Journal of Environmental Management 225 (2018) 32–45

Contents lists available at ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Research article

# A dynamic management framework for socio-ecological system stewardship: A case study for the United States Bureau of Ocean Energy Management

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ARTICLE INFO

*Keywords:*
Management framework
Resilience
Socio-ecological system
Adaptive governance
Decision making
Panarchy
Iterative scenarios

ABSTRACT

An effective and efficient stewardship of natural resources requires consistency across all decision-informing approaches and components involved, i.e., managerial, governmental, political, and legal. To achieve this consistency, these elements must be aligned under an overarching management goal that is consistent with current and well-accepted knowledge. In this article, we investigate the adoption by the US Bureau of Ocean Energy Management of an environmental resilience-centered system that manages for resilience of marine ecological resources and its associated social elements. Although the framework is generally tailored for this Bureau, it could also be adapted to other federal or non-federal organizations. This paper presents a dynamic framework that regards change as an inherent element of the socio-ecological system in which management structures, e.g., federal agencies, are embedded. The overall functioning of the management framework being considered seeks to mimic and anticipate environmental change in line with well-accepted elements of resilience-thinking. We also investigate the goal of using management for resilience as a platform to enhance socio-ecological sustainability by setting specific performance metrics embedded in pre-defined and desired social and/or ecological scenarios. Dynamic management frameworks that couple social and ecological systems as described in this paper can facilitate the efficient and effective utilization of resources, reduce uncertainty for decision and policy makers, and lead to more defensible decisions on resources.

## 1. Introduction

Managing natural resources is a critical endeavor for national governments. A success factor depends on the structures in place in those governance organizations and the recognition that those institutions themselves are systems that have material and social dimensions, bringing them into the class of systems referred to as socio-ecological systems. Social entities play a critical role in the socio-ecological system (SES) concept that was defined decades ago (Hollingshead, 1940) and can act with great influence to couple the social and ecological subsystems as part of a single, integrated overarching system that also includes the physical environment. Since then, and particularly after the early 2000s, there has been growth in addressing environmental issues by considering SESs (Andersson and Ostrom, 2008). More recently, this conceptual approach has been emphasized by many researchers (e.g., Guerrero and Wilson, 2017; Kok et al., 2016), as well as in high-level documents created with input from the international community, such as the peer-reviewed reports from the Intergovernmental Panel on Climate Change (Pachauri et al., 2014), the *Laudato Si* encyclical on the environment (Francis, 2015), and the Arctic Resilience Report (Arctic Council, 2016). We examine how management entities are hardwired to the ecological system that they manage and how the managerial (social) subsystem part of a given SES may be structured to function in a manner consistent with the natural system under consideration.

Scientists and policy makers in United States (US) federal, state, and local agencies are currently facing a number of challenges when managing natural resources while pursuing their respective missions. First, these agencies operate at different scales and have different geographical jurisdictions, and their responsibilities were set decades ago. These geographical jurisdictions often overlap or are in close proximity in such a way that managed environments, or even parts of them, often occupy more than one geographical jurisdiction and therefore are affected by management decisions from more than one

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https://doi.org/10.1016/j.jenvman.2018.07.078
Received 7 January 2018; Received in revised form 30 May 2018; Accepted 23 July 2018
0301-4797/ Published by Elsevier Ltd.

organization. In addition, some federal agencies are responsible for the study and management of population units througout their ranges (e.g., tagging permits for scientific research, hunting and fishing permits/licenses), but they do not fully regard the associated environments..

Second, there are legal challenges, because most current environmental legislation, such as the Endangered Species Act and the National Environmental Policy Act (NEPA), has its roots in outdated knowledge, e.g., Benson and Garmestani, 2011a,b; Craig, 2013; Craig and Ruhl, 2014; Garmestani et al., 2013. These legislative actions took place before ecological concepts such as resilience, biodiversity, climate shifts, and scale discrimination became accepted as key factors affecting the environments over which different agencies have jurisdiction and decision-making power.

A third challenge is that some agencies lack the overarching management goal of aligning current and past knowledge (generated by them or others) in a common direction and organizing it in a way that is consistent with their mandated activities. This situation makes it difficult for management, governance, internal structure, legal, and policy considerations to be aligned and consistent with temporally dependent environmental stewardship priorities of all pertinent organizations, federal and otherwise.

These challenges are not new, and other challenges certainly exist, but a simple fact that we highlight throughout this paper is that the definition of environmental systems and their components affects the resulting environmental outcomes from natural resource management activities. Therefore, it is important to carefully consider the definitions of environmental systems and their components.

In the 2010–2011 timeframe, the former Mineral Management Service (MMS) was reorganized into three smaller agencies, with one of those three being the new Bureau of Ocean Energy Management (BOEM), whose mission is *to manage development of US Outer Continental Shelf (OCS) energy and mineral resources in an environmentally and economically responsible way*. BOEM is a regulatory agency with geographical jurisdiction in US federal waters, theOCS, which includes all submerged lands, subsoil, and seabed lying between the seaward extent of the states' jurisdiction and the seaward extent of federal jurisdiction BOEM hosts three main programs: oil and gas, renewable energy, and marine minerals. BOEM's responsibility includes using the best available information to inform its decision-making process while following existing legislation, e.g., the NEPA and the OCS Lands Act. The oil and gas program creates a mandated-by-law Five-Year Program for oil and gas development, which establishes a schedule of oil and gas lease sales proposed for planning areas of the US OCS. The program specifies the size, timing, and location of potential leasing activity that the Secretary of the Interior determines will best meet national energy needs while balancing stewardship of the environment. BOEM conducts necessary environmental studies and prepares required environmental documents, and consults with states, tribes, and the general public. Based on this information, BOEM proceeds with its oil and gas leasing decisions on offshore energy. The renewable energy program is in charge of the environmental compliance aspects in connection with the offshore installation or deployment of equipment, devices, and infrastructure able to generate and transport electricity from renewable sources of energy, such as wind, wave, and ocean currents energy. The marine minerals program addresses issues of coastal erosion in state areas by transplanting sand and gravel from federal waters to eroded beaches.

A broad description of the path followed by traditional and scientific knowledges within the BOEM structure is given in Kendall et al. (2017) where they define traditional knowledge as a body of evolving practical knowledge based on observations and personal experience of indigenous residents over an extensive, multi-generational time period (BOEM, 2012). In Kendall's paper the authors specifically focus on how traditional/indigenous knowledge can enter the streamlined path of BOEM's process at six different stages or entry points, and where consideration of physical, chemical, socio-economic, and biological information enter this path after BOEM's Environmental Studies Program

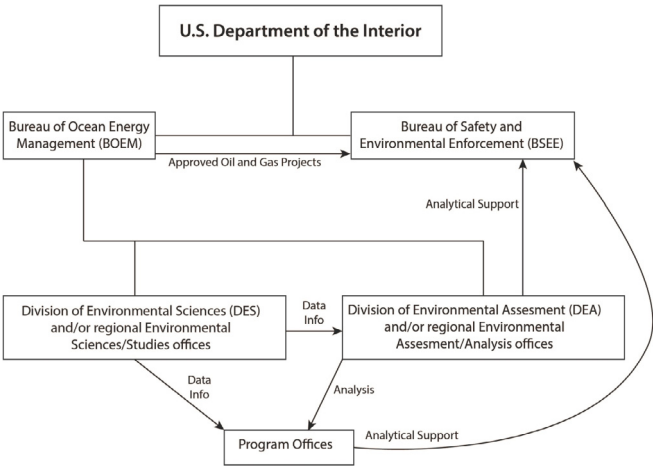


**Fig. 1.** Relationship among offices and bureaus. BOEM and the Bureau of Environmental Safety and Enforcement (BSEE) are the two agencies within the U.S. Department of the Interior (DOI) charged with managing marine energy and mineral resources (BOEM) and resource extraction operations (BSEE). Within BOEM, DES oversees the ESP at the headquarters level, and local environmental sciences/studies offices oversee the ESP at the regional level. DES and the regional sciences/studies offices provide data to DEA and regional environmental assessment/analysis offices. All of these provide data, analyses, and other information to the program offices (including the Economics Division in headquarters). DEA, the regional environmental assessment/analysis offices, and the program offices all provide information to BOEM and/or DOI decision makers, as appropriate. When the lengthy process of auctioning offshore oil and gas leases and approving individual projects is complete, authority passes from BOEM to BSEE, which regulates safety and environmental protection during the operations phase. BOEM's environmental offices and Economics Division often work with BSEE to support analyses and decisions. Connectors without arrowheads represent organizational structure.

(ESP) scientists and managers identify information needs on an annual basis. The last stage in that path is commonly a decision on offshore energy, e.g., leasing decisions, permits, notice to lessees, among others. Along the path, they describe the ESP, which includes the Division of Environmental Sciences (DES) and regional studies sections, which collect and evaluate existing environmental information that the Division of Environmental Assessment (DEA), in coordination with regional assessment sections, uses to prepare legally required environmental documents, such as environmental impact statements (EISs) and environmental assessments (EAs). Ultimately, the Leasing Division coordinates the analyses and data in these documents, along with information on strategic resources (typically geophysical information from below the seafloor), to inform decisions at the highest levels which include lease sales for oil and gas development, conducted by BOEM's regional offices (Fig. 1). Generally, resources associated with different program needs include geophysical data (oil & gas program), sand and gravel availability (Marine Minerals Program), and speed and direction of wind, waves, and currents for different locations and seasons (renewable energy program).

Currently, DES makes decisions on which research activities to conduct within a recently defined strategic framework, inspired by the present work, and based on the bureau's information needs in light of upcoming potential decisions. Use-inspired studies are driven by the needs of DEA and regional assessment sections, or information requirements created by such sources as high-level directives, new legislation, or executive orders from the US President or the Secretary of the Interior. Based on existing information needs, defined within this strategic framework, higher-priority studies are designed, and BOEM then announces requests for proposals. Technical review panels select from among the proposals submitted by academic, private, governmental, and non-governmental organizations. In this manner, the research that will inform decisions is conducted by third parties.