Global Oceans Governance: New and Emerging Issues

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Abstract

Increased interest in oceans is leading to new and renewed global governance efforts directed toward ocean issues in areas of food production, biodiversity conservation, industrialization, global environmental change, and pollution. Global oceans governance efforts face challenges and opportunities related to the nature of oceans and to actors involved in, the scale of, and knowledge informing their governance. We review these topics generally and in relation to nine new and emerging issues: small-scale fisheries (SSFs), aquaculture, biodiversity conservation on the high seas, large marine protected areas (LMPAs), tuna fisheries, deep-sea mining, ocean acidification (OA), blue carbon (BC), and plastics pollution.

Contents

INTRODUCTION

NGO: Nongovernmental organization

OA: Ocean acidification

A review of new and emerging issues in global oceans governance is timely given contemporary interest in oceans by government, scientists, the private sector, nongovernmental organizations (NGOs), and philanthropic foundations (see Sidebar: Oceans on the Agenda). Interest is driven by both recognition of the economic potential of oceans—oceans as a development opportunity—and concern about the health of ocean ecosystems and their role in global environmental processes—oceans as a conservation concern (1–3). Governance interventions to support development and/or conservation (4) will confront a series of challenges based on the biophysical, political, and social nature of oceans.

Biophysically, oceans are vast, varied, complex, fluid, and three-dimensional. For humans, ocean environments are difficult to see beyond their surfaces, and underwater environments are hostile to and remote from habitation. As a result, many scientific unknowns remain (5). In just the past several decades, critical basic discoveries have been made, e.g., the existence of *Prochlorococcus*, a single-cell marine cyanobacteria that plays a major role in the global carbon cycle (6). Scientific understanding of new environmental concerns, e.g., ocean acidification (OA), are emerging (7). Some ocean spaces are frontiers, being explored (and exploited) for the first time. Deep-sea

OCEANS ON THE AGENDA

Increased interest in oceans governance is reflected in the rapid proliferation of international meetings over the past decade. These include the Global Ocean Forum on Oceans, Coasts, and Islands, held five times, beginning in 2001; the International Marine Protected Areas Congress, held three times, beginning in 2005; the Society for Conservation Biology's International Marine Conservation Congress, held every two years, beginning in 2009; the World Small-Scale Fisheries Congress, held twice, in 2010 and 2014; the World Ocean Summit, held three times, beginning in 2010; and the Our Oceans Conference, hosted by the US Department of State in 2014 and by the Government of Chile in 2015. These meetings reflect scientific, government, nongovernment, and private sector interests in oceans governance generally and in relation to specific ocean activities.

hydrothermal vents—with biotic communities of interest to scientists and mineral deposits of interest to the mining sector—continue to be discovered (8).

Politically, existing national and multinational oceans governance is a product of post–World War II constructions of the nation state and of the international order established by the United Nations (UN). The United Nations Convention on the Law of the Sea (UNCLOS) provides the overarching legal framework for protection and management of globally shared ocean resources in areas beyond national jurisdiction (ABNJ). Existing measures implemented through UNCLOS are issue specific; for example, Regional Fisheries Management Organizations (RFMOs) address fisheries in ABNJ. UN governance of ABNJ is often described as inadequate and incomplete, with gaps related to specific issues (9) such as biodiversity conservation (10). UNCLOS also guides signatory states in exercising authority within a 200-nautical-mile exclusive economic zone (EEZ). State authority over the seabed can extend beyond 200 miles to the extent of the continental shelf. In many states, ocean resources are conceptualized as public goods [e.g., under the Public Trust Doctrine in the United States (11)] and extracted under a variety of access regimes, including open access. With some exceptions, governments lease or license spaces and resources to individuals or firms rather than transfer them to private ownership, but communities and resource users also claim access by other means (12).

Socially, dominant Western constructions of oceans portray them as "unpeopled" spaces of nature, but not society (13, 14), and the biophysical features described above support such constructions. For most of Western industrial history, human interactions have been considered predominantly economic, with oceans providing resources and a smooth surface for ship-based trade and military movement (14). By reviewing alternative historical and cultural understandings of oceans, Steinberg (15, p. 2092) illustrates how social constructions create "the cultural and political environment in which certain interventions are deemed desirable and others deemed unattainable." Efforts to develop new or modify existing oceans governance regimes are situated within, or alternatively challenge, such constructions.

Oceans governance regimes reflect the combined biophysical, political, and social features of oceans. Western constructions of oceans as unpeopled support a commitment to freedom of the seas (14). In the post–World War II era, nationalized spaces of the EEZ and UN measures for ABNJ reflected evolving understanding of biophysical features and changing political and social commitments (9, 14, 16, 17). For example, the inaccessibility of seabed minerals in ABNJ, recognition of their potential value, and the concept of an ocean commons combined such that seabed minerals were designated as the "common heritage of mankind" by UNCLOS (14, 17). Since then, technological developments have increased mineral accessibility, and new rules to control access, minimize environmental impacts, and distribute benefits of seabed mining are being negotiated in the International Seabed Authority (ISA). These rules may or may not uphold the common heritage principle; social and political ideas about ocean resources and governance processes have also changed.

In this review, we outline the concept of environmental governance and focus on three governance themes: actors, scale, and knowledge. Under five broad categories of ocean activities—food production, biodiversity conservation, industrialization, global environmental change, and pollution—we review new and emerging issues in each: SSFs and aquaculture for food production, biodiversity conservation in ABNJ and large marine protected areas (LMPAs) for conservation, tuna fisheries and seabed mining for industrialization, OA and blue carbon (BC) for global environmental change, and plastic pollution for pollution. We selected these categories and issues based on several criteria. First, they have received attention on a developing global oceans agenda (e.g., 18), which several of us have been tracking for almost a decade (1, 2, 19, 20). Although this agenda intersects with oceans governance within EEZs and we consider such intersections, the

United Nations Convention on the Law of the Sea (UNCLOS): the legal framework for protection and management of ocean resources

Areas beyond national jurisdiction (ABNJ): include the water column (the highs seas) and the seabed (the area)

RFMO: Regional Fisheries Management Organization

Exclusive Economic Zone (EEZ): designates the extent of state authority over adjacent oceans

ISA: International Seabed Authority

Small-scale fisheries (SSFs): are difficult to define (as detailed by the FAO; see **http://www.fao.org/fishery/ssf/en**) but are generally contrasted to industrial, highly commercialized fisheries

Large marine protected areas (LMPAs): larger than 30,000–250,000 km^2

Blue carbon (BC): the carbon stored, sequestered, or released from coastal and ocean ecosystems

GPO: Global Partnership for Oceans

issues are discussed in international venues as globally significant. Second, we select issues recently identified, such as OA (7), or those long-standing but subject to renewed attention, such as SSFs (21). Third, the issues illustrate both variety and similarity in their relation to our governance themes. By choice and necessity, many issues are excluded from our review. Our attention to new issues means that long-standing issues such as coastal and marine tourism, offshore oil and gas development, and industrial fishing generally are not covered. Some new issues, e.g., sea level rise and the changing Arctic Ocean, are also omitted due to space constraints. The framing of our review reflects scholarship in the fields of human geography and political ecology, social studies of science, and common-pool resources theory, fields that are underrepresented in oceans research (e.g., compared to law or economics), but that have much to contribute to understanding and addressing oceans governance challenges.

ENVIRONMENTAL GOVERNANCE

Although the concept of governance is broad and variously defined (22), core inter-related characteristics support its contrast to government. First, governance marks a shift away from state-centric, territorial-based power and "acknowledges that a plethora of forms of social organization and political decision-making exist that are neither directed toward the state nor emanate from it" (23, p. 191). Second, governance foregrounds participation by nonstate actors (e.g., private companies, NGOs, civil society groups and movements) and shifts in influence among these (24). Third, governance problematizes categories of public and private, as well as global, national, and local. Authority is multilayered and multiscalar, and the boundaries between types of actors and the scales of interaction are porous and unfixed (25–27). Fourth, science and technology are often critical to governance, determining what and how to govern and lending legitimacy to actors seeking influence (28–30). Finally, contemporary governance often emphasizes market over regulatory mechanisms; for environmental issues, this often necessitates enclosure and privatization of the commons (26, 31).

Informed by our ongoing research tracking global oceans governance over the past decade (1, 2, 19, 20, 32), we highlight issues of actors, scale, and knowledge as themes particularly relevant to global oceans governance. A focus on governance directs us to look not only at formal politics among states, but also at the more subtle politics among diverse actors working to influence who participates in (and is subject to) governance regimes, the scale at which these governance problems are conceptualized and solutions implemented, and the knowledge that informs such decisions. This is certainly not the only way to think about governance; for example, in contrast to our emphasis on broad characteristics of governance, others have focused on more specific mechanisms and institutions for governing oceans (33, 34).

Actors

Although governance highlights the role and importance of nonstate actors, the formal politics of nation states and multilateral institutions continue to play central roles in global oceans governance due to the political history described above. Oceans have received renewed attention in the UN as reflected in the inclusion of a goal for oceans in "Transforming our World: the 2030 Agenda for Sustainable Development" (35) and the June 2015 UN General Assembly resolution on the development of a new legally binding instrument under UNCLOS to allow for the conservation and sustainable use of biodiversity in ABNJ (36). Renewed interest is also seen in the World Bank, where its Global Partnership for Oceans (GPO) (2012–2015) launched a major reinvestment in

oceans by multilateral financial institutions after more than a decade of inattention (4). Nation states pursue their interests in global oceans through the UN and related agreements.

Scientists and scientific collaborations are also key actors in global oceans governance, often in partnership with state and UN agencies. For example, the Intergovernmental Ocean Commission of the UN Educational, Scientific and Cultural Organization (IOC-UNESCO) supports more than a dozen scientific programs such as the Global Ocean Observing System. The UN Convention on Biological Diversity (CBD) has led scientific efforts to identify areas of significant biodiversity on the high seas (37), and the United Nations Food and Agricultural Organization (FAO) has overseen the identification of vulnerable marine ecosystems (VMEs) (38). The Census of Marine Life, a decade-long study of global marine biodiversity, lists hundreds of partners and sponsors—including states, multilateral agencies, the private sector, NGOs, and academic institutions.

FAO: United Nations Food and Agriculture Organization

MPA: Marine protected area

NGOs are involved in oceans governance, and UNCLOS recognized their role in the 1980s, a decade prior to their general ascendance at the 1992 UN Conference on Sustainable Development (24, 39). NGOs have unparalleled opportunities for influence in oceans governance due to governance gaps, and they exert this influence in policy development and agenda setting, education, capacity building, science, watchdogging, and rapid response (40). They have advocated for particular forms of oceans governance [e.g., marine protected areas (MPAs) (19) or ecosystem-based management (41)] and sometimes play active roles in implementation (40, 41). Many receive financial support from US and European private foundations active in oceans philanthropy. Civil society organizations with interests beyond environment are less evident, especially in ABNJ. In international negotiations related to oceans governance, topics that are politically contentious for terrestrial resources (e.g., poverty, gender, rights, justice) are seldom discussed, and when they are, it is mostly at the scale of the nation state (e.g., how small island developing states might capture more benefits from tuna fishing). Small-scale fishers are the exception, represented in international forums by organizations such as the International Collective in Support of Fishworkers or the World Fishermen's Forum (1).

Private sector actors have long been using ocean resources, and some ocean industries are major components of the global economy (e.g., shipping, industrial fisheries, offshore oil and gas extraction). Corporations are increasingly active in oceans governance, advocating for industrial best practices and engaging in public-private partnerships (P3s). In ABNJ, UN organizations are now joined by groups such as the World Ocean Council (**http://www.oceancouncil.org/**), an industry leadership alliance committed to corporate ocean responsibility. World Ocean Council programs include analyzing and seeking to influence ocean policy and a smart oceans/smart industries initiative that promotes using private sector infrastructure (e.g., ships, oil drilling platforms) as platforms for ocean science. P3s for oceans governance were a major theme at the 2014 UN Conference on Sustainable Development (hereafter Rio+20) (2) and were central in the World Bank's GPO (2, 4).

How these actors will influence emerging oceans governance is a compelling research question. In international venues such as the CBD, NGOs and ocean scientists from the Global North have been the primary advocates for conservation, particularly MPAs (19), and NGOs have played a key role in facilitating conservation in ABNJ in specific places (42). However, large international NGOs often fail to translate their international successes into policies that work at a local level (43), in part because their global conservation priorities conflict with the priorities of local communities and national governments (44), and sometimes with those of their own local-level staff (45). Similarly, Abbott et al. (4) raise questions about the private sector in oceans governance, pointing out the historical tensions among corporate, state, and NGO partners. For example, the GPO's promotion of transparency conflicts with private sector interests in proprietary data. In a subsection

of Abbott et al. (4), Liam Campling and Elizabeth Havice argue that P3s in other sectors have come with high costs to the state and risks for the public, while profits have been channeled to the private sector. On the basis of their studies of tuna fisheries, they critique the GPO for underemphasizing supply chain governance in questions of resource exploitation.

More generally, the diverse interests of ocean actors were reflected in efforts to define Blue Economy at Rio+20, where Silver et al. (2) identified four separate Blue Economy narratives: oceans as natural capital, oceans as good business, oceans as integral to small island developing states, and oceans as SSF livelihoods. Although government, NGO, scientific, civil society, and private sector actors promoting these narratives often invoked similar language, their underlying assumptions about human-ocean relationships, and thus the purpose of the Blue Economy, were quite different. Silver et al. argue that it is precisely because there is momentum toward increased oceans governance that actors worked to define the Blue Economy in particular ways; ocean actors sought to define a vision for the future of oceans governance.

Scale

Scale is relevant to oceans governance in three distinct ways. First, oceans are large in extent. Managing global oceans entails managing an environment that covers 70% of the planet (the oceans in ABNJ cover 64%). Accordingly, the extent of governance is also large. RFMOs manage fish stocks with transoceanic migrations. The FAO's *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication* (hereafter FAO-SSF Guidelines) (46) are applicable to the world's estimated 50 million small-scale fishers. Once developed, rules for extracting seabed minerals will cover the seafloor in all ABNJ and set minimum standards for mining within EEZs of UNCLOS signatory states. Governing oceans is an enormous undertaking.

Second, ecological features and processes as well as governance levels are described in scalar terms—the local, national, regional, or global—and scale denotes a relation among these. Scale and multiscalar interactions are confounding factors in global environmental governance (27, 47). One explanation for failed oceans governance is scalar mismatch; that is, a governance intervention (e.g., local fisheries management) is not well matched to the ecological scale of the feature or process being governed (e.g., migratory fish stock) (48, 49). The concern for scalar mismatch fuels support for governance at global or regional scales and coordination among scales (20). For example, Barkin & DeSombre (50) call for a new fisheries management agency to allocate individual transferable quota at a global scale. Emphasis on the global sometimes encounters resistance from proponents of the local (51), and at the very least raises questions about how scales might interact (52, 53). Berkes (48) argues that global management must integrate local management, but others are less sanguine. For example, scientists and conservationists have sometimes dismissed local claims to resources by invoking data that illuminate global and regional resource sharing (52, 54).

Third, there is a politics of scale that leads to questions of how scales are represented and to what effect (25). How do different actors invoke scale to pursue particular agendas? How are global, local, and national scales produced through efforts to govern oceans? Gruby & Campbell (32) trace the means by which some Pacific Island nations strategically enacted a Pacific Region at the meeting of the Conference of the Parties to the CBD to better influence negotiations, but also to attract funding associated with global ocean conservation. Gray et al. (20) attribute enthusiasm for MPAs to the ways in which they can align with distinct scalar narratives. Sievanen et al. (41) and Gruby & Basurto (55) illustrate how new scalar narratives about ocean resources, introduced through NGOs or international policy processes, promote particular forms of conservation in ways

that sometimes undermine existing national or local institutions for oceans governance. The fluid biophysical nature of oceans combined with the more fixed understanding of political boundaries (e.g., the EEZ separates the national and global) makes questions about the politics of scale in oceans governance particularly compelling.

Knowledge

Science and technology help us better know the oceans, "making visible what had previously been hidden or inaccessible" (56, p. 779). Remote sensing, global positioning systems, and satellite tracking illuminate ocean spaces, processes, and species from above (57), whereas remote and autonomous underwater vehicles do so from below (58). The Census of Marine Life, a decade-long study of marine biodiversity, illustrates scientific efforts to better know oceans; more than 2,500 scientists employed 30 technologies in more than 540 expeditions to discover and describe more than 1,200 new species and confirm the existence of 250,000 others (59).

Technological advancements also support development opportunities; many emerging ocean issues, e.g., seabed mining and aquaculture, are emerging because of technological possibility. These opportunities have potential environmental costs. In industrial fisheries, increased technological capacity to extract fish in the absence of governance regimes limiting fleet development has contributed to overfishing (60, 61). So-called roving bandits in fisheries are supported by both technological developments in fishing practices and technologies that support the spread of information on markets at speeds that outpace policy responses. Simultaneously, technology can support improved monitoring of vessels (62), and Global Fishing Watch (**http://www.globalfishingwatch.org**), a collaboration between Google, SkyTruth, and Oceana, illustrates such potential.

What we know about oceans interacts with how we govern them. The task of knowing oceans has generally been given to natural scientists, particularly in global governance regimes where science provides universals around which conservation projects can be structured (63, 64). What scientists (and scientific collaborations) see, however, is influenced by what they look for. Social scientists have raised the concern that studies of the global environment via the technologies described above produce representations that render people and their resource claims invisible (65) or, if they are seen, that trump them (52, 54).

Concerns about the visibility of people and their resource claims are amplified with regard to oceans, given the construction of oceans as unpeopled. This is not only a philosophical problem, but also a practical issue of data availability. Considering the spatial turn in marine resource management, St. Martin & Hall-Arbor (56) argue that data gaps in relation to the so-called human dimensions result in a cartographic silence that overlooks communities and their dependence on resources. Even when management agencies attempt to include people and their understandings of environment and resources in policymaking, agency commitments to science-based assessment and monitoring render them unable to accommodate alternative ways of knowing (66). Attention to the role of science and technology in knowing and representing oceans, and the interactions of such knowledge and representations with governance, is a critical area of research.

NEW AND EMERGING ISSUES

In the following sections we review nine new and emerging issues in global oceans governance, highlighting how governance actors, scale, and knowledge are shaping and sometimes confounding governance efforts.

Food Production

Neither SSFs nor aquaculture are new issues, but they are subject to increasing interest due to their contributions to food security and employment for millions of coastal residents, particularly the poor, and to their role in conservation and development of coastal environments and economies (21, 46, 67). SSFs are characterized by diverse fishing techniques, spatial and temporal dynamism in terms of the number and types of species caught, and low levels of capitalization (46). Aquaculture produces an estimated 50% of total seafood and has grown at an average rate of 6.2% per year since 2000 (68). Our review focuses on the culture of marine organisms, which accounts for roughly 18% of global seafood production (68). Marine aquaculture (hereafter aquaculture) operations vary in production models and species, including open water culture of tuna and other pelagics in pens, pond-based culture of shrimp, and cage-and-rope-based culture of bivalves. Aquaculture is characterized by a divergence between intensive industrial practices and small-scale operations. The diversity of production methods and contexts for both SSF and aquaculture contribute to their governance challenges.

Small-scale fisheries. Historically, SSFs have been geographically, economically, socially, and politically marginalized and have played practically no role in the development of fisheries science (and vice versa) (69). SSF diversity challenges state capacity to collect and generate landing statistics, and self-reported catch data, often linked to taxable income and/or quota allocation, suffer from under- and overreporting (70). Similar challenges constrain the quality and availability of social science data, making SSFs generally data poor. Efforts are ongoing to increase knowledge about SSFs (21).

In the mid-twentieth century, government agencies, NGOs, and multinational agencies pursued economic development and poverty alleviation via modernizing SSFs through technological investments in capture and storage infrastructure (69). As in industrial fisheries, state-sponsored subsidies resulted in bigger and more efficient boats, motors, and fishing gear, as well as larger catches over greater areas. Better processing infrastructure promised better connections to markets and larger profits. This technology-centered approach failed to attend to resource access and traditional tenure and often led to conflict over increased harvesting rates and resource depletion (71). The 2014 FAO-SSF Guidelines (46) offer a different vision of SSF development, one centered on fisher livelihoods, human rights, and institutions (72).

Historically, state governance of SSFs, in addition to the activities described above, has focused on determining what type of scientific information constitutes valid data for regulatory purposes and on controlling fisheries access through licensing, quota allocation, and other regulatory measures (69). States have yet to pay sufficient attention to fishers as actors (e.g., the ways they organize and self-govern their harvesting and marketing interactions) or to use this information to develop regulations that account for organizational differences (12). Many fishers organize through fishing associations, whereas others do so through informal contracts with patrons. Each of these forms is likely to offer very different outcomes for human well-being and conservation (12), their contributions to food security of marginalized populations (73), and even their ability to adapt to climate change (74).

Fisher organization is in part overlooked because of the dominant understanding of fishers as individual rational actors seeking to maximize individual benefits. As a result, many national governments and the World Bank's GPO promote rights-based fisheries management that emphasizes well-defined exclusionary property rights as a solution for SSF governance (75). However, rights-based reforms are often resisted by fishers themselves who do not trust that such reforms will benefit them, as seen in comparable tenure reforms for land, water, and forests (76).

NGOs have emerged as another important actor in SSF governance and are involved in certification and labeling programs to promote premium markets for sustainably caught and processed seafood. By defining the conditions under which SSF harvesting, processing, and commercialization take place, these NGOs effectively become SSF regulatory bodies. In contrast to the industrial fisheries for which certification programs were initially designed, most SSFs are unable to internalize the high costs of evaluation and sector-level reforms needed to attain certification status (77). Although there have sometimes been unexpected political benefits for certified SSFs, many challenges remain for certification in developing countries (78).

The complex interdependencies of fishers and markets with the biology of targeted species make coordination across scales of governance particularly relevant for SSFs. Fifty years ago local fishers might have been able to implement access and use agreements that contributed to human well-being and resource health (79). Increased mobility of fishers and technological development increasingly challenge fishers' abilities to self-govern, and conflicts between local fishers and highly mobile fleets are common and of global concern (62). Co-management, the shared responsibility of governance duties between government and fishers (80), is increasingly seen as a viable alternative to address larger-scale coordination needs. However, further work to determine what contributes to effective co-management is needed (81).

Aquaculture. Although aquaculture is estimated to account for 50% of global seafood, such estimates mask unevenness in the global distribution of production and consumption, and are contingent upon production projections that may considerably underestimate current aquaculture capacity (81). The 50% figure does not distinguish between freshwater and marine aquaculture, making it more difficult to understand the intersections between aquaculture, marine capture fisheries, and oceans governance. Whatever the figure, creating resilient and adaptive aquaculture systems remains a significant challenge, as monoculture and intensive coastal development may undermine long-term resilience. Climate change poses particular risks, as many high-value sectors such as shrimp and shellfish production are vulnerable to the direct impacts of sea level rise (82). Impacts on feed supply, health of cultured organisms, and shifting disease environments due to climate change are concerns for virtually all sectors, and particularly for high-value species such as shrimp and salmon (82).

Aquaculture development has primarily pursued a technically focused best management practices (BMPs) approach, in which more efficient or sustainable production practices and technologies are introduced to farmers and industry members in an attempt to curtail negative impacts. BMPs include those that prevent escape of cultured species, use preferred chemicals or feeds, avoid or reduce use of antibiotics, and properly site facilities. Efficiency gains from BMPs have frequently proven insufficient to motivate their adoption, in many cases necessitating enforcement by the state or actors in the supply chain (83). Such technical approaches do a poor job of addressing social and environmental issues that occur at scales beyond the farm level, particularly in addressing structural issues that lead to negative social and environmental outcomes for vulnerable populations (73, 84).

Both multinational agencies and NGOs have played a key role in shaping the emergence of aquaculture governance. During the 1980s and 1990s, multinational agencies supported aquaculture development in many areas of the Global South as a means of poverty alleviation and rural development. As aquaculture value chains began to mature, development goals shifted from establishing aquaculture to promoting sustainable governance (85). During this transition, a variety of NGOs participated in developing governance schemes, through drafting BMPs or developing certification and labeling programs to promote sustainable production (73). As in SSFs, certification provides a pathway for NGO, retailer, and consumer preferences to guide production practices,

and is well established in many aquaculture commodities, particularly species commonly consumed in the United States and Europe such as shrimp, salmon, and pelagic finfish (86). Despite widespread adoption, the effectiveness of aquaculture certification programs may be limited due to a lack of capacity for monitoring and oversight in producer areas (87). Furthermore, they have been criticized for undermining state-level management capacity, marginalizing producers in decision-making processes, targeting a narrow range of species, and disproportionately focusing on species and environmental issues important to consumer countries (86, 88, 89).

Aquaculture markets are increasingly global in nature, with many high-value products produced in in the Global South and consumed in the Global North. The global nature of these markets is reflected in approaches to governance, which have historically involved market-based approaches and P3s operating across scales. In developing BMPs, certification, and labeling, global actors set standards for local producers. However, not all aquaculture is tied to global markets, which precludes the use of these multiscalar approaches. The most important example is China, where roughly 72% of domestic fish and shellfish consumption comes from domestic culture (67, 90). Penetration of global governance schemes into China is minimal, and data concerning production and domestic governance trends are often unreliable (67).

Industrialization

The governance of long-standing and newly emerging ocean industries is in flux. "Old" industrial activities such as fishing are held up as examples of failed oceans governance (60, 61), whereas new industrial activities, e.g., aquaculture and seabed mining, are promoted as opportunities for developing countries and coastal communities (1, 2, 17, 91). Governance of one long-standing industrial activity (tuna fishing) and one emerging industrial activity (seabed mining) reveals the tensions between greater scientific understanding of the conservation significance and development potential of oceans and emergent questions about who should be involved in oceans governance and at what scale.

Tuna fisheries. Tuna fishing is a complex multiscalar industry. Tuna are highly migratory with transoceanic journeys that cross EEZs and ABNJ. Vessels from one country (e.g., China) purchase licenses to capture tuna in the waters of other countries [e.g., Papua New Guinea (PNG)], and it is normal for fleets that target various tuna species and stocks to be in different territorial waters at different times of the year (92, 93). Tuna fishing is also embedded in a global commodity network (94, 95). Tuna caught in the waters of PNG might be processed in hubs in Thailand or the Philippines before being shipped to canned tuna markets in Europe and the United States (94).

Regional research on tuna fishing and management in the Pacific Ocean illustrates the power dynamics and social implications of the tuna industry's multiscalar governance. Since the introduction of EEZs, tuna catch has grown from 450,000 metric tons in the 1970s to 2.2 million metric tons in 2011, for a total landed value of US$5.5 billion in 2011 (96, 97). Although Pacific Island states license foreign fleets to fish tuna in their EEZs, they capture a relatively small proportion of total economic rent, as foreign firms, sometimes with the help of national governments, negotiate license agreements with very favorable terms and then export raw catch for processing elsewhere (93, 94). In 2010, PNG—a country whose waters supply 11–12% of global tuna catch—collected 5–6% of exports valued at more than US$766 million (94).

Regional patterns in tuna distribution/migration, available infrastructure, working conditions, and colonial histories differentially temper local experiences of tuna fishing among Pacific Islanders (92, 98). One tuna cannery in Fiji, for example, has at times employed up to 70% of the available

local workforce. However, most processing happens in facilities in Southeast Asia, and it is rare for large industrial tuna fishing vessels to employ Pacific Islanders (92). To address these sorts of uneven outcomes, eight Pacific Island states have increasingly worked as a bloc under the Nauru Agreement and have been able to incrementally strengthen their control over tuna access, and in some cases to negotiate increased local processing activity (94, 96). However, even as these small successes accrue, terms of resource access remain embedded in "complex bundles and webs of power and social relations that operate across institutional and geographical boundaries" (94, p. 432) and that are influenced by a variety of actors.

The Fish Stocks Agreement, an UNCLOS implementing agreement, mandates cooperative management of all shared fish stocks. For tuna, cooperative management is facilitated through tuna RFMOs (93). RFMO processes bring together coastal states home to tuna stocks and states where fishing fleets originate, to jointly study stocks and determine management provisions such as openings and quota volumes (93). Although RFMOs are an important governance arrangement, complex political relations and significant disconnects between scientific recommendations and policy outcomes challenge RFMO management. For example, Berkes (48) and others (92, 93) have criticized RFMOs for privileging the interests of strong fishing nations, often to the disadvantage of smaller developing states.

The relationship between science and policy has been important in the North Atlantic, where North American versus European interests are at stake and are negotiated in the International Commission for the Conservation of Atlantic Tunas RFMO. At least two genetically distinct populations exist in the Atlantic (99), and they are managed as such (separated by longitude 45°W). However, recent satellite tagging data suggest mixing between populations (100). This new insight complicates management of both stocks and raises questions regarding who is responsible for taking action to rebuild them. Although satellite tagging data reveal location and movement of tuna, the meaning of such information needs to be interpreted and will not necessarily be translated into new governance regimes. Whether or not an RFMO can adjust a fixed management boundary in light of new scientific evidence remains to be seen.

Seabed mining. Significant mineral reserves (in cobalt, copper, gold, iron, manganese, nickel, rare-earth elements, silver, and zinc) exist on, and in the subsurface of, the seabed. Although private sector and state actors have recognized the economic potential of seabed minerals since at least the 1960s, technological challenges and political/regulatory uncertainty, particularly in ABNJ, have made industrial mining untenable (14, 17). However, this is changing and decisions about future mining must weigh private interests against a longer history that designated these minerals common heritage (17). When proposed during initial UNCLOS negotiations, this designation recognized the potential value of minerals, as well as the potential impacts of their removal. Politically, it also guarded against ABNJ enclosure, a possible outcome that Western nations wanted to avoid (14, 17). Although developing countries' vision of deep-sea minerals managed via a UN production company for global benefit was watered down in the 1994 UNCLOS implementing agreement, the common heritage principle remains.

The 1994 implementing agreement established ISA as the regulatory body guiding seabed development, responsible for both distribution of benefits and environmental protection. In ABNJ, exploration and exploitation must adhere to ISA guidelines. The first guidelines for exploration were adopted in 2000, but ISA has yet to provide any for exploitation. Such guidelines are needed, for several reasons. First, recent exploration activities have revealed concentrations of deep-sea mineral deposits to be significantly greater than those of remaining accessible terrestrial resources (101). Second, demand for minerals is expected to increase, given their use in many consumer goods [e.g., cell phones, laptops, hybrid cars, solar panels (101)]. Third, prospects for mining are

imminent; some of the initial exploration contracts granted by ISA are reaching their 15-year limit, and ISA is expected to convert these to exploitation contracts.

Once ISA regulations for mining in ABNJ are in place, ISA member countries will have to meet or exceed ISA standards. Regulations are on the docket for the 2016 ISA session, but a time line for their approval is unknown. In the absence of ISA regulations, coastal states with mineral resources are working to develop their own guidelines, but the world's first deep-sea mining lease was obtained in 2011, when PNG signed an agreement with Nautilus Minerals, a Canadian mining company, prior to the establishment of national guidelines. The cost of developing guidelines is high, particularly for Pacific Island nations where interest in mining is most concentrated. The Secretariat of the Pacific-European Union Deep Sea Minerals Project (SOPAC) aims to address this through a regional approach to seabed mining that will create stronger, harmonized management (**http://gsd.spc.int/dsm/**). Supported by SOPAC, The Pacific Island Forum Leaders endorsed the Regional Legislative and Regulatory Framework for deep-sea minerals in 2012, and in 2014 Tonga became the first nation to implement supporting law in their Seabed Minerals Act (102).

The key actors seeking to influence emerging governance regimes are countries with mineral resources and countries with mining industries. In ISA, a designated seating system on its Council recognizes the interests of major consumers of seabed minerals, major investors in mining, major exporters of minerals, and special interests (such as small island developing states; see **http://www.isa.org.jm**). However, as exploitation becomes a reality, broader developed versus developing country politics may emerge, particularly around benefits sharing. Non-mining countries and NGOs committed to biodiversity conservation in ABNJ may also engage more directly. For example, the Deep Sea Conservation Coalition is a group of more than 70 NGOs, fisher organizations, and law and policy institutes that have worked to influence UN regulations on deep-sea bottom trawling. It has criticized ISA for limiting participation and observation by civil society (see **http://www.savethehighseas.org**).

Although underwater environments are assumed to be undervalued by society, emerging evidence challenges this assumption (103). Public awareness of deep-sea environments is increasing as the same technologies that reveal minerals also reveal unfamiliar and exotic biodiversity. Commercial mining in PNG has faced unexpected resistance prior to any mining taking place; indigenous PNG communities have expressed concern that mining activities will interfere with customary practices such as shark calling (104). Deep-sea mining advocates often promote the minimal human impacts relative to terrestrial mining, but it would be a mistake to assume such impacts are nonexistent (105).

Biodiversity Conservation

International effort to establish a global network of MPAs is a key feature of contemporary oceans governance (19). At the center of this effort are targets, most notably the CBD target aiming to protect 10% of the ocean by 2020 (106). Although the merits of target-driven conservation are debated (107), targets have dominated the ocean conservation agenda in recent years and are clearly implicated in both the trend toward LMPAs within EEZs and the ongoing effort to establish MPAs in ABNJ (108). Although the total ocean area under protected status is less than 4% (see the WDPA; **https://www.iucn.org/about/work/programmes/gpap_home/gpap_biodiversity/gpap_wdpa/**), the rate of increase is rapid and is evidence of a broad effort to expand conservation territories at sea.

Biodiversity conservation in areas beyond national jurisdiction. There is currently no legally binding mechanism for conservation and sustainable use of biological diversity in ABNJ. Multiple actors have been working toward closing this governance gap for more than a decade, particularly by advocating for an UNCLOS implementing agreement to facilitate the establishment and management of MPAs in ABNJ (10). In 2004, the UN General Assembly established the Ad Hoc Open-ended Informal Working Group to study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction (hereafter the Working Group). After nine years of meetings, the Working Group submitted in February 2015 a recommendation that the UN develop an international, legally binding instrument under UNCLOS to better enable conservation in ABNJ (109), and in June 2015 the UN General Assembly adopted a resolution to develop such an agreement (36). The agreement will include provisions for a package of issues, including area-based management tools such as MPAs, benefit sharing in relation to marine genetic resources, environmental impact assessments, and capacity building and technology transfer (10). A preparatory committee will negotiate draft text for this agreement and report back to the UN General Assembly by the end of 2017.

In spite of recent advances in scientific knowledge related to biodiversity in ABNJ (59), many aspects of marine biological diversity (e.g., total number of species) will remain unknowable (5). However, MPAs are advocated as one important tool for effectively slowing marine biodiversity loss (110). Scientific efforts to establish criteria for identifying areas in need of increased management have advanced through several parallel UN agencies and processes. The CBD has adopted scientific criteria for identifying ecologically or biologically significant areas (EBSAs) in ABNJ, established an EBSA repository, and identified candidate EBSAs through a series of regional workshops (37), and the FAO has overseen the identification of VMEs through RFMOs (38).

We note three challenges related to the evolving science-policy domain of MPAs in ABNJ. First, the relationship between the EBSA criteria and potential MPAs will need to be negotiated. Although the development of the EBSA criteria was motivated by calls for more effective conservation in ABNJ, including through MPAs, the EBSA process has been repeatedly characterized as a scientific exercise that does not imply any political or management obligations, in order to assuage the concerns of various states (20, 37). Second, although there is complementarity among the various sets of institution-specific criteria, including EBSAs and VMEs (37, 38), the manner in which they might collectively inform the establishment of a network of MPAs in ABNJ is unclear. A systematic approach to conservation planning is needed (9), especially given the lack of cooperation between sectors to date (111). Finally, a systematic approach will need to incorporate social data and engage a broad array of stakeholders (9). The EBSA process has focused explicitly on biological data and criteria and not on use. Extensive research on MPAs within EEZs has demonstrated the importance of accounting for human uses and social context in MPAs (112). Although the social context of ABNJ is quite different from that of inshore areas, there are nonetheless multiple actors and interests (e.g., fisheries, mining, shipping) that will need to be engaged.

To date, the main actors involved in pursuing conservation in ABNJ have been states and NGOs, especially the 27 NGO members of the High Seas Alliance. NGOs have facilitated efforts to establish particular MPAs in ABNJ (42) and lobbied for an UNCLOS implementing agreement (1). Supportive states have also played a key role as champions (42). As with many international environmental issues, conservation in ABNJ is perceived as a rich country issue (20); there has been particular tension between developed and developing countries around benefit sharing in relation to marine genetic resources (10). Although all states have now agreed to negotiations on an implementing agreement, a few, including Canada, the United States, and Russia, have actively resisted this effort (1). It remains to be seen whether and how they will engage in negotiations in

the future. The private sector has not played a prominent role in the discussion thus far, although the World Ocean Council has represented the ocean business community at Working Group meetings as well as Conferences of the Parties to the CBD (113).

Until there is an UNCLOS implementing agreement, and possibly even under the mandate of a new agreement, conservation in ABNJ will need to proceed through existing institutions (111). A scalar narrative has thus emerged that identifies MPAs in ABNJ as science-based tools for the conservation of a global good that must be realized through regional agreements and organizations (20). The only MPAs in ABNJ have arisen in this manner, e.g., the OSPAR Commission in the Northeast Atlantic (114). Although these MPAs in ABNJ offer proof of concept for regional cooperation that integrates concerns for both biodiversity conservation and sustainable use of fisheries (9), they are also challenged by their nonbinding/voluntary status, inability to enforce their regulations on nonparties, and limitations of consensus-based decision making (111, 114).

Large marine protected areas. The recent expansion in LMPAs began in the early 2000s, with 16 new sites designated between 2006 and 2014, and at least four more currently under development (115). LMPAs have been variously defined as MPAs larger than 30,000 km^2 (116), 100,000 km^2 (108), or 250,000 km^2 (117). They account for most of the significant increase in global MPA coverage from 0.5% in 2010 to 2.93% in 2013 (108, 118), leading some to conclude that they provide the "best hope for arresting the global decline in marine biodiversity" (117, p. 7). Others, including many conservationists, are skeptical about their conservation value (119) and critical of their social implications (116); although helping to meet numerical targets, LMPAs may not be effectively managed (119). There is an emerging debate about the unique opportunities and challenges of "going big "(120), with many open questions about how LMPAs function as governing systems.

As vast ocean spaces often remote from populated areas, LMPAs pose numerous scale-related governance challenges. One concern is about effective monitoring and enforcement in such large areas and the potential illusion of conservation created by paper parks (119). Interest and investment in new surveillance technologies is developing rapidly, however. In addition to Global Fishing Watch, The Pew Charitable Trusts in partnership with the company Satellite Applications Catapult have developed Eyes on the Seas, a project that merges satellite tracking and imagery data with fishing vessel databases and oceanographic data to identify suspicious activities in a "Virtual Watch Room" (121). Another scalar challenge for LMPAs relates to institutional interactions. National LMPA policies that affect large portions of EEZs may interact with other institutional arrangements in new patterns with as yet unclear consequences. For example, LMPAs that ban fishing in large portions of EEZs, such as that in Palau, will interact with bilateral and multilateral tuna access agreements in ways that smaller MPAs would not (115).

Although empirical research has been limited, the emerging dynamics of decision making for LMPAs variously support and challenge theories of shrunken state and expanded civil society roles in environmental governance. There is a common assumption that remote LMPAs will be politically easier to establish than smaller MPAs closer to shore, with fewer challenges from local stakeholders (108, 122). Under this assumption, several sites have been developed through top-down processes initiated at the highest levels of government by state actors and international conservation organizations (116, 123). The largest nongovernmental programs promoting LMPAs include The Pew Charitable Trusts, Global Ocean Legacy project that aims to establish 15 marine reserves 200,000 km^2 or larger by 2022, and National Geographic's Pristine Seas project that is working with governments to establish no-take LMPAs in remote areas. The Global Ocean Legacy project is funded by philanthropic foundations, and the Pristine Seas project is supported through foundation and private sector funds. Although additional research is needed, at this stage it appears

that a significant number of LMPAs reflect hybrid forms of governance through which centralized governments are driving efforts to conserve vast ocean areas in partnership with national and international conservation NGOs and donors. The extent to which other nonstate actors (e.g., industry, indigenous populations) are engaged in the initiation and development of LMPAs is an open and important question (121).

In contrast to activities in ABNJ, science and scientists have so far played a relatively limited role in the development of LMPAs. Marine ecologists have long argued that MPAs and reserves must be scaled up to provide significant conservation benefits (124), and LMPAs have been promoted for their ability to protect connected ecosystems, habitats not often included in smaller MPAs, and highly migratory species (120). Critics question these benefits, suggesting that LMPAs in practice are established in residual, unthreatened areas to advance progress toward global targets while minimizing costs and conflict with resource users (122). There is little empirical work to resolve such debates. The establishment of LMPAs has progressed ahead of the relevant science, and research agendas are being articulated in response to their rapid development (115, 125). There is a need for both biophysical and social science research to inform the ongoing management of existing LMPAs as well as the establishment of new ones.

Global Environmental Change

The ocean activities and governance efforts described in previous sections are taking place in the context of environmental change. The oceans are critically important to the global environment and climate regulation, and there is considerable interest in better understanding, measuring, and valuing the ecosystem services oceans provide. The intersection of oceans and climate governance is manifesting in the rapid emergence of new environmental concerns and proposed solutions. This section looks at one emerging concern—OA—and one proposed solution—BC. These two issues have recently been prioritized on the global oceans agenda. For example, in *A Blueprint for Ocean and Coastal Sustainability* (126), a high-profile interagency UN report prepared for Rio+20, developing OA and BC governance strategies are proposals 1A and 1B toward future ocean and coastal sustainability.

Ocean acidification. The chemical mechanisms behind OA are well known (127), as are many of its direct impacts on certain taxa. As the oceans take up increasing atmospheric CO_2, chemical interactions reduce seawater pH (acidifying the seas) and decrease the concentration of carbonate ions necessary to form biologically important minerals such as aragonite and calcite. Mollusks, some gastropods, corals, and coralline algae rely on these minerals for shell and skeletal formation, and decreasing seawater mineral saturations inhibit proper growth (7, 127). Some fishes and other organisms experience altered larval development and brain function due to lowered pH (128, 129).

Scaling up OA's effects is a complicated task, and the relationships between OA's direct impacts and indirect ecosystem interactions are often unclear (130). For example, current OA research methods can make only limited predictions about food web interactions (128), and physiological responses vary across species and individuals (131). New research is working to address these gaps, for example finding that OA's indirect effects of habitat modification may have far-reaching consequences for fish populations (132). Further complexity arises as OA interacts with other ocean stressors such as ocean warming and deoxygenation or localized acidification events linked to seasonal and regional variation (3). Although OA is globally dependent on atmospheric CO_2, coastal pH is influenced by local processes such as eutrophication, riverine runoff, and nearshore upwelling (129, 133). Although OA's impacts on global oceans are largely negative, they are not uniform. There will likely be winners and losers with variable consequences for both

ecosystems and people (128). To account for these factors, improve future research, and better predict outcomes, scientists have called for reexamining OA through ecological theory that remains underapplied within the field (e.g., foraging theory, competition theory, biodiversity models) and suggest new research opportunities that explicitly take complexity into account (e.g., multiple stressors and evolutionary adaptation to OA) (130).

Currently, OA research and advocacy is largely driven by the scientific community, and other actors have only recently engaged OA in governance discussions (1). These actors debate both the available governance mechanisms (134) and the appropriate scale at which to address OA (135). More generally, the literature attends primarily to OA's economic and management implications, and the social and political dimensions of OA (e.g., impacts on communities or food security) are understudied (127, 135, 136). Regardless, it is clear that addressing OA may necessitate new governance interventions. For instance, coral reef area losses (136) and harvest reductions in fisheries and shellfish aquaculture (127, 137) could have significant economic costs across scales. To address this, new research has begun to explicitly include OA in integrated fisheries models (138), gauge public understanding of OA to inform better policy and management (139), and investigate emerging OA science and connect it to communities and policymakers alike (140). As Frisch et al. (139) show, even in a heavily fisheries-reliant region (Alaska) where residents are aware of OA, there is limited public understanding of its biological and economic risks.

Perhaps in response to growing frustration with global inaction on CO_2 policy (1), governance discussions have recently shifted away from framing OA as the "other- CO_2 problem," a companion to global climate change, toward a new emphasis on local and regional action (129, 133). This includes taking OA into account in (sub)national fisheries and aquaculture management (135), coastal planning and pollution laws (133), and local adaptation measures, while still acknowledging the importance of global CO_2 mitigation. This multiscalar approach brings together new actors in governance processes—such as industry, community, and regional actors—to enact OA programs at smaller scales. This is important due to the likely heterogeneity and inequity of OA impacts; many of the poorest coastal areas that rely heavily for food and income on small-scale reef and shellfish fisheries are expected to be most adversely impacted by acidification (129, 137). Efforts to engage new actors, science, and policies at smaller scales and to explore governance options that address local impacts while providing secondary benefits (e.g., pollution reduction) are emerging trends (133, 135). Rather than considering OA a singular global event, it may be more appropriately understood as a process that affects seawater, organisms, and peoples differently across space and time.

Blue carbon. BC is carbon stored in vegetated coastal ecosystems such as salt marshes, mangrove forests, and seagrass meadows (141), ecosystems that account for nearly half of the total carbon in ocean sediments and sequester carbon more quickly than terrestrial ecosystems (142). Researchers, policymakers, and other actors are working to quantify and value these habitats to support new BC governance strategies (141). Many proposed BC strategies involve monetizing coastal ecosystem services to trade on global and regional markets and draw theoretical inspiration from terrestrial payments for ecosystem services (PES) programs such as REDD+ (143, 144). They aim to provide a market-based oceans "solution" that addresses global environmental change as well as local coastal issues and are supported by many international, state, and NGO actors (142). For example, the Blue Carbon Initiative—a globally-funded partnership led by IOC-UNESCO, Conservation International, and the International Union for Conservation of Nature—is developing climate and coastal policy focused on BC management and sustainability, with an emphasis on valuation of services and financial governance mechanisms (**http://thebluecarboninitiative.org**). More

generally, BC scientists and policymakers are exploring ways to enroll BC in both new and existing carbon markets (e.g., adding mangroves to REDD+ or trading BC credits on regional voluntary markets) (143, 145).

BC strategies are representative of a more general shift toward governance characterized by an emerging Blue Economy discourse that focuses on the natural capital of oceans and coastal spaces (2). BC PES strategies continue the trend of commodifying nature in order to conserve it (31). Although this may offer real environmental benefits in some cases, it is also problematic, given that ocean and coastal spaces are often public or common property, rather than privately owned and managed. Many BC strategies require rationalizing this complexity by subsuming coastal ecosystems into the sphere of capital, a difficult and potentially detrimental process for local environments and peoples. Thomas (146, p. 34), for example, explains that although BC "represents an opportunity to support sustainability outcomes" in Malaysia's proposed Tun Mustapha Park, establishing BC programs requires navigating complicated and sometimes overlooked local factors ranging from race relations to local informal governance arrangements. In fisheries, market-based regulatory reform has met with resistance in some places while disrupting traditional practices and social relations, such as labor and wage patterns (147). In the terrestrial context, the REDD+ projects that provide models for many BC strategies have had variable outcomes both ecologically and socially (148), resulting in significant concerns over social justice, adverse community impacts, and governance gaps (149). More generally, PES schemes require translating ecosystem science into prices in ways that are sometimes incomplete or even incoherent (150), creating commodities and markets that do not reflect the multifaceted value of nature.

Ecosystem science and valuation is critical to BC strategies. In particular, ecologists, economists, and others work to determine the total areas of BC ecosystems and their carbon stores, rates of carbon sequestration, and potential carbon emissions if transformed (e.g., for aquaculture or development). Although this research has rapidly increased since 2005 (142), in part due to technical advances in remote sensing, it is still limited and many of these values are uncertain (143). Global salt marsh estimates are unclear due to ambiguous recordkeeping and categorizations, and global seagrass extent is also uncertain (142). Even though global mangrove forest cover is better estimated, the dynamic nature of these habitats means carbon sequestration rates can vary dramatically across space and time (151). Similarly, shoreline erosion can limit or overwhelm the carbon storage capacity of salt marshes by narrowing the ecosystems, potentially turning some coastal carbon sinks into net sources (152). Quantifying BC ecosystem services is further complicated as these spaces provide other roles and functions beyond carbon storage. Mangroves offer shoreline and erosion protection, ameliorating storm damage or sea level rise (142). Sea grass beds can locally buffer acidifying seas, protecting nearby coral reefs (153), and many coastal environments have cultural value. It is not immediately apparent how these diversities of values can be quantified and enrolled in market regimes, although some scholars suggest broader PES schemes that account for noncarbon services may be more successful for BC ecosystems (154). Alternatively, BC may be better viewed as a new consideration for more traditional environmental regulation (e.g., habitat conservation laws or ocean and shoreline restoration programs), rather than requiring a market-based approach for its management. Regardless, as with OA, BC governance will likely require engaging new actors beyond the scientific and NGO communities, as well as new social science to examine and inform policy interventions at local and global scales (145).

Pollution

Ocean pollution has been a concern since at least the 1970s, but recent attention to plastic-waste pollution warrants its inclusion here. Early UN efforts to address ocean pollution focused on

sea-based activities, and the International Convention for the Prevention of Pollution from Ships, adopted in 1973, added a 1998 Annex V that imposed a ban on the disposal of all forms of plastics at sea. Attention has since shifted to plastic-waste leakage from land-based activities, and the 1995 Global Program of Action for the Protection of the Marine Environment from Land-based Activities included litter as a concern. Nevertheless, the plastics problem has grown as plastics have become ubiquitous in global trade, particularly in packaging, and as human population growth in coastal areas has increased. A 2015 study estimates plastics entering oceans from land at 4.8–12 metric tons annually, and that without improvements to waste management infrastructure there will be 1 ton of plastic for every 3 tons of fish by 2025 (155). These types of figures have put plastics at the forefront of ocean pollution concern: "Because of its longevity, ubiquity, and sheer volume, plastic debris is emerging as a new, truly global challenge" (156, p. 3).

Scientific studies of plastics estimate amounts entering the ocean (155), model where they go (157), and assess their impacts (158); they also inform policy debates. For example, concern was once directed at large plastics floating at the ocean surface; washed up on shore, they are an aesthetic nuisance and expensive to remove, and at sea they entangle and/or are ingested by large marine mammals, fish, and sea birds (159). Although these concerns remain, attention is focused increasingly on microplastics that result both from the breakdown of large plastics and from direct release into the water system due to their prevalence in personal care and other household products. The size of microplastics means that they pass through filtration devices in water treatment systems and can be taken up by microorganisms such as zooplankton, thus entering the food web at the lowest levels. Impacts on ingesting organisms have been shown, and these potentially bioaccumulate in the food chain, including in human consumers of fish. Mitchell (160) argues that these new understandings of microplastics and their potential effects on humans effectively challenge the traditional boundaries established between the human and nonhuman, between places of people (land) and places of nature (oceans).

The shift from sea-based to land-based plastic-waste leakage and the inclusion of microplastics as a concern expands the realm of governance actors engaged in the issue to include governments that provide and/or regulate waste management infrastructure, the private sector that uses plastics for products and packaging, consumers who make purchasing and disposal decisions, and NGOs that have led efforts to raise public awareness and galvanize national and international action. In some of the countries with the highest levels of plastic-waste leakage, the informal sector—trash pickers—are stakeholders that will be affected by and critical to changed waste management practices and should not be overlooked (156).

Although targeted efforts and resources directed toward improving waste management in a small number of countries with the highest amount of plastic-waste leakage hold promise (155), the global problem will require regionally specific solutions. Analysts variously promote market-based incentives directed at consumer and producer behavior (161); technological innovation to collect plastics from oceans; improved waste management infrastructure (155); and government regulation, including banning particular products (162). In the United States, several municipalities and counties have banned (or taxed the use of) plastic bags, and Congress and Senate recently approved a ban on the production (effective July 2017) and sale (effective July 2018) of personal care products containing plastic microbeads. Reducing and/or eliminating use of plastics helps to balance the distribution of costs and benefits associated with addressing the plastics problem. For example, although a small percentage of plastic-waste leakage originating from the United States is a result of mismanagement, high per capita plastic consumption puts the United States in the top 20 countries contributing to plastic-waste leakage globally (155). Focusing only on waste management practices in the top polluting countries belies the complexity of the plastics problem and its ties to the global economy.

CONCLUSIONS

In this final section, we highlight the similarities and differences in the ways in which actors, scale, and knowledge are relevant for efforts to govern new and emerging ocean issues. Actors engaged in oceans governance vary by issue, sometimes reinforcing and sometimes challenging the existing political framework for oceans governance. States and UN institutions continue to play key roles, particularly in ABNJ and for traditional conservation and development issues, such as establishing MPAs or rules for seabed mining. NGOs are making inroads on other issues, however, sometimes in partnership with states as in LMPAs, sometimes with scientists as in conservation in ABNJ, and sometimes with the private sector as in new ocean surveillance efforts, such as Global Fishing Watch. The private sector has specific interests in extractive activities, such as seabed mining and tuna fishing, but is increasingly attending to broader policymaking processes, working collaboratively through groups such as the World Ocean Council. For some issues such as plastic pollution, engagement of all actors is necessary for a comprehensive and effective solution to the problem.

Although we have highlighted distinct and sometimes conflicting interests of diverse actors throughout, here we note a familiar dynamic that runs through our review, i.e., tensions between the Global North and the Global South, or developed and developing countries. We see it across oceans issues, primarily in the story of developed country actors asserting their power over their developing country counterparts, e.g., via certification schemes that establish global standards for developing country producers and sometimes undermine state authority, northern NGOs pursuing a conservation agenda on the high seas, and northern firms getting favorable deals in tuna. Although there is resistance to this dynamic—as seen in the Nauru Agreement on tuna, developing country insistence on a package deal for the ABNJ, and the human rights versus property rights emphasis in FAO-SSF Guidelines—the divide between the developed and developing world remains prominent in oceans governance, even as actors involved in governance have evolved.

Our review has highlighted the importance of scale in multiple ways. First, scalar mismatches are evident in new and emerging issues and in efforts to govern them. RFMO governance of tuna fisheries might be necessary from an ecological perspective but has disadvantaged small island states and favored fishing fleets and their home nations. The Nauru Agreement challenges this system, via regional cooperation. Cooperation among Pacific Island nations to set appropriate environmental impact and benefits sharing rules for seabed mining in their EEZs before mining begins may avoid repeating the experience of tuna fisheries. Global FAO-SSF guidelines that emphasize local rights and needs may improve outlooks for fish stocks and people through multiscalar governance regimes such as co-management. A shift in focus from framing OA as primarily a global problem to a focus on questions of local adaptation and resilience may bring new and important actors into the science-dominated discussion and result in more diverse governance efforts. These responses to scalar mismatch are promising, but there are also cases where global narratives—of the need for more MPAs, fisheries certification, and market-based solutions—are driving initiatives that have the potential to marginalize local actors and overlook their diverse connections to coastal and marine ecosystems.

Knowing the oceans remains primarily a function of science. Science and technology are implicated in multiple ways, facilitating new exploitation opportunities (e.g., seabed mining) and informing BMPs for these (e.g., aquaculture). Science is determining where conservation efforts should be focused (e.g., EBSAs) and revealing new information on ocean resources that are complicating existing management (e.g., tuna fisheries). In some cases, development and conservation

interventions have had little scientific basis (e.g., SSFs and LMPAs), and data gaps constrain the ability to evaluate the impacts and effectiveness of particular interventions.

In almost all cases, science has focused on resources and ecosystems rather than human use of or values attached to these, or institutional arrangements for their governance. This is partly a function of constructions of oceans as unpeopled and human interests as remote (e.g., in ABNJ and LMPAs). It also results from framing problems as technical, ones of identifying EBSAs, developing aquaculture BMPs, calculating BC, or predicting OA impacts. In SSFs, historical lack of scientific attention reflects marginalization of SSF fisheries in global fisheries science.

The tendency to overlook or understate human uses and values is reflected in many emerging governance regimes, for example, in some LMPAs that are being established with limited consultation and without a full understanding of the potential social, economic, and political impacts, and in efforts to protect biodiversity in ABNJ that have yet to engage resource users. Aquaculture and SSF certification schemes do account for human values, but those of seafood consumers rather than producers. The FAO-SSF Guidelines stand out as an exception in this review, attending as much to questions of resource access, human rights, and food security as they do to questions of fisheries ecology. In many cases, predetermined governance preferences—for MPAs in ABNJ, for LMPAs, for PES—are driving research efforts. Data gaps remain in our understanding of the biophysical features of oceans, but data gaps related to diverse human values, uses, and institutions for oceans are pronounced, and new research efforts to inform governance should address both.

Efforts to guide future oceans governance are ongoing and outcomes, both general and specific to issues discussed here, are anything but predetermined (2). For example, broader trends toward market-based environmental governance are evident for some ocean issues (BC, aquaculture and SSF certification schemes), but not for others. For tuna fishing and seabed mining, governance by national and multinational government remains key. Similarly, for LMPAs, traditional state support for protection is a prerequisite, although such support is now encouraged and incentivized by NGOs and other nonstate actors. Some emerging oceans governance efforts seem to indicate further privatization and/or enclosure of the ocean commons (e.g., aquaculture, MPAs), whereas others, such as the FAO-SSF Guidelines, challenge this logic.

We see opportunity to create governance regimes that support environmental sustainability and human well-being. These opportunities exist in part because of governance gaps and in part because governance processes are evolving, with ever-changing emphases on who participates and what types of information inform them. Although existing political frameworks and dominant social constructions of oceans are often a constraint, opportunities exist for new actors to exert influence, and are enhanced by our increasing ability to see and know oceans and for actors to work across scales. New actors and technologies could help break down old ideas about scale in the oceans, bridging scales or even descaling the complexity of ocean problems. For example, by working both in communities and on a global/regional carbon market, an NGO (or any other actor) might ultimately transcend governance gaps in ways that were not possible when oceans governance was in the realm of the state and multinational institutions alone. Whether such an outcome increases democratic participation and strengthens global civil society or reinforces existing power imbalances between developed and developing countries remains to be seen. However, these and other governance questions are ones that social scientists can and will continue to pose and explore in ways that might support progressive politics and practices for oceans governance.

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