Characterizing and Comparing U.S. Marine Fisheries Ecosystems: Successful Factors in Moving Toward Ecosystem-Based Fisheries Management

Caracterización y comparación de ecosistemas pesqueros marinos de EE. UU.: factores exitosos para avanzar hacia la ordenación pesquera basada en ecosistemas

Caractérisation et comparaison des écosystèmes des pêches marines des États-Unis : facteurs de réussite dans l'évolution vers une gestion des pêches fondée sur les écosystèmes

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EXTENDED ABSTRACT

Implementing ecosystem-based fisheries management (EBFM) requires a comprehensive examination of the fundamental components of fisheries ecosystems, including the identification of characteristics and strategies facilitating this more systematic approach. Coupled natural and human factors, biological productivities, and systematic governance factors all influence Living Marine Resource (LMR) and socioeconomic status within a given socio-ecological system (SES). Determining the relative prominence among these components is timely and warranted given the many issues facing marine ecosystems. In several recent works (Link & Marshak 2019, 2021; Marshak & Link 2021), we characterized U.S. marine fishery ecosystems by examining these facets and compiling a consistent, multidisciplinary view of coupled SESs using commonly available, integrated data for each ecosystem. In carrying out these investigations, we examined a suite of over 90 indicators (including socioeconomic, governance, environmental forcing, major pressures, systems ecology, and fisheries criteria) for nine major US fishery ecosystem jurisdictions. From these we ascertained the determinants for successful LMR management. In addition, we systematically tracked the progress the country has made toward advancing EBFM and making it an operational reality (Link & Marshak 2021) and examined if major patterns and lessons emerge when comparing across SESs. Overall, we found that inherent biological productivity was a major driver determining the level of fisheries biomass, landings, and LMR economic value for a given region, but that human interventions can offset this basal production. We also documented novel relationships between primary productivity and LMR-based economics for US and international large marine ecosystems (LMEs) and elucidated intermediate relationships between production, total biomass, fisheries landings, revenue, and LMR-based employment (Marshak & Link 2021). We observed that factors including human population, exploitation history, and governance interventions significantly influence these relationships. Quantifying the direct link between primary production and fisheries economic performance serves to better inform ecosystem overfishing thresholds (Link & Watson 2019; Link 2021) and their economic consequences. Further acknowledgement and understanding of these relationships are key to ensuring that these connections are accounted for more effectively in sustainable management practices, including through the development and refinement of ecosystem level reference points (ELRPs). In addition, we found that good governance could overcome certain ecosystem limitations, and vice versa, especially as tradeoffs within regions have intensified over time. We also found that U.S. regions perform well (i.e., mid-level ranked) in terms of certain aspects of LMR management, with unique successes and challenges observed in all regions, including the northern Gulf of Mexico and U.S. Caribbean. While attributes differ, transferrable commonalities for successful management across regions include having: stock status identified; stable but attentive management interventions; tracking broader ecosystem considerations; landings/biomass exploitation rates typically <0.1; areal landings typically <1 metric ton km^2 y^{-1}; ratios of landings/primary production typically <0.001; and explicit consideration of socioeconomic factors in management. In these studies, we emphasize cross-regional comparisons among SES indicators, focusing on U.S. temperate, subtropical, and tropical ecosystems. In doing so, these analyses cover 11 LMEs, representing nearly 10% of the world's ocean surface area, spanning over 70 degrees of latitude and 100 degrees of longitude, and considering major parts of two ocean basins, with the lessons learned directly applicable to a wide range, if not most, marine fisheries ecosystems. Integrated, cross-disciplinary perspectives and systematic comparative syntheses such as these offer insight for determining regionally-specific and overarching approaches for successful LMR management. Overall, we view EBFM progress throughout U.S. and international jurisdictions as being synonymous with improved management of LMRs in general. The needs and benefits of EBFM are gaining in awareness, acceptance and implementation, with these systematic marine management approaches better allowing for the accounting of interconnected environmental, ecological, economic, and system-level tradeoffs. Ultimately, greater recognition that foundational primary production within an ecosystem indeed limits its sustainable harvest, in addition to the associated economic performance and benefits derived from its marine resources, is key to ensuring that these connections are accounted for more effectively in management approaches. As emphasized in these studies, an ecosystem approach allows us to better coordinate, prioritize LMRs at higher risk, deal with

a large set of ecological and human-dimension complexities, gain efficiencies, address multiple mandates and objectives, and explore all goals and objectives simultaneously rather than attempting to do this piecemeal, species-by-species, mandate-by-mandate, and fleet-by-fleet.

KEYWORDS: ecosystem-based fisheries management, productivity, governance, ecosystem indicators, socioecological systems

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