



Progress and promise in spatial human dimensions research for ecosystem-based ocean planning

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ABSTRACT

Human activities in ocean environments have resulted in significant impacts to ocean health and diminishing returns to society from these ecosystems. In response, there have been increasing calls for implementing ecosystem-based approaches to ocean planning and management. Such approaches require consideration of the complexity of human relationships with ecosystems including their social, cultural, political, and economic dimensions in order to develop and implement management viable strategies. This article reviews progress in spatial research on human activities and social dimensions of ocean environments and explores the promise this research has for enhancing ecosystem-based ocean planning. A global review reveals growth in the number and sophistication of research on social dimensions of oceans, with an increasing focus on new tools and technologies that involve stakeholders in the production, maintenance, and use of data in planning processes. Notably, most research is undertaken in the developed rather than the developing world, pointing to possible discrepancies in the capacity and resources required to engage this research. There is promising, albeit limited, evidence for the successful use of social data and applied research approaches in ecosystem-based ocean planning initiatives. This review shows that spatial research on the human dimensions of the ocean environments has much potential to engender a more comprehensive understanding of these complex seascapes, and to aid in planning processes aimed at achieving sustainable social and ecological outcomes.

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1. Introduction

Ocean environments are complex areas to manage and govern. The combination of increases in coastal resource use intensity and value has led to significant impacts to ocean health and diminishing returns to society from these ecosystems [1,2]. Major human impacts to ocean environments include overexploitation, land-based sources of pollution, invasive species, climate change, and other human activities. The cumulative impacts of these stressors have become increasingly well documented at regional [3,4] and global scales [5], and recent research indicates that when multiple stressors interact, the number of synergistic interactions can become even more ecologically severe [6].

Coastal and marine governance has for the most part been slow to adapt to the intensifying nature of human interactions with the oceans. Ocean governance systems comprise the set of regulatory processes and institutions through which human factors influence actions and environmental outcomes. Governance systems vary based on the institutional architecture specific to a given place, sociopolitical context, legal and policy regime, or

scale of a given system [7]. Ocean governance has primarily focused on regulating individual sectors, ignoring interactions among sectors and with ocean ecosystems, and placing at risk the heritage, livelihoods, and cultures of coastal communities that rely on healthy ocean environments [8–10]. Centralized governance structures that do not take social–ecological linkages into account have resulted in problems with compliance and increased conflict between ocean uses, and in some cases, governance failures [11,12]. Further, the globalization of market systems and global environmental change has made it difficult for local or national-level governance systems to effectively manage the threats and pressures placed upon marine ecosystems [13,14].

To address failures in ocean governance, new perspectives have emerged that explore a more holistic approach to manage complex seascapes. These include spatial management approaches such as marine protected areas and marine spatial planning, which both seek to implement ecosystem-based management. Ecosystem-based management (EBM) is described as “an integrated approach to management that considers the entire ecosystem, including humans. The goal of EBM is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. EBM differs from conventional approaches that usually focus on a single species, sector, activity, or concern; it considers the cumulative impacts of different sectors” [15].

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emphasis added. Although core aspects of EBM have been articulated in the academic literature e.g., [16–18], conventional management approaches are only just beginning to develop EBM approaches on the ground. This implementation gap has been attributed to the complexity of resource governance systems in coastal zones [10], the complexity of natural ecosystems themselves, and critically the lack of understanding of how to integrate social information about resource users, stakeholders, and diverse coastal communities effectively into ecosystem-based ocean planning and management [19–21].

Human dimensions data and applied social research are increasingly recognized as indispensable to management, conservation, and policy around the globe [22–24]. As defined here, social data refer to information on the diversity of human activities, uses, and relationships with ocean environments, including information on both impacts to ecosystems and the ecosystem goods and services that flow from these ecosystems to society [20]. Human dimensions research comprises a diverse, multi-disciplinary field that seeks to address the complexity of human relationships with ecosystems including their social, cultural, political, and economic dimensions [20,21].

The need to more adequately define and integrate social data into ecosystem-based management, and ocean planning and policy in particular, has become a focus of recent research. In practice, ecosystem-based ocean planning initiatives have increasingly relied on a foundation of spatial information to develop plans and management strategies e.g., [25–28]. In recent years, there has been substantial progress in spatial research on social dimensions of coastal and marine environments. The increased development of spatial social datasets provides more opportunity for these data to be integrated into planning process, as practitioners increasingly adopt spatial approaches to develop and implement management plans.

This article reviews progress in spatial research on human activities and social dimensions of ocean environments and explores the promise this research has for enhancing ecosystem-based ocean planning. The purpose of this review is to: (1) assess the state of spatial social research in ocean environments; (2) identify key gaps that need to be addressed by the research and practitioner community; and (3) suggest ways in which spatial social research can be more feasibly integrated into ecosystem-based ocean planning. The overarching goal of this review is to highlight the potential for this research field to advance ecosystem-based ocean planning and to illuminate pathways toward integrating both social and biophysical spatial data into planning and policy processes.

2. Methods

This literature review and synthesis focuses on characterizing the common methods, data types, and geographic distribution in spatial human dimensions research. Due to the recent, rapid expansion of social research on ocean environments, a diversity of approaches and corresponding publications have emerged in the literature. This review focuses on recent literature (from the past two decades) and relies on the following criteria to appropriately constrain this review of studies. Research included in the review: (1) assesses human ocean uses in an explicitly spatial manner; (2) clearly describes the methodology, region, and human ocean uses considered; and (3) reports the primary dataset or analysis (i.e., was not a review or synthesis of previously published work).

A broad base of peer-reviewed literature, gray literature and reports, and other sources that characterize human ocean uses was reviewed. The review was compiled from studies identified through Internet search queries between November 20, 2011 and March 20, 2012. Two web-based search engine and research tools,

Web of Science and Google Scholar, were used to identify studies. The following keywords initially comprised the search: social, human dimension, geographical informational systems, GIS, Marxan, spatial, spatial analysis, marine, fisheries, recreation, indigenous people, commercial, marine protected areas, restoration, infrastructure, compatibility, aquaculture, boating, tourism, shipping, community-based. The set of keywords was developed based on the authors' familiarity with this research area, the list was subsequently expanded as necessary to capture relevant research.

To organize this review, a typology of human ocean uses was developed that categorizes search results in a nested, hierarchical design. This approach draws on approaches that have been advanced and used by social researchers in ocean planning e.g., [29,30] (Table 1). Each spatial study that met the selection constraints was evaluated for three main components: (1) the specific human ocean uses or activities it focused on; (2) the data collection methodology utilized; and (3) the geographical region in which the research was undertaken.

3. Results

3.1. Scope of review

A total of 74 studies were identified that met the criteria for inclusion; the full list is available as supporting online material (SOM)—in a summary table (Table S1) and annotated bibliography (Table S2). The results suggest that the spatial study of human dimensions is a rapidly burgeoning field—93% of all studies were published within the last decade and 57% of studies reviewed were published within the last five years. There has been an increasing trend in the number of studies per year over the past two decades (Fig. 1).

The geographic scope of the review was global (Fig. 2). Most studies were based in North America (48%), Europe (20%), and Oceania (14%) (Table 3). 32 countries were represented in the dataset, but the majority of countries comprised only a single study (59%). 11 countries had two or more studies. Most studies were conducted in the United States (48.6%), Canada (6.8%), and the United Kingdom (5.4%).

3.2. Methodological approaches to social data

Researchers used a variety of data collection methods to assess social dimensions of the marine environment. Six primary data collection methods were identified in this review, including: (1) procurement of secondary data (e.g., using existing datasets); (2) individual interviews or surveys; (3) participatory (user-generated) approaches; (4) participant observation or on-the-water visual surveys; (5) aerial photography or remote sensing; and (6) focus groups, group interviews, or workshops. Table 2 presents the number and studies incorporating each methodology, as well as the percentage relative to the total number of studies ($n=74$); Table S1 in the SOM shows which methods are most commonly used for which human activities. Many studies utilized multiple data collection methodologies; in these instances, all of the methodologies used were included. A majority of studies (74%) focused on multiple human activities (versus single use or single sector studies). Below, the article reviews the three most common methods for collecting social data, drawing on examples from the review to highlight the utility of these approaches.

Collecting and synthesizing secondary data was the most common approach for data collection, (70% of studies). This generally involved synthesizing and analyzing pre-existing datasets on human

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