A practical approach for putting people in ecosystem-based ocean planning

John N Kittinger[1,2*], J Zachary Koehn[1], Elodie Le Cornu[1,3], Natalie C Ban[4,5], Morgan Gopnik[6], Matt Armsby[7,8], Cassandra Brooks[9], Mark H Carr[10], Joshua E Cinner[4], Amanda Cravens[9], Mimi D'Iorio[11], Ashley Erickson[1], Elena M Finkbeiner[12], Melissa M Foley[1,13], Rod Fujita[14], Stefan Gelcich[15], Kevin St Martin[16], Erin Prahler[1], Daniel R Reineman[9], Janna Shackeroff[6], Crow White[17], Margaret R Caldwell[1,7], and Larry B Crowder[1,12]

Marine and coastal ecosystems provide important benefits and services to coastal communities across the globe, but assessing the diversity of social relationships with oceans can prove difficult for conservation scientists and practitioners. This presents barriers to incorporating social dimensions of marine ecosystems into ecosystem-based planning processes, which can in turn affect the success of planning and management initiatives. Following a global assessment of social research and related planning practices in ocean environments, we present a step-by-step approach for natural resource planning practitioners to more systematically incorporate social data into ecosystem-based ocean planning. Our approach includes three sequential steps: (1) develop a typology of ocean-specific human uses that occur within the planning region of interest; (2) characterize the complexity of these uses, including the spatiotemporal variability, intensity, and diversity thereof, as well as associated conflicts and compatibility; and (3) integrate social and ecological information to assess trade-offs necessary for successful implementation of ecosystem-based ocean planning. We conclude by showing how systematic engagement of social data – together with ecological information – can create advantages for practitioners to improve planning and management outcomes.

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Ocean and coastal environments provide important benefits and services to communities worldwide (Beaumont *et al.* 2007; Barbier *et al.* 2011), yet approaches for comprehensively assessing social relationships with the ocean are currently lacking. In contrast, there are well-established methods in planning practice to assess patterns of biodiversity, habitat distributions, and other critical biophysical attributes of ecosystems, as well as approaches to include these assessments in conservation planning (Margules and Pressey 2000; Pressey and Bottrill 2009; Foley *et al.* 2010). The complex social dimensions of ocean ecosystems need to be more fully understood and integrated into planning practice to improve outcomes, particularly given that human ocean use patterns, activities, and behaviors are the principal targets for most policy and management actions (Fulton *et al.* 2011).

In a nutshell:

- Social data are critical for coastal and ocean planning, but methods and approaches lag behind biophysical assessments
- We offer step-by-step guidance that practitioners can use to characterize the social characteristics of a planning region more comprehensively
- Integrated social–ecological assessments can help resource managers identify trade-offs by weighing ecosystem services against cumulative impacts for different human activities
- Systematic engagement of social and ecological data can better provision decision-making and may help improve planning outcomes

[1]*Center for Ocean Solutions, Stanford University, Stanford Woods Institute for the Environment, Monterey, CA* *(jkittinger@gmail.com); [2]*Conservation International, Betty and Gordon Moore Center for Science and Oceans, Honolulu, HI;* [3]*Université Paul-Valéry Montpellier III, Montpellier, France;* *continued on p 456*

Although having been used to support terrestrial planning practice for decades (Friedmann 1987; Greed 1999; Hoernig *et al.* 2011), social assessments have lagged behind in ocean planning contexts, due largely to disparities in data availability and familiarity with social science research methods among planners, managers, decision makers, and researchers (hereafter "practitioners"; Koehn *et al.* 2013; Le Cornu *et al.* 2014). However, the importance of social data in marine planning and management is increasingly recognized, with myriad applications from fisheries to marine protected areas (St Martin and Hall-Arber 2008; Charles and Wilson 2009; Pollnac *et al.* 2010; Scholz *et al.* 2010). Human relationships with ocean environments are diverse, and include social, cultural, political, and economic dimensions (Cinner and David 2011; Kittinger *et al.* 2012). Correspondingly, social data can include information on a wide range of human activities, attitudes, beliefs, practices, and relationships, which can be characterized through a variety of methods (Panel 1).

There are a growing number of examples where social data have been incorporated into marine planning (eg Richardson *et al.* 2006; Klein *et al.* 2008; Ban and Klein 2009), along with integrative conceptual frameworks for incorporating social data in conservation planning

(Stephenson and Mascia 2009; Reyers *et al.* 2010; Ban *et al.* 2013). Despite these advances, practice-based approaches for incorporating social data in coastal and ocean planning are limited (eg Dahl *et al.* 2009). Furthermore, many practitioners are unfamiliar with social science methods; as a result, social data are not as commonly applied as biophysical data in ocean planning practice (Le Cornu *et al.* 2014). For these reasons, even well articulated conceptual frameworks (eg Ban *et al.* 2013) face translational barriers that inhibit their implementation. These limitations hinder the practice of conservation planning in ocean and coastal environments, and ultimately the success of planning initiatives.

The purpose of this paper is to present practical advice for planning, which can guide practitioners to incorporate social data into ecosystem-based ocean planning processes more systematically. Our approach builds on existing guidelines for practitioners (Dahl *et al.* 2009), and can be used to implement existing conceptual frameworks that incorporate social theory into conservation planning (eg Stephenson and Mascia 2009; Reyers *et al.* 2010; Ban *et al.* 2013). We base this guidance on two previously published empirical reviews, including a global assessment of spatial social research in ocean environments (ie tools available to practitioners; Koehn *et al.* 2013) and a review of the use of social data in ocean planning practice (Le Cornu *et al.* 2014). Additionally, we conducted a set of focus groups and an expert technical workshop (WebPanels 1 and 2).

Our approach seeks to meet practitioners on familiar territory, by providing a step-by-step process that is applicable to a broad range of geographies and contexts. We supplement this with real-world examples and tools to aid implementation. These guidelines focus specifically on human uses, for several reasons: (1) a recent assessment shows that planners are most familiar with this social data type (Le Cornu *et al.* 2014); (2) these data can be spatially characterized, allowing for inclusion in spatial decision-support tools; and (3) in many cases, human use data can serve as a proxy for other social factors that may be more difficult to characterize or for which data are limited (eg understanding the diversity of uses can help identify important stakeholder groups). We recognize that a diversity of social data is relevant to planning (Panel 1), and key social principles such as equity, legitimacy, power, and stakeholder engagement are highly relevant to planning processes (Hoernig *et al.* 2011; Gopnik *et al.* 2012). While these issues remain critical for research and practice, here we focus specifically on how practitioners can provision planning with adequate social data, presenting guidance that is generalizable across different scales, contexts, and levels of institutional capacity. Next, we show how practitioners can integrate social and ecological data into comprehensive assessments in order to understand trade-offs, a key component of implementing an ecosystem-based approach to ocean planning. Our overarching goal is to enable planners to more systematically incorporate social data – together with eco-

Panel 1. Moving beyond human uses: diverse social relationships require diverse data and tools for application

Planning practice can be enhanced by drawing on a wider variety of social, economic, and cultural data that incorporate human attitudes, beliefs, knowledge, preferences, and other aspects of social relationships with marine resources and ecosystems. Such data provide insights that go well beyond what planners can learn from considering human uses alone, and may have tangible impacts on planning process and outcomes. For example, planners may benefit from information on issues of community structure, social equity, or institutional capacity, in order to develop management alternatives that are acceptable to stakeholders and durable in their implementation (eg Reed 2008; Hoernig *et al.* 2011; Gopnik *et al.* 2012). To meet this challenge, researchers are developing innovative methods to assess various social dimensions of ocean ecosystems, providing new datasets and tools for practitioners. Some tools, such as bioeconomic models to inform marine reserve planning (Klein *et al.* 2008; White *et al.* 2012), have become prevalent. Newer approaches, such as assessments of stakeholder values (Raymond *et al.* 2009; Ruiz-Frau *et al.* 2011) and place attachment (Brown and Raymond 2007), are currently in development and stand to benefit planning initiatives (for a review, see Koehn *et al.* 2013). These quantitative approaches are developing alongside long-used social science research methods. For instance, social scientists often collect and analyze qualitative data – using surveys, interviews, ethnographies, and other approaches – that can yield a richness and complexity of information. These data, which are often gathered through participatory approaches, can provide a more nuanced understanding of social interactions that may be useful to planning practitioners (Hall-Arber *et al.* 2009). Ultimately, these innovations may drive monitoring efforts, data portal systems, and decision-support tools to include more social data, allowing practitioners to realize the benefits of a more comprehensive understanding of social relationships. Even with these innovations, practitioners must continue to develop practical ways not only to collect and analyze a variety of social data but also to effectively communicate results in ways that can inform planning processes.

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In Fiji, community managers work with user-derived data to consider new no-take areas in traditionally managed fisheries.

Table 1. A step-by-step approach for incorporating human use data into ocean planning practice

Process steps	*Description*
1.0 Develop a typology of human ocean uses that occur within the planning region	
1.1 Account for all human uses	Include existing and proposed human uses and activities, and past uses if relevant
1.2 Modify a general typology	Use a generalizable template of human uses (Table 2) and modify per place-based or site-specific uses. The typology of uses will vary by scale of the planning unit (eg a harbor versus a region).
2.0 Gather key information on critical aspects of human ocean uses	
2.1 Characterize spatial and temporal footprint of uses	Determine the spatial footprint and scale for uses: where does this use occur? What is the scale of use versus scale of planning unit? Temporal variability: does the use vary by season or by year?
2.2 Determine intensity and diversity of uses	Intensity: does intensity for a given use vary spatially or temporally? Diversity: how many different uses occur in the planning region or zones?
2.3 Develop a compatibility matrix	A compatibility matrix can be used to quickly assess potential conflicts and compatibility of uses. Account for threshold effects: are there thresholds for use intensities or diversities that exist?
3.0 Integrate social and ecological information into a social–ecological systems (SES) analysis	
3.1 Determine social benefits and ecological impacts of different activities	Cumulative impacts: assess ecological impacts associated with specific sectors/activities, and cumulative effects of multiple, overlapping uses Ecosystem services: assess the total value or benefit of ecosystem goods and services associated with specific sectors/activities and holistically for ecosystem components and processes in the planning region
3.2 Develop an integrated social–ecological assessment	Integrate social and biophysical information into a social–ecological assessment that can help practitioners make more informed decisions about priorities and trade-offs

logical information – in order to improve planning and management outcomes.

Integrating social data into ecosystem-based ocean planning

Our approach includes three sequential steps: (1) develop a typology of human ocean uses that occur within a planning region, (2) characterize these uses, and (3) integrate social and ecological information (Table 1). Below, we describe these primary steps and their sub-components in greater detail, drawing on examples from our literature review. Subsequently, we discuss how to integrate social data with biophysical information in social–ecological assessments for planning, and discuss important considerations specific to social data that affect use in policy and planning.

Develop a typology of human ocean uses

The first step is to identify the multiple activities that occur – or may occur in the future – within a planning region (Step 1 in Table 1). In some cases, planners may also be interested in accounting for historical human uses (eg to revive traditional fishing practices). A typology is an inventory of human uses, which practitioners can organize in a nested structure (Table 2). Human uses are context dependent and, depending on the region and issues, practitioners may be concerned with a subset of uses that are most relevant to the goals and objectives of a specific initiative. However, for holistic planning processes, all uses should first be identified through careful, on-the-ground study with the relevant communities in order to understand and comprehensively plan for social and ecological outcomes. Several typologies of human uses have previously been used in planning practices (eg Dahl *et al.* 2009), and practitioners might look to these as a starting point, modifying and reorganizing as needed from a generalizable template (Table 2). The presence or absence of legal designations, such as jurisdictional boundaries or special management zones, should be noted, given that they often influence the scope of planning alternatives and decisions, frequently by limiting specific human uses.

Characterize human ocean uses

The next step captures the complexity of human uses that occur in ocean environments (Figure 1). This step includes documenting the spatial and temporal variability of human activities, the intensity and diversity of uses, and their conflicts and compatibility in planning regions (Step 2 in Table 1).

Spatial and temporal variability

Human ocean uses can vary in both space and time (Figure 1) and capturing such variability is important for ocean planning. Many ocean activities are mobile (eg fishing and sailing; Figure 2a), some are static (ie immovable, such as offshore energy installations, shipwreck diver sites, coastal seawater intake or discharge points), and others are rigid, or relatively fixed in space through established use and are difficult to relocate (eg shipping lanes; Figure 2b). The extent to which existing and proposed uses are mobile, static, or rigid can affect the options available to ocean planners. For example, ecotourism activities such as fishing and whale-watching can be spatially optimized alongside a proposed static use such as offshore energy installations (White *et al.* 2012). Even rigid uses such as shipping lanes (Figure 2b) may be shifted – eg to protect vulnerable marine species – with possible mutual benefits for industry and marine life.

Practitioners have developed various methods for mapping and quantifying human activities in ocean spaces (for a review of tools, see Koehn *et al.* 2013). Participatory mapping with ocean users can generate primary data and may also carry benefits in terms of stakeholder engagement. Datasets on human uses are increasingly being integrated into existing spatial decision-support tools that generate visualizations to aid in planning (Center for Ocean Solutions 2011; Koehn *et al.* 2013; Merrifield *et al.* 2013).

Intensity and diversity of uses

Human ocean activities can also vary in intensity. For instance, some recreational dive sites are heavily trafficked, whereas others are used infrequently (Figure 1b). Use intensity data can be collected and mapped to assess areas of intensive use and potential conflicts. Intensity is often represented using a "heat map" for easy visualization (Figure 2b). Understanding the diversity of uses that exist within specific planning units can also aid decision makers in assessing proposed management actions. For example, mapping the range of extractive and non-extractive activities may inform the siting of a proposed marine reserve; similarly, understanding the spatial intensity of fishing can help evaluate reserve performance.

Table 2. A typology of human ocean uses, modified from Koehn *et al.* (2013), which draws on Table 7 in Dahl *et al.* (2009)

A. Fishing	A1. Commercial Commercial fishing: nets Commercial fishing: hook/line Commercial fishing: pots/traps Commercial fishing: trawls/dredges A2. Non-commercial (recreational/subsistence/cultural) Non-commercial fishing: nets Non-commercial fishing: hook/line Non-commercial fishing: pots/traps Non-commercial fishing: spearfishing
B. Recreation	B1. Non-motorized boating/sailing B2. Motorized watercraft B3. Wildlife watching B4. Surfing/kiteboarding/windsurfing B5. Diving/snorkeling B6. Paddling/rowing/kayaking
C. Transportation	C1. Shipping lanes C2. Ferry routes C3. Cruise ships
D. Energy	D1. Oil and gas development D2. Wind farms D3. Wave/tide/current energy installations
E. Ports and harbors	E1. Harbor and shipping facilities E2. Cruise ship facilities E3. Industrial infrastructure
F. Marine management areas	F1. No-take reserves F2. Multi-use marine parks F3. Scientific research reserves F4. Critical habitat for threatened species
G. Cultural and maritime heritage sites	G1. Maritime archaeology sites G2. Cultural heritage sites G3. Tribal/indigenous sacred sites
H. Mining and dredging sites	
I. Aquaculture	I1. Coastal/shoreline operations I2. Offshore installations
J. Cables and pipelines	
K. Military uses	
L. Other	

Notes: This table is generalizable and can be adapted to different contexts, with the organization of human uses reflecting importance, priority, or relevance specific to a planning initiative.

Understanding conflicts and compatibility

Planning initiatives can create opportunities to transparently address potential conflicts among ocean uses through strategic, proactive allocation of ocean space (Douvere and Ehler 2008). One tool used to achieve this is a compatibility matrix, which identifies potential conflicts versus compatibility among pairs of uses that cooccur. The matrix can then be cross-referenced with spatial use patterns to pinpoint potential areas of conflict (Figure 2c), as well as areas where multiple uses can coexist to create synergistic benefits. By way of illustration, Wiggin *et al.* (2009) used this approach to aid in the development of the Massachusetts Ocean Plan.

Some human uses exhibit intensity threshold levels that affect their degree of conflict with other activities. For example, surfing and ocean kayaking may be compatible at low use levels, but conflict may emerge at higher intensity levels. In these cases, compatibility matrices can be configured to consider the dynamic interactions between use intensity and conflict. Participatory research with user groups engaged in these activities may help characterize the thresholds for conflicts among different activities (eg Lafranchi and Daugherty 2011), but additional research is needed on spatial characterization of intensity thresholds.

Identifying complementary activities can also aid practitioners to find and promote positive synergies among

Figure 1. *Human uses of the ocean can have multiple dimensions that need to be considered in ecosystem-based ocean planning. (a) Human activities can operate at different scales in a planning region, with large, industrial shipping industries operating in the same ocean space as artisanal fishing fleets. (b) Human uses can also vary in their intensity in a planning region, including seasonal variations as illustrated by summertime dive tourism. (c) Some uses may be compatible, such as kayaking and recreational sailing, while others may not, requiring creative planning solutions to mitigate potential conflicts.*

uses and activities. For example, locating marine reserves in close proximity to areas accessed by recreational users (eg kayaking, SCUBA diving, and shore-based wildlife viewing) may simultaneously enhance the conservation goals of reserves by increasing compliance monitoring while improving wildlife viewing opportunities for recreational users.

Moving toward social–ecological assessments in ecosystem-based ocean planning

To understand the complexity of human–environmental interactions in a planning region, practitioners must ultimately bring all available social and ecological information together into integrated assessments (Pasquini *et al.* 2010; Ban *et al.* 2013). Here, we define *social–ecological assessments* as inclusive of approaches that include social and biophysical data, and explicitly assess human–environmental interactions, taking into account their dynamic nature. In planning, social–ecological assessments can also consider the extent to which different management alternatives may affect these linkages, as well as scenarios for outcomes. Efforts to develop integrated social–ecological assessments for planning are proliferating, although there is variability in terms of their level of depth and level of integration in practice (Pickett *et al.* 2001; Yli-Pelkonen and Niemelä 2005; Alessa *et al.* 2008; Okey and Loucks 2011; Halpern *et al.* 2012; Figure 3).

Human–environmental interactions in seascapes are complex, but for the purposes of social–ecological assessments, these relationships can be grouped into two primary direct interactions (following the framework in Kittinger *et al.* 2012): (1) the impacts of different human activities on ecosystems, and (2) the benefits humans derive from the ocean, often described as ecosystem services. While uses and activities are familiar concepts for practitioners, in planning the focus is often on impacts, without also considering the social benefits associated with a given use (Le Cornu *et al.* 2014). As practitioners begin to incorporate more social data into ocean planning, they will need to consider a wider range of social data that includes information on both impacts and benefits associated with human ocean uses (Step 3 in Table 1). Both of these aspects of social–ecological interactions need to be assessed if decision makers are to make informed choices about priorities and trade-offs, and to adequately evaluate management alternatives.

Anthropogenic impacts

Estimating the existing and potential impacts of human activities on ecosystem structure and function is a critical dimension of conservation planning (Pressey *et al.* 2007; Foley *et al.* 2010). In systematic conservation planning, these activities are characterized as "costs" because the establishment of ecosystem protections may displace existing activities and are thus a "cost" for conservation actions (Ban and Klein 2009). Methods for assessing impacts derive primarily from ecology and environmental sciences (eg Driver, Pressure, State, Impact, Response [DPSIR] approaches or before-after-control-impact [BACI] designs), but expert elicitation (eg Selkoe *et al.* 2008) and risk assessment approaches (eg Hobday *et al.* 2011) are often used when field data are incomplete. Although frequently associated with negative consequences, human activities can also have positive effects on ocean ecosystems (eg coastal restoration efforts to eliminate invasive species or remove marine debris).

Recently, more attention has focused on characterizing the *cumulative* impacts of many different human activities (Figure 3) rather than evaluating the individual effects of each one. Assessing cumulative impacts allows practitioners to account for potentially synergistic or nonlinear effects of multiple, overlapping human activities. Cumulative impact mapping (eg Halpern *et al.* 2008) provides a concrete tool that practitioners can use in environmental impact assessments, which have been the subject of study, litigation, and debate in the environmental law and policy field for many years.

Ecosystem services

Social benefits from ocean environments encompass a broad and diverse set of ecosystem goods and services, from food and medicines to climate control and water supply (Beaumont *et al.* 2007). Researchers in this area often characterize these services using the familiar typology from the Millennium Ecosystem Assessment framework, which includes provisioning, regulating, cultural, and supporting services (MA 2005). Scientists have developed a wide range of methods and tools to quantify these services, from monetary valuation schemes (Costanza *et al.* 1997; Barbier *et al.* 2011) to mapping a broader set of cultural values and services such as sense-of-place and cultural heritage (Green *et al.* 2009; Ruiz-Frau *et al.* 2011). Ecosystem service assessments can identify benefits that would otherwise remain unaccounted for, creating opportunities to develop service-based management interventions to improve human well-being (Figure 3).

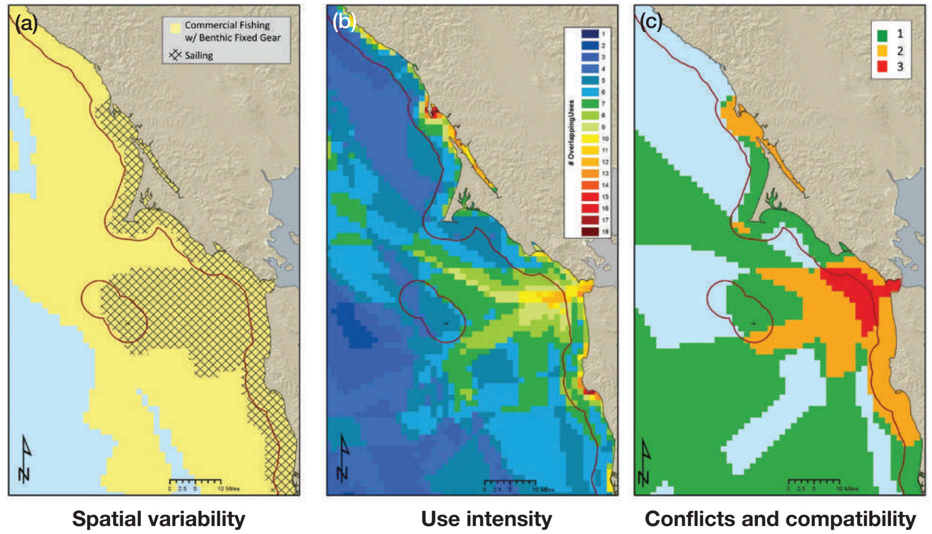

Figure 2. *Examples of spatial mapping approaches to characterize human uses in ocean environments, based on data from coastal California, outside San Francisco Bay. (a) Spatial variability is illustrated with two common activities in this coastal area: commercial fishing with benthic fixed gear and recreational sailing. These uses can also vary seasonally, resulting in temporal patterns that practitioners may need to consider. (b) Human use intensity is indicated in a "heat map", with increasing intensities (warm colors) toward the mouth of the bay and in high-use coastal zones north and south of the bay. Commercial shipping lanes, a rigid ocean use, are shown around the mouth of the bay (green and yellow areas that extend into the mouth of the bay); rigid activities are typically fixed in space and thus other uses usually navigate around these features. (c) Areas of conflict are identified by mapping different human uses, showing where overlapping activities create a high potential for negative interactions (orange [2] and red [3] zones), as well as areas of low conflict (green [1] zone). Data courtesy of the National Oceanic and Atmospheric Administration's National Marine Protected Areas Center.*

To incorporate ecosystem services more fully into ocean planning, practitioners may require better methods and tools to characterize benefits, particularly for cultural services that are difficult, or even culturally inappropriate, to quantify (Chan *et al.* 2012). Conservation initiatives that include an explicit focus on ecosystem services are associated with more successful outcomes (Goldman *et al.* 2008; Tallis *et al.* 2009; Ruckelshaus *et al.* [in press]). This success has spawned the development of various tools to characterize ecosystem services (see reviews of tools and methods in Kareiva *et al.* 2011). As ecosystem service assessment tools become more accessible to practitioners, these benefits will likely become more common in planning initiatives (Chan *et al.* 2011).

Advantages of social–ecological assessments

Integrated assessments that account for social–ecological interactions can enhance ecosystem-based planning in several ways. First, practitioners can ascribe specific benefits and impacts to different uses, activities, or sectors. By identifying ecosystem attributes that correspond with particular ecosystem services or service portfolios (eg species or ecosystem functions), practitioners can understand the consequences of diminishing those elements in terms of lost service flows with consequent impacts to human well-being. Second, practitioners can begin to assess the cumulative impacts of different overlapping uses and activities, along with the cumulative benefits (both direct and indirect) provided to human communities by ecosystems in the planning region. Finally, practitioners may be able to associate specific human uses with specific ecological outcomes. The latter is particularly important because it allows practitioners to weigh the effects of different uses on both ecological resilience and desired social outcomes (see the section below on new tools to assess trade-offs). Such approaches are likely to be most advantageous to decision makers when all relevant information (both biophysical and social) is available to make informed decisions about priorities and trade-offs. Conversely, decisions made in the absence of adequate consideration of social–ecological linkages may run the risk of undesirable and unintended outcomes (Degnbol and McCay 2007; Fulton *et al.* 2011; Kittinger *et al.* 2013).

■ Caveats and limitations of social data

Our approach raises several issues and potential limitations that practitioners must consider. First, stakeholders may be reticent – outside their families, social networks, or communities – to share the locations of sensitive cultural sites, favorite and well-guarded fishing spots, refuge sites for endangered species, or submerged historical artifacts. Although transparency in public decision-making processes is important, there is also a need to advance the appropriate use of confidential information in order to maintain trust and legitimacy. Common methods for dealing with sensi-

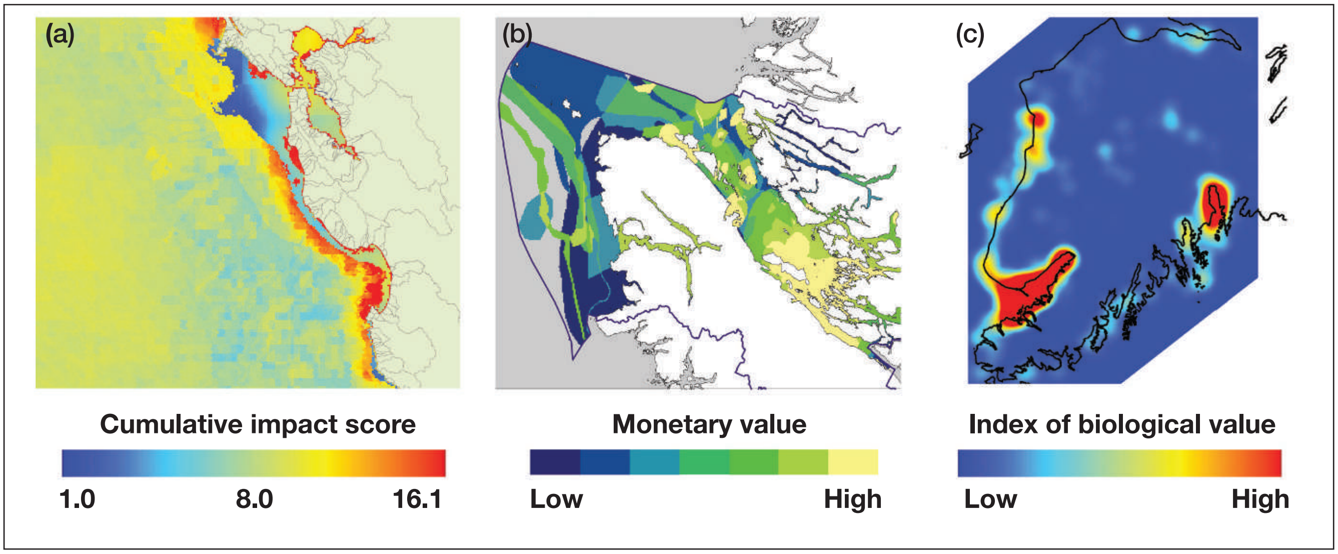

Figure 3. *Examples of spatial approaches and tools used in integrated social–ecological assessments for ecosystem-based ocean planning. (a) Mapping cumulative anthropogenic impacts in the California Current (from Halpern* et al. *2009). Determining the cumulative impacts of multiple human activities is an important step in our approach (Step 3.1 in Table 1) and can help practitioners assess the spatial heterogeneity of impacts in a planning region. (b) Spatial monetary valuations of ecosystem services as determined through participatory mapping with stakeholders in British Columbia, Canada (from Klain and Chan 2012). Mapping ecosystem services can help determine specific values and benefits that coastal communities derive from coastal ecosystems (Step 3.1 in Table 1). Together with information on the cumulative impacts of various threats, this can help practitioners better understand potential trade-offs between impacts and benefits. (c) Social–ecological "hotspot" mapping in the Kenai Peninsula, Alaska, showing overlaps between areas designated by local respondents as having high biological value and areas with estimates of high net primary productivity (from Alessa* et al. *2008). Social–ecological assessments may help decision makers make more accurate choices about priorities and trade-offs (Step 3.2 in Table 1).*

tive data include: (1) aggregating data or changing the resolution of data representations to coarser levels, (2) making data anonymous, and (3) removing sensitive data categories from datasets or data representations in products shared with the broader public. In US federal fisheries policy, for instance, landings datasets that contain fewer than three catches per reporting block are considered confidential. As with other public planning processes, decision makers may use closed sessions to review confidential data that are important to include in planning decisions but not appropriate to share with the broader public.

Second, we focus on quantifiable human use data. Human uses are not the only relevant quantitative social data and, equally important, much of the social information related to ocean environments is not amenable to quantification (Hall-Arber *et al.* 2009). One potential solution is to translate non-quantitative information into quasi-quantitative forms for inclusion in analyses. For example, social scientists are developing innovative methods to characterize various social relationships with ecosystems, developing new tools for practitioners (Panel 1; Koehn *et al.* 2013). Although these methods are novel, some social scientists may be justifiably concerned that an over-reliance on spatial, quantitative analytical methods may potentially devalue or preclude the use and consideration of critical but non-quantitative or non-spatial social information (Hall-Arber *et al.* 2009).

Third, decision makers are inevitably faced with difficult choices involving priorities and trade-offs, based on information types that are not directly comparable. For instance, it is difficult to compare the economic value of jobs and industries associated with offshore energy installations with aesthetic impacts, potential risks to human health, or cultural impacts on coastal communities. To more rigorously assess trade-offs in marine planning processes, researchers are advancing methods that include socioeconomic assessments of different human ocean uses and ecosystem services, using a variety of methods such as multi-attribute trade-off analysis (eg Brown *et al.* 2001), bioeconomic modeling (eg White *et al.* 2012), and efficiency frontiers between multiple services (eg Lester *et al.* 2013). Trade-off analyses can reveal optimal spatial management scenarios, demonstrating the benefits of comprehensive planning for multiple, interacting services over managing single services (Lester *et al.* 2013).

Finally, institutional capacity and resource constraints (eg personnel, time, or funding) determine how much effort practitioners can realistically devote to gathering and analyzing social and biophysical information. Ultimately, incorporation of *some* social data may be better than none, provided that the limitations are acknowledged. The minimum social information that practitioners will need to take into account includes the accurate characterization of human uses in a planning region (Steps 1 and 2 in Table 1). In data-limited settings, even this amount of information may be difficult to obtain (Richardson *et al.* 2006). In areas with more data, however, comprehensive social–ecological assessments can be developed to evaluate management alternatives that consider the dynamic nature of these linkages (Ban *et al.* 2013; Kittinger *et al.* 2013).

Conclusions

Our step-by-step approach seeks to aid practitioners in systematically characterizing human uses of ocean space and their interactions with ecosystems, which can help practitioners evaluate, select, and implement management alternatives. Although planning processes and initiatives will vary by context, we have endeavored to present practice-based guidance that is adaptable and applicable to a broad spectrum of legal and policy contexts, institutional capacities, and coastal settings. Our approach explicitly focuses on social data that are familiar to practitioners (ie human activities), and suggests ways these data can be extended to integrate social–ecological assessments into ecosystem-based ocean planning. Further, human use data are amenable to quantitative, spatial analyses that facilitate the use of decision-support tools now prevalent in planning.

Incorporating social data into planning is likely to create several practical advantages for practitioners, including: (1) provisioning planning processes with more comprehensive and representative social information, thus incorporating social assessment more centrally into ocean planning practice; (2) "leveling the playing field" among stakeholders through broader characterization of costs and benefits to different groups; and (3) providing stakeholders with a way to "see" their activities and interests represented in the information provided to decision makers, ideally with opportunities to shape, interpret, and act on this information. Integrated social–ecological assessments may assist practitioners in developing more comprehensive analyses for decision making, and responding more effectively to environmental or social changes, for example through more informed scenario planning. Integrated approaches are ultimately necessary to understand the deep connections between human communities and seascapes and enable opportunities for better social and environmental outcomes from planning initiatives.

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[4]*Australian Research Council Centre of Excellence for Coral Reef Studies, James Cook University, Townsville, Australia;* [5]*School of Environmental Studies, University of Victoria, Victoria, Canada;* [6]*Duke University Marine Lab, Beaufort, NC;* [7]*Environmental and Natural Resources Law and Policy Program, Stanford Law School, Stanford University, Stanford, CA;* [8]*Resources Law Group, Sacramento, CA;* [9]*Emmett Interdisciplinary Program in Environment and Resources, Stanford University, Stanford, CA;* [10]*Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA;* [11]*National Oceanic and Atmospheric Administration, National Marine Protected Areas Center, Monterey, CA;* [12]*Hopkins Marine Station, Stanford University, Pacific Grove, CA;* [13]*US Geological Survey, Pacific Coastal and Marine Science Center, Santa Cruz, CA;* [14]*Environmental Defense Fund, San Francisco, CA;* [15]*Center for Applied Ecology and Sustainability (CAPES) & Laboratorio Internacional en Cambio Global (lincglobal), Departamento de Ecología, Pontificia Universidad Católica de Chile, Casilla, Chile;* [16]*Department of Geography, Rutgers University, Piscataway, NJ;* [17]*Biological Sciences Department, California Polytechnic State University, San Luis Obispo, CA*

