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Bridging academic theory and management practice to enhance the adaptive capacity of fisheries to climate change

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Results add to the growing literature on the ability of fisheries to adapt to change



This study bridges academic theory and management practice to enhance the adaptive capacity of fisheries to climate change. Through interviews with key individuals involved in decision-making processes in U.S. federal fishery management, it explores perceptions of adaptability of fisheries systems to change. Results add to the growing literature on the ability of fisheries to adapt to change, becoming increasingly important as global climatic change accelerates. Photo of shrimp trawler preparing to set gear off the coast of Oregon by Tkliles (CC BY-SA 4.0, <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons).

Fisheries worldwide are facing **unprecedented change** (<https://doi.org/10.1126/science.aau1758>), linked to climate change, including overall changes in productivity, species distribution shifts and increased frequency of severe storms, among other impacts. The vulnerability of specific fisheries and communities to the impacts of climate change depends on their exposure (the specific stressors that a system faces), their sensitivity (the degree to which people depend on the natural resources threatened by those stressors) and finally their adaptive capacity (ability to respond to or take advantage of those stressors to create **transformative change** (<https://doi.org/10.1038/s41558-017-0065-x>)).

The academic literature has produced proliferating **definitions** (<https://doi.org/10.1016/j.gloenvcha.2011.01.019>) of adaptive capacity based on a variety of theoretical frameworks. Therefore, for the purposes of this analysis, adaptive capacity is defined here as broadly as possible as the ability of a system – including ecological, socioeconomic, and governance components of the system – to anticipate and respond to change, including environmental, social and/or regulatory changes. This definition is adapted from the one used by the **Intergovernmental Panel on Climate Change** (<https://www.ipcc.ch/>), but expands that definition to consider all types of change.

Along with this definitional complexity, another challenge to considering adaptive capacity in the fishery management process is that, while a fishery's exposure and sensitivity can be evaluated using projected climate change and the nature of the community's reliance on seafood and marine industry-related livelihoods, adaptive capacity is more difficult to measure. This difficulty is due, in part, to this system characteristic's dependence on a wide variety of emergent, difficult-to-observe traits, including ecosystem variables, fishers' material and socio-cognitive traits, and the governance structure that regulates a fishery.

Despite this complexity, adaptive capacity is increasingly being incorporated into climate change vulnerability assessments and there is a growing academic literature on the aspects of complex social-ecological systems like **fisheries that enable adaptive capacity** (<https://doi.org/10.1038/s41558-017-0065-x>) in the face of change. **These include** (<https://doi.org/10.1111/faf.12630>) flexibility in governance systems, fishing communities and ecosystems; assets like natural resources, infrastructure, fishing gear, human capital and wealth; organized social and ecological relationships at different scales that promote resilience, including effective leadership, ecological connectivity and social capital; opportunities for fishers and managers to learn and innovate; and people's and institutions' freedom and agency to make and act on choices. Some analyses also consider the socio-cognitive constructs of individuals and communities, such as risk tolerance and cognitive biases.



(<https://link.ctlbl.com/aquapod>).

This article – **summarized** (<https://creativecommons.org/licenses/by/4.0/>) from the **original publication** (<https://doi.org/10.1016/j.marpol.2024.106321>) (Golden, A.S. et al. 2024. Enhancing the adaptive capacity of fisheries to climate change: Bridging academic theory and management practice through practitioner interviews. *Marine Policy* Volume 168, October 2024, 106321) – presents the results of a study that used semi-structured interviews with key individuals involved in decision-making processes in the United States federal fishery management system to explore the overlap between theoretical concepts about adaptive capacity to change and these individuals' perceptions of what influences the ability of fisheries systems to adapt to change.

Study setup

A **previous report** (<https://doi.org/10.1093/icesjms/fsad189>) based on this interview process highlighted a central tension in the U.S. governance system between the traits needed to enhance adaptive capacity in fisheries and the current structure of the fishery management process: the fact that fishers and managers cite an urgent need for flexibility in order to adapt, but management systems are built around rigid structures designed to promote fisheries sustainability [20].

This study delves into more detail about specific matches and mismatches between academic ideas around adaptive capacity and their application to fisheries governance. Specifically, it asks:

- How do fishery management practitioners define adaptive capacity, and how do their definitions compare to the understanding of these concepts in the academic literature?

- What attributes of fisheries do practitioners see as being important to their adaptive capacity, and how do these attributes match or diverge from the domains of adaptive capacity identified in the literature?

The study then uses this analysis to identify key mismatches between the academic literature and fishery professionals' perspectives on adapting to change, which we use to inform three future pathways through which researchers can reconcile this divide between theory and practice. These pathways are to:

- More explicitly distinguish adaptive capacity from the existing fisheries practice of adaptive management when communicating with fishery professionals;
- Use practitioners' practical insights to deepen the literature on the adaptive capacity of governance systems; and
- Expand the academic dialogue to explicitly consider the capacity to adapt on appropriate timelines given the scale and pace of systemic change.

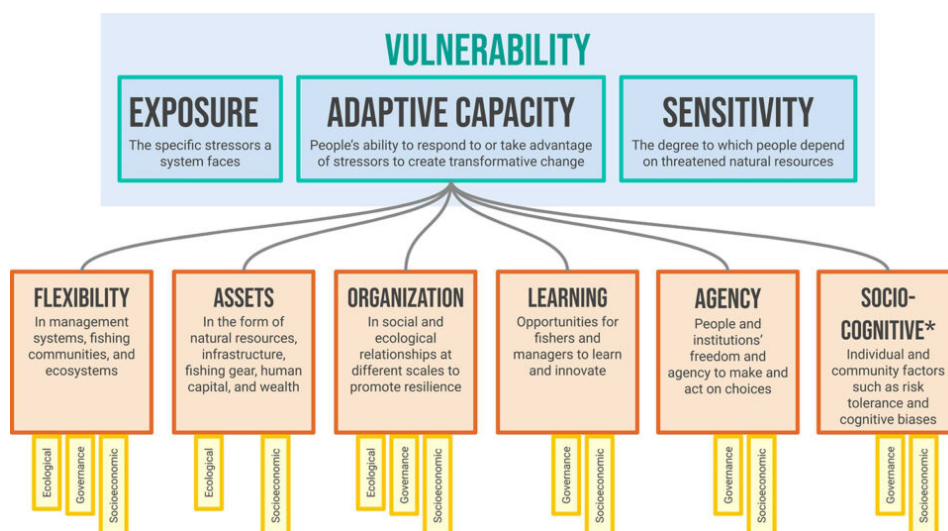


Fig. 1. Conceptual diagram showing hierarchical links between elements of vulnerability and adaptive capacity. Aspects of vulnerability commonly identified in the literature are outlined in blue, and domains of adaptive capacity in orange. The subsystems of fisheries social-ecological systems in which each domain can appear are outlined in yellow at the bottom. Note that some newer analyses include socio-cognitive constructs (indicated with an asterisk) as a domain of adaptive capacity, but this concept is less fully operationalized than the other five domains of adaptive capacity, so it is not a main focus of this paper.



Amid warnings, some marine species exhibit climate resilience as oceans warm

Warming oceans are causing major changes, yet some fish species, where the waters are most in flux, are showing climate resilience.



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Results and discussion

In general, the academic concept of adaptive capacity to change was broadly salient to interview respondents, with the exception of two respondents in the Southeast who were unfamiliar with the concept. Overall, study respondents' understanding of adaptive capacity overlapped broadly with academic ideas, with respondents considering all five main components of adaptive capacity as relevant and important to their regions.

In addition, interviews revealed some important mismatches between the two. Specifically, respondents generally defined adaptive capacity narrowly. They rarely identified it as an attribute of all three components within fisheries (ecological, socioeconomic, and governance) and/or rarely considered adaptation to multiple types of change at once (e.g., intersecting stressors of climate change and changing market conditions). Some of them also **conflated** (<https://doi.org/10.3390/su14127249>), adaptive capacity with adaptive management, a more established idea in fisheries science.

While all the domains of adaptive capacity from recent synthesis efforts were relevant to respondents, respondents added useful complexity to these theoretical domains, mostly by providing concrete examples of aspects of these domains within the governance system. Finally, they emphasized a specific temporal dimension to adaptive capacity that is not generally highlighted in academic discussions but can be crucial to fishery social-ecological systems' ability to adapt.

Overall, this research emphasizes the broad salience of the adaptive capacity literature to on-the-ground practitioners, while the areas of mismatch they identify point toward productive pathways for making this literature more accessible and useful to marine fishery managers, and toward places where these professionals can help provide conceptual advances in defining theory in this field. These mismatches are translated into three action items below.

Fig. 2: Sankey diagram (which tracks flow) of the fishery subsystems (left) and types of stressors (right) that respondents included in their definitions of adaptive capacity. The width of the link between each subsystem on the left and stressor on the right indicates the number of respondents who included this linkage in their definition of adaptive capacity. The total number of links associated with each stressor and subsystem category is listed in parentheses next to the text label for that stressor/subsystem. Adapted from the original.

Action 1: Build a shared definition of adaptive capacity

First, to increase uptake of ideas around adaptive capacity, researchers should consider ways to differentiate it from the concept of adaptive management, which is more established within the field of fishery science and which many fishery professionals will have **prior experience** (<https://doi.org/10.3390/su14127249>), researching or implementing. Although only a subset (20 percent) of respondents conflated the two concepts, the respondents for this study were purposively selected as individuals in leadership positions with high-level expertise in climate-ready fisheries management and science.

Because even leaders in the field experienced this confusion, clarifying what is meant by “adaptive capacity” will be crucial when communicating with the profession as a whole. One way to do this could be simply to define the two terms whenever discussing adaptive capacity in the context of fisheries and to state explicitly that the ideas are related but distinct. More broadly, this finding suggests the need for

more **deliberate and evidence-based scientific communication strategies**

(<https://doi.org/10.3389/fmars.2021.642372>) to effectively share these critical topics with practitioners, including clear communication goals; political, cultural and ethical sensitivity; and collaboration.

Action 2: Practitioner insights to gain a more nuanced understanding of adaptive traits

This work revealed two clear mismatches between academic ideas about the traits needed for adaptive capacity and how fishery professionals conceptualized these traits. First, while the academic literature strongly emphasizes ecological flexibility (e.g. adult mobility, larval dispersal, habitat diversity), ecosystem connectivity, abundant natural resources and biodiverse communities as traits that influence ecosystems' ability to adapt, respondents rarely spoke about these ecological traits as an aspect of their decision making. This mismatch could simply be the result of the open-ended interview structure used here, in which respondents were not prompted with specific adaptive traits and may have been more likely to bring up the adaptive traits and strategies they considered in their decision making on a day-to-day basis.

Alternatively, respondents could have been fully cognizant of these ecological traits but opted not to raise them in the context of the interviews because they are less easily managed using the tools available to fishery managers such as effort and catch controls. However, it could also mean that the extensive literature on ecological and evolutionary adaptation to climate change is not reaching the on-the-ground fishery practitioners whose actions can influence ecosystems' adaptive traits most strongly. Because the root causes of this mismatch are not clear, it would be premature to recommend a specific action item to address it.

Action 3: Make temporal factors explicit

Finally, interviews revealed an underlying question that shaped the way respondents perceived their regions' ability to adapt to change: On what timescale are governance systems able to adapt, and does that timescale match the pace and scale of change? As many respondents emphasized, the U.S. fishery management system is already adaptive and has the elements of adaptive capacity embedded in it. However, the system is most able to adapt at a slow, deliberate pace, and that pace is lagging behind the rate of environmental change. This question of timing is not necessarily a domain of adaptive capacity, per se, but can be thought of as an essential consideration for all domains of adaptive capacity.

This key insight from the interviews has implications for both scientists and decision makers. As scientists conduct research relevant to fisheries adaptation to change, they should incorporate a temporal lens and should be clear in communicating the appropriate timescales of proposed interventions. For management practitioners, respondents cautioned against rushing to respond to every type of change, given that some short-term adaptive coping mechanisms may be maladaptive in the long run. An alternative approach could be to set long-term goals in response to observed and anticipated changes and work towards those goals incrementally.

Fig. 3: Number of interview respondents out of 20 who described each domain of adaptive capacity as relevant (purple) and not relevant (green) to their management region. The number of respondents who brought up a domain unprompted before the interviewer introduced it is indicated with a blue diamond overlaid on the “relevant” column. Adapted from the original.

Study limitations

While this study’s in-depth qualitative interviews provided nuanced insight regarding how those involved in fishery management processes understand key concepts of adaptive capacity, the purposive sampling technique used here limits the ability to identify differences between management regions or different priorities for respondents based on their role in fisheries management. Instead, this study focuses on exploring consistent themes, identifying gaps in the current academic literature, and generating hypotheses for future quantitative work.

Perspectives

This study adds to the growing literature on the ability of fisheries to adapt to change, a literature that is becoming increasingly important as global climatic change accelerates. It adds a novel dimension to this literature by systematically eliciting the perspectives of fishery professionals whose expertise spans a broad range of marine systems across multiple management regions in U.S. fisheries. The resulting analysis reveals a broad concordance between practitioners and the literature: Respondents generally defined adaptive capacity in ways consistent with the literature and generally considered all five broad elements of adaptive capacity (flexibility, assets, organization, learning and agency) to be relevant to their regions.

At a more granular level, it identifies a number of mismatches between this current theory and how on-the-ground fishery practitioners think about the specifics of what they need in order to adapt to change. The manuscript then suggests three shifts in how researchers frame and present new advances in the

adaptive capacity literature to help bridge this gap between theory and practice. They are 1) distinguishing between adaptive capacity and adaptive management when communicating with practitioners, 2) using practitioner insights to deepen the field's investigation of the adaptive capacity of governance systems, and 3) adding an explicitly temporal component to studies of adaptive capacity to change, especially when proposing specific interventions.

Finally, this study suggests intriguing trends in responses based on management region, which can be explored further with more quantitatively robust methods like surveys. A follow-up survey of a broader sample of fishery professionals throughout the U.S. is currently in development to explore some of these trends further.

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