

**Polycentric governance for reef resilience: A case study of Florida's
Coral Reef Resilience Program**



Polycentric governance for reef resilience: A case study of Florida's Coral Reef Resilience Program

Final Report

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Management Summary

Here we report results from the first phase of a multi-year project that will evaluate and strengthen adaptive reef governance through Florida's Coral Reef Resilience Program. Our primary focus during Phase 1 (February 1, 2026-June 30, 2026) was drafting a literature review that synthesizes existing scholarship on coral reef governance globally to identify key findings, lessons learned, and knowledge gaps. The review provides an important foundation for our research and for coral reef management in Florida broadly by highlighting governance challenges and opportunities documented across reef systems worldwide, while also identifying areas where additional research is needed to support effective governance and management. Our findings are preliminary and remain in draft form; the review will be finalized in Phase 2.

The literature consistently shows that coral reef governance is multi-level in nature, involving diverse actors, institutions, and decision-making authorities across scales. However, the presence of governance arrangements does not necessarily translate into effective governance outcomes. Existing frameworks for emerging climate interventions and coral restoration are frequently found to be inadequate for their intended purposes. While governance systems often demonstrate the capacity to adapt incrementally to environmental change, they rarely achieve the structural transformations needed to address escalating threats. Across the literature, recurring challenges include scalar mismatches, limited institutional fit, and issues related to participation. At the same time, recommendations for improving coral reef governance tend to remain broad, offering limited guidance for implementation in specific contexts.

The literature captured in this review is geographically concentrated in Australia, the broader Indo-Pacific region, and, to a lesser extent, the United States. Research focused specifically on Florida's coral reefs is limited. Overall, the review suggests that our empirical study of coral reef governance in Florida is well positioned to address an important gap in the literature, generating insights that can inform management in Florida and advance broader scientific understanding of coral reef governance.

Next steps

In the second phase of the project, we will:

- Finalize the literature review and data collection instruments.
- Collect data for our case study of Florida's Coral Reef Resilience Program through semi-structured interviews, document review, and participant observation at relevant meetings and events.
- Process and analyze data.
- Convene a knowledge co-production technical meeting to share preliminary findings and gather input on how the research can best inform management, policy, and practice.

Executive Summary

Governance, which includes the actors, individual and organizational, institutions, formal rules, norms, and laws, and decision-making processes is foundational for how coral reefs are managed and restored. Our literature review synthesizes existing research on coral reef governance across five analytical themes: i) structure of coral reef governance, ii) navigating environmental change, iii) coral restoration governance, iv) scalar mismatches and institutional fit, and v) participation and power.

Key findings

- Compared to ecological studies, the literature on coral reef governance is relatively small and under-developed but growing.
- The literature has established that coral reef governance is consistently multi-level across different contexts, involving multiple actors, institutions and decision-making authorities, advancing insights about who governs and through what mechanisms.
- Structural density does not equate to functionality as a governance system can appear robust but be underperforming. Essentially, having governance structure in place does not mean it is working.
- Novel marine climate interventions and restoration programs are actively being developed and implemented, yet governance frameworks are consistently not fit-for-purpose. Beyond the regulatory and permitting dimensions, broader governance questions such as legitimacy, authority, and values remain understudied.
- Coral reef governance systems appear capable of adopting incremental, adaptive responses to climate impacts but do not seem to catalyze structural transformations demanded by environmental change. How governance responds and is transformed by environmental change remains an empirical gap.
- Scalar mismatches, institutional fit, and participation and power dynamics are cross-cutting conditions that shape coral reef governance. Institutional fit remains a core challenge in coral reef governance, and participation and power are determinants of governance. Key questions such as how multi-level or polycentric governance systems can overcome the challenge of scalar misfit and what formal and informal mechanisms can promote meaningful public and community participation in the governance of coral reefs remain.
- Recommendations for improving coral reef governance are broad and conceptual, often lacking practical guidance for specific contexts.
- The gaps identified in this literature review are particularly prominent in Florida's coral reef context, where there has been very little research.
- An empirical application of polycentric reef governance in South Florida is well positioned to address gaps identified in the literature review. Theory on polycentric governance offers a productive approach for evaluating the ability of Florida's reef governance system to adapt to change, mitigate risks, and solve scalar mismatches and answer questions such as how complex, multi-level governance is operating in Florida and what is the role of the Florida Coral Reef Resilience Program within the broader governance system.

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1. BACKGROUND

This is Phase 1 of a multi-year project. The overall goals of the multi-year project are to:

- 1) Document the emergence, historical evolution, and current structure of the Florida Coral Reef Resilience Program;
- 2) Evaluate the form and function of the Florida Coral Reef Resilience Program within a polycentric governance system;
- 3) Develop actionable recommendations that may enhance the performance and outcomes of the Florida Coral Reef Resilience Program

Phase 1 of this project was conducted February 1, 2026-June 30, 2026. Tasks for Phase 1 contribute to all project goals, and include:

- Obtain approval from University of Miami's Institutional Review Board for research with human subjects
- Develop a first draft of a synthetic review of literature on coral reef governance and polycentric governance
- Develop data collection instruments
- Introduce the project to FCRRP community
- Begin data collection

We have completed all tasks for Phase 1 and submitted appropriate documentation as attachments. **Within this report we present our deliverable for Task 3: a working draft of a synthetic literature review on coral reef governance. We emphasize that this is a draft** that will plan to continue to revise and finalize in Phase 2, pending confirmation of funding (July 1, 2026 - June 30, 2027).

2. INTRODUCTION

Humans have studied coral reefs for centuries (NOAA, 2025). While ecological knowledge gaps for coral reefs persist (Morais et al., 2018), the vast majority of research on coral reefs has come from the natural sciences. Social science scholarship remains significantly underrepresented in the broader coral reef research field (Westoby et al., 2020). The marine social sciences are a “diverse and interdisciplinary branch of the social sciences that embraces quantitative and qualitative methods to provide multiple empirical and conceptual lenses through which the relations between humans and the ocean can be understood” (Partelow et al., 2023). The field incorporates diverse social science disciplines, including but not limited to, political science, human geography, and psychology, to apply a human dimensions lens to environmental problems (Spalding & McKinley, 2025). Governance is one of several analytical lenses through which coral reefs have been studied within the broader marine social sciences.

The concept of governance is broad and differentially framed across contexts, but it can be distinguished from the concept of government since it operates beyond state-led authority and incorporates nonstate actors (e.g. private corporations, NGOs, civil society) across multiple local to global boundaries (Campbell et al., 2016). Morrison et al. (2020) provide a definition for coral reef governance as follows: “[Coral reef] governance is broader than government and incorporates the overarching structures and processes for creating knowledge about coral reef degradation, prioritizing issues, formulating policy, delegating responsibility, and for making decisions about how to intervene” (Morrison et al., 2020, p. 65). Governance will guide, enable, and constrain actions toward sustaining coral reefs and is therefore foundational to their resilience. In short, governance will ultimately determine how effective our decisions will be in saving these threatened social-ecological systems.

The urgency in sustaining coral reefs has catalyzed a diverse portfolio of interventions, including global greenhouse gas emission reduction strategies and localized management, including marine protected area networks and active restoration interventions (NASEM, 2019). The success of strategies and interventions, however measured, rely on well-designed governance arrangements, while poor governance arrangements can undermine the most ecologically well developed and robust interventions. The breadth of strategies and interventions prompt critical coral reef governance questions, including how to address coral reef degradation without generating unintended consequences before it is too late. This literature review aims to synthesize existing research on coral reef governance globally to distill lessons learned and identify remaining knowledge gaps.

3. METHODS

We define governance broadly to include the actors (individual and organizational), institutions (formal and informal rules/norms/laws), and decision-making processes that shape how coral reefs are managed and restored. Using Google Scholar and Scopus, we assembled a diverse range of peer-reviewed empirical studies, perspective pieces, and reviews between February and April 2026. Search terms included “coral reef governance”, “coral governance” and combinations of “coral” with governance*, institution*, and manag*. Some queries included restoration* as a search term to capture restoration-focused literature due to its prominence as a management intervention and may not be captured under broader governance terms. To ensure we captured coral reef governance research in Florida specifically, we also ran queries with “Florida.” In Scopus, the latter only yielded seven publications, two of which were relevant, and one additional study (Master’s thesis) in Google Scholar. Studies were included only if coral reef governance was the primary focus (e.g. ecology studies that reflect on policy implications in a discussion section would be excluded).

For this initial draft, we excluded papers that focused on fisheries governance or MPAs in coral reef contexts, since their inclusion would have rendered the review unmanageable. After reviewing abstracts for relevance, only papers that explicitly incorporated discussions of coral reef governance, including regulatory dimensions, governance actors and knowledge(s), policy, and institutions, were selected. From this subset, we identified additional literature through references. Ultimately 30 peer-reviewed articles were included in this literature review, including 18 empirical studies, 6 perspective and commentary pieces, 5 reviews, and 1 framework paper. Defining the boundaries of the coral reef governance scholarship remains a challenge. The terms “coral reefs” and “governance” are expansive and clarifying what coral reef governance is and is not, is a critical next step for this review. We will address this in future drafts by expanding the search strategy to include broader governance terms and describing relevant literatures, such as MPA governance in coral reef contexts.

We coded each study with attention to its analytical foci, key findings, and theoretical framing. We also recorded study gaps and limitations and looked for patterns across different geographical and institutional contexts. Overall, we found that the body of literature on coral reef governance is relatively small but diverse and growing.

4. RESULTS

4.1. Geographic context

The literature captured in this review is geographically concentrated in Australia, the Indo-Pacific region, and United States, likely reflecting the search terms and screening process we used for this review. For instance, six studies in this review focus exclusively on the Great Barrier Reef (GBR) in Australia, but there is certainly a broader body of GBR governance literature that was not captured because it is framed in terms of marine protected area governance (vs coral reef governance). It is also possible that a substantial portion of the literature may not explicitly use ‘governance’ or related terms in their titles, and therefore, was not captured by the initial search strategy. Indonesia, Philippines, and the United States are also well represented. Beyond these contexts, coral reef governance studies are scattered across single case studies in Mexico, Brazil, Costa Rica, Kenya, Thailand, and the Caribbean. Several studies in the literature were not empirically grounded in a specific geography as several conceptual pieces and multi-region reviews inform broader coral reef governance discussions.

There have been very few coral reef governance studies in Florida. We identified just two peer reviewed studies and a Master’s thesis, all published within the last 3 years. Wally et al. (2024) compared the formal, regulatory structure of the Florida Keys National Marine Sanctuary (FKNMS) to the informal network of the Southeast Florida Coral Reef Initiative (SEFCRI) in managing a novel coral reef ecosystem. Henry et al. (2025) examined how FKNMS actors responded to the 2023 marine heatwave while Morris (2023) integrated climate models with stakeholder interviews to assess how FKNMS decision-makers are enacting adaptive governance amidst coral bleaching events. The paucity of coral reef governance research in the Florida context and continuing decline of the Florida Reef Tract indicates a critical need for future research in the region to investigate the governance, institutional, and policy landscape of coral reefs to support decision-making.

4.2. Key analytical themes within the coral reef governance literature

The following sub-sections present the key analytical themes from the literature, with a synthesis of major findings and remaining gaps and questions: i) structure of coral reef governance, ii) navigating environmental change, iii) coral restoration governance, iv) scalar mismatches and institutional fit, and v) power dynamics.

4.2.1. *Structure of coral reef governance*

A substantial portion of the literature examines how coral reef governance is structured: that is, who governs and through what mechanisms across scales and levels. The multi-level nature of coral reef governance is perhaps the most consistent descriptive finding, where multiple,

overlapping decision-makers, such as government agencies, academic institutions, NGOs, private sector actors, local communities, and international bodies interact to address coral reef governance challenges at multiple scales (e.g. Fidelman et al., 2019; Matorres et al., 2024; Razak et al., 2022). Very few studies explicitly engage the literature on polycentric governance as a theoretical or analytical lens, despite its relevance for evaluating the functionality of multi-level governance. Crucially, when “polycentricity” appears in the literature, it is primarily a descriptive observation rather than an analytical one (Foster et al., 2025; Mcleod et al., 2019). Morrison (2017) offers the most theoretically engaged application of polycentricity to examine the robustness and effectiveness of the GBR’s governance system. Gorris and Glaser (2021) and Langle-Flores et al. (2025) also draw on polycentricity as a theoretical framework but invoke it to primarily characterize governance arrangements and contextualize findings.

Some studies in the literature effectively map who governs and through what mechanisms, serving important descriptive insights and documentation. Fidelman and Ekstrom (2012), for example, mapped the Coral Triangle’s institutional landscape, but also explicitly stated the limitations of their study for evaluating outcomes because it does not examine the extent to which international environmental arrangements are effective for compliance, achieving outcomes, and coordination. Assessing the functionality of diverse governance structures is essential –a point emphasized by Turner et al. (2020). Their study used social network analysis to map information brokerage across four Caribbean countries and found that even when actors occupied formal structural brokerage positions aimed at connecting different actors within coral reef governance networks it did not always translate into effective information flow to resource users such as fishers and tourism operators. As the authors found, a formal brokerage position does not mean information transmission is happening and underscores how structural density does not guarantee effective functionality. The studies highlight that future research should move beyond the descriptive mapping of coral reef governance arrangements to theoretically grounded assessments of how they function over time.

Several governance studies situated in the GBR highlight the importance of moving beyond the descriptive mapping of coral reef governance arrangements to reveal the structures that are performing effectively and/or underperforming. Vella et al. (2025) used the GBR’s Reef 2050 Plan as the benchmark, the GBR is considered well governed by global standards, but the health of the system is weakened by fragmented implementation, limited local capacity building, and weak program integration as some examples, which may not have been evident without assessing how a seemingly robust GBR governance system functions. The authors argue that priority areas for improvement in the GBR include genuine power sharing with key actors, improved coordination between federal, state, and local governments, building a culture of subsidiarity, integrated knowledge systems, collaboration toward regional decarbonization, and better communication of positive governance and successes. Additionally, Morrison’s (2017) longitudinal analysis of the GBR empirically demonstrates how “low visibility” multiscale

changes (e.g. internal restructuring) eroded the ability of the GBR's polycentric system to achieve its desired outcomes.

Key findings

- Coral reef governance is consistently multi-level, across different contexts, involving multiple actors and institutions across scales, levels, and jurisdictions. Descriptive research on the structure of coral reef governance has generated important insights for understanding the actors, institutions, and mechanisms through which coral reef governance operates across diverse settings.
- Documenting the actors and institutions involved in coral reef governance is necessary but the structural density of a governance system does not equate to functionality and robustness – i.e. having governance in place doesn't mean it's working.

Key gaps and questions

- The use of theoretical frameworks and methods, such as polycentricity, can help move beyond structural description of governance toward a more theoretically informed assessment of whether coral reef governance arrangements are functioning as intended. Polycentricity can build a shared understanding of how coral reef governance is functioning by asking key questions on how multiple decision-making authorities interact, adapt, and mitigate risks.

4.2.2. Navigating environmental change

Climate impacts represent one of the most serious governance and ecological challenges for coral reefs (Hoegh-Guldberg et al., 2018). Specific to coral reef governance, key debates have coalesced around the development and use of novel marine-climate interventions to address the continued deterioration of coral reefs due to climate impacts. Examples of novel climate interventions for corals include assisted evolution, synthetic biology, and genetic engineering. Some advocate that precautionary decision-making for developing and implementing interventions that increase thermal tolerance may foreclose the options needed to respond to climate impacts (Anthony et al., 2017; Baker et al., 2025) and as unconventional technological innovations for corals increase there needs to be a shift from protectionist to interventionist forms of governance (Shumway et al., 2023). Others adopt a more critical outlook, calling for principle-driven transformations in governance that contend with the myriad of risks associated with the development and implementation of novel climate interventions (Morrison et al., 2025). Hughes et al. (2023) argue that assisted evolution poses unknown evolutionary, ecological, and ethical risks with limited prospects for success in terms of scalability and cost-effectiveness, detracting from more transformative governance pathways that address the structural drivers of environmental change. Lockie and Paxton (2026) directly challenge these positions, pointing out that framing novel adaptation and mitigation strategies as competing priorities is empirically

unsubstantiated and counterproductive. They argue that critiques against novel climate interventions for coral reefs should be brought forward to open new inquiries for knowledge creation and different possibilities for action.

As is clear from the above, debates surrounding novel climate interventions are as much about technology and ecology as they are about governance: how should these consequential decisions be made and by whom? How should policymakers and managers weigh competing interests, knowledge, values, and ethics when making these decisions? Empirical research on the governance dimensions of novel marine-climate interventions for coral reefs is limited. The few studies that do exist found that the governance for novel climate interventions is not designed to support their development or implementation (Fidelman et al., 2019; Foster et al., 2025; Shumway et al., 2025). Foster et al. (2025) argued that marine cloud brightening does not neatly fit into current governance frameworks because most were developed for preventing environmental harm. Similarly, Fidelman et al. (2019) found that novel restoration interventions such as genetic engineering trigger several permits under different legislations, contributing to fragmentation and duplication, and agencies responsible for regulation lack the technical expertise necessary to evaluate safety and feasibility, resulting in delays in development and deployment. Baker et al. (2025) argue that legal and regulatory frameworks create a state of “analysis paralysis,” stalling assisted gene flow efforts for Caribbean coral species. Most studies remain primarily focused on the regulatory and permitting dimensions of governance for supporting or constraining novel climate interventions for coral reefs. However, broader governance questions such as who has the authority and legitimacy to make consequential decisions and how competing knowledge, values, and ethics should be weighed remain empirically understudied. As a first step, Fidelman et al. (2019) call for improved interagency coordination and more inclusive decision-making processes that bring together diverse actors, including Traditional Owners, industry, and communities.

Beyond the regulatory landscape, what constitutes a novel climate intervention is itself an open empirical question – and quickly evolving. Harangody (2026) argued that parametric reef insurance is a novel financial risk management technology that has transformed the governance of coral reefs in Hawai’i. The study highlights that novel climate interventions extend beyond ecological or biotechnological tools but can also include financial and market-based mechanisms.

The governance of novel climate interventions is not the only understudied dimension of coral reef governance. How existing governance arrangements respond to, and are transformed by, climate impacts also remain an underdeveloped area of research. Morrison et al. (2024) conducted a systematic review of 75 empirical studies published between 2004 – 2021 on science-policy responses to reef heating. The authors found that despite the broad range of challenges spanning ecological, socio-economic, institutional, and policy and governance dimensions, proposed solutions are primarily confined to two responses: i) inclusive adaptation, management measures involving local communities to assess and plan for climate risks and outcomes, and ii) the efforts

of scientists to integrate marine and climate science into government assessments to enhance usability of science by decision-makers. The authors label this as a science-policy lock-in, placing the burden of reef heating responses on vulnerable communities and avoids the structural drivers of reef decline.

In the studies that assess responses to environmental change, the focus is on adaptive governance and climate impacts. Two studies in South Florida offer complementary views into the governance of the FKNMS under climate stress (Henry et al., 2025; Morris, 2023). Morris (2023) found that certain aspects of the FKNMS have adapted to the realities of environmental change, such as the transition from a decentralized restoration program to a formal large-scale program (Mission: Iconic Reefs), but many interviewees noted that projected future climate scenarios have already happened, suggesting that the FKNMS may be catching up to the realities of environmental change. Henry et al. (2025) found that FKNMS actors were more prepared to handle disease outbreaks when the 2023 marine heatwave happened, but most adapted their job responsibilities to support coral evacuation efforts. Critically, Henry et al. (2025) do not ground their findings in an adaptive governance framework, making it difficult to determine whether the system was truly adaptive or reactive to an unfolding crisis. Only one study explicitly examined if climate events propelled governance transformations. Datta et al. (2022), drawing on adaptive governance theory and social network analysis, found that even after multiple bleaching events, the governance of the GBR's priorities and actor influence within existing forums, arrangements, and relationships did not change, nor catalyze governance transformations to address environmental change more effectively. Across the studies, while governance systems do appear capable of responding to environmental change as they unfold, they fall short of addressing the deeper structural transformations needed that environmental change demands – reinforcing the lock-in Morrison et al. (2024) describe. Consequentially, whether and how governance for coral reefs transforms in the era of climate impacts remains an open question.

These studies identified several challenges and barriers in responding to environmental change effectively, reflecting that governance arrangements are often not designed for the scale and pace of climate impacts. Ineffective cross-level and scalar coordination constrained the implementation of climate adaptation strategies in both the GBR and Florida, with efforts fragmented across sectors and levels (Fidelman et al., 2013; Morris, 2023). Resource and capacity constraints – primarily labour, funding, and infrastructure limits for coral nurseries – limited how actors can respond (Fidelman et al., 2013; Henry et al., 2025; Morris, 2023). In the GBR, local governments should play a critical role in climate adaptation yet lack the authority to act as top-down dominance from federal and state agencies is enduring. (Fidelman et al., 2013). In some of the restoration studies, climate impacts were identified as a threat but was not analytically evaluated within governance arrangements (Palou Zúniga et al., 2023; Wambugu et al., 2025). Broad recommendations such as better cross-level coordination, increased resources for local capacity, and explicit integration of climate projections into governance (Fidelman et

al., 2013; Henry et al., 2025; Morris, 2023), were offered, yet Shumway et al. (2025) argues that the recommendations are broad and lack practical guidance. Morrison et al. (2024) is the only paper to propose complimentary research directions for future work. The authors identify four directions: i) socially responsible transformations, focused on issues of fairness and legitimacy in governance responses, ii) upscaled capacity building through longer-term, multiscale investments in institutional capacity beyond stop-start funding, iii) networked pre-conditions calls for the examination of people, institutions, and coral reefs, and iv) brokered political economies to engage with science-policy solutions within the general political economy framework. The challenges suggest that coral reef governance may be misaligned and structural transformations are necessary for navigating environmental change.

Key findings

- The literature reflects ongoing debate about the governance of novel marine interventions. Some perspectives emphasize governance reforms that enable innovation, while others focus on ensuring that governance systems adequately address the diverse risks these interventions may pose.
- The literature has advanced our understanding on the regulatory landscape for governing novel climate interventions and consistently find that current frameworks are not fit-for-purpose.
- Governance responses are capable of incremental, adaptive responses but do not appear to catalyze the structural transformations demanded by environmental change.
- Multiple challenges and barriers for responding effectively exist including ineffective cross-level and scalar coordination, resource and capacity gaps, top-down, hierarchical dominance of climate adaptation strategies, science-policy lock-in, and climate impacts treated as a consideration instead of a priority.
- Recommendations for improving the governance environment for navigating environmental change lack practical guidance for implementation and are confined to a narrow set of solutions and future research directions signal the need to broaden disciplinary engagement, such as drawing from political economy and social-ecological networks, to move beyond science-policy lock-in responses.

Key gaps and questions

- The role of novel marine-climate interventions for coral reefs is a critical emerging and controversial topic. Currently, the literature is primarily conceptual. There is a need for empirical research on how governance processes can facilitate deliberation, debate, and decision-making.
- Empirical research on how governance responds to and is transformed by climate events is limited. Thus, the enabling conditions under which coral reef governance arrangements are adaptive to environmental change as opposed to reactive are unknown. Stronger

engagement with environmental governance theories such as adaptive governance or polycentricity may be useful for diagnoses.

- The literature identifies significant challenges and barriers for coral reef governance to deal with climate impacts, but the transformations necessary for overcoming them remains an open question.

4.2.3. Coral restoration governance

The debates surrounding coral reef restoration mirror discourse on the development and deployment of novel climate interventions as many of these innovations are restoration-focused, indicating that these governance challenges are not separate issues but reflect a field that is grappling with the same unresolved questions under an expanding restoration paradigm for corals. The literature examines how governance arrangements shape, enable, and constrain coral restoration efforts across a range of contexts, including local community-based projects in Kenya and Costa Rica and larger-scale restoration programs in Indonesia, the Philippines, Australia, and Florida. Similar to findings from Westoby et al. (2020), we find that the governance, policy, and institutional contexts of coral restoration is under researched, although additional studies have been published since the date of their review. Empirical studies on community-based or community-led governance of coral restoration is notably limited. The case studies we did find in Kenya and Costa Rica position the specific diverse multi-actor and multi-scalar governance of local-scale restoration projects as “successful”. The enabling conditions they identify include positive local perceptions of project benefits (Palou Zúniga et al., 2023), compliance with regulatory frameworks, and the diverse network of actors that enable access to human and financial resources (Palou Zúniga et al., 2023; Wambugu et al., 2025). The findings of these studies offer insights into what enables coral reef restoration governance in community-based arrangements, the transferability to other settings such as larger-scale, more institutionally complex contexts remain underexamined.

Beyond the community-based examples above, much of the literature find that governance frameworks for coral restoration are inadequate. Shumway et al. (2025) conducted an integrative literature review of 42 documents, from peer-reviewed and grey literature, on the governance of marine and coral reef restoration. The authors found that the literature converges on three main governance recommendations: i) adaptive and flexible governance frameworks to accommodate social and ecological uncertainty, ii) inclusive, collaborative, and co-designed governance especially for novel interventions, and iii) better governance to support restoration risks and coordination at larger scales. Similarly, Saunders et al. (2024) distilled findings from a national engagement process to develop ten guiding principles for coastal and marine restoration in Australia, with similar conclusions to Shumway et al. (2025) such as co-design and fit-for-purpose governance. Regulatory frameworks for restoration are fragmented, repetitive, and are primarily designed for conservation rather than active restoration, resulting in what Fidelman et al. (2019) call “regulatory paralysis”, in which restoration technologies have advanced faster than

governance institutions can accommodate. In the GBR, restoration interventions and emerging technologies are subject to multiple permitting requirements across agencies and legislations (Fidelman et al., 2019). In Indonesia and the Philippines, overlapping jurisdictions across a range of federal agencies have caused fragmentation and duplication (Matorres et al., 2024; Razak et al., 2022, 2024), generating confusion for practitioners when applying for permits (Matorres et al., 2024). In Florida, Morris (2023) found that the involvement of numerous agencies and organizations in the permitting process, such as the Association of Zoos and Aquariums and several federal and state agencies constrains the deployment of coral restoration projects.

Across these contexts, the governance landscape for coral restoration is framed as an obstacle for its development and deployment. Horigue et al. (2026), drawing from the decentralized context of the Philippines, contend that restoration interventions should only be pursued when governance capacity already exists since sites with stronger permitting, monitoring, and regulatory infrastructure can better sustain restoration. While the argument by Horigue et al. (2026) is logical, the literature highlights that the governance capacity for coral restoration is insufficient, presenting a dilemma; effective governance is necessary for successful restoration but delaying restoration whilst developing suitable governance is itself a governance action/decision that may further harm coral reefs that are actively degrading. This raises more fundamental questions about what a functional governance environment for coral restoration looks like and what transformations are needed to effectively support restoration interventions from development to deployment.

Beyond regulatory fragmentation, a consistent set of governance challenges emerge across the literature. Sustainable financing for restoration is challenging and undermines the long-term investment needed for restoration (Palou Zúniga et al., 2023; Saunders et al., 2024; Wambugu et al., 2025). Lack of technical expertise and human capacity limits the quality of restoration interventions and the ability of governance actors to evaluate them (Fidelman et al., 2019; Matorres et al., 2024; Palou Zúniga et al., 2023; Wambugu et al., 2025). Across multiple contexts, monitoring challenges driven by capacity constraints, including the absence of post-project oversight was a recurring theme (Matorres et al., 2024; Razak et al., 2022, 2024; Saunders et al., 2024). Unsurprisingly, environmental change uncertainty was identified as a threat but how and if it is accounted for in restoration is unknown in several contexts (Palou Zúniga et al., 2023; Saunders et al., 2024; Wambugu et al., 2025). Broad recommendations include sustainable funding mechanisms, stronger monitoring frameworks, streamlined regulatory oversight, and enhanced technical capacity (Fidelman et al., 2019; Horigue et al., 2026; Matorres et al., 2024; Saunders et al., 2024; Wambugu et al., 2025), but Shumway et al. (2025) are correct in highlighting that recommendations across the novel coral reef restoration literature offer a vision for what effective restoration governance should look like but without practical guidance on how to implement them in specific contexts. The same limitation for actionable recommendations applies here as in the previous theme on navigating environmental change. The findings indicate

that the governance landscape has not been able to keep pace with the scale and urgency in which coral restoration is being implemented.

Key findings

- The few empirical case studies on small-scale, community-based restoration projects position the diverse multi-actor and multi-scalar governance arrangements as assets for meeting restoration outcomes. Other enabling conditions include positive local perceptions of project benefits and compliance with regulatory frameworks.
- The literature recognizes that effective coral restoration governance requires adaptive frameworks that account for social-ecological uncertainty, inclusive co-design, and governance infrastructure that is capable of managing risks and the scaling of restoration.
- The literature has produced meaningful insights for understanding the governance barriers to coral restoration, identifying fragmentation and duplication as drivers of regulatory paralysis. Other major challenges for restoration governance include: sustainable financing, lack of technical expertise and human capacity, robust monitoring, and environmental change uncertainty.
- Similar to the analytical theme of navigating environmental change, recommendations for improving the governance environment for restoration lack practical guidance for implementation.

Key gaps and questions

- As outlined by Westoby et al. (2020), there is still a paucity of research on the governance, policy, and institutional contexts of coral restoration. Despite additional studies having been published in the 6 years since their review, it remains an understudied dimension in coral research.
- The enabling conditions identified in small-scale, community-based restoration contexts raise important questions for other settings. What governance conditions are necessary for larger scale, more institutionally complex coral restoration contexts?
- While issues of fragmentation and duplication in coral reef restoration governance is well-documented in the literature, how governance arrangements can be reformed to accommodate a growing coral reef restoration agenda has not been fully addressed.

4.2.4. Scalar mismatches and institutional fit

Coral reefs are ecologically connected systems whose boundaries do not necessarily align with political or jurisdictional boundaries. This often creates a problem called spatial scalar mismatch, which refers to a disconnect between the ecological scale of the problem and the scale at which

governance interventions are developed and implemented. The scalar challenge may also be temporal – a misfit of institutions to the pace of decision-making needed in a rapidly changing environmental context. In fact, scalar mismatches are implicit within many of the previously discussed themes (e.g. governance arrangements that don't fit temporally with the pace of environmental change or marine-climate interventions), indicating that scalar mismatches are a core, cross-cutting challenge. Some studies address this explicitly. For example, Fidelman and Ekstrom (2012) discuss the spatial mismatch of governance arrangements in the Coral Triangle Initiative. Many of them do not apply to all the member countries and overlapping topical and geographic coverage reveal a disconnect between the institutional boundaries and the ecological system. Using the example of marine cloud brightening, Foster et al. (2025) identify a scalar governance mismatch between regulating planetary-scale geoengineering interventions and localized ones, challenging logics that suggest smaller-scale marine cloud brightening interventions need “less governance” since issues of termination shock, public acceptability and moral hazard are still relevant even at smaller scales. In South Florida, the issues of scalar mismatch are also evident. Wally et al. (2024) found that the federally-led FKNMS and the informal SEFCRI (which has since been replaced by state-led oversight/management) have different governance capacities, leaving a significant portion of the Florida Reef Tract under-governed compared to the FKNMS. These cases highlight that at least one key source of governance challenges lies in the misalignment between institutional arrangements and the coral social-ecological system they are meant to govern, what is known as lack of institutional fit (Epstein et al., 2015).

Key findings

- The lack of institutional fit is a core challenge for coral reef governance.

Key gaps and questions

- How can multi-level or polycentric governance systems overcome the challenge of scalar misfit?

4.2.5. Participation and power

Power dynamics, such as whose interests shape decision-making and how influence is distributed among actors to achieve goals, is critical for understanding governance outcomes. Similar to scalar mismatches and institutional fit, power is a cross-cutting theme that shapes coral reef governance. Yet, despite the critical role power plays in governance, consideration of power within the current literature is descriptive and undertheorized.

The exclusion of key actors in governance processes is a key finding. This pattern is most extensively documented in the GBR. Over 70 Traditional Owners are represented in GBR governance through formal reef committees, yet many do not feel valued, listened to, or genuinely

engaged with in coastal and marine restoration projects (Saunders et al., 2024). Vella et al. (2025) identified the lack of genuine power sharing with Traditional Owners, local government, and industry as key structural weaknesses in the GBR 2050 Plan that may undermine the legitimacy and effectiveness of the GBR governance system. Beyond the GBR, social network analyses in the Caribbean, Brazil, and Indonesia revealed that local resource users, such as fishers and tourism operators, were poorly connected to wider governance networks despite the presence of coordinating forums and bridging organizations (Eider et al., 2023; Gorris & Glaser, 2021; Turner et al., 2020), suggesting that the current structures for inclusion were not sufficient for meaningful participation and influence. While Shumway et al. (2025) flag that studies prescribe community engagement as critical, all studies in their review leave unaddressed questions of whether or how communities should help decide if, when, and where novel interventions are deployed.

We found only one study that engages with power in reef governance in a theoretically informed way (Harangody, 2026). Drawing from political ecology, science and technology studies, and Foucauldian concepts of power, the study analyzes how the purchase of parametric reef insurance in Hawai'i by the Nature Conservancy quietly redistributed authority of the reefs. Unlike other studies, Harangody's theoretical engagement with power connects it to governance processes and outcomes, asking whose interests are reflected, who bears the risks, and what does the redistribution of power mean on the ground for local actors. The case indicates that power is not merely an outcome of governance but a determinant of it. This requires moving beyond describing the power dynamics at play but to move toward the use of theories and frameworks that analyze power as a dynamic and contested feature of coral reef governance and how it enables and constrains reef sustainability.

Key findings

- Participation and power are not merely outcomes of governance but determinants of it.

Key gaps and questions

- What formal and informal mechanisms can promote meaningful public and community participation in the governance of coral reefs?
- How power is distributed among multiple authorities within multi-level governance systems - and with what consequences for governance outcomes- is understudied. Frameworks for understanding power (*see e.g. Morrison et al., 2019*) in addition with other disciplines such as political ecology can contribute critical insights to the coral reef governance scholarship.
- Power, participation, and legitimacy are inextricably linked and the literature in this review does not engage with key questions at their intersection, such as: what is the social license for novel climate interventions?

5. DISCUSSION AND MANAGEMENT RECOMMENDATIONS – POLYCENTRIC GOVERNANCE OF FLORIDA’S CORAL REEF IN THE CONTEXT OF ENVIRONMENTAL CHANGE

This literature review has reviewed the state of coral reef governance scholarship across five analytical themes: i) structure of coral reef governance, ii) navigating environmental change, iii) coral restoration governance, iv) scalar mismatches and institutional fit, and v) participation and power dynamics in coral reef governance. Collectively, the literature reveals a growing field that has produced substantial knowledge about the multi-level and multi-actor coral reef governance landscape across diverse contexts. Simultaneously, there are existing gaps and future research needs for advancing theoretically grounded empirical coral reef research. In general, there is less known about whether governance arrangements are functioning effectively compared to what is known about their structure. Understanding the governance frameworks for novel marine climate interventions and restoration are a critical area for future empirical research. Based on emerging studies, governance responses to climate impacts appear to be incremental and adaptive but remain in a science-policy lock-in. Considerable gaps remain in understanding how governance responds to and is transformed by environmental change. Scalar mismatches and power dynamics are acknowledged as cross-cutting conditions but remain under-examined in the literature. Future research should build on the diagnostic insights generated in the literature by advancing theoretically grounded, empirical research that can provide practical guidance and inform decision-making.

The gaps identified in this review are particularly salient in the Florida coral reef context, where there has been surprisingly little research. Florida is home to the only coral social-ecological system in the continental United States and is ground-zero for some of the most active and experimental coral restoration programs in the world (Baker et al., 2025; Hodges & Hallock, 2025). The few studies focused on coral reef governance in Florida are valuable, offering insights into how specific decision-making authorities respond to climate-driven events, but do not examine the broader governance system of the Florida Reef Tract. Empirical questions such as how the multiple, overlapping authorities responsible for the Florida Reef Tract interact, coordinate, and exercise influence remains unanalyzed. Additionally, whether the governance landscape is effective in addressing dynamic ecological challenges and well-suited for a growing restoration paradigm and emerging technologies remains unknown.

Analyzing coral reef governance in Florida through the lens of polycentricity can help address some of the gaps mentioned in the review. Theoretically, polycentric governance systems assume several advantages including adaptive capacity, good social and ecological fit (institutional fit), and risk redundancy (Carlisle & Gruby, 2019). However, polycentric systems are not a panacea for complex environmental problems and dysfunctional polycentric governance may have drawbacks including unequal representation among actors, and greater transaction costs and time

for producing solutions (Baldwin et al., 2024; Ostrom, 2010). How is polycentric reef governance playing out in Florida? What is the role of the Florida Coral Reef Resilience Program within the broader polycentric system? With ongoing ecological stresses and technological advancements, the lens of polycentricity offers a productive approach for evaluating the ability of Florida's governance system to adapt to change, mitigate risks, and solve scalar mismatches. The findings from a study of this nature can generate practical context-specific guidance for practitioners, decision-makers, and scientists working in the Florida Reef Tract. This work can contribute greater complexity and data to an increasingly critical body of knowledge for conserving and restoring coral reefs in an era of environmental change

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