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Perspective

Commonalities and complementarities among approaches to conservation monitoring and evaluation

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ABSTRACT

Commonalities and complementarities among approaches to conservation monitoring and evaluation (M&E) are not well articulated, creating the potential for confusion, misuse, and missed opportunities to inform conservation policy and practice. We examine the relationships among five approaches to conservation M&E, characterizing each approach in eight domains: the focal question driving each approach, when in the project cycle each approach is employed, scale of data collection, the methods of data collection and analysis, the implementers of data collection and analysis, the users of M&E outputs, and the decisions informed by these outputs. *Ambient monitoring* measures status and change in ambient social and ecological conditions, independent of any conservation intervention. *Management assessment* measures management inputs, activities, and outputs, as the basis for investments to build management capacity for conservation projects. *Performance measurement* assesses project or program progress toward desired levels of specific activities, outputs, and outcomes. *Impact evaluation* is the systematic process of measuring the intended and unintended causal effects of conservation interventions, with emphasis upon long-term impacts on ecological and social conditions. *Systematic review* examines existing research findings to assess the state of the evidence regarding the impacts of conservation interventions, and to synthesize the insights emerging from this evidence base. Though these five approaches have some commonalities, they complement each other to provide unique insights for conservation planning, capacity-building, adaptive management, learning, and accountability. Ambient monitoring, management assessment, and performance measurement are now commonplace in conservation, but opportunities remain to inform conservation policy and practice more fully through catalytic investments in impact evaluations and systematic reviews.

Contents

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1. Introduction

Monitoring and evaluation (M&E) has a long history in conservation, with diverse approaches developed for diverse purposes (Stem et al., 2005). In recent years, scholars have advocated M&E as a means to facilitate the wise use of scarce conservation funds (Ferraro and Pattanayak, 2006; Sutherland et al., 2004), respond to the environmental implications of ineffective management (Hockings et al., 2006), promote accountability (Christensen, 2003; Jepson, 2005), and track progress towards broader conservation goals (Gratwicke et al., 2007). These aspirations for widespread and effective use of conservation M&E have become increasingly codified in policy (e.g., DANIDA, 2006; USAID 2011), technical guidance (e.g., Hockings et al., 2006; Kapos et al., 2008; Margoluis and Salafsky, 1998), and practice (Miteva et al., 2012), as scholars, practitioners, and donors have sought to target conservation investments, track progress, foster adaptive management, ensure accountability, and catalyze learning within the conservation sector.

Despite previous reviews (e.g., Birnbaum and Mickwitz, 2009; Kapos et al., 2008; Stem et al., 2005), the commonalities and complementarities among current approaches to conservation M&E are not well articulated. This absence of clarity creates the potential for confusion, misuse, and missed opportunities to inform conservation policy and practice through M&E (Stem et al., 2005). Misuse of M&E tools and approaches poses a number of risks (Oral History Project Team, 2007), including misallocation of M&E resources, unreasonable expectations of M&E activities, inaccurate assessments of conservation interventions, and misguided allocation of conservation resources (Ferraro and Pattanayak, 2006; Stem et al., 2005). If conservation M&E fails to realize its potential because of misuse and missed opportunities, the perceived value of M&E may decline and its use may be limited further. Effective use of M&E, by contrast, may catalyze a virtuous cycle of wider adoption across the conservation community, as predicted by social theories of innovation diffusion (Rogers, 1995).

To foster more effective application of M&E approaches within the conservation sector, we examine commonalities and complementarities among five approaches to conservation M&E: ambient monitoring, management assessment, performance measurement, impact evaluation, and systematic review. We define each approach and characterize each in eight domains: the focal question driving the approach, when in the project cycle the approach is employed, the scale of data collection, the methods of data collection and analysis, the implementers of data collection and analysis, the users of M&E outputs, and the decisions informed by these outputs. We then explore the relationship of these five approaches to established frameworks for conservation planning and analysis, and highlight the implications for conservation science and policy. By providing conservation scholars and practitioners with a framework for understanding the relationships among approaches to conservation M&E, we hope to empower better informed "consumers" and "producers" of M&E.

2. Concepts and terminology

The abundance of jargon, much of it ill-defined, contributes to confusion regarding conservation M&E. In this analysis, we adhere to the concepts and terminology within the established literature on program evaluation (Table 1), as studied and practiced by members of the American Evaluation Association (www.eval.org). *Monitoring* is an ongoing function that systematically collects data on specified indicators, whereas *evaluation* is the systematic and objective assessment of an ongoing or completed project, program, or policy, often in order to determine the merit or worth of the intervention (DAC, 2002). (*Merit* is the impact attributable to the intervention; *worth* is the value of these changes to decisionmakers and key stakeholders.) The distinctions among *inputs*, *activities*, *outputs*, *outcomes*, and *impacts* allow clear differentiation among approaches to conservation M&E (below). Similarly, *projects*, *programs*, and *policies* represent distinct scales of human action at which conservation M&E may occur. Some approaches to conservation M&E strive to document and measure progress against an intervention's *theory of change*, which articulates and graphically illustrates the assumed logical and causal relationship between an intervention and its anticipated outcomes (Weiss, 1995). Of the five approaches to conservation M&E that we examine, impact evaluation and systematic review attempt to explicitly test or examine the validity of these theories of change. Ambient monitoring, management assessment, and performance measurement, by contrast, do not explicitly test – and often assume – the validity of the underlying program logic (i.e., implementation of an intervention will lead to desired outcomes).

3. Approaches to conservation M&E

3.1. Ambient monitoring

Focal question: What is the state of ambient social and/or environmental conditions, and how are these conditions changing over time and space?

Ambient monitoring is the process of systematically observing the state of social and/or environmental conditions over time, independent of any conservation intervention. Sometimes referred to as "status assessment" (Stem et al., 2005) or "surveillance monitoring" (Nichols and Williams, 2006), *ambient monitoring is not intended to measure the attributes or consequences of conservation interventions*, but, rather, to characterize the broader social and ecological context within which conservation occurs. Depending upon the spatial and temporal scale of ambient monitoring, *however, data derived from ambient monitoring efforts can be repurposed to inform M&E efforts that directly examine conservation interventions*. Ambient monitoring may measure variables such as human demography (e.g., Hobbs and Stoops, 2002), human health (e.g., ZIMSTAT and ICF, 2012), patterns of natural resource use and other human behaviors (e.g.,

Table 1
Definitions of key concepts in conservation monitoring and evaluation.

Monitoring[a]	An ongoing function that systematically collects data on specified indicators
Evaluation[a]	The systematic and objective assessment of an ongoing or completed project, program, or policy, often in order to determine the merit or worth of the intervention
Input[a]	The financial, human, and material resources used for an intervention
Activity[a]	Actions taken or work performed through which inputs are mobilized to produce specific outputs
Output[a]	The products, goods, and services that result from an intervention
Outcome[a]	The desired ends that intervention outputs are intended to induce (i.e., changes in knowledge and attitudes, behaviors, and/or social and environmental conditions)
Impact[a]	The intended and unintended consequences (i.e., changes in knowledge and attitudes, behaviors, and/or social and environmental conditions) that are directly or indirectly caused by an intervention
Project[b]	A discrete set of planned activities collectively trying to achieve a specific outcome or set of outcomes, often as a component of a program and as a manifestation of a policy
Program[b]	A suite of projects collectively organized to achieve a specific outcome or set of outcomes, often serving as a tactical means of achieving policy ends
Policy[c]	A broad or strategic statement of intent to accomplish specific aims, often implemented through one or more programs
Intervention[a]	Specific action (project, program, or policy) designed to effect a specific desired change; may be manifestation of broader strategy
Theory of change[d]	An articulation and frequently graphical illustration of the assumed logical, causal relationships between intervention (project, program, policy) inputs, activities, outputs, and outcomes

[a] Definitions adapted from DAC (2002).
[b] Definition adapted from Bartlett (1994).
[c] Definition adapted from Brewer and DeLeon (1983).
[d] Definition adapted from Weiss (1995). Sometimes referred to as a *logic model*, *logframe*, *logical framework approach*, or *results chain*.

Ticheler et al., 1998), wildlife population size (e.g., Mysterud et al., 2007), and the condition of important habitats (e.g., Hansen et al., 2008). Government censuses of human populations, which date to perhaps the 16th century B.C. (Missiakoulis, 2010), were likely the first formal attempts at ambient monitoring; farmers, fishers, and forest users have informally monitored resource conditions for even longer, their observations influencing survival strategies and resource use (Danielsen et al., 2000). Formal ecological monitoring initially focused on monitoring populations of various species over time. For instance, on the basis of fish catch records, Bertram documented the (declining) population of inshore Scottish herring *Clupea harengus* in the 19th century (Bertram, 1865). Methods for ambient monitoring have since diversified and become more sophisticated (Gardner, 2010).

Ambient monitoring provides valuable information for conservation planning and priority-setting, complementing knowledge of history, culture, political dynamics, and other contextual factors. Information regarding spatial patterns and temporal trends in the status of social and ecological conditions helps conservation decisionmakers to identify locations for future conservation interventions, to set priorities among these locations, and to set management targets for these sites (Gardner et al., 2008; Stephanson and Mascia, in press; Yoccoz et al., 2001). Ambient monitoring data also helps decisionmakers to identify socially and ecologically appropriate interventions in a given location (Funder et al., 2013; Stephanson and Mascia, in press). Ambient monitoring may also provide the data required to explore socio-ecological relationships and, as the social and ecological context for conservation shifts, foster adaptive management (Stephanson and Mascia, in press). Thus, in a landscape context, ambient monitoring data from a national census and an ecoregional forest monitoring program could help conservation decisionmakers to (a) identify priority sites for conservation interventions; (b) choose among potential strategies (e.g., national parks v. community forests) in these locations; (c) understand the dynamic relationship between human populations and forest cover; and (d) revisit conservation strategies as human populations and forest cover change with time.

Ambient monitoring provides information relevant to decision making across scales, informing senior decisionmakers and local resource users alike. However, ambient monitoring can be difficult or expensive to undertake (Gardner et al., 2008; Nichols and Williams, 2006; Stem et al., 2005). Locally-based ambient monitoring schemes, when properly designed and carefully tailored to local issues, provide a low-cost alternative that simultaneously builds capacity among local constituents (Danielsen et al., 2005). Such locally-based monitoring schemes may prompt practical and effective management interventions by increasing the speed of decision-making and by providing information to address environmental problems at operational scales of management (Danielsen et al., 2010). More generally, novel methods of participatory monitoring (e.g., crowd-sourcing data) present opportunities for citizen science to expand monitoring of social and ecological conditions (Dickinson et al., 2010).

3.2. Management assessment

Focal question: What are the management inputs, activities, and outputs associated with a conservation intervention, and how are these changing over time?

Management assessment is the process of measuring the management inputs, activities, and outputs associated with a conservation intervention, in order to identify management strengths, weaknesses, and needs (e.g., NOAA, 2011). Management assessments are not linked to specific performance goals or an explicit program logic, but are instead predicated on the assumption that conservation interventions with sufficient management capacity and appropriate activities are more likely to deliver positive conservation outcomes than interventions with low capacity and misaligned activities (Ervin, 2003; Leverington et al., 2010a). Thus, management assessments allow one to know if an intervention is "well-managed" (i.e., has a robust management presence on the ground) or exists solely on paper (e.g., "paper park"). Management assessments originated in the late 1990s, when it became clear that (a) declaration of protected areas did not necessarily result in adequate management inputs, and (b) biodiversity was declining, despite the increasing number and spatial extent of protected areas (Ervin, 2003; Hockings and Phillips, 1999). Today, management assessments are still primarily employed by governments and international organizations to assess protected areas and protected area systems (NOAA, 2011; Stolton et al., 2007), though this approach is applicable to other conservation interventions. (Management assessment is distinct from "management effectiveness evaluation" and its associated tools, though data generated by the latter are often used to assess the adequacy of management inputs, activities, and outputs [see Discussion]).

Management assessments vary in complexity, but the most commonly used methods are relatively fast, simple, and inexpensive to implement (e.g., NOAA, 2010, 2011). Management assessments often employ a standardized, self-administered questionnaire to measure intervention inputs (e.g., funding, personnel), activities (e.g., enforcement, boundary demarcation), and outputs (e.g., management plans, regulations) (Ervin, 2003; NOAA, 2011; Stolton et al., 2007). Project managers usually complete the self-administered questionnaires and then compile the results using a

standardized scorecard; information requirements for such management assessments are typically modest, and largely rely on (a) accessible information that is available on site and (b) the knowledge of those undertaking day-to-day management (Cook and Hockings, 2011). Because management assessments are generally self-administered by project managers, scholars have questioned the validity and comparability of the resultant data (Cook and Hockings, 2011; Stoll-Kleemann, 2010). At the same time, self-assessment are perhaps more likely to foster clarification of management objectives, use of qualitative data that might otherwise be overlooked, and the integration of results into management decisions (Cook and Hockings, 2011).

To promote public reporting and transparency, many donors include management assessment as a mandatory component of protected area M&E (e.g., Global Environment Facility, World Bank, Critical Ecosystem Partnership Fund). Management assessments have been used in more than 6200 protected areas around the world (Leverington et al., 2010a), and are increasingly being used to assess national and international management and conservation strategies (e.g., Butchart et al., 2010; Pavese et al., 2007; Quan et al., 2011). Despite these M&E investments, it remains unclear whether "well-managed" interventions lead to more successful conservation, since (a) management assessments do not directly measure biodiversity or human well-being, and (b) researchers have not yet widely tested the assumption that protected area inputs, activities, and outputs foster positive conservation impacts (but see Nolte and Agrawal, 2013; Nolte et al., 2013).

3.3. Performance measurement

Focal question: To what extent is a conservation intervention making progress toward its specified objectives for activities, outputs, and outcomes?

Performance measurement is the process of measuring progress toward specified project, program, or policy objectives, including desired levels of activities, outputs, and outcomes (DAC, 2002). Sometimes referred to as "performance monitoring" (Rich, 1998) or "performance evaluation" (USAID, 2011), performance measurement rose to prominence in the 1980s and early 1990s, as governments and private sector actors responded to a perceived need for greater accountability regarding the performance of public and private sector program investments in education, public health, social services, and other fields (Rich, 1998; Wholey, 1997). The conservation sector was a relative latecomer to performance measurement, with concerted efforts widely implemented only since the 1990s (Stem et al., 2005). Government agencies, nongovernmental organizations (NGOs), and academia subsequently developed numerous performance measurement methodologies (e.g., Kapos et al., 2008; Margoluis and Salafsky, 1998; UNDP/GEF, 2005). Though the term "performance measurement" has sometimes been used interchangeably with "performance-based," "results-based," or "outcomes-based" management, we follow Wholey (1996) in recognizing performance *measurement* as a mechanism to provide information necessary for *management* (i.e., decisionmaking).

Performance measurement tracks the progress of a single project or program over time against intended levels of accomplishment, in order to provide managers, organizational leadership, donors, and the public with information about project or program performance. Indicators are defined to track progress along a theory of change, toward both interim objectives (e.g., activities completed, policies changed, threats diminished) and ultimate objectives or goals (e.g., improved status of a species or ecosystem, enhanced human well-being). Tensions exist among rigor, simplicity, and cost-effectiveness when identifying data collection methods and analyses for performance measurement (Margoluis et al., 2009), particularly for outcome indicators that may be difficult to measure reliably or precisely via expert judgment or existing secondary sources (Cook et al., 2010). Because performance measurement usually relies heavily upon existing information and expert judgment, it is often relatively inexpensive and does not require specialized expertise or complex research design. More intensive performance measurement efforts (e.g., primary data collection, attention to confounding variables) require greater expertise and financial investments, but may provide greater certainty and precision.

Performance measurement is widely applied among governmental and nongovernmental conservation organizations to monitor project progress, inform adaptive management, and foster reporting and accountability. Performance measurement thus provides useful information to managers, especially where financial and human capacities are limited. The findings derived from performance measurement are overstated, however, by those who would attribute observed changes in outcome indicators to intervention activities and outputs (Ferraro and Pattanayak, 2006). In fact, because performance measurement approaches do not compare the outcomes of an intervention to a valid counterfactual that isolates the effects of an intervention from the effects of other causal factors (e.g., by monitoring nonintervention comparison groups), performance measurement cannot definitively attribute observed changes in outcome variables to intervention activities and outputs (Rossi et al., 2004). Nonetheless, if indicators along a programmatic theory of change are strategically chosen and clearly defined from the outset, performance measurement provides valuable information regarding the progress of a project or program toward its stated goals and objectives.

3.4. Impact evaluation

Focal question: What intended and unintended impacts are causally induced by a conservation intervention?

Impact evaluation is the systematic process of assessing the causal effects of a project, program, or policy (Gertler et al., 2011). By comparing what actually happened *with* an intervention to what would have happened *without* it (i.e., the counterfactual), impact evaluations measure the intended and unintended consequences attributable to a (conservation) intervention (Gertler et al., 2011). In addition to providing evidence regarding positive and negative impacts, well-designed impact evaluations may provide insights into the variation in impacts within and among groups, the attributes of an intervention that foster positive (or negative) impacts, and the contexts in which an intervention is most likely to succeed (or fail) (Miteva et al., 2012). Impact evaluations often employ experimental research designs (i.e., random assignment to treatment and non-treatment groups) or quasi-experimental research designs (i.e., statistical identification of appropriate comparison groups); differences in observed changes between the treatment group and non-treatment comparison group represent the impact of the intervention (Rossi et al., 2004). Other research designs are also employed in impact evaluation (e.g., statistical analyses of observational data, in-depth case studies), "though the credibility of their estimates of program effects relies on how well the studies' designs rule out competing causal explanations" (GAO, 2009, p. 1). Impact evaluation has a strong grounding in the field of economics, with widespread use in the health, education, and development sectors (Patton, 2008). Interest in impact evaluation *per se* emerged within the conservation sector in the mid-2000s (e.g., Ferraro and Pattanayak, 2006), spurring an increasing number of impact evaluations from government agencies, NGOs, and universities (Miteva et al., 2012). Recent impact evaluations have examined the impacts of protected areas on forest fires (Nelson and Chomitz, 2011), recovery planning on

Table 2
Commonalities and complementarities among five approaches to conservation monitoring and evaluation. Table reflects most common characteristics of each approach, but exceptions do occur and, in practice, scholars and practitioners sometimes mix or integrate approaches.

	Ambient monitoring	Management assessment	Performance measurement	Impact evaluation	Systematic review
Focal question	What is the state of ambient social and/or environmental conditions, and how are these conditions changing over time and space?	What are the management inputs, activities, and outputs associated with a conservation intervention, and how are these changing over time?	To what extent is a conservation intervention making progress toward its intended objectives for activities, outputs, and outcomes?	What intended and unintended impacts are causally induced by a conservation intervention?	What is the state of the evidence for the impact of an intervention, and what does this evidence say about intervention impacts?
Timing	Varies; often pre-intervention	During implementation	During and after implementation	Post-implementation, with pre-implementation baseline	Post-implementation
Scale	Any; often state/province (social), landscape, ecoregion (ecological), or country (both)	One or more interventions, usually protected areas	Single project or program	Multiple projects or one or more programs, with corresponding nonintervention comparison group	Multiple projects, programs, or policies
Implementer	Professional researchers, citizen volunteers	Project and program managers, government agencies	Project managers	Professional researchers and evaluators	Professional researcher
Decisions supported	Spatial and temporal priority-setting, selection of strategies and objectives	Setting priorities among potential capacity-building investments at one or more projects	Program reporting & accountability assessments; Adapt activities & strategies to enhance performance	Adaptive management of existing and future interventions, scaling up or down future investments in said intervention	Selecting an intervention; scaling up or scaling down investments in said intervention
Practitioner audience	Decision makers at local to global levels	Project and program managers, donors, senior decisionmakers	Project & program managers, donors, senior decisionmakers	Project and program managers, senior decisionmakers, donors	Project and program managers, senior decision makers, donors
Data collection methods	Primary data collection; remote sensing, transects (ecological); household surveys, focus groups (social)	Expert judgment, secondary sources	Expert judgment, secondary sources, occasional primary data	Primary data collection or manipulation of secondary source data; remote sensing, transects (ecological); household surveys, focus groups, interviews (social)	Data extraction from secondary sources
Data analysis	Moderate to complex; may require data processing and statistical analyses	Simple; requires scoring self-administered questionnaires	Simple to moderate; may require statistical manipulation of secondary source data	Complex; requires data management and sophisticated statistical analyses	Moderate to complex; requires sophisticated data extraction and statistical analyses

the status of endangered species (Bottrill et al., 2011), and communal conservancies on human well-being (Glew, 2012).

Impact evaluations inform decisions associated with curtailing, reforming, and expanding (conservation) initiatives (Gertler et al., 2011). Accordingly, the use of impact evaluations is most appropriate with fully implemented programs or interventions, where the goals and activities of the initiative have been defined, and where potential users of the evaluation are identified and prospects for use are strong (GAO, 2009). For emerging or contested interventions, where the theory of change that links interventions to impacts remains unproven, impact evaluation may have particularly high policy relevance and prospects for use by decisionmakers (Gertler et al., 2011; Patton, 2003, pp. 219–220). Experimental and quasi-experimental impact evaluations are most easily employed (a) when it is possible to maintain separation between the treated and untreated populations; (b) where the causal factors that link interventions to impacts are understood and can be measured; and (c) where a good counterfactual can be identified and necessary data obtained (Ferraro, 2009; GAO, 2009). Since real-world conservation settings often possess unique or rare characteristics, which vary by setting and intervention, opportunities for effective use of experimental and quasi-experimental approaches may be limited (Ferraro, 2009; Margoluis et al., 2009). In addition, impact evaluation – especially experimental and quasi-experimental methods – requires substantial expertise, can be costly to implement, and is not always possible for ethical, logistical, or legal reasons (Ferraro and Pattanayak, 2006; GAO, 2009). Given these constraints, impact evaluation is best employed selectively, in appropriate situations where the additional rigor of impact evaluation is required to inform major policy or program decisions (GAO, 2009; Gertler et al., 2011).

3.5. Systematic review

Focal question: What is the state of the evidence for the impacts of a conservation intervention and what does this evidence say about intervention impacts?

Systematic review is a structured process that collates, appraises, and synthesizes all available empirical evidence of relevance to a specific research question (Pullin and Knight, 2009), facilitating the conversion of scientific knowledge into (conservation) practice (Pullin and Knight, 2001, 2009; Stevens and Milne, 1997). At its simplest, evidence synthesis can take the form of a literature review of two or more studies, but the gold standard methodology is systematic review, which attempts to maximize transparency and objectivity (minimizing bias) in capturing and critically appraising all relevant studies. Systematic review for evidence synthesis began in the 1980s, when clinical medicine sought to interpret and translate the findings from many individual studies to inform decisions on which interventions might be most effective for any given medical problem (Pullin and Knight, 2001). First proposed for conservation by Pullin and Knight (2001), the approach is now relatively widespread in the health sector and is also used in the fields of education, social services

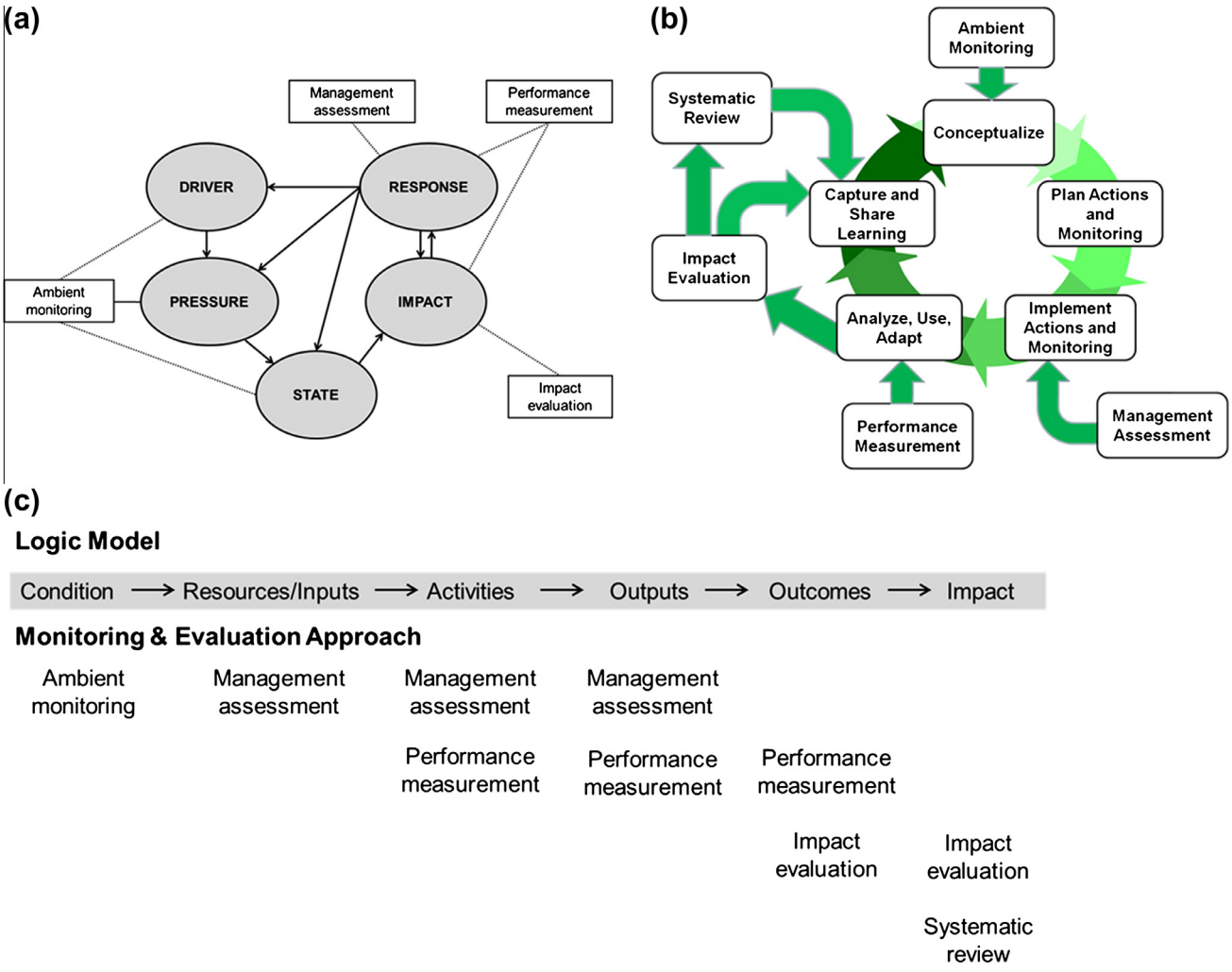

Fig. 1. Relationship between ambient monitoring, management assessment, performance measurement, impact evaluation, and systematic review and three common frameworks for conservation planning and analysis. The Drivers–Pressures–State–Impact–Response (DPSIR) framework (a) elucidates the relationships among *Drivers*, human activities that exert *Pressure* on the environment and, as a consequence, may change the *State* of the environment and society; these *Impacts* may elicit societal *Responses* that address these factors (Smeets and Weterings, 1999). The conservation project cycle (b) begins with an initial *conceptualization* phase, followed by *planning*, *implementation*, *analysis and adaptation*, and *learning* (CMP, 2007). The program logic model (c) articulates the hypothesized causal links between project or program inputs, activities, outputs, outcomes, and impacts (Kellogg Foundation, 2004).

and environmental management, and international development (Petticrew, 2001). Recent systematic reviews in conservation have examined the evidence for engineered structures on salmonid abundance (Stewart et al., 2009a), community forest management on biodiversity and poverty (Bowler et al., 2012), and the conservation impacts of temperate marine protected areas (Stewart et al., 2009b).

Systematic review contributes to a shared evidence base for decisionmakers, addressing questions concerning whether an intervention works or not, and its degree of impact (Pullin and Knight, 2001, 2009). Systematic reviews characterize the state of the evidence by gathering together and describing diverse sets of data generated by studies with contrasting designs, which is particularly useful for achieving consensus when studies have conflicting findings. Systematic review is, thus, most useful when (a) an intervention has been widely and independently applied to achieve a specific goal and (b) multiple well-designed studies of the intervention's effectiveness or impact exist. Systematic review is less suitable where studies and data are few, since data limitations increase the risk of arriving at null or faulty conclusions. In the absence of a robust scientific literature, systematic reviews can highlight knowledge gaps and inform research priorities (e.g., Bowler et al., 2012).

Systematic reviews are normally conducted by an independent review team that combines subject matter experts with review and synthesis experts (CEE, 2010). Systematic reviews require significant resources, time, and technical expertise (CEE, 2010). Though systematic reviews are standard in other sectors, they have not been widely used in conservation, despite their potential (but see www.environmentalevidence.org). Moreover, processes are needed to integrate evidence from systematic reviews into useful policy guidance (Segan et al., 2011). Government agencies and NGOs are beginning to commission systematic reviews to help meet their evidence needs and inform decision making (e.g., Bowler et al., 2012). With an increase in the number of studies that measure the impacts of conservation interventions, opportunities for systematic review and its application to conservation policy will grow commensurately.

4. Discussion

4.1. Conservation M&E in theory

Though ambient monitoring, management assessment, performance measurement, impact evaluation, and systematic review

share some methodological commonalities, these five approaches to conservation M&E address distinct questions and inform distinct policy decisions (Table 2). These five approaches are employed at different points in the project/program cycle (CMP, 2007); examine different aspects of the drivers, pressures, states, impacts, and responses that constitute the relationship between people and the environment (Smeets and Weterings, 1999); and assess distinct components of an intervention (Kellogg Foundation, 2004; Fig. 1). These complementarities can lead to productive synergies, such as when ambient monitoring data are resampled and repurposed to document impacts through impact evaluation, or when impact evaluation and perhaps performance measurement provide the evidence necessary for systematic reviews.

The five approaches we examined do not represent the full range of approaches to conservation M&E. Impact assessment – the *ex ante* estimation of likely ecological and social impacts of proposed future public or private sector activities – is widely employed in conservation and environmental management (Stem et al., 2005). Similarly, both spatial and strategic conservation planning (CMP, 2007; Margules and Pressey, 2000; Pressey and Bottrill, 2009) sometimes act as forms of formative evaluation (i.e., evaluative activities intended to guide program improvement (Rossi et al., 2004; Scriven, 1991)). Needs assessment is an additional, distinct approaches to M&E (Rossi et al., 2004), though it is less commonly applied in conservation.

Similarly, "management effectiveness evaluation" is a concept widely discussed and applied by conservation practitioners (Hockings et al., 2006; Leverington et al., 2010b). As defined by Hockings et al. (2006, pp. 12–13), "management effectiveness evaluation" examines the context, planning, inputs, processes (i.e., activities), outputs, and outcomes of a protected area, a framework for evaluating protected areas that largely mirrors conventional definitions of program evaluation writ large. Examining the site-specific context for an intervention, for example, is characteristic of needs assessment; intervention inputs, activities, and outputs are the typical focus of management assessment, performance measurement, and formative evaluation; and outcomes are principally the domain of impact evaluation. The primary focus of "management effectiveness evaluation" is rarely effectiveness in the conventional sense of the term (i.e., outcomes or impacts; Table 3) (Cook and Hockings, 2011; Leverington et al., 2010b, p. 3).

Additional concepts from the field of program evaluation provide further clarity to our understanding of conservation M&E. The academic literature on program evaluation distinguishes between *formative* and *summative* evaluation, emphasizing not only what is measured but also the relationships among actors and the means by which findings are interpreted and used. *Formative evaluation* is the systematic examination of the ongoing success of an intervention and its processes, which can provide information, insights, and advice about how these can be improved (Rossi et al., 2004; Scriven, 1991). Formative evaluation is generally conducted throughout an intervention, in order to assure continual improvement in efficacy, relevance, logic, and efficiency, and to facilitate ongoing adjustments as the intervention matures (Scriven, 1991). Data collection methods include literature reviews, focus groups, structured surveys, interviews, and direct observation of inputs, activities, outputs, and outcomes. Management assessment and performance measurement address aspects of formative evaluation, particularly those aspects that involve monitoring inputs, activities, and outputs and modifying activities accordingly to improve program performance. In some situations, impact evaluation may serve as a form of formative evaluation (Scriven, 1991). Effective formative evaluation involves decision-makers and stakeholders to ensure that the evaluation is salient and legitimate, and that the findings and recommendations feed into the program cycle (Patton, 2003; Scriven, 1991). Though management assessment and performance measurement provide useful insights for program improvement, they do not answer important questions such as "What is the relevance of this intervention to stakeholders?" or "How do we promote uptake and incorporation of recommendations?" Formative evaluation provides tools to engage stakeholders, complete the program feedback loop, and assure continued relevance of the intervention.

Table 3
Measurement foci of two assessment tools commonly associated with "management effectiveness evaluation:" Management effectiveness tracking tool (METT) and rapid assessment and prioritization of protected areas management (RAPPAM).

Assessment tool	Object of inquiry	# Questions	% Total
METT[a]	Context	1	3.3
	Planning	7	23.3
	Inputs	8	26.7
	Process	11	36.7
	Outputs	1	3.3
	Outcomes	2	6.7
	Total	30	100.0
RAPPAM[b]	Background information	8	5.3
	Pressures & threats	24	15.8
	Context	20	13.2
	Vulnerability	10	6.6
	Planning	15	9.9
	Inputs	20	13.2
	Processes	15	9.9
	Outputs	10	6.6
	Protected area system level	10	6.6
	Protected area policies	10	6.6
	Policy environment	10	6.6
	Total	152	100.0

[a] Based on categorization in Stolton et al. (2007). In addition, the METT includes approximately 30 background questions and 50 contextual questions about pressures and threats that are not considered part of the formal METT assessment process.
[b] Based on categorization in Ervin (2003).

Summative evaluation judges the merit and worth of an intervention (Scriven, 1996). Summative evaluation typically occurs in the final stages of an intervention, to decide whether to continue, discontinue, or expand the intervention (Scriven, 1991). Summative evaluation uses many methods, including empirical experiments, cost-benefit analysis, case studies, interrupted time series, program theory methods, and meta-analysis. Whereas impact evaluation and systematic review similarly document impacts attributable to an intervention, these two approaches to conservation M&E do not generally examine questions related to the value of these impacts to stakeholders and decisionmakers.

4.2. Conservation M&E in practice

The practice of conservation M&E starts by defining the "research" question that will guide data collection, analysis, and use (Fig. 2). The subject of evaluation, the type of knowledge desired, and the intended use for results all inform the development of evaluative questions (Rossi et al., 2004). Once the question has been defined, it is possible to identify the appropriate M&E approach and, subsequently, the appropriate scope, methods, and tools. These choices will also be influenced by the evaluators' information needs, as well as resource and timing limitations. Matching the appropriate M&E approach to the evaluation question, and context, fosters clear expectations about what will be measured, how it will be measured, and the insights for conservation policy and practice that are likely to emerge as a result.

Ambient monitoring, management assessment, performance measurement, impact evaluation, and systematic review each address complementary questions and inform complementary policy

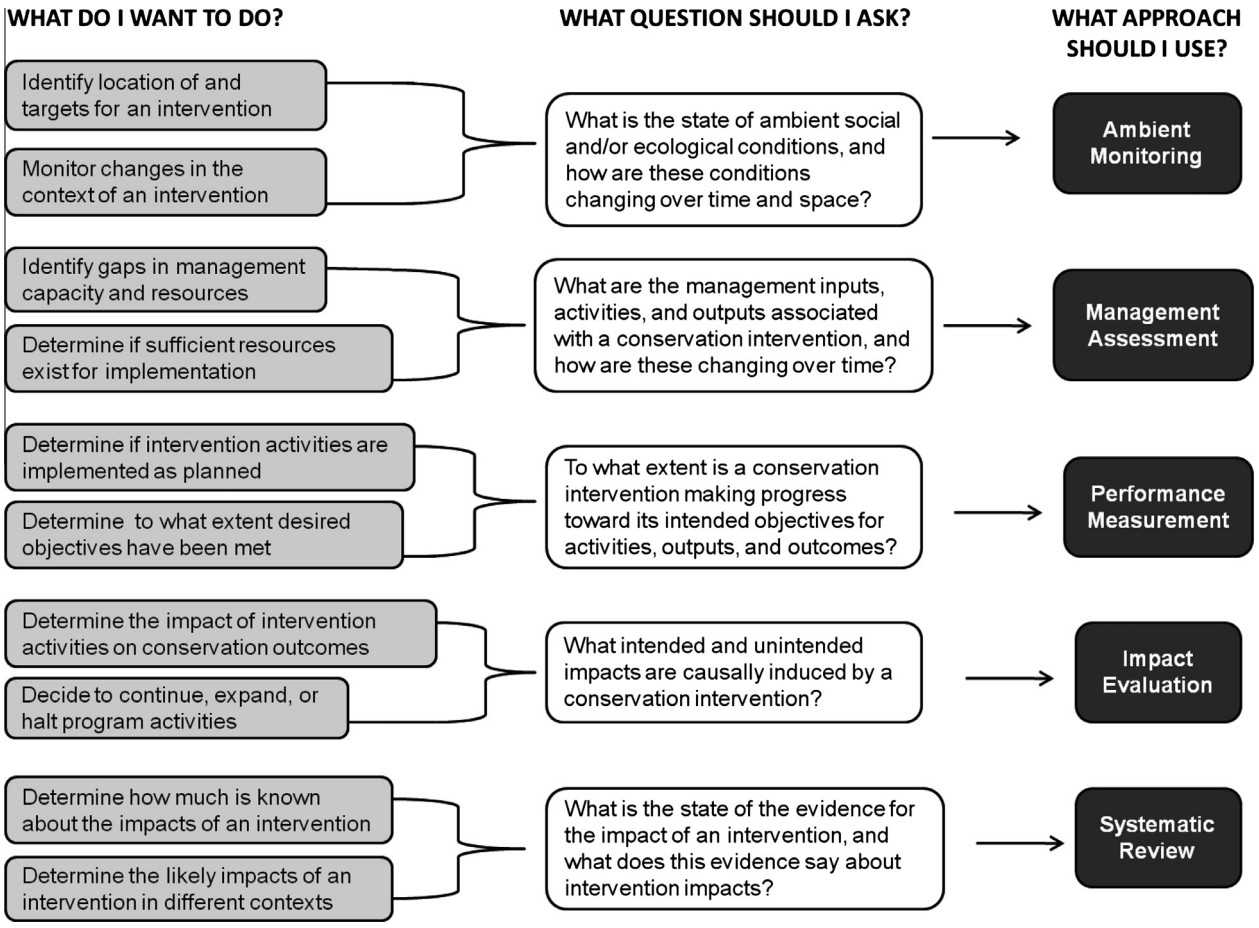

Fig. 2. Decision tree highlighting common information needs in conservation, and the question and approach to monitoring and evaluation that can best respond to those information needs.

decisions, but use of these five approaches to conservation M&E has varied. Ambient monitoring and performance measurement are ubiquitous, and management assessment is commonly applied to protected areas around the world. Impact evaluations and systematic reviews are growing in number, but remain uncommon (Miteva et al., 2012; Segan et al., 2011). Why are some approaches used more widely than others?

Though an approach to M&E is ideally selected in accordance with the focal question, M&E is also influenced by information needs, financial resources, timing, and human capacity. In many conservation settings, resources, time, and expertise are often constrained (Bruner et al., 2004; Gardner et al., 2008; Nichols and Williams, 2006). Management assessment and performance measurement, by design, are useful M&E approaches in resource-constrained contexts, providing valuable information quickly at a low cost, albeit with less rigor and certainty. Ambient monitoring, impact evaluation, and systematic review, on the other hand, require substantial time, expertise, and financial investments, which are not always readily available. Yet the longstanding tradition and diverse contributions of ambient monitoring (often beyond the conservation sector) frequently ensure continued investments despite its cost, time, and expertise requirements.

Incentives also influence the selection of an approach to conservation M&E. Donors and conservation decisionmakers often prioritize and provide financial resources for information gathered within the scope of a project (InterAction, 2010), neglecting alternatives. As a result, M&E is often conducted only within the timeframe of an intervention (i.e., rarely post-project); with existing (and often few) resources; and with data only from within the project area (ignoring conditions at comparison sites outside of the intervention) (Ferraro and Pattanayak, 2006). Program or project implementers may also perceive conservation M&E as an unwanted diversion of scarce resources, a threat to their activities, or simply as an exercise unlikely to add inform or advance conservation policy and practice (Ferraro and Pattanayak, 2006). These factors currently limit opportunities for impact evaluations and subsequent systematic reviews.

5. Conclusions

As the conservation community enters its third decade since the Rio Convention of 1992, ambient monitoring, management assessment, performance measurement, impact evaluation, systematic review, and other approaches to conservation M&E each have complementary roles to play in advancing more informed conservation policies and practices. In the years ahead, greater human capacity, financial investments, and organizational incentives for conservation M&E will be required, especially to generate the impact evaluations and systematic reviews that will enable us to better understand what works, what does not, and why. Knowledge alone, however, will not ensure that the conservation community replicates successes, reforms failures, and avoids repeating the mistakes of the past. Effectively addressing the enduring challenge of biodiversity conservation will require a transformation of conservation policy and practice, through integrated investments in

conservation M&E that advance knowledge, inform policy, build evaluation capacity in the developed and developing world, and catalyze a culture of evidence-based decisionmaking.

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