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Developing scientific information to support decisions for sustainable coral reef ecosystem services

Susan Harrell Yee [a,*], John F. Carriger [a], Patricia Bradley [b], William S. Fisher [a], Brian Dyson [c]

[a] US Environmental Protection Agency, Office of Research and Development, Gulf Ecology Division, Gulf Breeze, FL 32561, USA
[b] US Environmental Protection Agency, Office of Research and Development, Atlantic Ecology Division, Narragansett, RI 02882, USA
[c] US Environmental Protection Agency, Office of Research and Development, Land Remediation and Pollution Control Division, Cincinnati, OH 45268, USA

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ABSTRACT

The U.S. Environmental Protection Agency (EPA) has recently realigned its research enterprise around the concept of sustainability, including improving understanding of benefits derived from ecosystems. We provide an example of how EPA is applying structured decision-making (SDM) as a framework for guiding development of scientific information, data, and models to support watershed and marine-based management in coastal communities. In particular, we have been using the Driver–Pressure–State–Impact–Response (DPSIR) model as a tool in the SDM process to identify and assemble a broadly applicable suite of information with relevancy for coastal management, including 1) development of conceptual models to clarify the decision context, 2) identification of measurements of ecosystem attributes, ecosystem goods and services, and their connection to stakeholder objectives, 3) elaboration of potential decision alternatives, and 4) identification of ecosystem production and valuation functions for modeling consequences of decision alternatives on benefits derived from coral reefs. Finally, we overview how this information is being applied for two case studies: development of water quality criteria and watershed management to protect coastal resources. We posit that applying a systems thinking framework, such as DPSIR, within a structured decision-making approach will better enable marine ecosystem managers to utilize scientific information toward more sustainable decision-making.

1. Introduction

Despite growing recognition that human well-being is inextricably linked to sustainable use of environmental resources, ecosystem function and services are often overlooked or taken for granted in social and economic decision-making (MEA, 2005; NRC, 2005). A key challenge is that environmental assessments typically focus on ecological endpoints, yet decisions can also cause changes to social and economic variables that are important to stakeholders. The U.S. Environmental Protection Agency (EPA) and other federal agencies have been criticized in the past for relying too heavily on technical-based assessments, and failing to adequately consider stakeholder values in decisions (Arvai and Gregory, 2003; EPA SAB, 2001). Integrating stakeholder values with scientific information can ensure that future research, data gathering, and model development better support the decision making process (Maguire, 2003).

Applying the concepts from value-based decision-making to complex environmental management problems requires a formalized process to ensure that decisions are consistent with stakeholder values, cognizant of tradeoffs among alternatives, and account for uncertainties and risks. The structured decision-making (SDM) approach can be described as an iterative process that uses principles from decision analysis to integrate fact-based and value-based thinking (Failing et al., 2007; Gregory et al., 2012). The first step consists of understanding the context for decisions, which will frame the focus of the problem and the subsequent analysis (Fig. 1). The next step requires characterizing what is valuable to stakeholders through objectives and identifying evaluation measures to define what is valued in the decision context. Once alternatives for achieving objectives are identified, technical analyses can be done to compare the potential outcomes from decisions and explore tradeoffs that stakeholders and/or decision makers are willing to make. The final step is selecting and implementing strategies for achieving objectives that are consistent with values and preferences of stakeholders, and monitoring the success of the decision.

The EPA has recently realigned its research enterprise around the concept of sustainability (Anastas, 2012), including the sustainable delivery of social and economic benefits derived from ecosystems. For research to be effective, it must include consideration of whole systems thinking, long-term consequences, and stakeholder involvement (NRC, 2011). In this paper, we describe how our EPA research team is applying the Driver–Pressure–State–Impact–Response (DPSIR) framework (EEA, 2005) in conjunction with the SDM approach (Fig. 1) as a tool to link ecological science with stakeholder values toward development of scientific information in support of watershed and coastal management decisions.

* Correspnding author. Tel.: +1 850 934 9397.
E-mail address: yee.susan@epa.gov (S.H. Yee).

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