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The status of marine and coastal ecosystem-based management among the network of U.S. federal programs

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ABSTRACT

In the United States, management of marine and coastal resources has moved towards ecosystem-based management (EBM), which is a more systematic and integrated approach than conventional (e.g., single sector or single species) approaches. This paper summarizes the status of EBM for federal programs under the agencies of the National Ocean Council that implement or support marine and coastal EBM activities. Using social network analysis techniques, including network visualization, cohesion measures, programs degree and betweenness centrality, similarities among programs in different topic areas (e.g., type of audience, partners, training, EBM best management practices and principles) were explored. Results highlight substantial differences in perceived and effective performances across programs, with Management programs showing a higher level of integration of EBM approaches than Non-Management programs. The use of EBM best management practices and principles among programs is unbalanced, with some key elements of EBM strategies less commonly employed in the management planning. This analysis identified gaps in the implementation of EBM strategies that can inform natural resource managers and other interested parties. This paper presents the results of the analysis and discusses the implications for the implementation of EBM approaches and strategies at the federal level.

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1. Introduction

Marine ecosystems provide a broad range of crucial economic, societal, and environmental services to humans [1]. The condition of these ecosystems and the services they provide have been influenced by a variety of natural and human-based processes and activities for centuries [2,3]. These activities (e.g., fisheries, energy exploration, shipping, tourism and recreation, and coastal development) and their impacts (e.g., resource overexploitation, reduced water quality, habitat loss and degradation) have resulted in increased use of and pressure on natural marine resources, which has altered the natural state of marine ecosystems [2,4,5]. The cumulative impacts of multiple human "drivers" and "pressures" on ocean, coastal, estuarine, and Great Lakes ecosystems are compounded by natural drivers (e.g., climate change, natural fluctuations) and associated habitat and biodiversity losses, and shifting species distribution [6–8].

Conventional approaches (e.g., single user sector or single species) to the management of ocean and coastal uses and natural resources have limitations in successfully predicting and addressing variability in resource condition and the outcomes of management actions [3,6]. In this regard, many scientists, managers, and policy experts, as well as marine users and interests, have argued in support of ecosystem-based management (EBM) as a valid, comprehensive strategy to address multiple pressures exerted by human activities on the state of natural resources and ecosystems [9].

EBM is a management approach that integrates across multiple user sectors and that considers the entire ecosystem, including humans.[1] The goal of EBM is to collectively manage natural resources, habitat, and species in a sustainable manner, while

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[1] For the purpose of this study the definition of EBM adopted by the NOP, which was included in the ORAP [19] guidelines, was employed:

"Ecosystem-based management (EBM) is an integrated approach to resource management that considers the entire ecosystem, including humans. It requires managing ecosystems as a whole instead of separately managing their individual components or uses. EBM considers all the elements that are integral to ecosystem functions and accounts for economic and social benefits as well as environmental stewardship concerns. It also recognizes that ecosystems are not defined or constrained by political boundaries. The concept of EBM is underpinned by sound science and adaptive management as information or changing conditions present new challenges and opportunities".

maintaining ecosystem productivity and resiliency so that it can provide the services humans need and want on a long-time horizon [9]. This strategy differs from traditional approaches that focus on single species, sectors, and activities, in that it considers different aspects of ecosystem management through an integrated and comprehensive approach [9]. To support decision-making, EBM is informed by science and includes as key elements: connections and linkages between and within ecosystems as well as with social and economic systems; cumulative impacts of multiple activities both within and among activities; adaptive management strategies; multiple objectives among services or sectors; and trade-off evaluations [7,10]. As such, EBM is a dynamic, adaptive, and iterative management approach that changes based on the spatial scale (i.e., local, regional, ecosystem) of the natural resource managed [11].

Despite the great potential for better coordinated and integrated management through EBM, and a broad interest in applying this approach in the marine environment [12], there has been limited systematic implementation of EBM in ocean and coastal ecosystems [13]. One reason for this is a lack of knowledge and understanding by managers of the principles and best practices of marine EBM and its implementation [13]. Documenting and sharing the lessons of other efforts to implement EBM would help to address this gap. Specifically, knowing the current state of practice among federal EBM programs in the U.S. will provide natural resource managers from these and other programs a better understanding of how to implement EBM efficiently, effectively, and consistently across the federal government, and in compliance with federal legislative and regulatory authorities. Similarly, this information may guide appropriate or suitable EBM approaches and strategies outside of the federal government.

The primary aim of this paper is to provide a general picture of the current state of practice among the many and varied U.S. federal programs employing EBM approaches in the ocean, coastal zone, and the Great Lakes. The results of this study allow managers to compare their use of marine and coastal EBM with other programs and to identify gaps in knowledge or implementation strategies to enhance their EBM framework. They inform natural resource managers and other stakeholders about EBM implementation within U.S. federal agencies, and will advance the discussion on the best strategies for enhancing marine and coastal EBM implementation. Therefore, this information is not only relevant for individual programs but for federal management as a whole.

After a brief review of the history of EBM adoption and implementation in the U.S. and a description of some examples of marine and coastal EBM programs in the U.S. and worldwide, the research methods are presented, followed by results of the analysis. This paper concludes with a discussion on the implications for implementing EBM strategies within U.S. federal agencies followed by a conclusion describing what considerations this study raises for marine and coastal resource managers.

2. A brief background of marine and coastal EBM history and policy in the U.S.

The absence of an integrated holistic strategy for the management of marine natural resources and their environments was one of the main shortcomings reported by two separate national commissions studying U.S. ocean policy: the Pew Ocean Commission (POC) in 2003 [14]; and the U.S. Commission on Ocean Policy (USCOP) in 2004 [15]. Results from both Commissions called for comprehensive EBM strategies to manage marine resources, and led to a Joint Ocean Commission to monitor implementation of their recommendations [16,17].

Echoing these recommendations, the George W. Bush administration issued Executive Order 13366 (Fed. Reg. 76591, December 21, 2004) to establish a Committee on Ocean Policy. This group established working committees for science and technology and for coordination, although it lacked a legislative mandate and funding to advance ocean policies and programs [17]. In recognition of these efforts and the necessity for a long-term vision, the Interagency Ocean Policy Task Force (OPTF) was established in June 2009 by President Obama. This task force was charged with organizing a comprehensive policy approach to enhance national stewardship of the Nation's ocean, coasts, and Great Lakes, by developing and implementing EBM strategies and recommendations for the long-term conservation and use of national natural resources [17].

Following on the recommendations provided by the OPTF, Executive Order 13547 (Fed. Reg. 43023, July 22, 2010) was signed by President Obama on July 19, 2010, to establish a comprehensive National Ocean Policy to ensure the protection, maintenance, and restoration of the health of ocean, coastal, and Great Lakes ecosystems and resources. This Order establishes EBM as the foundational approach to address conservation, economic activity, users' conflict, and sustainable use of ecosystem services across sectors. To translate this long-term vision into action, the National Ocean Council (NOC) developed a National Ocean Policy Implementation Plan (NOP-IP) [18]. The NOP-IP describes specific actions that federal agencies will take to address key challenges for ocean, coasts, and Great Lakes by adopting EBM strategies. The NOP-IP established a federal interagency subgroup (NOP EBM-Subgroup) to provide policy advice on EBM strategies and technical representation from the federal agencies that are part of the NOC. As a result of this national effort, and in support to the NOC long-term strategy, a guideline to identify strategies and recommendations to advance national implementation of EBM for oceans was released by the Ocean Research Advisory Panel (ORAP) in December 2013 [19]. A key finding of the ORAP is the need for clarity and understanding of EBM's concepts, practices, and principles across participatory groups. This requires federal agencies and their partners to develop and implement a coordinated and integrated set of decision-support tools, training materials and products to enhance EBM strategies, to address inconsistencies in EBM approaches, and to identify effective EBM best practices in support of cross-sectoral federal priorities.

3. Marine and coastal EBM implementation in the U.S. and elsewhere

Many examples of successful marine and coastal EBM implementation exist across the U.S. and internationally, which vary in their spatial scale and the level of cross-sectoral integration. Nevertheless, they offer important lessons for the current efforts to apply regional scale and fully integrated EBM approaches [19].

Chesapeake Bay restoration efforts offer one of the largest and longest running examples of EBM in the U.S. This initiative began in the 1980s and over the years has expanded integrating many state and federal efforts across terrestrial and marine sectors to improve ecosystem health and habitat restoration. In 2009, President Obama signed an executive order establishing the Federal Leadership Committee for the Chesapeake Bay to further coordination and ecosystem-based protection for the bay [19].

The Elkhorn Slough National Estuarine Research Reserve on the central coast of California offers a smaller scale EBM effort; it is a collaboration of the California Department of Fish and Game, NOAA, and a local non-profit organization, the Elkhorn Slough Foundation. The restoration and conservation efforts at Elkhorn Slough are science-based multi-stakeholder efforts, expanding

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