Revisiting Approaches to Marine Spatial Planning: Perspectives on and Implications for the United States

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Marine spatial planning (MSP) offers an operational framework to address sustainable and well-planned use of ocean space. Spatial allocation has traditionally been single-sector, which fails to account for multiple pressures on the marine environment and user conflicts. There is a need for integrated assessments of ocean space to advance quantitative tools and decision-making. Using the example of offshore wind energy, this article offers thoughts about how MSP has evolved in the United States and how the varying scales of MSP achieve different outcomes. Finally, a review of quantitative and qualitative studies that are needed to support MSP are presented.

Key Words: MSP, Tradeoffs, Stakeholder Engagement, Offshore Wind Energy

The oceans and coasts host countless recreational, commercial, scientific, and security-related activities that often occur near the areas determined as and managed for resource protection and conservation goals (The White House Council on Environmental Quality 2010). Today, human activities – fishing, shipping, cable crossings, pipelines, and recreational activities – require a considerable amount of ocean space and place stress on marine ecosystems. Marine spatial planning (MSP) considers the interaction among various uses of the ocean in spatial and temporal scales and represents a powerful method for reconciling diverse and often seemingly overlapping needs of ocean users. As human development has expanded on land, constraints and future developments have long been managed through land use policies that employ zoning and land use restrictions (e.g., Sanchirico et al. 2010), but

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planning for future ocean uses has only recently been in the policy rhetoric in the United States.

In the United States, allocation of ocean space has traditionally been single sector, which causes user conflicts and may lack conservation objectives (Douvere 2008). The single-sector management model fails to account for the multiple, possibly conflicting ocean uses and users. However, it is not difficult to identify the origins of such a model; the oceans are governed by multiple federal and state agencies, where each agency has a somewhat narrow charter. For example, the Bureau of Ocean Energy Management (BOEM) regulates offshore oil and renewable energy by overseeing leases of the seabed, the U.S. Fish and Wildlife Service and National Marine Fisheries Service (NMFS) both manage marine mammals and endangered species, NMFS regulates commercial fishing and aquaculture, and the U.S. Coast Guard and Army Corps of Engineers both regulate ocean navigation. In all, at least twenty federal agencies are involved in ocean governance in the United States (Crowder et al. 2006) and further, each coastal state manages its coastal zone with associated regulations and state agencies. Single-sector management is ineffective in considering the multiple ocean uses by people, because it does not account for the outcomes of such interactions, cumulative effects over spatial and temporal scales, and how ecosystem services (provided to people) may be affected, nor does it allow for explicit consideration of tradeoffs among ocean users (Halpern et al. 2008).

Because ocean governance is conducted by a myriad of federal agencies under multiple laws and frameworks, Douvere (2008) recounts that achieving "economic and environmental sustainability" (p. 763) requires balancing multiple priorities. Principles of integrated coastal zone management (ICZM) were incorporated in the United States, where coastal management focused on multisector coordination (Douvere 2008). These shore-based principles were part of the early framework of ecosystem based management (EBM), which both extends beyond to the coastal zone into the ocean, and explicitly considers ecological components (Douvere 2008). The novelty of this concept in ocean planning is the focus on place, rather than on species (Crowder et al. 2006).

EBM is a management approach that considers linkages across entire ecosystems, with biological, physical, and human components (Kappel 2011). Rather than explicitly managing ecosystems, the principle of EBM is to manage the multiple human interactions with the environment (Long, Charles, and Stephenson 2015). A core goal of EBM is maintaining ecosystem services (Rosenberg and McLeod 2005). Ecosystem services are affected by environmental and social factors such as habitat, environmental quality, access, and markets (Halpern et al. 2008). People depend on ecosystem services provided by the oceans, and EBM has gained broad international acceptance, yet operationalization of EBM has remained elusive.

MSP has been suggested as both a process and a tool to facilitate EBM (Douvere 2008). Future-oriented, MSP can be an effective means of implementing ecosystem-based management that provides guidance in determining appropriate sites for future ocean uses. MSP offers an operational framework to preserve the value of marine biodiversity while also allowing sustainable and well-planned use of the economic potential of ocean space (Ehler and Douvere 2009). However, ecosystem-based management is not the only proposed solution to address the continuing problems with sustainable management of the ocean and marine species. Eagle, Sanchirico, and Thompson (2008) argue for ocean zoning as a solution to market failures that affect groups (such as commercial fishers) as well as implementation of larger conservation objectives. The authors suggest that "dominant use" areas could be allocated and would allow for more "efficient management" of ocean users (Eagle, Sanchirico, and Thompson 2008 p. 655). Sanchirico et al. (2010) extend this framework by suggesting an allocation scheme for dominant uses and user rights within those zones.

By definition, MSP, also referred to as coastal and marine spatial planning (CMSP[1]) is a public process of allocating and analyzing the spatial and temporal distribution of human activities in marine areas to fulfill economic, social, and ecological objectives that are commonly specified through political processes (UNESCO 2010). MSP is relatively nascent in the United States, in the process of moving beyond a conceptual framework to a regional, ecosystem-based planning mechanism. Efforts are currently underway in the northeast, mid-Atlantic and other regions of the United States to engage stakeholders, understand existing and future ocean uses and users, and provide a broad vision for balancing multiple regional priorities. However, the United States' experience of MSP has yet to move towards an operational framework. An operational framework, more common in European MSP, includes spatially explicit goals and defined zones for economic activity (Collie et al. 2013).

Varying Spatial Scales of MSP

MSP in the United States can be implemented at multiple spatial scales: national, regional, or state-level. The spatial scale influences process and implementation, due to the varying regulations that apply, as well as the varying drivers to MSP efforts and thus, stakeholder concerns.

National Scale MSP

MSP at the national scale is best observed through experiences of other countries. Looking to examples in Europe, MSP was mandated in several countries among the North and Baltic Seas, and has been largely a top-down approach resulting in data collection, mapping exercises, and culminating in sectoral or multi-use zones allocated to existing and future ocean users

[1] CMSP terminology is used primarily in the United States and includes planning in the coastal zone.

(Collie et al. 2013; Madsen et al. 2011). In Asia, China has traditionally engaged in MSP using a top-down approach akin to ocean zoning, and has more recently incorporated ecosystem principles, although is still managed by the ruling party of China (Lu et al. 2015).

To date, MSP in the United States bears little similarity to experiences abroad. In effect, there is no coordinated MSP effort, although President Obama addressed MSP through Executive Order 13547, establishing the National Ocean Policy (NOP) for the oceans, coasts and great lakes. However, this order emphasizes a regional, rather than national, approach to ocean planning. Emphasis on the importance of MSP in the National Ocean Policy framework is well placed, given the potential to facilitate EBM. However, the NOP was not adopted through the legislative process, and Congress has opposed implementation of MSP amid stakeholder concerns, constraints of existing ocean activities, and additional government oversight (Fluharty 2012). The NOP does not provide funding or new authority under existing agencies (Fluharty 2012) and is voluntary. Therefore, any MSP efforts must be implemented under existing authority. A key driver of the MSP effort at the national level was interest in offshore renewable energy, namely offshore wind. The U.S. Government received unsolicited lease requests, such as the Cape Wind project off the Massachusetts coast. At the time, the Federal Government had no existing framework for reviewing or leasing the ocean for renewable energy; after missteps in federal review, the project became mired in legal battles amid strong opposition by coastal residents and enthusiasts. More recently, federal agencies have supported MSP through efforts such as the Marine Cadaster, a web-based mapping platform, data repository, and support tool center for ocean planning (https://marinecadastre.gov), jointly administered by BOEM and NOAA. Further, federal agencies have supported MSP activity at the regional level.

Regional-Level MSP in the United States

While the NOP did not mandate MSP at the national level, it did strengthen ocean governance and coordination, establishing guiding principles for ocean management, and adopting a flexible framework for effective MSP to address conservation, economic activity, user conflict, and sustainable use of offshore areas. Under the NOP, federal agencies in the United States are tasked with forming regional entities to create ocean plans. There were regional ocean planning entities prior to the NOP, such as the Mid-Atlantic Regional Council on the Ocean (MARCO), and the Northeast Regional Ocean Council (NROC).[2] These entities were formed as governor's alliances in response to coordinated needs in ocean planning that affect the region. For example, one

[2] Other regions of the United States have ocean planning partnerships as well; Northeast and mid-Atlantic released the first ocean plans and are thus the focus of this discussion.

of the priorities of MARCO is offshore renewable energy, in part driven by interest in offshore wind off the coast of several mid-Atlantic states. MSP was added as an additional priority issue for MARCO as a tool to coordinate the other core areas (Bates et al. 2012). Each of these regional entities hosts a web-based mapping tool and data portal to aid planners, stakeholders, and policy makers.

The Regional Planning Bodies (RPBs) formally convened are separate from existing regional ocean alliances, consisting of federal, tribal, and fisheries management representatives. Several RPBs went through a multiyear process, and by the end of 2016, two of those regions, the Northeast[3] and the mid-Atlantic[4], had completed final ocean plans. The plans were developed after several years of data collection and aggregation, and stakeholder input, and each plan includes extensive mapping of baseline conditions and human uses. These data are meant to assist public officials, private firms, and stakeholders in understanding existing spatial and temporal uses and aspects of the ocean.

While mapping the ocean and convening stakeholders were important goals and outputs of each of these plans, the plans are notably absent in identification of areas that might be considered “zones” where one ocean use is preferred over another. Additionally, maps can be flawed, and data that are represented in aggregated spatial units can underestimate or overestimate the importance of low and high values to the casual reader, depending on how the units are displayed. Identification of preferred ocean uses is a critical aspect of MSP, especially because future ocean uses (that may conflict with existing ocean uses) have been a major driver of MSP policy and efforts. As directed in the NOP, regional ocean plans do not extend beyond mapping ocean uses and notably do not identify optimal locations for future ocean uses. Instead, examples of allocating ocean space to existing and future uses in the United States have been initiated by the states.

State-Level MSP in the United States

In the United States, early examples of MSP have been implemented by individual states, including Massachusetts and Rhode Island. Each of these was produced under state mandates and funding and resulted in identification of specific areas, or zones, for certain human use activities. These plans are notable in the approach to MSP absent a federal effort, and highlight alternative pathways to MSP in the United States.

The State of Rhode Island has used ecosystem-based management of coastal areas. Renewable energy mandates prompted the formation of the Ocean Special Area Management Plan (SAMP) to outline policies and make

[3] The Northeast Regional Ocean Plan can be found at http://neoceanplanning.org/plan/
[4] The Mid-Atlantic Regional Ocean Action Plan can be found at http://www.boem.gov/Ocean-Action-Plan/

recommendations for the siting of offshore renewable energy (Rolleri 2010). Including waters 500 feet from shore, extending into state and federal waters, the Ocean SAMP is an adaptive ecosystem-based management tool to guide the development and protection of Rhode Island's ocean resources (Rhode Island Coastal Resources Management Council (RI-CRMC) 2010). Zones for specific activities were designated, such as renewable energy development, multi-use zones, and planning areas that overlap with other states (Massachusetts) (RI-CRMC 2010).

The Rhode Island Ocean SAMP is notable for several reasons. First, authority for the Ocean SAMP was derived from an existing federal law, the Coastal Zone Management Act (CZMA) of 1972, 16 USC §§ 1451 et. seq. Rhode Island used the SAMP provision of the CZMA, which emphasizes planning for natural resource protection and growth of coastal economies (Nutters and da Silva 2012). The state extended the Ocean SAMP into federal waters, and upon approval of the Ocean SAMP by the National Oceanic and Atmospheric Administration in 2011 under the federal consistency provision, the state has authority to review any proposed ocean developments under federal jurisdiction, within the Ocean SAMP designated area.

Second, the Ocean SAMP process included extensive stakeholder input, and therefore the designation of spatially explicit zones was a collaborative approach between government and stakeholders. A high level of engagement occurred with various existing ocean users in Rhode Island, such as the fishing community, energy proponents, environmental scientists and advocates. The stakeholders involved in MSP are extensive. Stakeholder engagement can be challenging, contentious, and frustrating. Even with a process-oriented MSP in Rhode Island, commercial fishers expressed concern that they were not adequately engaged and were unable to stay abreast of deadlines and planning timelines (Nutters and da Silva 2012). Although there are challenges, engaging stakeholders in MSP may lead to desirable outcomes or outcomes that lessen tensions between stakeholders and wind developers. For example, Firestone et al. (2012, p. 1399) state:

> …when individuals are given voice and developer and government agency actions are seen as just (reasonable and fair), outcomes may be produced that feel more satisfying even if they do not please all of the stakeholders.

Proactive stakeholder engagement may have alleviated implementation delays due to opposition from key ocean users, and could also lead to jointly determined siting decisions for new technologies or mitigation measures that are effective, minimize costs, and are mutually agreeable. One highly visible outcome of this state-driven MSP effort is the development of the Block Island Wind Farm, the first commercial-scale offshore wind project in the United States.

The Commonwealth of Massachusetts also took steps in an effort to lay the framework for managing human activities on the ocean in an ecosystem-based approach, mandated in the Oceans Act of 2008. The Oceans Act required the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) to develop an Ocean Management Plan with a number of directives, including identification of appropriate locations for renewable energy projects.[5] After establishing baseline conditions, assessing priorities, and analyzing data, the study area was zoned into three regions: prohibited, renewable energy, and multi-use (EEA 2009). This process included public input; however, the plan was amended in 2015 to exclude large areas of these wind energy sites due to sensitive ecological conditions and stakeholder concerns (EEA 2015), showing the adaptive and flexible planning potential of MSP.

These examples, and other state spatial planning mechanisms, are considerably smaller scale than regional or national planning efforts, yet still required extensive stakeholder engagement. These state efforts resulted in extended knowledge of baseline environmental conditions and past and present ocean uses, and ultimately delineated *specific locations* for future ocean uses. How this process will translate to much larger ocean regions is unclear. States have the advantage of working within much smaller spatial areas and within existing policy frameworks, which reduces timelines and generates forward-thinking outcomes. Regional-scale planning has the considerable advantage of addressing ecosystem-based management, as much ocean activity is not limited to administrative boundaries. However, regional planning efforts to date have been unwilling to take the additional step of recommending locations for future ocean uses. The state-level model is a near-term approach to operationalize MSP in the United States.

Data Collection and Mapping in MSP

Regional, ecosystem-based approaches to MSP in the United States have largely focused on mapping efforts, both utilizing and aggregating existing data, and data creation from stakeholder workshops and environmental studies. The importance of mapping existing ocean uses was highlighted in early offshore wind energy proposals. Under the Energy Policy Act of 2005, and regulations promulgated by the U.S. Department of the Interior's (DOI) Minerals Management Service (now BOEM), leases can be issued for renewable energy development on the OCS beyond the federal-state water boundary (generally three nautical miles). Based on preliminary research and through its state task forces and consultation with tribes, local and state governments and federal agencies, BOEM identified "wind energy areas" (WEAs), areas that were "best" suited for development within the Atlantic Outer Continental Shelf.

The initial designation of sites by BOEM, known as *call areas*, was not without controversy. Within the initial site selection, some sites, such as in Maryland,

[5] The 2008 Global Warming Solutions Act mandates greenhouse gas emissions at 80% below 1990 levels by 2050, with a target of 10–25% reduction by 2020.

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were proposed to be located either in or at the seaward terminus of existing navigational Traffic Separation Schemes (U.S. Coast Guard (USCG) 2016), while others were placed near or in the traditional vessel routes used on Atlantic coastwise transits. This created confusion among the shipping industry, offshore wind developers, and the public, and concern among other regulatory agencies such as USCG; stalling offshore wind development in some areas. Concerns over navigational safety issues and future increases in ship traffic density in the region has subsequently led the USCG to identify wind lease blocks in Maryland that should not be developed or where further study is needed. Consequently, the Maryland area that was submitted publically under a "request for interest" was reduced by more than half of the proposed allotted area, from 207 to 94 square miles (79,706 acres) (BOEM 2012). Similar concerns were voiced regarding the westernmost part of the Virginia WEA (Hagerman 2010).

Wind energy areas also have been designated in Massachusetts and Rhode Island, though amendments were made due to concerns over impacts to commercial fishing and to North Atlantic right whale habitat (BOEM 2012). In North Carolina, call areas were significantly affected by Naval interest, view from shore, and the National Park Service.[6] In the example of the North Atlantic right whales, one of the most critically endangered species in North America and facing ongoing threats as human use of the marine environment intensifies (Laist et al. 2001), known migrations occur between feeding grounds in the Gulf of Maine and calving grounds off the Florida coast, yet the routes are not well understood. Data analysis can provide estimates of the temporal and spatial scale of migration; for example, using statistical methods, Firestone et al. (2008) determined the likely departure date of whales leaving the winter calving grounds to the summer feeding grounds. In 2016, NOAA greatly expanded the critical habitat of North Atlantic right whales in the Gulf of Maine and in the southeast as far north as North Carolina. Designation of critical habitat has legal implications for marine mammals because the Endangered Species Act protects against significant habitat modification of a threatened or endangered species (*Babbitt v. Sweet Home Chapter of Communities for a Great Oregon*, 515 US 687, 1995); designation of these zones will limit any activities that may have adverse effects on whales, which may include offshore wind or other future uses of ocean space. Better understanding of the spatial and temporal patterns of migration, and periods of residency, will help ocean planning as future ocean uses are considered.

The fact that several offshore wind sites have been significantly amended due to existing human uses or environmental factors emphasizes the importance of public input and data collection during the MSP process. While these ocean uses can be

[6] National Park Service (NPS) is required to conserve scenery per the NPS Organic Act of 1916, and is thus concerned with visual impacts of wind turbines from NPS sites.

mapped and identified through the existing MSP framework, valuation of the impacts, or more importantly, explicitly considering the tradeoffs among ocean uses, is absent from MSP in the United States at the regional and national level.

Role of the Community in the MSP Process

Understanding Stakeholder Concerns

The process of engaging the public in a meaningful way is a vital step in planning for future uses of the ocean (National Research Council 2008). Stakeholders are people who have an interest in a project, meaning that almost any person or group can be considered a stakeholder (NOAA 2007). Stakeholders may be local citizens or institutions, with institutions often having better access to the decision-making process (McGlashan and Williams 2003). With 39% of the United States population living in a county directly adjacent to the shoreline (National Ocean Service 2014), affected residents are numerous. The interests of these stakeholders vary from concerns about lifestyle and enjoyment of natural places, to concerns of wildlife, and the effect on livelihoods. Engaging the public can include providing information, having a two-way consultation, or interactive participation. By simply providing information, large audiences can be reached quickly, but such communication does not usually leave room for debate and thus is limiting. To have a dialogue and foster consensus and interaction, activities such as meetings, committees, and workshops can be facilitated (Johnson and Dagg 2003). For example, during the development of Rhode Island's Ocean SAMP, community meetings, presentations, participatory mapping, and direct communication were all incorporated to enhance public awareness, provide an opportunity for the public to be heard, and to gain insight into public preferences (RI-CRMC 2010).

Stakeholder engagement has long been a component of resource management, with the degree of inclusion varying greatly. Stakeholders are commonly consulted when a new, major program or initiative is proposed. In general, engaging a wider community of people can benefit resource planning, by highlighting alternatives and by bringing additional knowledge to the table (Johnson and Dagg 2003). Early engagement in the planning process for resource management decisions is especially advantageous (Johnson and Dagg 2003). As coastal areas are usually densely populated, the MSP process is likely to attract a variety of users who are highly knowledgeable about the coastal environment (Johnson and Dagg 2003). Examples of stakeholders in the MSP process include citizens, electric utility providers, federal and state government employees, tribal representatives, NGOs, interest groups, resource users, residents of coastal areas, among others. Using MSP to plan for future ocean uses, such as offshore wind infrastructure, can serve as an excellent platform for public consultation, given the variety of users of the ocean.

Differing views about which activities should occur and where, and overlapping uses can generate conflict and tensions among stakeholders. Certain stakeholders have voiced concerns about future ocean uses as an industry, such as commercial fishers. For example, nine commercial fishing organizations sought an injunction for the lease sale of the New York WEA in 2017 (*Fisheries Survival Fund v. Jewell,* U.S. District Court for D.C., 2017) in part due to the loss of fishing grounds if an offshore wind farm were developed off the coast of New York/New Jersey (the injunction was denied). These users, and other users such as commercial shippers, or the military, are likely to be more concerned with *where* new uses or developments are sited, rather than *if* they are developed, because their use of the ocean is spatially defined. On the other hand, wildlife conservationists may be more likely to be concerned about *whether* future development progresses at all, because marine wildlife will likely occupy any and all each of the locations suggested for new development, although the species distributions and habitat quality vary. In the example of offshore wind energy, however, when facing energy choices where decisions may exacerbate versus mitigate climate change, the siting of offshore wind will likely be of critical interest to wildlife conservationists. Engaging stakeholders and addressing these concerns early in the process may lead to better siting and planning decisions, and potentially avoid costly delays and negative media attention. These were some of the issues facing the Cape Wind project off the coast of Massachusetts (Kempton et al. 2005).

Applying Public Opinion Research to MSP

Research scientists, regulatory agencies and ocean industry developers should make greater use of surveys and public engagement strategies, such as meetings, dialogues and workshops (Johnson and Dagg 2003) in coastal communities early in the planning and siting process. This could provide a baseline for understanding the key challenges and concerns and address/mitigate those concerns as part of a proposal moving forward. This is in contrast with the National Environmental Policy Act (NEPA), in which stakeholders have an opportunity to comment on the scope and draft plans of any federal actions that may have the potential for environmental impacts when an Environmental Impact Statement is prepared, but in general, stakeholders are not directly involved in the formulation of policy and decisions and thus consultation becomes more reactive than proactive.

Consideration of stakeholders is a key tenant of MSP (Douvere 2008), and a critical component in wind energy planning; thorough assessments of affected communities *before* energy developments are underway can increase economic efficiency and avoid lengthy and costly delays in project development. Beyond stakeholder engagement, survey research should be incorporated into MSP efforts. As new ocean uses are proposed and ocean space is allocated for new activities, people who may be affected by those developments can be vocal advocates or opponents and affect both timelines and implementation.

Studies have shown that people who reside in coastal areas seem to have a special attachment to the ocean landscape, or the "seascape" (Kempton et al. 2005). A recent study indicates that in geographically proximate communities, drivers of support for and opposition to offshore wind energy can differ significantly (Bates and Firestone 2015). One aspect of public choice of offshore wind energy considers Willingness to Pay (WTP), and more specifically, the spatial dimension of choice. For example, Krueger, Parsons, and Firestone (2011) used a stated preference choice model to capture the external costs to coastal residents where wind turbines would be seen from shore at different distances. The authors (ibid) were able to determine the external cost differences by distance and identify distances at which the external costs drop dramatically. A comprehensive review of renewable energy economic preferences detail the methods and results of known studies, identifying a "significant gap" in understanding the spatial effects on stated preference (Knapp and Ladenburg 2015, p. 6196). What is known, however, is that local opposition to renewable energy has substantially slowed development both on land and offshore (Aitken, McDonald, and Strachan 2008; Bell et al. 2013; Haggett 2011). These studies highlight the importance of community engagement and public opinion research in the early stages of identification of future ocean uses, and subsequent proposals to develop those sites. Examining each community separately enlightens that perceptions vary between different communities, which in turn informs public engagement priorities. Importantly, public opinion is nuanced and a number of factors are likely to be relevant as to whether communities come together in support changes to the seascape, or reject such a proposal.

In addition to public opinion research, social science methods can identify areas of importance to maritime communities (Bates 2016; St. Martin and Hall-Arber 2008). For example, participatory mapping is a tool that can help wind energy planners and industry alike by asking the fishing community to identify and assign a relative importance value to productive fishing grounds and associated supporting services (e.g., Klain and Chan 2012). Efforts to identify important fishing grounds may use data from vessel monitoring systems (VMS) for empirical analysis (Fock 2008), or vessel trip reports (VTR) to quantify net revenue of commercial fishing at specific locations (Jin, Hoagland, and Wikgren 2013). Hoagland et al. (2015) quantified regional economic impacts and welfare effects from a complete spatial exclusion of commercial fishing in one area of the northwestern Atlantic from offshore wind facilities. Evaluation of spatial conflict can be completed within the framework of MSP, but has not yet been incorporated into U.S. regional plans.

Decision Support Tools that Support MSP

Economists, policy analysts and other scientists can help the MSP process and regulatory authorities by contributing to the analysis of ocean space. While the current questions surrounding MSP efforts in the United States seem to be based on where *existing* ocean uses are *currently* occurring, the more important and useful questions should be where *existing and future* uses *should* be occurring. Currently, mapping exercises are useful in answering the first question, but complex analyses including quantitative models, qualitative studies, impact evaluation, and incorporation of user and traditional knowledge all are necessary to operationalize MSP and to answer the second question. Analytical decision-support tools are necessary to both avoid conflict among ocean users, and also to identify optimal solutions that have the highest value to society. Such tools can assist planners with specific information that supports analysis and decision-making (Collie et al. 2013). More broadly, decision tools must be used with conservation objectives at the forefront, which necessarily combines ecology with social, economic, and legal objectives (Hughes et al. 2005). Balancing conservation targets with other goals, such as fisheries management, has been implemented in marine reserve design in early examples of marine planning, such as marine zoning in the Great Barrier Reef, and includes both biological and economic principles (e.g., Gaines et al. 2010; Hastings and Botsford 2003; Sanchirico and Wilen 2001; Stewart and Possingham 2005).

Quantitative studies can analyze the potential conflicts between current and future ocean uses, and optimize scenarios for development that maximize value. Evaluating spatial use patterns to achieve biological and economic efficiency has been used in land management (Polasky et al. 2008). A number of models have been implemented to assist decision-making for EBM, and by extension, MSP. Economic decision-support tools for EBM are described in detail by Holland, Sanchirico, and Johnston (2010). Quantitative models assess the effects of alternative actions on the value of ecosystem services to humans—a value that can be used as either as an evaluation or decision criterion. In the example of offshore wind energy, locations suitable for large-scale development have largely been determined by government allocation or at the request of a wind developer. Using quantitative methods is one way to account for competing ocean users, and can lead to better siting of wind energy facilities while providing significant economic benefits to society, by increasing net revenues both to the wind industry and to other industries, such as commercial fishing (White, Halpern, and Kappel 2012). Some examples of quantitative models that have been implemented in either multi-sector analysis or MSP are described below, to provide a foundation and springboard for future research.

Although MSP aims to balance multiple uses of the ocean simultaneously, it is often both useful and practical to consider two high-priority uses at a time, in order to facilitate an analysis of tradeoffs and properly account for each use. Some initial studies have quantified marine uses and users. For example, the U.S. Coast Guard prepared a shipping study, the *Atlantic Port Access Route Study* (2016), specifically to address potential shipping conflicts and to evaluate the need for modifications to the current vessel routing measures to accommodate offshore wind energy development. Cost-effective analysis (CEA) was implemented by Samoteskul et al. (2014) to compare the costs and benefits to society from building offshore wind projects near shore or farther off the coast. They show that significant cost savings to society can occur by modifying commonly-used shipping transit routes. Moving vessels farther offshore allows for greater wind energy development closer to shore, with significant reductions in the cost of construction, operations and maintenance at a comparably small cost to shippers (ibid).

Ecosystem services are not always easily monetized, and can be difficult to represent in the MSP context. Asking stakeholders to provide data on areas and importance of ecosystem services through participatory mapping, intangible values can be included in the MSP context (Klain and Chan 2012). Importantly, these models can help managers make decisions about societal tradeoffs when conflicting uses exist.

Ecosystem tradeoffs analysis is well suited to EBM (Holland, Sanchirico, and Johnston 2010) but a full tradeoffs analysis, using market and non-market values, is rarely used in MSP (Collie et al. 2013). However, decision-support tools can be used to support tradeoff analysis that generate either *optimal* scenarios, or *user-defined* objectives (Collie et al. 2013). Lester et al. (2013) examine ways in which ecosystem service tradeoff analysis can be integrated into EBM to inform MSP by modeling the optimal distance from shore to locate a wave energy facility using values for viewshed, crab fishery profits, and profits from the wave energy facility. The authors analyze multiple scenarios and derive solutions that increase one service without a large cost of the other (ibid). White, Halpern, and Kappel (2012) revealed the value of using tradeoff analysis for ecosystem services in the marine realm, showing that it can be extended into the framework of MSP and increase net benefits to society. However, a typical net present value (NPV) evaluation might be incomplete because certain societal preferences (e.g., existence and bequest values) and certain benefits (e.g., climate change and health benefits from wind power displacing fossil fuel generation) may not be priced in the market, therefore underestimating benefits to society.

Economic cost data also may be used to evaluate areas most suitable for ocean development. Notably, the Spatially Continuous Resource Economic Analysis Model for offshore wind (SCREAM-offshore wind) builds upon earlier models and consists of three spatial elements, joined together to identify suitable areas for wind development. The elements include: 1) a wind power production calculator using wind power density and wind power technology data with an output of MWh/unit area; 2) levelized production costs, including cable/turbine/foundation costs, investments, and O&M; and 3) exclusion of areas deemed legally or practically unsuitable, or areas otherwise occupied (Moller 2011).

In a different framework, a compatibility analysis was completed by quantifying the harvestable wave energy on the west coast of Vancouver Island, Canada, and comparing wave energy with conflicting marine uses (Kim et al. 2012). Wave energy value was expressed in NPV (discounted revenue and costs over the lifetime of the system). They also examined other marine uses with areas that have a positive NPV to assess the spatial conflict (Kim et al. 2012). In a similar vein, offshore wind potential was compared for conflict or compatibility with commercial fishing in the mid-Atlantic, with a spatially explicit model that used fishing effort and spatially variable costs of wind power (Bates 2016). This method identifies how costs vary spatially if one region is chosen over another for future energy development, and how the cost per unit of energy will be affected. This is a straightforward method to highlight the tradeoffs that must be made to accommodate existing ocean users, if suboptimal (higher cost per unit energy) locations are selected for wind development. This study (ibid) also highlights that we too often refer to broad categories of users—in this case "commercial fishermen," while the potential conflicts that arise differ by much smaller segments of those categories.

Risk assessment can facilitate MSP as it helps place estimates on the likelihood and severity of positive or negative effects on human, biological and physical systems (Ram 2008). Risk assessment also may assist stakeholders in understanding the interactions among multiple threats and measure change within complex, highly interconnected systems under conditions of uncertainty (Ram 2008). Within a MSP framework, risk assessment may be especially useful for effective siting strategies. These are based on avoiding irreducible risks, mitigating those risks that cannot be reduced, and applying adaptive, cost-effective practices when possible (Ram 2009 p. 3–4). Risk analysis has been used to assess the potential ocean user conflicts in a MSP context. Using pre-defined conflict values, Gimpel et al. (2013) identify risk drivers, such as offshore wind, that affect ecosystem services, such as fisheries. Conflict values between fisheries and offshore wind were predetermined on a scale of zero (no conflict) to five (mutually exclusive), using presence or absence of a specific fishery in an area as the evaluation metric rather than the level of fishing in that area. Finally, Gimpel et al. (2013) use Geographic Information Systems (GIS) map overlays to identify areas in which there are low, medium and high levels of conflict of ocean uses.

Closing Thoughts

This essay uncovers the current framework and challenges of ocean planning in the United States, and many research opportunities remain. Importantly, a key message is that community values towards ocean development may vary significantly, and therefore communities should be researched independently. Findings from such studies inform the policy process and provide context to ocean development, but independent efforts should be undertaken in relevant communities to understand where key issues exist, and to inform a public engagement strategy. A second key message is that we must make use of analytical tools and conduct explicit analyses for future ocean uses, to understand the implications of shifting ocean uses. Without such analyses, we cannot make informed decisions about the growth and scale of new and existing industries.

Because of the limited policy formation surrounding ocean zoning, it appears unlikely that the United States will allocate portions of the ocean exclusively by zones in a way that other countries have done, at least in the near future, or like it has been done on land (e.g., national forest management plans), and future developers and regulatory agencies will likely suggest spatial zones for development. Having access to a spatially explicit representation of conflict areas of multiple ocean users can expedite that process and minimize conflict. Sectoral analyses may have a place within the MSP context, and early studies can inform which stakeholders to engage, and in what capacity. However, analyses of multiple stakeholders will better inform siting decisions for future development such as offshore wind. In keeping with the principles of MSP, multiple stakeholders should be accounted for and jointly incorporated into conflict scenarios. This is a key tenet of the National Ocean Policy and can guide efforts to develop comprehensive spatial plans in the United States.

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