention on Biological Diversity

(Gurney et al., 2023), Elinor can be used to monitor protected areas and OECMs under target 3 of the Kunming-Montreal Global Biodiversity Framework. Although the 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. Elinor complements SAGE and METT in measuring and monitoring the effectiveness and equity of management and governance and could 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).

Despite these opportunities, Elinor does not eliminate all existing challenges to using governance and management data. First, although Elinor encourages focus groups for data collection, how users apply this guidance determines whether data from Elinor are subject to the biases facing existing governance and management assessments (Table 1), including observer biases from protected area managers (Carbutt, 2013; Cook & Hockings, 2011; Cook et al., 2014). Although the data visualization features and guidance on data use are designed to increase transparency around how data were collected and raise awareness around potential biases, users of Elinor must navigate these biases when interpreting and applying Elinor data. Like many governance and management assessment tools, Elinor collects perceptual data from focus group participants or practitioners. Though the credibility of perceptual data for evidence-informed decision-making has been debated (Adams & Sandbrook, 2013; Haddaway & Pullin, 2013), they are central to understanding governance and management (Bennett, 2016). For example, the resource-boundaries attribute in Elinor asks whether boundaries are clearly defined and the extent to which they are known by relevant rights holders and other actors. In addition to answering these questions, users can upload management plans and shapefiles of the boundaries. Together, these 3 lines of evidence provide complementary data on the clarity of boundary definitions and people's perceptions of them, which are important to effective and equitable environmental governance and management.

Second, ensuring that evidence on governance and management plays a role in decision-making requires effort at individual and organizational levels. Ensuring that they do requires systemic changes to the structures and norms that shape conservation decision-making. Implementing agencies must allow more time for engaging with evidence and learning at strategic decision points, particularly at strategy reviews and the start or end of funding cycles (Mahajan et al., 2023). Because governance and management data alone are also not sufficient for most conservation monitoring and evaluation needs (Meehan et al., 2020), ensuring that data from Elinor and other biophysical, ecological, and social assessments are combined is critical to guiding decision-making on actions that could improve governance and management and biodiversity conservation (Mascia et al., 2017).

Third, Elinor can introduce governance and management concepts to more conservation practitioners, but holistic training and capacity development are needed to sustain Elinor's use over time. Future plans include developing accessible, online

training materials in multiple languages on the concepts of governance and management and how to facilitate, analyze, and use Elinor data. However, sustaining the platform and support resources will require continued financial commitments from governments, funders, and conservation organizations. There is a particular 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 (e.g., using Elinor to share knowledge internally or externally) might identify incentives for its use in monitoring and learning and promote broader interest in monitoring, evaluation, and learning by demonstrating its added value (Rogers, 2003). In the short term, Elinor will likely have greater uptake by NGOs, given the codesign process focused on NGO staff and researchers. We hope to engage more diverse conservation actors (e.g., government staff, park managers, community leaders) in Elinor development in the future to ensure it can evolve to meet the needs of the broader conservation community. If after further testing, Elinor proves to be useful, identifying where it should be a requirement for monitoring area-based conservation could facilitate broader uptake.

Developing standardized and long-term monitoring systems always requires navigating changes in the theory and practice of governance and management. If Elinor needs to evolve, new questions can be added to complement, but not replace, existing questions so as not to compromise long-term monitoring data. If, however, users deem certain questions or attributes unnecessary, they can be phased out, and data on these indicators can be archived using a standard system for naming, numbering, and documenting changes.

CODESIGNING SYSTEMS FOR EVIDENCE-INFORMED CONSERVATION

The development of Elinor highlighted challenges, opportunities, and practical lessons for codesigning assessments and data platforms in conservation. Elinor was conceived by NGO scientists (S.L.M. and G.A.) in response to challenges in harmonizing place-based monitoring systems with national and global policies and practices. The development process was designed to be collaborative, particularly between conservation NGO staff with portfolio-level roles and local staff who lead place-based conservation implementation. Although it took approximately 3 years to codesign Elinor, centering place-based practitioners' roles and needs ensured the tool was fit for purpose and created ownership of Elinor by future users. Involving academics in the tool's design process helped ensure Elinor 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. For example, the decision on how to store data (publicly or privately) was influenced by discussions with users. The codesign process also helped identify ways users wanted to collect data and use

outputs, which influenced the development team's decision to prioritize functionality for site-based outputs over global outputs in the short term. Codesigning the tool with portfolio and project managers ensured that funding was available to support the tool's development.

Challenges to the development of Elinor and similar collaborative tools and data platforms will remain (Cox et al., 2021). Time limitations prevented the Elinor development process from being coowned by all those involved. 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 made important decisions on behalf of the group based on feedback, especially to resolve differences among participants. Due to these limitations, and particularly travel constraints related to COVID-19, the collaborative design process did not involve representatives of groups affected by the area-based conservation projects 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 has implications for the political questions of what knowledge guides conservation efforts and may impose limits on the extent to which 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). Future changes to Elinor and similar monitoring tools would benefit from collaborative thought on how codesign processes can better engage with diverse knowledge and priorities of rights holders and other actors, and balance inclusion with real-world opportunities and constraints (Mahajan et al., 2022).

The data platform will also continue to face challenges. Close work with project and program managers helped secure some financing for Elinor, but currently, the platform depends on philanthropic funding, which may not be sustainable. A business plan that enables the platform to generate revenue is critical for sustaining collaborative data platforms, but is challenging to balance with the need to keep it free to users (Ahumada et al., 2020).

We expect there will continue to be tensions around sharing and interpreting data. For example, tensions may arise when stakeholders perceive governance and management status and trends differently. Powerful stakeholders (e.g., conservation funders, 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 over time. There may also be tensions around the use of Elinor assessment data in scientific publications and reports, although collaboration principles that outline how users can ethically share and use data have been developed to mitigate this risk (Appendix S1, elinordata.org/collaboration).





CONCLUSIONS

Equitable governance and effective management are critical for ensuring that area-based conservation provides enduring social and biodiversity benefits (CBD, 2022a). 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. Integrating Elinor data with other types of knowledge and evidence can help ensure Elinor supports a holistic approach to evidence-informed conservation. In particular, understanding how 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 to monitoring can play a vital role in answering these important questions across scales. Collaboratively testing and adapting Elinor based on real-world experience will 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 becomes a valuable platform for realizing improved, inclusive stewardship of life on Earth.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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