



A modified diagnostic social-ecological system framework for lobster fisheries: Case implementation and sustainability assessment in Southern California



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ABSTRACT

Fisheries exemplify the immense complexity of interactions in social-ecological systems (SESs). This complexity has created management challenges and raises concerns for the sustainability of our marine natural resource systems. This article contributes to SES fisheries research and management in two ways: first, it enhances our understanding of lobster fisheries as complex social-ecological systems, focusing on the Southern California Spiny Lobster Fishery (SCSLF) as a case study. Secondly, it demonstrates a methodological approach for assessing component interactions in SESs that can be used to assess the sustainability of management approaches. The first contribution involves the systematic review of the literature on lobster fisheries management and their SES characteristics. The review results are then used to modify and extensively define the diagnostic SES framework for specific use in lobster fisheries. For the second contribution, we demonstrate how to operationalize the modified framework for the diagnosis of a real-life case, using the SCSLF as an example. This involves framing the SCSLF classificatory diagnosis for analysis of the stakeholder-comprised management group of the SCSLF as a social-ecological action situation. This analysis is aided by the Institutional Analysis and Development (IAD) framework, a SES-imbedded tool used in our case to assess sustainability in resource management systems through critical analysis of stakeholder and resource system interactions. More generally, we find that research in lobster fisheries could benefit from broadening its scope of analysis, as overly narrow research foci have worked to limit the production of more holistic SES knowledge. Our exemplary analysis of the LAC's management of the SCSLF shows that the SES contains multiple components which have been associated with sustainable outcomes elsewhere; however, the fishery still faces many obstacles, including how to adapt to future challenges. Our results contribute to developing a holistic methodological approach for operationalizing SES framework research into practical fisheries management.

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1. Introduction

The oceans and coasts of the world continue to experience rapid transformations through land use change, biodiversity loss, excessive extraction and general ecosystem degradation, exemplifying the immense impacts of increasing concentrations of human settlements and expanding exploitation of marine and coastal resources (Berkes et al., 2006; Halpern et al., 2008). Fisheries in

particular demonstrate how the exploitation of resources can cause significant changes in system functions and processes, which may threaten the long-term sustainability of such resource systems globally (Berkes et al., 2006). Such changes also have important implications for the livelihoods (Checkley et al., 2013; Kittinger, 2013), cultural identities (Ernst et al., 2010; Van Putten et al., 2013), and economic stability (Gourguet et al., 2013; Martinet et al., 2007) of those individuals and communities who rely on the use of these resource systems. The reciprocal social and ecological impacts of marine and coastal resource exploitation demonstrate that both social systems and natural resource systems are embedded in complex social-ecological systems (SESs)

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(Ostrom, 2009, 2007).

The complexity inherent in SESs requires that their assessment consider a multiplicity of dimensions, including ecological characteristics as well as the quality and design of resource management institutions (Basurto et al., 2013; Billy Ernst et al., 2013). Sufficient understanding of the various components of these complex systems, as well as the interactions within and between system components, is needed for the design and implementation of sustainable management approaches (Agrawal, 2003, 2001; Lange et al., 2013). Though many studies research human–environment interactions, the complexity of coupled SESs remains not well understood (Liu et al., 2007; Ostrom, 2007). Ill-informed interventions due to e.g. a lack of knowledge, can produce problems of ineffective and unsustainable management (Gutiérrez et al., 2011). As means to avoid this pitfall, case studies of SESs in particular can provide important insights into the context-specific nature of these management challenges, supporting the targeted production of knowledge about relevant system components and their internal interactions in context-specific ways (Ostrom et al., 1999).

In this article, we demonstrate how complex SESs can be characterized and analyzed and how the results of such an analysis can be harnessed to inform improved management of natural resource systems. We do so by focusing our attention on lobster fisheries management as an exemplary research field, though the demonstrated approach is applicable to virtually all SESs. We begin by drawing on a comprehensive review of the existing academic literature on lobster fisheries, as well as consultative expert interviews with practitioners and academics, from which we modify the well-known SES diagnostic framework to make it specifically applicable to lobster fisheries. We then apply the modified framework to a multi-use lobster fishery in the coastal region of Southern California, U.S.A, namely the Southern California Spiny Lobster Fishery (SCSLF). The steps needed to elaborate the framework beyond the general characteristics of lobster fisheries to the specifics of a real-world management case are exemplified and discussed.

Through diagnostically classifying the SCSLF with the modified lobster SES framework, we undertake a demonstrative sustainability assessment of the case study fishery, utilizing data gathered from a survey conducted with the SCSLF Lobster Advisory Committee (LAC). Taken together, we exemplify a methodological procedure for how to operationalize a more comprehensive case assessment (though we do not attempt a comprehensive assessment here). Furthermore, our precursory analysis of the SCSLF LAC serves to highlight how researchers and practitioners can utilize results from a modified diagnostic SES framework analysis to identify potential challenges relevant for the long-term sustainable management of multi-use SESs.

Our research results feed into the broader ambition for the diagnostic SES framework to provide a template for building cohesive data between SESs for collective inter-case analyses, such as modeling interactions and outcomes across fisheries and testing theory, though we do not specifically pursue such an approach in this article. Beyond inter-fishery analyses, the general conclusions drawn from this work regarding the relationship between research and management (i.e. knowledge and action) are applicable to virtually any SES, terrestrial or marine, and thus contribute to a primary objective of SESs studies (Ostrom and Cox, 2010) and sustainability science more broadly (Kates, 2011; Wiek et al., 2012).

2. Background

2.1. Lobster fisheries and SES research

Worldwide, lobster fisheries present resource systems that are largely common-pool in nature (Ostrom, 2007), relatively well

researched, and are globally distributed in locations with very different historical (Davis and Wagner, 2006; Billy Ernst et al., 2013) and social-institutional (Basurto and Coleman, 2010; Brewer, 2012) settings. Building on this breadth and diversity, lobster fishery scholars have produced many quality case examples. These cases are particularly useful when elaborating on the process of moving from general SES component identification to diagnosing context-specific resource management systems. Focusing on distinctive contextual settings supports case-specific diagnosis of resource management problems while simultaneously contributing to integrated research approaches relevant to all SESs (Kittinger et al., 2013).

While research aimed at identifying SES components in fisheries is not uncommon (e.g. Basurto et al., 2013; Billy Ernst et al., 2013; Hearn, 2008), there has been far less attention paid to management configurations and social-institutional interactions in SESs (Basurto and Coleman, 2010; Basurto et al., 2013; Gutiérrez et al., 2011; Kittinger et al., 2013). Furthermore, heuristics for moving from general SES component identification to context-specific management case analysis are lacking. This is significant given that SES management strategies have historically adopted universalist approaches, panaceas, that have been largely unsuccessful in attaining sustainable outcomes due to their lack of contextual sensitivity (Ostrom, 2007). Closing this knowledge-action gap is particularly important for management of marine resources as they are immensely complex and thoroughly integrated with and impacted by a wide range of human activities (Berkes et al., 2006).

2.2. Inheriting a SES research agenda

The diagnostic SES framework was originally developed by Nobel Laureate Elinor Ostrom and colleagues in response to the insufficient conceptualization of complex system components and interactions in resource management studies. Additionally, the framework was intended to bring workable and transdisciplinary-oriented foundations to research aimed at addressing the problematic practice of developing and implementing one-size-fits-all 'solutions' to resource management problems. The diagnostic SES framework, at its roots, emerged out of a critique of streams in game theory which over-simplistically conceptualized human decision making in resource management, leading to both insufficient outcomes in policy approaches and a generally pessimistic outlook for the prospects of human society's capacity to sustainably manage common-pool resources, most notably captured in Hardin's (1968) Tragedy of the Commons. The SES diagnostic framework, introduced by Ostrom (2007) and shown in Fig. 1, was an influential step for distilling variables and interactions from a wide swath of empirical natural resource management research cases from around the world. In the end, this framework is essentially a "systematic analytical tool to work through and categorize complexity," (Basurto et al., 2013, p.1375).

The diagnostic SES framework is meant to facilitate the identification, categorization and organization of relevant variables necessary for understanding resource management processes and outcomes. The framework begins to classify an integrated human–environment system through the four initial first tier variables: Governance System (G), Resource System (RS), Resource Units (RU) and Actors (A). Subsequent variable tiers identify specific sub-system variables relevant at different scales and levels within the specific SES. For example, in this study these subsequent tiers are modified for purposes of classifying lobster fisheries generally, and then further adjusted in relation to the specifics of the SCSLF. As the framework merely provides a means to identify variables and structure data collection in an SES, acting as a sort of checklist, an analysis of how variables interact requires a complementary but

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