Marine Policy 92 (2018) 48–57

Contents lists available at ScienceDirect

Marine Policy

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

Building effective fishery ecosystem plans

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ARTICLE INFO

Keywords:
Ecosystem-based fisheries management
Adaptive management
Fisheries ecosystem plan
Fisheries management

ABSTRACT

U.S. fisheries management has made tremendous strides under the current management framework, which centers on single stocks rather than ecosystems. However, conventional management focuses on one fishing sector at a time, considers a narrow range of issues, and is separated into individual fishery management plans often leaving little opportunity to consider overarching management goals across fisheries. Ecosystem-based Fisheries Management (EBFM) provides mechanisms to address these but has not been widely adopted. Here, we review and analyze the development of Fisheries Ecosystem Plans (FEPs) as a means to implement EBFM. In doing so, we provide a blueprint for next-generation FEPS that have the potential to translate EBFM to action. We highlight FEPs as a structured planning process that uses adaptive management to operationalize EBFM. This "FEP Loop" process starts by identifying the key factors that shape a fishery system and considering them simultaneously, as a coherent whole. It then helps managers and stakeholders delineate their overarching goals for the system and refine them into specific, realistic projects. And it charts a course forward with a set of management actions that work in concert to achieve the highest-priority objectives. We conclude that EBFM is feasible today using existing science tools, policy instruments, and management structures. Not only that, nearly all of the steps in the proposed "FEP Loop" process are presently being carried out by U.S. fishery managers. The process of reviewing regional experiences in developing and applying the FEP loop will lead to adaptations and improvements of the process we propose.

1. Introduction

U.S. fisheries management has made tremendous strides under the mandates for sustainability prescribed by the Magnuson Stevens Act (MSA) [1]. Since reforms to MSA in 1996 [2], the number of stocks with biomass below overfished thresholds has declined dramatically, from

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https://doi.org/10.1016/j.marpol.2018.01.019
Received 13 October 2017; Received in revised form 17 January 2018; Accepted 19 January 2018

86 to 38, and the number of stocks subjected to unsustainable rates of harvest has plunged from 72 to 28 [3]. In addition, fishers and other stakeholders, managers, and scientists have cooperated to reduce bycatch (e.g, [4]), conserve habitats (e.g., [5]), and improve the equity and safety of fisheries (e.g. [6]).

Despite these successes, conventional fisheries management has limitations. It generally focuses on one fishing sector (e.g., groundfish, coastal pelagic species, anadromous species) at a time, which may lead to perverse outcomes for other sectors [7]. It often considers a narrow range of issues, potentially overlooking factors that shape fishery systems at larger scales, such as loss of habitat and the behavior of people and markets [8]. And fundamentally, the current management system is segmented into individual fishery management plans (FMPs), restricting opportunities to consider overarching management goals for the fishery system or the trade-offs across fisheries that attend almost every decision [9].

Ecosystem-based Fisheries Management (EBFM) provides mechanisms to address these issues and many others. Here we define EBFM as a holistic, place-based framework that seeks to sustain fisheries and other services that humans want and need by maintaining healthy, productive and resilient fishery systems [9–13]. This contrasts with the focus of conventional fisheries management that emphasizes the *direct* consequences of management actions on targeted stocks and protected non-target species.

Fundamental to EBFM is conceptualizing fisheries as systems. Fishery systems consist of linked biophysical and human subsystems with interacting ecological, economic, social, and cultural components [14,15]. A system is made up of its components (e.g., targeted fish stock, interacting species, habitats, people employed by fishing), and the links among them (e.g., predator-prey interactions, fishermen who shift from one fishery to another). These links can span regulatory units and jurisdictions. Management actions that do not account for these links can produce unintended indirect effects [16].

The goal of EBFM is to improve decision-making by providing a means for managers to explicitly consider all components of a fishery system, ecological, social, and economic, across all fisheries prosecuted in the system, that is, the “triple bottom line” (*cf*, [17]). Conventional management can take the triple bottom line into account within a single fishery, but EBFM does this comprehensively by looking across species, fisheries, and jurisdictions [18]. That is, it considers the system as a whole. A holistic view of systems can help managers better identify the full suite of threats to fisheries and provide a more coherent framework to account for the dynamics of systems. EBFM can identify elements that confer resilience, helping managers avoid exceeding limits that may lead to rapid and irreversible system change. Finally, EBFM can improve the rigor of setting catch levels by explicitly incorporating environmental and ecological information in science advice, where appropriate.

In the United States, revisions to the MSA have incentivized Regional Fishery Management Councils – the bodies that manage U.S. federal fisheries along with the National Oceanic and Atmospheric Administration (NOAA) – to expand the scope of conventional management over the past several decades. In addition to habitat protection and reduction of bycatch, fisheries managers have enacted precautionary measures such as biomass buffers to protect forage fish, which can serve as important prey to other species [19]. Stock assessment models have also advanced. Some stock assessments now link recruitment to environmental conditions, track changes in mortality due to predators, or use information on habitats to support abundance indices and assessment recommendations. In a recent review of 207 quantitative stock assessments, Essington and colleagues [20] found that roughly 22% included habitat or oceanographic conditions and 1% included predation (an additional 11% of assessments included data on predation in the report for context). This progress demonstrates the capacity to include ecosystem information in stock assessments and the opportunity to expand the application of EBFM in conventional management.

Concurrent with Councils’ expanding scope of conventional management, an effort to establish ecosystem planning in the U.S. began two decades ago. In 1999, the Ecosystem Principles Advisory Panel (EPAP) concluded that while conventional fishery planning approaches included provisions to address ecosystem principles, they were not sufficient to implement EBFM [21]. Instead, a new tool was needed: Fishery Ecosystem Plans (FEPs). The purpose of an FEP is to improve decision-making through the incorporation of the principles of EBFM. By applying a broad suite of ecosystem-based considerations and scientific tools, managers can achieve sustainability goals for fishery systems. The EPAP report included recommendations for the development of FEPs with three objectives in mind: 1) provide a clear description and understanding of the biophysical, and human/institutional context of ecosystems within which fisheries are managed; 2) direct how that information should be used in the context of Fishery Management Plans; and 3) set policies by which management options would be developed and implemented [21].

Over subsequent years, eight FEPs have been developed (others are currently in development), covering four Council regions. The scope of these FEPs varies widely (Table 1), but one notable and consistent pattern is that FEPs generally do not include direct links to management actions. This point is also noted in a recent review of FEPs in relation to the recommendations in the EPAP Report [22], which found that several of the EPAP recommendations had not been implemented.

2. Next generation fishery ecosystem plans

Recognizing the challenges in implementing EBFM, The Lenfest Fishery Ecosystem Task Force[1] was convened in 2014 to review existing FEPs (and similar EBFM projects around the globe), and to provide a blueprint for the next generation of FEPs [20]. Over 2.5 years, the Task Force members and staff, engaged with scientists, stakeholders, managers, and other decision-makers through workshops around the U.S. At each workshop, the Task Force invited individuals to share their experiences with EBFM in their region and had candid discussions about EBFM progress, hurdles, and potential next steps.

These conversations were valuable in shaping the Task Force perspective of what is possible and in developing recommendations of what is necessary to move EBFM forward in U.S. fisheries management. The Task Force concluded that existing FEPs often focus on system description rather than management action [20]. To support progress, The Task Force recommended that FEPs be used to create a structured process for translating EBFM principles into action. This means developing actionable components for FEPs – ways in which ecosystem considerations lead to management responses.

Decision-making in an EBFM context needs to be structured and deliberate to account for uncertainty and trade-offs among competing objectives [23,24]. By structured, The Task Force means that there is a logical, sequenced process, and by deliberate, The Task Force means that the process is conducted with clearly articulated intentions to achieve specific goals.

Below, a Fishery Ecosystem Plan (FEP) process is described that is intended to support decision-making, thereby translating the concepts and principles of EBFM into action. This process relies on the active participation of stakeholders throughout FEP development. It allows for both the long-term aspirational nature of EBFM and the need for actionable, practical steps in the short term.

The Task Force approach, summarized in Fig. 1, is grounded in the concept of adaptive management [23,25], a structured approach for improving resource management by systematically learning from

[1] The Lenfest Task Force was chaired by T.E. Essington, co-chaired by P.S. Levin and staffed by K. N. Marshall and L. Koehn. Members included L.G. Anderson, A. Bundy, C. Carothers, F. Coleman, L.R. Gerber, J.H. Grabowski, E. Houde, O.P Jensen, C. Möllmann, K. Rose, J.N. Sanchirico and A.D.M. Smith.