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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.

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

Table 1
A nested, hierarchical typology of human ocean uses used in this literature review and synthesis. This typology draws on previous approaches developed for ocean planning initiatives [29,30].

A. Fishing	A1. Commercial A2. Non-commercial (recreational/subsistence/cultural)
B. Recreation	B1. Non-motor/sailing B2. Motorized watercraft B3. Wildlife watching B4. Surfing B5. Kiteboarding/windsurfing B6. Diving/snorkeling B7. Paddling/rowing/kayaking or similar B8. Coastal leisure/tourism
C. Transportation	C1. Shipping lanes C2. Ferry routes C3. Cruise ship facilities
D. Energy	D1. Oil & gas development D2. Wind farms D3. Wave/tide/current
E. Ports and harbors	E1. Facilities E2. Industrial infrastructure
F. Marine protected areas	F1. No-take reserves F2. Multi-use marine parks
G. Cultural and maritime heritage sites	G1. Maritime archeology sites G2. Cultural heritage sites G3. Tribal/indigenous sacred sites
H. Mining & dredging sites	
I. Aquaculture	I1. Coastal/shoreline operations I2. Offshore installations
J. Cables & pipelines	
K. Other	

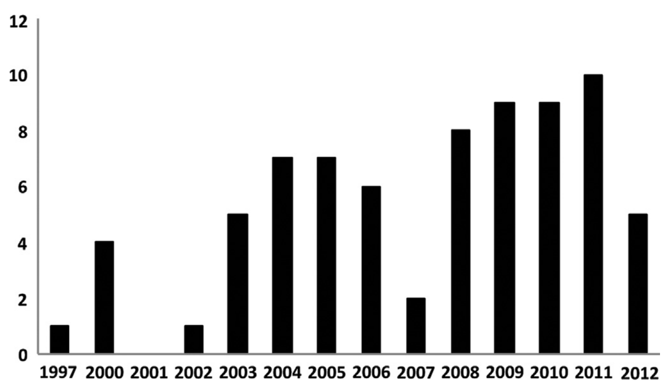

Fig. 1. Number of studies published per year during the study period.

uses such as fisheries landings, tourist densities, employment rates, and locations of existing infrastructure e.g., [3,31]. Large quantities of secondary data exist for many coastal areas, and are often compiled in accessible databases that researchers can access e.g., [32].

Secondary data were often synthesized and imported into spatial analysis software to assess interactions between human activities or sectors in a multidimensional analysis. Ban and Alder (2008), for example, investigated the cumulative intensity of marine activities in the Canadian EEZ of British Columbia, incorporating over 39 secondary data layers including recreational use, commercial exploitation, transportation, harbor infrastructure, as well as shipping. The layers were then analyzed to determine that cumulative human activities have impacted the majority of EEZ waters.

Interview or survey methodologies were often used to engage directly with ocean users and stakeholders in order to gather social information (43% of studies). Interviews typically involve direct data acquisition from interaction with ocean users and survey-based approaches delivered in a variety of ways (e.g. via face-to-face interviews, or via mail or email surveys). Interview methodologies have been used to gather more refined and ground-truthed social data that is typically unavailable through secondary sources. For example, in 2010, Cinner and Bodin, studied the value of marine resources to household livelihoods by conducting surveys with 1564 households to better understand the occupational roles of household members in the community. Key community members were then interviewed to gain an understanding of community-level infrastructure, which was then combined with socioeconomic secondary data to create a socioeconomic development index. Information gathered by surveys and interviews was then synthesized using network analysis. The resulting "livelihood landscapes" network map informs decision making by giving authorities a simple visualization that contains considerable information about occupational participation and interrelatedness [33]. Other examples used interview and survey methodologies to collect information on traditional and cultural uses [34,35] and attitudinal data on management plans or approaches [36].

Participatory, or user-generated, approaches were also frequently utilized for a comprehensive understanding of social dimensions (28% of studies). Such approaches allow ocean users to directly document or collect their own local knowledge of marine resources through working with researchers. For example, St. Martin and Hall-Arber worked with fishers in the Gulf of Maine to map fishing grounds of different fishing communities [37]. Participant fishers directly amended maps of fishing patterns, and were asked questions about community composition, spatial pattern, change over time, and local environmental knowledge. The user-generated data was then synthesized using GIS-based software to create a spatial

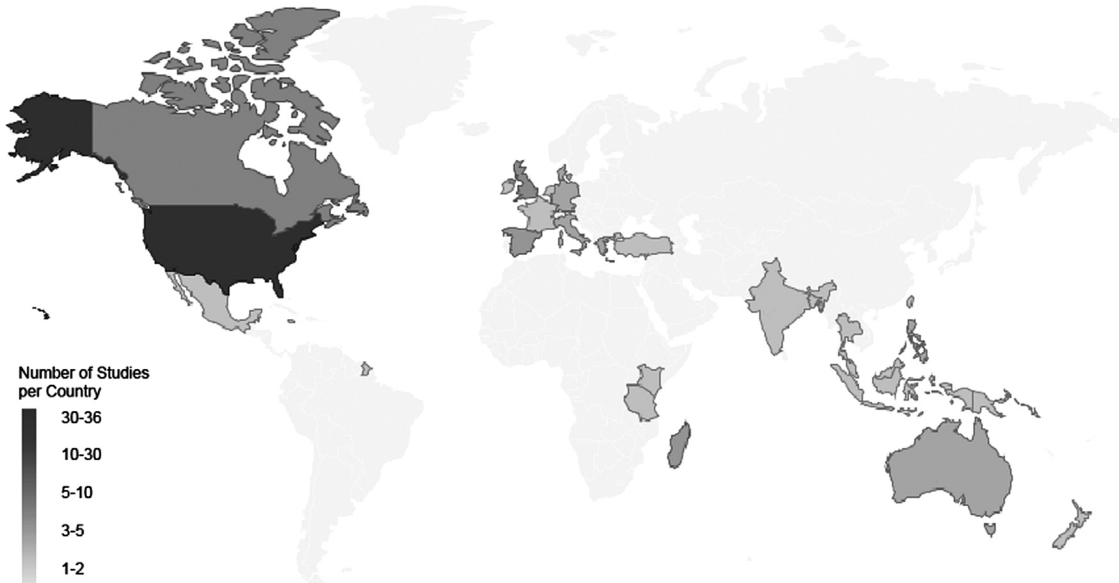

Fig. 2. The global distribution of studies that collect or analyze spatial social data. Due to the significantly higher number of studies conducted in the United States, a log $(x+1)$ transformation was used on the data in order to create the shading gradient seen in the figure, where "x" equals the number of studies conducted in that country. Figure created using open-source data visualization software "Many Eyes", developed by IBM.

Table 2
Common methods of data collection utilized in studies. VMS=vessel monitoring systems; N=74 studies.

Data collection method	Percentage of studies (%)	Number of studies
Secondary data including VMS	70	52
Interviews and surveys	43	32
Participatory (user-generated) approaches	28	21
Participant observation	24	18
Aerial photography/remote sensing	15	11
Focus groups/group interviews and workshops	14	10
Included among studies	100	74

representation of the fishing grounds for different fishing communities. Participatory mapping exercises with resource users have been used to spatially characterize an increasing diversity of social attributes, from resource locations and distributions, to social values, sense of place, and other social relationships (SOM). The spatial nature of these data allow them to be imported into various spatial tools for analysis [38].

This review also reveals a reliance on mixed-methodology approaches, which rely on multiple, different methodologies to collect and synthesize data (SOM Table S1). Such approaches were more common (62%) than those using a single data collection method. Most mixed-methodology approaches combined 2 methods (35%), with most studies relying on secondary data and interviews or surveys. Investigators combining 3 methods were less common (12%), and usually relied on interviews or surveys and, to a lesser degree, secondary data and participatory approaches.

Researchers are also increasingly relying on various spatial decision-support tools (DSTs). DSTs include a suite of spatially-explicit tools that help: (1) incorporate social and/or biophysical data; (2) allow investigators to assess management alternatives and trade-offs; (3) often include stakeholder involvement or participation; and (4) can be used to evaluate progress toward specified goals or objectives [39]. In this review, 10 studies (14%) relied on DSTs to synthesize and evaluate datasets, and such approaches were used for both basic research projects and for applied planning initiatives such as marine protected areas and marine spatial planning efforts. It is also important to note that research and planning initiatives may have relied on DSTs but the use of these tools may not have been reported in the primary literature that was the focus of this review.

3.3. Characterizing human activities in ocean environments

Researchers have spatially characterized a wide variety of human ocean uses and activities in ocean environments. These various uses and activities were categorized using a nested typology (Table 1). Overall, fishing was the most studied human use, followed closely by recreation. Other sectors studied include: marine protected areas, ports and harbors and, to a lesser degree, transportation and cultural heritage. Most studies assessed multiple human uses, which were compiled to spatially analyze the distribution of human uses and activities e.g., [40]. In some cases, researchers characterized the cumulative impacts of different activities on marine ecosystems e.g., [31].

Fishing was studied in 30% of studies reviewed, with a primary focus on commercial and recreational fishing. Fishing was studied to: (1) synthesize multiple human activities in a single ocean area [31,41]; (2) better understand the conservation impacts of fishing [41–44]; and (3) generate novel fisheries data through fishermen's local knowledge [45–47]. For example, a 2012 study by Moreno-Báez et al. interviewed fishermen in Baja, Mexico to collect local knowledge on how fishing communities utilized marine protected areas [44]. Information about where fishermen traveled, as well as the distribution and seasonality of target species were compiled to understand how uses of the areas varied in different communities. Fishers provided valuable first-hand information on the importance of marine protected areas to socioeconomic and ecological conditions of the fisheries. An additional benefit found that involving local fishermen in research fostered a sense of ownership over the research and decision-making process, which tends increase compliance with management strategies [47–52]. The results of similar studies on fishing have generated data used to inform fisheries management and large-scale, multi-use ocean planning initiatives [53,54].

Table 3
Regions where researchers have characterized spatial human ocean uses.

Regions	Percentage (%)
N. America	48
Europe	20
Oceania[a]	14
Asia	9
Africa	6
Latin & S. America	2
Antarctica	0

[a] 6/9 studies occurred in developed states and countries in Oceania, including Hawai′i, Australia, and New Zealand.

Recreation was also a commonly studied sector, occurring in 25% of all research. Studies commonly focused on the spatial intensity of recreational use of a given area, especially coastal leisure, tourism and recreational boating [55,56]. Use-intensity information was often collected for use with conservation objectives or for use with ocean planning processes [57]. The results of the study by LaFranchi and Daugherty, for example sought to gather information regarding the spatial pattern of recreational users along the state's coastline use for the state's ocean planning initiative [58]. A web-based tool was used to collect data, which collated the data and spatially analyzed the cumulative use along the state's coastline. The cumulative geospatial data on recreation was then added to Oregon's MarineMap, a spatial decision support tool used to support Oregon′s ocean planning initiative.

4. Discussion

4.1. Global research trends

The results of this review show a disparity in spatial social research between developed and less developed countries (Fig. 2). The three countries with the most research activities included the United States, Canada, and the United Kingdom. Of the 13 total countries where more than one study has been conducted, six were members of the European Union. These results suggest that spatial studies of human uses are more commonly undertaken in developed countries. However, the web-based research process may have biased the results toward developed countries, as many existing research studies may not have been published online and thus may not have been uncovered in this research. Existing examples in this review from data-poor contexts and developing countries (SOM Table S2) are particularly important for highlighting useful approaches and tools that can be successfully used in these contexts.

There are several potential factors that may explain why more spatial research on human activities is undertaken in the developed versus the developing world. First, the technical nature of spatial studies may make low-funded ventures into human use research of the ocean potentially difficult to implement. Second, financial costs are often associated with accessing and using the tools and technology required to anneal data and display results.

The most common type of social data used in the reviewed studies was secondary data, which is highly accessible and is often freely available through government agencies, particularly in countries with more developed data monitoring programs. The use of secondary data in existing research points to the utility of these monitoring programs, both for basic research and for use to support applied planning and management initiatives. The availability of secondary data collection is likely a significant driver for its predominance over other data types, and the existence of social datasets and monitoring programs may in the longer term reduce the costs associated with spatial human dimensions research. Additionally, many of the studies reviewed were associated with ocean planning initiatives such as marine protected areas or marine spatial planning efforts. It is apparent from the global distribution of research (Fig. 2) that countries with spatial data are also those that have engaged in larger and more complex ocean planning initiatives. These include the United States, Canada, and the United Kingdom, as well as Germany and Australia [59]. Comprehensive, spatially explicit ocean planning is often technologically intensive, and it is likely that countries with the economic capacity to conduct ocean planning also have more capacity (e.g., through funding, institutional support, and technical expertise) for conducting spatial human use research.

4.2. Seascape complexity and decision-support tools

The complexity of coastal seascapes creates a challenge for researchers who must synthesize multiple collection methodologies, data types, and spatial distributions into cross-sector, comprehensive analyses. The majority of studies incorporated more than one data collection methodology, suggesting that research is increasingly moving toward multiple collection methodologies in order to accurately characterize the complexity of human interactions with the ocean. The accessibility and cost-effectiveness of secondary data likely explain why this is the most commonly used data procurement method, but such data may have limitations for researchers and practitioners seeking to characterize the complexity of socioeconomic and cultural facets of a given study area. For example, secondary data can often furnish spatial information regarding fisheries landings at a large scale, but it may not capture important elements about the heritage, history, and cultural dimensions of fisheries inherent to coastal communities [60]. For these reasons, there is much growth in the development of primary datasets, particularly as part of the assessment process in various planning initiatives. This points to the rising importance of applied social research as an important data provisioning and stakeholder engagement aspect of coastal planning processes.

Researchers are also increasingly relying on a suite of decision support tools (DSTs) to synthesize spatial data and investigate the complex relationships between social and biophysical dimensions. DSTs help inform both basic research and decision-making as these tools allow investigators and practitioners to synthesize multiple collection methodologies, data types, and spatial distributions into multi-sector analyses [39,61,62]. DSTs are gaining momentum for their ability to support planning with key information at various stages of the planning process: from setting planning objectives, to identifying planning objectives and collecting initial data, to deciding between various management alternatives to monitoring and evaluating implemented plans. These tools also have advantages in that they allow researchers and planners to leverage modeling approaches and trade-off analyses. Marxan software (http://www.uq.edu.au/marxan/), for example, displays the intensity and compatibility of human uses in under a variety of conservation scenarios. In addition, tools like InVEST (http://www.naturalcapitalproject.org/InVEST.html) are able to display linkages and feedbacks between social and ecological systems, which can be used to evaluate the importance of habitat protection or restoration for the ecosystem services they provide. Many DSTs are also being developed as free, open-source data systems and technical expertise can be developed through online tutorials (e.g., SeaSketch, http://www.seasketch.org/). These factors may help these tools become more widely used, particularly in developing countries, where financial costs and expertise present barriers.

4.3. Implications for ecosystem-based ocean planning

Managing coastlines and oceans through ecosystem-based management is inherently a place-based process, and requires substantial information on both the biophysical and social dimensions of a place and their interactions in a planning region. This presents challenges for planners and managers as they seek cost-effective ways to collect, analyze, and incorporate accurate data into planning processes to achieve better outcomes. While there has been significant progress in research on biophysical and ecological attributes of ocean environments, to date there has been far less focus on social data in these systems, which has significant potential to inform and improve ecosystem-based ocean planning processes. This review highlights a growing trend in spatial research focused on the social dimensions of seascapes as researchers increasingly use novel methodologies to collect data on a variety of human uses and activities of the ocean environments. An increasing spatial emphasis enables the visualization of complex and dynamic interactions of people in the ocean environments and facilitates incorporation of social data into planning processes through decision support tools.

An increased focus on incorporating spatial social data may aid planners and managers to implement policy that reflects the social–ecological complexity of a planning region. This review uncovers promising albeit limited evidence for the successful use of social data and applied research approaches in ecosystem-based ocean planning initiatives; these examples underscore the potential of such datasets and research approaches. For example, in the United Kingdom, the Marine Management Organization (MMO) identified 11 human ocean activities ranging from fisheries to tourism and recreation to energy and port infrastructure and spatially analyzed these uses to determine their impact on community wellbeing [63]. Researchers utilized 42 socioeconomic indicators (e.g., employment, wage, labor skill level; collected primarily as secondary data), to model "best-fit" scenarios for the siting of each marine activity. In addition, the researchers collected spatial data through interviews with key authorities to gauge the perception of issues associated with marine activities along the Eastern coastline.

These spatial, social data were incorporated into various stages of planning processes. For example, an important function of the study was to inform local authorities and stakeholders as they developed regional planning processes. Additionally, researchers incorporated their findings into a digital, publically available, interactive map, which allowed the public to view datasets and to comment on the quality of each data layer displayed. Open mapping tools and technologies can help enable transparent, collaborative planning processes and help to ensure that local stakeholder knowledge plays a role in the development and evaluation of management alternatives. This example and others e.g., [62,64] highlight the importance of spatial social datasets and the role of various tools and technologies in developing collaborative and transparent planning processes.

These initiatives highlight both the progress and promise for the inclusion of human dimensions data in ecosystem-based approaches to ocean planning and management across a variety of contexts. This review indicates there is a considerable and growing body of knowledge on both the human dimensions of the ocean and the methods by which researchers are describing and understanding them. An increased understanding of the social, cultural, and economic factors of a planning region has much potential to inform planning processes. Planners can also leverage novel techniques to analyze the impact of various management alternatives on important social factors such as livelihoods or cultural heritage. Further, incorporating more social data in addition to biophysical data enables planners to better understand human–environmental relationships and the necessary trade-offs that are inherent in ecosystem-based planning. Involving stakeholders in social research can increase the success of ocean planning by fostering a sense of ownership over the research and decision-making processes, and thus increasing compliance with management guidelines [47,48,51,52]. Successful implementation of ocean planning initiatives must reflect the social conditions of the planning region and as our review has shown, efforts to describe and understand these conditions are growing in number, sophistication, and application to planning practice.

5. Conclusion

Research on social dimensions of ocean environments has intensified over the past decade and new approaches show promise in informing ecosystem-based ocean planning initiatives. This review highlights the growth in this field in terms of global coverage, range of human activities and methodologies utilized, and development of tools to support analyses for both basic research and applied planning contexts. However, this review also shows that more research is focused in the developed world, which highlights the need to reduce barriers to this applied research field in these contexts. There is considerable variability both in terms of approaches and in human use sectors studied, which may be due to the high cost of procuring primary data (e.g., through intensive field interviewing approaches). The development and implementation of social data monitoring programs are likely to benefit ocean planning initiatives, as illustrated by the high usage of available secondary data in this review. This suggests that data monitoring programs that focus on social, economic, and cultural dimensions should be developed and implemented together with existing biophysical monitoring programs. There is broad variability in research on social dimensions of ocean environments. This diversity has fostered innovation in this research sector, but integrated frameworks are needed to guide planning practitioners on how to systematically collect and integrate human dimensions data together with ecological information into planning and management initiatives. Finally, this review uncovers limited, but promising, evidence for the application of spatial social data in ecosystem-based ocean planning initiatives. A larger focus on incorporating social data into planning initiatives may produce better social and environmental outcomes, as such data can help reduce user conflicts, maximize economic efficiency, and develop management alternatives that preserve environmental quality and important coastal uses and their associated economic and cultural dimensions. Spatial research on the human dimensions of the ocean environments has much potential to engender a more comprehensive understanding of seascapes, and to aid in planning processes aimed at achieving sustainable social and ecological outcomes.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.marpol.2013.01.015.

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