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Contribution to the Themed Section: '*Case studies in operationalizing ecosystem-based management*'

Food for Thought

Moving from ecosystem-based policy objectives to operational implementation of ecosystem-based management measures

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The aim of ecosystem-based management (EBM) is to maintain an ecosystem in a healthy, productive and resilient condition through the implementation of policies and management measures. Although cross-sectoral planning may be led by a planning competent authority, it is up to the sector competent authority to implement the necessary management measures within their operations to achieve EBM goals and objectives. We suggest that scientific impediments to EBM are no longer significant to implement EBM operationally. Instead, we consider that approaching EBM within current policy cycle approaches would provide the necessary policymaking process step to operationalize EBM. In addition to enabling and facilitating collaboration, exchange, understanding as promoted by EBM, policymaking processes also require that policy is to be implemented through programs, measures, procedures and controls that have expected outcomes to "*carry into effect*" the policy objective. We are of the view that moving EBM from planning and objective setting to operational implementation is a management problem solving issues instead of a scientific one.

Keywords: governance, implementation mechanisms, management measures, operational EBM, performance management, policy cycle.

Introduction

McLeod *et al.* (2005) defines ecosystem-based management (EBM) as an integrated approach to management that aims to maintain an ecosystem in a healthy, productive and resilient condition while providing the services that humans want and need. Although the aim of EBM is to sustain ecosystem composition, structure, and function, Christensen *et al.* (1996) stipulates that management is the implementation of policies, protocols, and practices, and made adaptable by monitoring and research to achieve explicit goals. Langeweg (1998) further argues that it is the integration of macro-economic and sector specific policies combined with management actions that control the sources and effects of environmental change that is needed to achieve ecosystem sustainability. Thus, it is ultimately reliant upon the implementation of management measures, procedures and practices for specific human activities that aim to achieve the goals of EBM (Christensen *et al.*, 1996; Langeweg, 1998).

There has now been over two decades of literature amassed on EBM and the underlying scientific research needed to support EBM. The scientific consensus for EBM has been clear for over a decade (McLeod *et al.*, 2005). There are numerous mandates in many parts of the global oceans calling for EBM to be implemented and made operational to improve the management of our coastal and marine ecosystems and resources (Ricketts and Harrison, 2007; EU MSFD, 2008; McFadden and Barnes, 2009; IOPTF, 2010). There are a couple published papers dispelling myths regarding the supposed impediments to implementing EBM (Murawski, 2007; Patrick and Link, 2015). Yet, there are few to no examples of EBM planning initiatives informed by ongoing advances in science that have been operationally implemented across multiple sectors (Browman and Stergiou, 2005; Espinosa-Romero *et al.*, 2011; Katsanevakis *et al.*, 2011; Halpern *et al.*, 2012; Carlman *et al.*, 2014).

We argue that the operational implementation of EBM is the later step of a policy cycle that is widely in practice in government and bureaucracies today. It has long been established that ecosystem research, stakeholder participation and spatial planning processes are practical outworkings of EBM (Mitchell, 2002; Crowder *et al.*, 2006; Koontz and Newig, 2014; Soma *et al.*, 2015). The outputs of a policy cycle include goals and objectives setting that are typically reflected in legislation from which regulatory policies are derived to impose restrictions or limitation upon human activities (Anderson, 2011). The mechanisms for implementing these goals and objectives can span the range from outright regulations to standards or guidelines (Cormier *et al.*, 2016). Marine planning and coastal zone management is technically a public policy-making processes (Ehler and Douvere, 2009; Sardá *et al.* 2014; Cormier *et al.*, 2015) where the key outputs include the setting of goals and ecosystem objectives for the protection, conservation, and use of the marine ecosystem (McLeod *et al.*, 2005; Douvere, 2008). In performance management, it is, however, operational outcomes that frame the accountability for the implementation of measures, procedures and controls to achieve the stated goals and objectives of the policy process (Baehler, 2003). Nested within the context of ecosystem objectives, operational outcomes could also frame the design of sector specific management measures needed to manage human activities to achieve EBM goals and objectives (Antunes and Santos, 1999; Runhaar, 2016).

We are proposing that EBM could overcome a primary impediment to operational implementation by adopting a policy cycle with particular attention to setting operational outcomes as requirements for sector specific management measures. Continuing the discussions held at a recent workshop on "Making the ecosystem approach operational" hosted by the Atlantic Ocean Research Alliance Coordination and International Council for the Exploration of the Sea (ICES, 2016), this paper introduces the basics of policy cycles and performance management and explores the potential of such an approach to further operational implementation of EBM.

Policy cycles and policy-making

Anderson (2011) defines policy as "*a relatively stable, purposive course of action or inaction followed by an actor or set of actors in dealing with a problem or matter of concern*". He further explains that policy is what is actually done instead of something being proposed or intended and he differentiates policy from decision which is a specific choice among alternatives. In a political system, policy-making is a process of identifying a problem and setting public policy priorities, goals, and objectives. These then lead to the formulation of alternative courses of action that could resolve the problem and the eventual adoption of a specific course(s) of action to achieve objectives in support of the goals. In practice, the policy is implemented through programs, measures, procedures and controls that have expected outcomes to "*carry into effect*" the policy objective. Evaluation closes the policy cycle to determine what the policy is accomplishing and improve the policy or change the course of action where needed.

In performance management, goals and objectives provide the necessary direction for the development of outcomes (Bunker, 1972). Goals are usually derived from a mandate or vision statement providing the direction for a given course of action (Ackoff, 1990). Once goals are defined, objectives express what needs to be accomplished to reach the goals. Outcomes provide the measurable effects of management regimes in practice (Lupe and Hill, 2016). Outcomes are evaluated through performance measures that compare indicators against a benchmark as a measure of achieving an objective. When the benchmark is not met, the management regime needs to be re-assessed or the goals and objectives re-examined (Behn, 2003; Poister, 2010). Although goals and objectives are extremely important, it is the programs and their performance measures that will inform the organization and its clients as to the performance of a given program in achieving objectives (Fielden *et al.*, 2007; Tung *et al.*, 2014).

Policy cycle and ecosystem approach to management

Adopting the policy cycle to implement EBM could be relatively straightforward (Figure 1) and lead to the enactment of management measures that aim to achieve the EBM objectives and goals so often defined in marine planning exercises. An EBM policy cycle consists of similar components as the management phases proposed by Borgström *et al.* (2015) for EBM. However, Borgström *et al.* (2015) viewed these components as a heuristic model approximating a continuum of management rather than distinct phases. Although this may be accurate in EBM implementation to date, there is significant value to be gained from viewing these components of the policy cycle as distinct activities with their own inputs, processes, and outputs. By defining the policy process as consisting of discrete activities it makes it clear what is needed from the policy process to operationalize EBM and how ecosystem science, integrated assessments and state of the oceans reports would be key scientific activities to identify problems to inform the policy process. Without this clear distinction of policy activities, it is likely that EBM will continue to lack the specific management measures and operational outcomes necessary to achieve the objectives and goals defined in marine planning activities. Marine planning initiatives, almost uniformly across the globe, do not have the authority to implement the specific management measures necessary to achieve the EBM goals and objectives articulated by their plans, because these authorities still reside within single sectors (Sardá *et al.*, 2014). A policy process where marine planning is then used to inform operational outcomes and the management measures intended to achieve

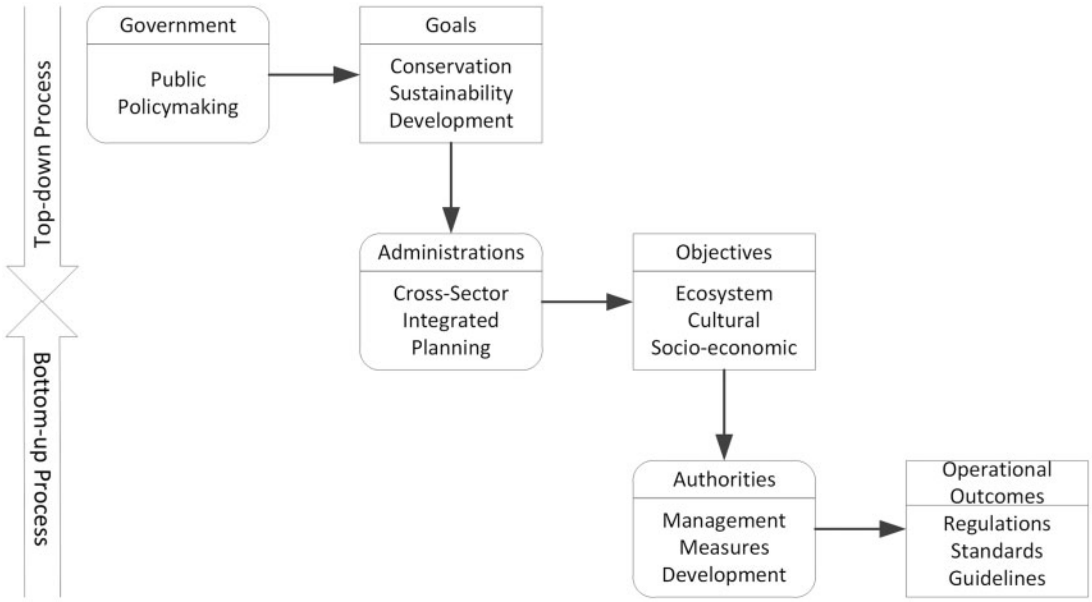

Figure 1. EBM meta-logic policy cycle.

these outcomes within single sectors could help overcome this impediment to operational EBM.

The policy cycle spans the spectrum from top-down to bottom-up processes as you move from strategic visionary goal-setting through planning into the implementation of specific management measures. From a top down perspective, government-led public policy-making processes set long-term goals for conservation, sustainability and development. These are typically reflected in legislation and may be prompted by national or international agreements (e.g. EU MSFD, 2008; Aichi Biodiversity Targets, 2012; UN SDG, 2015). Then, administrations or bureaucracies do the cross-sectoral planning and set regional ecosystem, cultural, social and economic objectives within the goals and mandate delegated to them by governments as the competent cross-sectoral authority to lead the planning. Planning uses decision support tools and stakeholder participation processes to facilitate the adoption of a specific course of action expressed as ecosystem objectives and applicable to all human activities operating within a given region or planning area. Once the objectives are set, the focus shifts to the developing of operational outcomes and environmental targets in collaboration with competent authorities of specific sectors to develop management measures. From a bottom up perspective, it would be the implementation of programs, measures and controls that would operationalize these plans against measurable expected outcomes to achieve the ecosystem objectives. It is important to note that it is the competent authorities of specific sectors that are accountable to implement the measures that are designed to manage their specific operations. Thus, it is the operational outcomes and environmental targets that provide the basis for an operational ecosystem approach to management. Without the integration of operational outcomes and objectives, any management measures developed under a given plan will likely have no relevance to the objectives and "*carry no effect*" in achieving them. Evaluations, based on ecosystem monitoring and compliance surveillance that assess if the ecosystem objectives are being achieved, provides the basis for adaptive management to close the policy cycle.

Generally, policy goals, objectives and outcomes are found in marine legislation and policies. As such, scientists should look in legislation and policy where the goals for the ecosystem have been articulated (Loomis and Paterson, 2014). However, they are not necessarily explicitly articulated, which often contributes to the confusion of what a given EBM initiative is to accomplish. For example, the goals of the EU Marine Strategy Framework Directive (EU MSFD, 2008) may be considered as "Paragraph 4: *Thematic strategy for the protection and conservation of the marine environment that has been developed with the overall aim of promoting sustainable use of the seas and conserving marine ecosystems*". The objectives can be found in "Annex I: *Quantitative descriptors for determining good environmental status*" while the operational outcomes may be found in "Annex VI: *Programmes of measures*" with the performance benchmarks defined as "Annex IV: *Indicative list of characteristics to be taken into account for setting environmental target*" needed by the "Annex V: *Monitoring Programmes*" to evaluate the performance of the programmes of measures. Although the Marine Strategy Framework Directive is a top-down piece of legislation, it is the programme of measures that "*carry into effect*" the bottom-up implementation of the ecosystem approach to management from an operational perspective.

Knowledge input in policymaking

The type of science required at each step of the policymaking process differs greatly because of the broad scope of the questions being asked (Table 1) (Campbell-Keller, 2009). At the onset of the public policymaking phase of the process, the role of scientific knowledge generated through research is to educate and inform the public and the political system as well as influence the agenda and priorities of a given government. This is one of the most important roles that science plays in society. This includes socio-economics providing the scientific information and influence for

Table 1. The science inputs into each activity of the policymaking process and the scientific products that should be developed to inform and implement the activity.

Activity	Science input	Science products
Strategic goal-setting	(i) Status and Trends of ecosystem and socioeconomic indicators;	(i) Ecosystem Status Reports;
	(ii) Prioritized threats to ecosystems;	(ii) Ecosystem Vulnerability/Risk Assessments;
	(iii) Identify opportunities to improve socioeconomic and ecosystem status	(iii) Indicators, Performance Measures, and Targets
Tactical objectives	(i) Evaluations of the ecological, cultural, social, and economic impacts of different objectives and actions;	(i) Define the Ecosystem's Safe and Just Operating Space with referenced limits;
		(ii) Trade-off analyses of objectives;
	(ii) Define Ecosystem Reference Points	(iii) Indicators, Performance Measures, and Targets
Management measures	(i) Predict impact of a management measure or suite of management measures to achieve cross sector objectives;	(i) Socio-Ecological Management Strategy Evaluations of proposed management measures;
	(ii) Evaluate proposed management measures ability to achieve prioritized objectives of stakeholders and managers	(ii) Risk of management measures to breach a reference limit;
		(iii) Comparison of alternative management measures against weighted objective priorities
Adaptive management	(i) Effective monitoring plan;	(i) Communication of ecological, cultural, social, and economic benefits and costs of the implemented management;
	(ii) Comprehensive evaluation of management effectiveness;	
	(iii) evaluation of alternative management options;	(ii) Socio-ecological Adaptive Management Scenario Evaluations;
	(iv) evaluation of scientific advice input into the policymaking process	(iii) Recommendations on how to improve scientific input into policymaking

development. The inputs include knowledge on ecosystem processes, state of the environment reporting, trends in ecosystem health, assessments of vulnerability to human induced stressors, socio-economic overview and development trends, and emerging technologies and investment opportunities, to name a few. The outputs of this step are mostly expressed in international and transboundary agreements, legislation and public policy regarding conservation, sustainability and development policy goals.

During the cross-sector integrated planning phase, the role of science is to provide advice and conduct decision analysis within the scope of the objectives being considered (Browman and Stergiou, 2005; Rice *et al.*, 2005; Rice, 2011) to reach the goals set in the prior step. Multi-Criteria Decision Analysis (MCDA) can be employed to help agencies and stakeholders set objectives based on potential scenarios and their relative values to an array of stakeholders (Huang *et al.*, 2011). The scientific analyses should then evaluate these objectives and priorities to inform managers and stakeholders of the ecological, cultural, social and economic repercussions of various objectives and courses of actions being considered in the planning within the context of the desired goals and to identify trade-offs or inconsistencies among the objectives. One of the initial science roles in setting objectives is to define the safe and just operating space for all of objectives being considered in the socio-ecological system. Using the boundaries of the safe and just operating space as reference limits not to be exceeded while developing objectives will ensure that devastating ecological, social, cultural, and economic repercussions are avoided (Raworth, 2012; Steffen *et al.*, 2015). The scientific advice does not make the decision, but provides evidence to inform the decision. For example, these would include the ecosystem basis of the potential impacts, the cultural basis of the changes to local communities, and the costs and benefits for society and economies as a whole. The inputs are in the form of future scenario evaluations, integrated ecosystems assessments, cumulative effects and impacts assessments, ecosystem, cultural and socio-economic overview reports, conservation and protection objectives, return on investment analysis and return on investment opportunities, and ecosystem risk assessments to name a few. The outputs of this step are typically in the form of integrated oceans and coastal management plans, marine spatial plans, protection and conservation plans for habitat and species, socio-economic objectives, and traditional and cultural objectives. Science needs to develop indicators and targets to assess and evaluate the performance of the management plan in achieving the objectives.

The development of management measures requires science to provide advice regarding the technical design and effectiveness of the proposed measures and to assess the efficacy of the suite of management measures. Economic and engineering considerations provide advice as to the implementation feasibility of the measures within an operational context. In an ecosystem-based operational context, the expected outcomes of operational management measures have to be consistent with and contribute to the planning objectives even though the measures are to be designed and implemented on a sector by sector basis. Such an approach ensures that the goals and operational objectives are operationally integrated with the specific development goals of a sector. Outcome-based indicators are used to measure performance in achieving objectives as determined by environmental targets. Such indicators are not designed to study trends or explain ecosystem processes or states. However, they must be placed in the context of such processes or states, laying the foundation for efficient and effective monitoring plans.

Monitoring must be designed to inform the different steps of the decision-making playing a central role in evaluating the performance of the management system and reviewing goals, objectives and outcomes in line with adaptive management principles. This is essential for EBM. Scientifically, we will never have all of the information to be absolutely certain of all of the implications of a proposed management measure. Different monitoring approaches are needed to determine if the goals, objectives, and outcomes are being achieved. For example, ecosystem science and ecosystem monitoring of trends, state changes, or shifts play an important role in reviewing public policy goals while regional integrated ecosystem and socio-economic assessments play an equivalent role in reviewing planning objectives. In an operational context however, assessments of stressors, effects, impacts and consequences also have to be paired with an evaluation of the effectiveness and feasibility of implemented management measures based on conformity assessments. The effectiveness and accuracy of the ecosystem science used to inform the process must also be evaluated and improved through this adaptive management and monitoring process (Levin *et al.*, 2014). It is the combination of monitoring and such surveillance that provides the basis for adaptive management by evaluating the performance of the management plan at achieving the objectives set in planning and, thus, in meeting its goals.

Concluding remarks

Although this discussion has artificially separated the science as an input into the policymaking process, it is critical that the science be developed in close collaboration with managers and policymakers to ensure that the most relevant science is being conducted and delivered into the policymaking meta-logic process displayed in Figure 1.

As discussed in the workshop, we still are lacking examples of operational, cross-sectoral EBM in marine and coastal ecosystems. This could be in part, because we don't have any clear cases where the policy process has been completed to implement EBM (Table 2). International agreements and marine planning policies have generated experience and best practices in the setting of ecosystem, cultural and socio-economic goals and objectives in countries around the world coupled with sound scientific research and knowledge in support of such initiatives. However, reviews of EBM have often cited a lack of guidance on how to implement EBM or a lack of specificity in objectives significant weaknesses (Foley *et al.*, 2013; Stelzenmüller *et al.*, 2013). We believe there is a disconnect between these EBM goals and objectives and within sectoral authorities charged with enacting management measures to achieve these objectives. This is why we propose the use of the policymaking process that explicitly states the need to institute management measures and operational outcomes to operationalize EBM. If followed, it will result in specific management measures being implemented by the appropriate authorities that are designed to achieve the EBM goals and objectives identified in numerous planning activities for marine EBM.

The scientific basis for EBM has been well established and continues to grow. This has resulted in considerable progress in the development of scientific frameworks and processes needed to undertake the science for an ecosystem-based approach to the management of human activities (Fletcher *et al.*, 2014; Samhouri *et al.*, 2014). These efforts have resulted in the mature development and implementation of many of the scientific methods needed to produce the required scientific inputs into the policy process. Moreover, many of these scientific products are already being operationally used for resource management, either within a single sector or for ecosystem restoration (Table 2). This suggests the scientific impediments to EBM are no longer significant.

Legislative and governance impediments may lie in the lack of legislative authorities needed to develop and implement the management measures to achieve the EBM objectives operationally. Legislation mostly provides the authority to lead and undertake ecosystem-based planning, such as the Oceans Act in Canada, The National Ocean Policy in the United States, and the Marine Strategic Framework Directive in Europe. This leaves the development and implementation of management measures to sector specific legislative authorities based on policy principles of collaboration leading to a mismatch between mandate, policy, authority, and operational implementation of the ecosystem approach.

Table 2. Examples of unclear cases completed policy processes and implementation of EBM.

Policy cycle activities	Science products	Operational	Reference(s)
Strategic goal-setting	Indicators, Risk Assessment, Socioecological Management Strategy Evaluation	No	Fletcher *et al.* (2014)
Strategic goal-setting		Yes, but too vague to be practically useful	Puget Sound Partnership (2006)
Strategic goal-setting		No	IOPTF (2010)
Strategic goal setting		In Progress	EU MSFD (2008)
Strategic goal-setting; operational objectives	Trade-off Analyses, Indicators	No	DFO (2005)
Adaptive management; management measures		Yes, in traditional exclusive use governance in Oceania	Aswani *et al.* (2012)
Adaptive management		Yes, for Ecosystem Restoration	Thom *et al.* (2016); LoSchiavo *et al.* (2013)
	Ecosystem Status Report	Yes, within a single sector in California Current and Alaska	Karnauskas *et al.* (2013); Zador *et al.* (2016); Garfield and Harvey (2016)
	Ecosystem Vulnerability/Risk Assessment	No	Samhouri and Levin (2012); Halpern *et al.* (2007, 2009); Cook *et al.* (2014); Teck *et al.* (2010)
	Indicators, Performance Measures, and Targets	Yes, for Ecosystem Restoration and single sector	Doren *et al.* (2009); Levin and Schwing (2011); Samhouri *et al.* (2011)
	Define Safe and Just Operating Space	No	Dearing *et al.* (2014); Raworth (2012)
	Trade-off Analyses (Ecosystem Services)	No	Lester *et al.* (2013); White *et al.* (2012)

Without legislative authority for management measures consistent with cross sector integrated planning, institutions currently involved in planning may not have the necessary governance processes or even the competencies needed to move from planning objectives to management measures and operational outcomes for EBM implementation.

This is placing unfounded responsibilities on the scientists leaving them to delve into the policymaking realm and figure out what to do as stakeholder and public awareness of issues and concerns increases. Although the scientific frameworks of EBM begins with defining ecosystem goals and objectives (Levin et al., 2008, 2009, 2014), it is the role of science to inform the policymaking process that develops these and not to develop the goals, objectives and outcomes. Scientists need to develop a sound understanding of policymaking to ensure that their advice is relevant to the decisions at hand (Burgman and Yemshanov, 2013). There is a need to include operational frameworks and procedures within current marine planning processes that overcome the lack of legislative authority within cross sector governance structures. There may also be a need for new education, professional training and development for managers, stakeholders and scientists in policymaking processes to understand the importance of implementation mechanisms of operational implementation such as regulations, standards, and guidelines.

Managers and stakeholders need to understand their information needs and, more importantly, the questions that need to be answered by the sciences and technical fields in order to pull through the relevant knowledge. Without this understanding, the scientist is left, not only to decide what information is needed for decisions, but is tasked with ensuring that this knowledge is transferred to the managers and stakeholders; thus, perpetuating, albeit unintentionally, the current debate as to whether or not sciences are providing adequate policy relevant information and whether or not managers are listening to science advice. In addition, a common or harmonized lexicon of terminology would facilitate the dialogue between scientists, technical experts, stakeholders and managers. This has been attempted with respect to indicator terminologies in the social and natural sciences (Loomis *et al.*, 2014), but needs to be broadened to include experts from management, policy, engineering, etc. In fact, the most valuable aspect of international standards is most often found in the harmonized processes and standardized vocabulary (ISO 2009a,b).

Existing sustainability policies and planning processes have been addressing the first two steps of the policymaking process for EBM. It is the third step that now needs to take place focusing managers, stakeholders, scientists, and technical experts on the development and implementation of operational management measures to achieve the planning objectives. As ecosystem features, functions, and components are the basis for ecosystem-based planning and management, the effectiveness and feasibility of the implemented management measures are the basis for operational EBM. Goals and objectives alone cannot manage human activities. The intent of transparency, ethics and fairness in decision-making are the challenges found in any such processes involving multiple interests and perceptions. Processes such as public policymaking enable and facilitate collaboration, exchange, and understanding needed to provide assurance that decisions are made transparently, ethically and equitably. Making EBM operational today, has more to do with a management paradigm than a scientific and technical one.

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