9. Adaptive governance for marine environments: methods, challenges, and lessons for ocean fisheries

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INTRODUCTION

For centuries, many perceived oceans to be inscrutable and infinite. In 1883, T. H. Huxley stated: "I believe, then, that the cod fishery… and probably all the great sea fisheries, are inexhaustible: that is to say that nothing we do seriously affects the number of fish. And any attempt to regulate these fisheries seems… to be useless." (Kurlansky, 1998). Some of Huxley's contemporaries disagreed (Sims and Southward, 2006); yet for a century on, the expansive size of oceans, their diversity and unpredictability, and their cross-scale interdependency and interactions, made governance seem impossible. By the mid-20th century, changes in technology increased the range and depth of ocean exploitation, and the illusion of limitless oceans and marine fisheries was dispelled by collapsing stocks and increasing conflicts over resources. Efforts by the United Nations to create governance systems for expansive marine environments had focused on centralised, "command and control" approaches that proved inadequate for dynamic marine settings. By the 1990s, the collapse of Northern Atlantic cod fisheries that Huxley perceived to be interminable highlighted the need for a more responsive governance approach (McCay and Finlayson, 1995).

Yet oceans present many challenges to coordinated governance. Marine environments encompass twice the surface area of terrestrial biomes on Earth, across latitudes from arctic to tropical zones. In addition, the marine context is multidimensional, including the entire water column from sea floor to surface, with physical processes (e.g. currents) and biological processes (e.g. species migration) occurring and interacting across scales, all made increasingly unpredictable by climate change (Greenhill et al., 2020; Jeffers, 2010). In marine fisheries, climate change is shifting the habitats and patterns of fish stocks, increasing uncertainty and creating pressure on governance to adapt quickly (Pinsky et al., 2021). In addition, the social and political dimensions of marine spaces have been undervalued in marine research (Levine et al., 2015), with poor attention to cultural meaning and power relationships. In spite of their importance to livelihoods, food systems, and community well-being, marine environments have frequently been conceptualised as "wild" or "unoccupied" spaces, overlooking existing institutions and governance histories (Fabinyi and Barclay, 2022).

The scale, diversity, and unpredictability of marine social-ecological systems, and in particular marine fisheries, have inspired and informed conceptualisations of adaptive governance. Adaptive governance (AG) is a framework for addressing uncertainty and change with institutions and policy processes that reflect the social context (Chaffin et al., 2014; Dietz et al., 2003; Folke et al., 2005). As discussed in other chapters of this book, at the centre of AG strategies is a process of knowledge sharing, learning and experimentation, and responding rapidly

to changing social-ecological systems, as well as governance failures. In developing these strategies, Dietz et al (2003) examine the cod fishery and identify a lack of information about changes in the system as a contributor to poor governance adaptability, informing the need for stakeholder participation and knowledge-sharing between decision-makers and resource users. The scale of marine governance has also informed conceptualisations of nested and cross-scale institutional arrangements, drawing inspiration from the strengths of traditional, self-organised, and polycentric governance of small-scale fisheries, such as in the Pacific (Folke et al., 2005). In turn, governance designed to address uncertainty and change aligns with the realities of vast, diverse, data-poor marine fisheries, and since the introduction of its key principles nearly two decades ago, AG has been adopted in contexts across the globe. Yet while they are theoretically a good match, the nascent state of marine governance institutions, challenges of spatial size and social-ecological complexity, and realities of power-sharing and stakeholder engagement leave room for improvement.

    This chapter provides a synthesis of the literature on AG in marine contexts. Relevant literature was identified with a non-systematic use of Scopus and Google Scholar searches that included "adaptive governance" and "marine", "ocean", and "coastal", as well as by reviewing the literature cited in selected papers. First, I discuss the history and diversity of institutional arrangements of marine governance. Second, I outline the challenges to developing effective adaptive marine governance, particularly for capture fisheries. Third, I evaluate how effectively AG has been implemented and how it has responded to sudden social and ecological shocks in diverse marine contexts. While issues such as pollution (Vince and Hardesty, 2017) and renewable energy development (Wright, 2015) are also important for marine governance, I focus on fisheries because of their unique challenges for institutional diversity and "fit", stakeholder participation, and responsiveness to a dynamic, living natural resource. This synthesis highlights the benefits of, and future directions for, adaptive marine governance.

HISTORY OF MARINE GOVERNANCE: A BRIEF OVERVIEW

Freedom of the Seas

Prior to the 20th century, ocean governance was generally limited to near-shore environments, as an extension of terrestrial territories. Based on the concept of "freedom of the seas" (*Mare Liberum*) introduced in Europe in the early 17th century, spaces beyond the coastline were unclaimed and unregulated (Steinberg, 2001). This openness allowed for unfettered travel and trade on the high seas – the marine spaces that are outside of the governance zones. However, colonial expansion and industrialisation led to a need to establish ownership and authority of coastal waters. State and colonial governments claimed navigable waters below the high-tide mark, erasing traditional tenure in coastal lagoons and bays and limiting the formal authority and control of local actors.

Law of the Sea and Exclusive Economic Zones (EEZs)

By the mid-20th century, there was a shift from "freedom of the seas" to recognition of the need to address resource management conflicts in the oceans. A significant step in ocean governance was adoption of the United Nations Convention on the Law of the Sea (UNCLOS)

40 years ago. Signed by 164 parties, the law establishes three types of governance zones: the traditionally recognised territorial seas up to 12 nautical miles from shore; a contiguous zone of 24 nautical miles, which serves as a customs zone in which countries have the right to regulate use, and a 200 nautical mile Exclusive Economic Zone (EEZ). This convention helped to clarify governance relationships and responsibilities and created an international tribunal and other procedural organisations to address issues on the high seas. In the United States, most coastal states and territories have jurisdiction over an area of 3 nautical miles from the baseline (high water mark); Texas, Florida, and Puerto Rico were granted larger 9-mile jurisdictions. Municipalities also have jurisdiction over coastal spaces above the high-water mark and can therefore influence integrated coastal marine governance. In other nations, state jurisdictions can overlap with or legally integrate customary tenure boundaries and Indigenous governance structures.

In establishing jurisdictions over previously unregulated ocean commons, UNCLOS stimulated governments to consider how to regulate, develop, and conserve resources within their territories (Wright, 2015). The creation of EEZs shifted control of previously open common-pool resources like fisheries to coastal states; Pacific Island nations in particular became "ocean-rich", with exclusive access to key resources including tuna stocks (Hannesson, 2008). The agreement also explicitly tasks governments with responsibility for the sustainable management of their marine territories, requiring more information and new governance tools. Yet, there remain vast marine spaces outside of these territories, and the interrelatedness of marine environments, varying social and political contexts, and more recently, the effects of climate change on ocean environments and fisheries, combine to produce several challenges for marine governance.

Collaborative Marine Governance Arrangements

The Law of the Sea catalysed the development of new marine governance systems that can become the basis for AG. The need to create cross-scale governance has led to many forms of hybridised and cooperative institutional arrangements at different scales, including regional transboundary governance, marine protected areas and marine managed areas, and co-management.

The expansiveness and interconnectedness of marine settings has inspired large-scale governance approaches for "seascapes" and "regional seas", that include networked, transboundary governance approaches (Fidelman et al., 2012). The UN Sustainable Development Goals identify the importance of strengthening capacity at the regional level (UN 2015), and there are now at least 25 global governance organisations for regional ecosystem-based management (Mahon and Fanning, 2019); yet their effectiveness and integration varies, with Indigenous (regionally-driven) frameworks proving most useful. Even in the European Union, where there is an established shared legal framework, fully integrated regional marine governance is slow to develop in practice (Soma et al., 2015). There are also several regional fisheries management organisations (RFMOs); these focus on specific transboundary fisheries and species, rather than spatial areas.

Marine reserves existed prior to UNCLOS, but the new agreement and a rise in the establishment of terrestrial protected areas and national parks inspired the creation of similar marine protected areas (MPAs) (Humphreys and Clark, 2020; IUCN, 2008). MPAs vary in size, from large-scale (LSMPAs) to networked locally-managed marine areas (Govan, 2009; Gruby et

al., 2021). MPAs frequently use an ecosystem-based management approach (Brown et al., 2013); however, MPAs have been criticised for providing a technocratic governance solution that emphasises quantitative economic and environmental measures over cultural complexity and social equity outcomes (De Santo, 2013; Humphreys and Clark, 2020), undercutting good governance. Researchers suggest ongoing evaluation of MPAs to address the dynamic effects of policy interactions in marine fisheries contexts and avoiding disruptions to local livelihoods and cultural needs (Gruby et al., 2021; McCay and Jones, 2011). MPAs have also been criticised for implementing a top-down structure; in response, some incorporate co-management approaches discussed below, with varied success (Brown et al., 2013).

Community-based approaches to fisheries management have flourished in the past few decades, in response to the failures of centralised, top-down governance approaches (Jentoft et al., 2010). While locally focused approaches show advantages in flexibility and responsiveness, it is crucial that they be incorporated into a nested, multiscale approach for dynamic and interdependent marine environments. Adaptive co-management, characterised as the operationalisation of AG that centres bottom-up, community-focused approaches (Olsson et al., 2004), has become a common strategy for small-scale fisheries and coastal management (Hunter et al., 2018; Quimby and Levine, 2018; Weeks and Jupiter, 2013). Traditional Indigenous institutions and culture are frequently incorporated into AG approaches in the Pacific to enhance responsiveness to change and rule compliance (Cohen et al., 2015; Quimby and Levine, 2021). Still, these hybridised approaches do not guarantee knowledge and power sharing across scales, nor equitable participation and outcomes for all community members (Aswani and Ruddle, 2013; Kleiber et al., 2017).

IMPLEMENTING ADAPTIVE GOVERNANCE FOR MARINE FISHERIES

Emergent collaborative governance arrangements for marine environments still struggle to address several issues; in particular: the allocation of access and use rights, conservation and protection of resources from overexploitation, monitoring and enforcement, and adaptation to changing ocean contexts (Haas et al., 2021; Wright, 2015). Theoretically, AG presents a way forward; however, there are several challenges to developing effective adaptive marine governance, particularly in marine fisheries (see Table 9.1).

Institutional Variety

As discussed earlier, the variety of marine environments and their socio-political histories have led to several different forms of institutional design that may form the basis of AG. Environmental governance includes the institutions (e.g., laws, rules, and norms), regulatory processes, and mechanisms for conflict resolution that are created and used by actors to shape actions and outcomes around the use and protection of natural resources (Chaffin et al., 2014; Lemos and Agrawal, 2006). Multilevel governance that effectively connects governance arrangements across local, national, regional, and global scales is important for common-pool resource management (Ostrom, 2005). While some scholars believe marine governance has developed a "sectoral and fragmented approach"(Kelly et al., 2018) that fails to address the interactions and interdependencies of marine ecosystems, others suggest that there are path-

Table 9.1   Challenges of adaptive marine governance

Strategies for adaptive governance (Dietz et al. 2003)	Social-environmental challenges of marine fisheries
Institutional Variety – including local social norms, laws, and markets (Folke et al., 2007)	Lack of "fit" for large-scale/transboundary governance
	Species-specific policy approaches
	Poor recognition of existing institutions and social and cultural dimensions of fisheries
	Rapid fluctuations in markets and fish stock distribution
Stakeholder Participation	Wide spatial distribution and diversity of stakeholders
	Self-organisation
	Procedural equity and gender inclusion
Power Sharing and Nested Authority	Cross-scale institutional integration
	Colonial histories and existing hierarchical governance
	Procedural equity

ways forward for better cross-scale integration (Fanning and Mahon, 2020). As Fabinyi and Barclay (2022) discuss in their examination of marine fisheries governance, "new" governance efforts do not occur in a void, but are instead overlaid and integrated with the pre-existing social and institutional context. AG is an opportunity to turn that existing institutional diversity into a strength through cross-scale linkages and polycentric arrangements that create redundancies and reflect the specific social-environmental context.

Governance "fit" is especially challenging for transboundary governance (Chaffin et al., 2014; Wilson, 2006). Matching governance to ecological scales has driven transboundary efforts; yet not only are marine spatially vast, but they are also interconnected with coastal spaces and governance institutions (Steinberg 2013; Partelow et al., 2020). Preconceptions of marine spaces as historically unoccupied and ungoverned can also obscure the existing human dimensions of an area (Bennett et al., 2015). Tuda et al. (2019) assess the potential for AG in the coastal waters that extend between Kenya and Tanzania by examining the current governance institutions and processes to identify enabling (or constraining) characteristics for developing AG. The area provides ecological continuity, with critical habitat for biodiversity, including coral reefs, mangroves, and seagrass used by dugongs and turtles. As such, local artisanal fishers move across national borders with seasonal variation. Through surveys of members of 81 organisations involved in coastal and marine management, including local community groups, NGOs, and government agencies, the authors conclude that strong networks and collaborative relationships exist to support knowledge-sharing with resource managers. However, these networks are highly centralised, narrowing the diversity of knowledge conveyed, and there is a lack of policy structure (rules) to guide managers, resulting in a lack of adaptive action. The study also notes that the function of any new governance system will depend on how well it reflects the region's significant social and cultural diversity.

Inadequate integration of existing formal and informal institutions – including social norms, markets, and Indigenous political processes – can reduce adaptive capacity. Social norms and informal institutions can be used in regulating behaviours in fisheries, but inadequate attention to actors' experiences and relationship to a dynamic social-environmental system has limited their use for improving flexibility and adaptive capacity (de la Torre-Castro and Lindström, 2010; Knudsen, 1995). Markets and economic pressures can also provide fishers with incentives for conservation or overexploitation; however, fishers are often more flexible

than governance institutions. For example, Aguilera et al. (2015) examine the flexibility of small-scale commercial fishers in California, who easily shift between sardine, anchovy, and squid, depending on fishers' perceptions of the availability or depletion of stocks; however, governance intransigence can hamper their adaptability. The authors suggest that species-specific regulatory processes permitting for different fisheries should recognise their interconnectedness, enabling greater adaptability to a highly variable, multi-species fishery.

Polycentric institutions have been embraced by commons theorists (Andersson and Ostrom, 2008) and offer another opportunity for organisational variety. Polycentric systems are considered to have several key strengths that support AG. First, a nested, cross-scale arrangement of semi-autonomous groups facilitates institutional fit to dynamic social-ecological systems (Folke et al., 2005). They also provide redundancies that can mitigate failures by any single actor or policy, in contrast with centralised approaches (Ostrom et al., 1999). Polycentric institutions can also be a way to "scale up" governance approaches, build on the strengths of local organisations and customary tenure while enabling coordination and knowledge-sharing across multiple jurisdictions or environments, from local to national or transboundary regional scales (see Carlisle and Gruby (2018) and Tuda et al. (2021)). However, the benefits of polycentricity are not a given, and there is a lack of empirical studies to examine their outcomes for marine AG.

Stakeholder Participation

Participation of diverse stakeholders – the individuals, organisations, and communities involved in a specific marine context – is fundamental to knowledge-sharing, informed decision-making, and policy implementation. Stakeholder participation is a key part of AG and widely recognised as a critical contributor to adaptability (Jentoft et al., 2010; Reed et al., 2018). However, the push to include local communities and stakeholders is very recent and contradicts traditional, established institutional models of top-down governance, creating tension in efforts to implement effective AG. Historical governance outcomes, such as the failures of past top-down governance, can create distrust between stakeholders. Further, the socio-political context can present difficulties for procedural and distributional equity. Gendered bias about livelihoods and hierarchical social norms has led to the exclusion and underrepresentation of women in knowledge-sharing and decision-making (Gustavsson et al., 2021; Kleiber et al., 2017; Schoeffel, 1985). While governance solutions have traditionally focused on institutional arrangements, this has led to inadequate technocratic solutions, and there is a critical need to increase attention to the agency of actors who are engaging with these institutions (Haas et al., 2021).

Identifying and recruiting stakeholders for participation in marine AG is complicated by scale, type of activity, and their relationship to different local and global value chains and markets. Spatially, the people engaged in a marine fishery can be distributed widely across multiple communities, and their presence and activities in a particular area will fluctuate over seasons and with the movement of species. Assumptions about engaged participants can also be subverted by scale, with staff from national agencies or international NGOs playing key roles in governance processes, in spite of not being local. Participation in decision-making and governance actions is also shaped by social dimensions, especially power relationships: who has the power to decide which groups or individuals should be invited to participate, and what their roles should be, informs the fairness and inclusiveness of any governance exercise (St. Martin, 2006).

In large-scale fisheries management, stakeholders are primarily engaged through formal organisations and institutions. In Europe, Regional Advisory Councils (RACs) were introduced in 2002 to increase stakeholder participation; however, an evaluation of the RAC for Pelagic fisheries in the North East Atlantic region identifies a need for decentralisation of decision-making and increased prioritisation of stakeholder input (Coers et al., 2012). In small-scale fisheries, efforts to identify participants have sometimes relied on limited indicators, such as boat ownership, that obscures social value and labour relationships – for example, subsistence fishers, and the people (often women) engaged in processing catch. In marine settings, AG also requires recognition of where different scales and practices of fishing intersect to support strong, representative participation. Chandra (2011) provides an illustration of the need for inclusion of stakeholders from many different fisheries sectors, including artisanal, commercial, and aquaculture workers, in Fijian coastal resource governance.

Bottom-up participation through self-organisation is a principle for common-pool resource governance, and a common consideration for small-scale fisheries governance (Mahon et al., 2008; Tam et al., 2021). Self-organisation through formal and informal social networks of individuals and groups is considered key for learning, trust-building and knowledge-sharing (Folke et al., 2005; Plummer et al., 2013). Self-organisation can originate from existing social networks or be facilitated with institutional support (Ayers and Kittinger, 2014). Communication through these groups can support social learning. Social learning is an iterative process of learning, knowledge creation, and building a shared understanding of phenomena in the world, that can support adaptive behaviours (Reed et al., 2010). For example, the creation of informal or semi-formal forums can facilitate knowledge-sharing and trust-building. In the United States, a Community Fisheries Action Roundtable was created by a non-profit resource centre to bring together full-time fishers from different commercial fisheries, particularly those working within the nearshore, state-managed waters of Maine. Research by Brewer (2013) finds that facilitating these meetings and workshops is expensive; however, the outcome was significant social learning among fisherman and more positive interactions with management institutions.

However, in large transboundary fisheries, an emphasis on technical solutions can overshadow learning. For example, Rubio et al. (2021) examine social networks in Basque tuna fisheries to understand how communication among stakeholders influences their choice of adaptation strategies. The authors found that communication was strong throughout the fishery and inclusive of many different types of actors, including government agents, NGO representatives, and fishing industry leaders. Many of these actors connected through a Regional Fisheries Management Organization for Atlantic tuna fisheries (ICCAT) and governance institutions at national and local scales. While there was regular communication between groups and across scales, actors focused less on learning than other strategies for adaptive capacity, such as organisational structure and agency. The authors suggest that raising the profile of actors with more holistic approaches to adaptation could increase knowledge-sharing and overall adaptive capacity.

In this way, institutional arrangements can affect stakeholder engagement and recognition; yet procedural equity, the capacity for stakeholders to participate in and lead decision-making processes, is also driven by the specific social-political context. There are several criteria for assessing and fostering procedural equity in small-scale fisheries (Bennett et al., 2020; Zafra-Calvo et al., 2017). Institutional arrangements can counter the exclusion of women and actively include diverse actors and perspectives (Frangoudes and Gerrard, 2018; Gustavsson

et al., 2021; Kleiber et al., 2017). However, in an analysis of MPA processes, Horigue et al (2016) find that the governance context, the socioeconomic and political processes and pressures, are the key drivers of participation. Fisheries governance can organise policy instruments to create limits on catch quotas or total allowable catch, regulate fishing effort such as gear and vessel types or licenses, and operational limits such as seasonal closures (Basurto and Nenadovic, 2012). These policies have direct effects on livelihoods and well-being. Therefore, explicit attention to equity in decision-making, management actions, and distributional outcomes is necessary for sustainable and adaptable governance (Bennett et al., 2020; Quimby and Levine, 2018).

Power Sharing and Nested Authority

As other chapters in this book discuss, AG requires thoughtful attention to conceptualisations of power and practices of power-sharing at all scales of AG. Coherence across nested institutions, even at smaller scales, can be inhibited by unique historical and social factors of each context. Evans et al. (2011) consider the "messiness" of developing AG for small-scale fisheries in Kenyan coastal waters. Although the fishery is under the control of a single nation, governance includes multiple scales of institutions and actors. While this model implements adaptive management strategies of nested authority across scales, they can become disjointed and lose coherence as institutions at different scales respond to different pressures. Evolving social networks and institutional arrangements influence how knowledge is gained and shared, and in turn how well governance structures and actors are able to learn and respond to change. Using multiple data collection methods including surveys, interviews, and participant observation, the authors find that at the local level, fishers' ecological knowledge primarily informs their decision-making, and due to historical conflicts over an MPA design, they are wary of top-down state interventions. State level organisation is equally stymied by a focus on inland spaces and poor representation of stakeholders in decision-making. In all, the authors find that lack of trust and cooperation between stakeholders, the pressures of poverty, and the persistence of centralised decision-making processes are inhibiting AG.

   Given the theoretical roots of AG in the empirical evidence of traditional environmental governance, a transition from local to polycentric AG would seem simple; however, Carlisle and Gruby (2018) demonstrate the difficulties in shifting power to a larger organisational structure. This study is a qualitative case study of a small-scale fishery governance system in Palau as it transitioned from community-based to polycentric governance. They consider how polycentric the system is, what are the enabling conditions, and what are the outcomes for institutional fit, mitigating risk through redundancy, and adaptive capacity. In all, the shift to polycentric governance weakened local power and control and created a "top-heavy" structure strongly influenced by NGO actors, which had some negative outcomes, including greater social tolerance of rule violations. They suggest that if the original governance structure was centralised and the process decentralising power, outcomes may have differed. Overall, the AG outcomes were mixed. The new polycentric system demonstrated some advantageous characteristics, such as willingness by actors to experiment with new policies and strategies when old approaches failed. However, there was also reduced engagement by actors who resented the influence of external actors, reducing the potential for knowledge-sharing and learning.

ADAPTIVE MARINE GOVERNANCE AND RESPONSE TO CRISIS

This section discusses three case studies of AG in marine settings that experienced a significant crisis or shock. The scales and contexts of each example are different, as are the institutional, social, and environmental stressors they experience. In all, they reveal the importance of social networks and their integration with governance institutions for adaptive capacity and resilience.

Österblom and Folke (2013) provide an examination of remote, transboundary adaptive governance in the Southern Ocean that reveals the important interplay between actors (individuals and groups) and structures (institutions and organisations) in the governance processes. The authors examine how a large-scale AG system (the Commission for the Conservation of Antarctic Marine Living Resources- CCAMLR) emerged for the Southern Ocean, a remote environment outside national boundaries. This transnational organisation was specifically formed to address illegal, unreported, and unregulated (IUU) fishing. Drawing on data from qualitative interviews, quantitative surveys, and social network analysis, they find that when the organisation struggled with a crisis (due in part to poor fit between regional environmental challenges and new transnational institutions), informal "shadow" networks filled the gap until formal structures could adapt. In this way, actors enabled fast adaptation, while the institutional structures supported the slower development of trust and legitimacy. The authors emphasise the need to consider both institutions and agency in assessing the functionality and outcomes of AG.

Another recent study elucidates the response of AG in a small-scale fishery to an unprecedented driver of social and economic change, the COVID-19 Pandemic. Pedroza-Gutiérrez et al. (2021) examined coastal fisheries and tourism based in villages of the Yucatan Peninsula, in the states of Campeche and Yucatan. In March of 2020, the fishery was suddenly closed; distribution channels were restricted, both local and export markets became unavailable, and seafood freezing plants locked down for several months. Analysis of interview data reveals that individuals quickly used their knowledge and social networks to cope, first with the full closure of ports, and later with the precipitous drop in market demand. Most fishers turned to catching for household consumption and or sharing with the community, with minimal sales through "friend-to-friend" networks reaching to neighbouring communities. Interestingly, illegal fishing decreased during this period, which the authors attribute to "social cohesion" and mutual respect for the circumstances, although the lack of open markets likely also contributed. The government solicited feedback from fishers to develop plans for implementing safety measures while supporting the reopening of the fishery with new local marketing. Critically, the authors identify new organisational and governance structures created in response to changes in market demand, social contacts, and other rapid shifts in the socioeconomic environment. Overall, while they found that most adaptation occurred at the individual level, with fishers making decisions based on their own knowledge and situation, the experience has also driven "learning and innovation" to build resilience within local social networks and implement new adaptive strategies at state and national levels informed by fishers' experience.

In Vanuatu, Eriksson et al. (2017) describe how AG approaches embedded in customary tenure and community-based fisheries management enabled quick responses to multiple environmental crises. After experiencing multiple shocks, including a tropical cyclone and earthquake event that destroyed reefs used for fishing, local communities experienced losses

to their livelihoods and infrastructure, as well as food shortages that increased pressure on local fisheries. In response, community leaders responded by temporarily lifting fishing restrictions in some areas. Government agencies encouraged and supported these openings, and took additional actions, such as the establishment of a women's market and distribution of new fishing gear. While the researchers do not address knowledge-sharing, they found that individuals relied on existing knowledge and skills, and found high social capital enabled the community's responses.

DISCUSSION

Adaptive governance approaches have demonstrated many strengths for addressing uncertainty and change in marine environments, including socially and environmentally driven shocks. The particular strengths of AG in marine settings include institutional design that can be configured for vast spaces, with cross-scale linkages that reflects/responds to organisational diversity and multiplicity at different levels. Fisheries AG has found particular relevance for settings with co-management structures that integrate local social networks and traditional institutions.

However, for its institutional strengths, AG also encounters some challenges for implementation and practice. Social learning and self-organisation to support trust building and knowledge-sharing are more challenging for large-scale AG efforts, due to the high transaction costs and difficulty identifying all relevant stakeholders. Lack of participation and representation from diverse fishing interests can reduce knowledge-sharing and trust. Fisheries are also experiencing a loss of knowledge and adaptive capacity due to the "greying of the fleet", as experienced fishers retire (Haugen et al., 2021). Large and small AG schemes continue to struggle with the issues of conflict and power-sharing raised by Dietz et al. (2003). When AG is embedded in institutions informed by traditional social hierarchies or colonial legacies, it can reduce procedural equity and adaptive capacity (Quimby and Levine, 2021). Overall, an emphasis on technical fixes and policies that overlook implementation and issues of power distribution can reduce the effectiveness of AG.

Fortunately, marine AG practitioners and theorists are exploring how to improve integration across scales of policy and planning (Greenhill et al., 2020). To improve social learning, Pedroza-Gutiérrez (2021) encourages AG to facilitate learning networks, which can diversify knowledge sources and support self-organisation to respond to crisis. These informal social connections compliment governance structures and actions, providing flexibility in times of rapid change. Effective participation and power sharing can also be supported by centring communities and fishers in the early stages of AG planning and conceptualisation, and reflecting on power relations in institutional processes (Cleaver and Whaley, 2018). De la Torre-Castro (2012) suggests viewing governance as embedded in social processes, in order to increase the focus on actors and equitable outcomes rather io technocratic solutions. Additionally, new frameworks for increasing procedural and distributional equity can help to address shortfalls of marine AG (Bennett et al., 2020; Gurney et al., 2021).

AG in marine environments will also benefit from creating more space to experiment and innovate. For example, Partelow et al. (2020) suggest building a broader governance toolbox and complimenting AG approaches with other theoretical frameworks, in order to better customize AG to the needs of a specific coastal marine context. There is also a push to recon-

sider how we conceptualize marine environments: "wet ontologies" for theorising dynamic aquatic environments beyond social-ecological systems provides a way to decouple marine governance from terrestrial standards and assumptions (Steinberg and Peters, 2015). Moving forward, there are opportunities to build on the established institutional strengths of marine AG and incorporate more context-specific, actor and practise-centred approaches.

CONCLUSIONS

This chapter presents a unique synthesis of the literature to examine the implementation, challenges, and responses of adaptive governance to diverse marine environments. Although AG was developed with marine contexts in mind, there are limited studies of adaptive marine governance and crisis outcomes beyond institutional analysis. This synthesis demonstrates that the application of AG at regional and local scales around the globe has yielded some positive results for social and environmental adaptation to complex, unpredictable pressures and needs. However, the implementation in diverse marine fisheries elucidate several lessons for improving the AG framework for addressing uncertainty and complexity.

Formal institutional structures are important for providing legitimacy and support for governance and can be designed to support inclusive and equitable stakeholder participation. However, fostering institutional variety across scales that adequately incorporate the sociocultural and political context and recognize existing Indigenous and local institutions overemphasis is key to avoiding technocratic approaches. Stakeholder participation at every stage is also challenging but vital; in many of the examples shown here, adaptive capacity was enabled through informal learning networks and inventive strategies by individual actors. Power sharing for large and transboundary governance areas requires more attention to ensure procedural equity across scales. Still, AG has proven to be sustainable and responsive in the face of social and ecological crises. In all, new institutional arrangements that recognise existing social and political dimensions, support social learning and equity, and move beyond conceptualisations of empty, ahistorical seas, will enable more integrated and responsive marine AG.

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