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Possibilities for a critical social science of assisted ecosystem adaptation and other climate intervention practices

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ABSTRACT

Increasingly severe climate change impacts are leading to increased interest in novel climate interventions including assisted ecosystem adaptation; that is, the deliberate acceleration of evolutionary responses to climate pressure through techniques such as assisted species migration, selective breeding and enhanced ecosystem restoration. Research into these and other techniques has attracted criticism, however, regarding the risk of unintended ecological consequences, the challenge of developing effective governance regimes, and the potential to justify inattention to the root causes of environmental change. We argue here that many of the criticisms levelled at assisted ecosystem adaptation in coral reefs, more specifically, are characterized by singular voices, polemic arguments, empirical short-cuts, and premature closure. While to make this argument we must evaluate criticisms of assisted reef adaptation, our intent is not to have the last word but to encourage curiosity among social scientists toward the development, evaluation, and implementation of climate intervention technologies and practices. With this in mind, we propose a framework for critical engagement that – drawing on the concepts of 'matters of concern' and 'matters of care' – shifts attention from arbitrating over the facts of intervention to facilitating more inclusive, foresightful, and constructive dialogue over climate intervention knowledge, goals, and ethics.

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Introduction

Compelling evidence that anthropogenic climate change is increasing the frequency, intensity, and impact of extreme weather events (IPCC 2022) and the signing of international agreements including the Marrakesh Accords of the UNFCCC (Bassett and Fogelman 2013) have precipitated dramatic growth since the turn of the century in policy and research focused on adaptation to climate change (Webber 2016). To date, most of this research has focused on agriculture, policy, urban planning, disaster risk reduction, and sustainable development (Nalau and Verrall 2021). However, research focused on assisted ecosystem adaptation is also growing (Vella et al. 2021), as is research into biotechnological tools for wildlife conservation and invasive species management (Kelz and Heger 2024) and geoengineering approaches to solar radiation management and the sequestration of atmospheric carbon dioxide (Baresi et al. 2025; Sovacool 2021).

None of these research directions are without controversy, and neither should they be. Climate adaptation and the prospect of strategies like carbon removal to actively intervene in ecological and physical processes provoke myriad scientific and moral questions while providing few straightforward answers. In the face of profound risks and uncertainties and an urgent need for effective action, now is not the time to shy away from rigorous debate about novel climate interventions. But what kind of debate? How do we grapple critically, ethically and constructively with the difficult issues climate change places on the table?[1]

Our own research focuses on how First Peoples, stakeholders, and other community members engage with, and in, practices intended to accelerate the adaptation of corals in Australia's Great Barrier Reef (GBR) to climate change (see Bartelet et al. 2025; Lockie, Bartelet et al. 2024; Paxton, Lockie, and Backhaus 2024). Clearly, we have our own beliefs and affective commitments in relation to assisted ecosystem adaptation, but it is not our objective here to stake out and defend a position. We first seek to encourage curiosity among social scientists toward the development, evaluation, and implementation of climate intervention technologies and practices, and second, to encourage critical self-reflection on the 'world-making effects' of our own collective research into, and representations of, these interventions (Puig de la Bellacasa 2011, 86).[2]

We will begin with a summary of the rationale for assisted ecosystem adaptation before moving on to a synthesis of criticisms levelled at assisted coral reef adaptation in the scholarly literature. Too much of this literature, we will argue, is dominated by singular voices, polemic arguments, empirical short-cuts, and premature

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closure. To make this argument we will need to evaluate and contest criticisms of assisted reef adaptation, but we make no pretence, in doing so, of offering a comprehensive or systematic review. Nor do we pretend that debates over assisted coral reef adaptation map directly onto debates about adaptation in other ecosystems or other climate interventions. Our purpose is to highlight what is lost when complex, indeterminate issues are boiled down into simple binary disputes and to explore possibilities for critical engagement that avoid rushing to judgement (Stengers 2005), open space for democratic dialogue (Latour 2004a), and ask what kinds of futures might be possible (Puig de la Bellacasa 2011).

Assisted ecosystem adaptation as novel climate intervention

Climate adaptation refers to processes of adjustment in human and natural systems in response to climate change (IPCC 2007; Lockie 2024). Adaptation may reflect adjustment to climate impacts as they are experienced, and it may reflect preparation for climate impacts that are anticipated (IPCC 2022). Similarly, adaptation can arise spontaneously from exposure to climatic stimuli, and it can arise from conscious and deliberate intervention (IPCC 2022). Adaptation can be incremental, reflecting minor changes that preserve system attributes and processes, and it can be transformative, reflecting fundamental change in existing attributes and processes in pursuit of higher order objectives (IPCC 2022). As the severity, pace and irreversibility of climate impacts are realized, materially and cognitively, so too are the urgency and magnitude of the adaptation challenge (IPCC 2022).

Assisted ecosystem adaptation is planned and anticipatory, employing a range of strategies to accelerate the evolutionary responses of target species and ecosystems to expected climate impacts (Anthony et al. 2017; Lockie 2024; Vella et al. 2021). These can include enhanced ecosystem restoration techniques, genetic screening of seed or brood stock for heat tolerance, selective breeding, assisted species migration – indeed, anything that helps ecosystems maintain vital functions and values despite rapidly changing environmental conditions (McLeod et al. 2022; Vella et al. 2022). Australia's Reef Restoration and Adaptation Program (RRAP), for example, identified 160 possible interventions relevant to coral reefs which were then evaluated for their potential, subject to further research and development, for large-scale, ecologically, socially and economically feasible, implementation (McLeod et al. 2022). In addition to interventions focused explicitly on adaptation, RRAP is now trialling local- to regional-scale solar radiation management as a short-term strategy to reduce the intensity of extreme heat events and thus to 'buy time' for adaptive responses (Butcherine et al. 2023). Cognate reef science programs focus on strengthening traditional ecosystem management approaches, such as water pollution and invasive species control, in order to reduce the cumulative impact of environmental stressors on reef health and adaptive capacity (Anthony et al. 2020).[3]

The rationale here is that while deep and rapid cuts in greenhouse gas emissions are needed to reduce the magnitude and pace of global environmental change, far greater investment is also needed in adaptation science, planning and action to reduce the impact of changes that have become inevitable (Anthony et al. 2017; Bay et al. 2023). Neither mitigation nor adaptation can be delayed. As mass coral bleaching events impacting the GBR in 2016, 2017, 2020, 2022 and 2024 demonstrate, dangerous climate change is as much a contemporary reality as it is a future threat.[4] Beyond the Great Barrier Reef, this is leading to debate over how best to apply the precautionary principle when an excess of caution itself risks increasing climate impacts (Bowman et al. 2017), and for an explicit focus on building resilience to future climate states in ecosystem conservation and restoration (Ren and Coffman 2023).

Contesting assisted reef adaptation

What criticisms then are levelled at assisted adaptation in coral reef ecosystems? Ecologically, according to Hughes et al. (2023); see also Bellwood et al. 2019; Morrison et al. 2020), assisted coral adaptation approaches have limited prospect of success. Existing restoration approaches, they argue, are neither scalable nor cost-effective. Further, they see no evidence that genetically enhanced corals will have greater lifetime fitness than wild corals, nor evidence enhanced corals can be deployed in sufficient number to transfer desirable traits. Adaptation through assisted colonization or assisted gene flow is similarly unlikely to be effective, according to Hughes et al. (2023), due to lack of fitness among corals moved from one reef environment to another and high mortality among coral larvae that have been harvested, settled and outplanted elsewhere. At the same time, they contend, while the potential benefits of coral restoration and adaptation are routinely over-estimated, the risk of reducing fitness and/or genetic diversity in wild populations is not understood and complementary approaches for promoting coral recovery – such as improving water quality – are underutilized (Hughes et al. 2023).

This last point speaks to the widespread belief that climate interventions like geoengineering and

assisted adaptation present moral hazards by encouraging greater risk-taking among actors who feed protected from the potential consequences of risk events (Corner and Pidgeon 2014; Fairbrother 2016; Maier and Simberloff 2016). There are several variants of the moral risk argument, most straightforward being the proposition that assisted adaptation weakens incentives to reduce greenhouse gas emissions (Hughes et al. 2023; Morrison et al. 2019). With strong action to reduce emissions proving politically difficult in Australia, according to Morrison et al. (2020), 'placebo policies' including reef restoration and other small-scale interventions provide governments with opportunities to be seen to be doing something about climate change without taking meaningful action to address its underlying causes (see also Bellwood et al. 2019). Governments, they argue, are caught in a 'governance trap' in which capacity to address reef degradation is constrained by its misdiagnosis as a localized problem to be addressed by local reef managers and consequent distraction from higher-level solutions such as ending fossil fuel subsidies. Nyberg and Wright (2024) contend, similarly, that Australian and Queensland Government support for reef adaptation is a deliberate strategy to divert attention from climate change mitigation and to defend the hegemony of the fossil fuel industry.

What then do critics of assisted coral reef adaptation see as the alternative? At its simplest, 'a dominant focus on dramatic emissions mitigation'; not, however, through individualized and marketized policies but through collective action, civil disobedience, and divestment to disrupt market capitalism (Nyberg and Wright 2024, 263). Even bans on fossil fuel use and other measures to directly reduce greenhouse gas emissions will have limited long-term impact, it is argued, in the absence of deeper, more radical action to reconfigure 'capitalist, exploitative and extractive systems' (Morrison et al. 2022, 1103). For Nyberg, Wright, and Bowden (2022), degrowth and democratization are needed in concert with decarbonization to challenge corporate hegemony and the treatment of adaptation programs as opportunities for profit-making that ultimately reinforce social and ecological vulnerabilities. Morrison et al. (2022, 1103) identify corporate accountability, transparency and integrity measures as starting points in the project of economic reform and basic income schemes, renewable energy, regenerative agriculture, public transport etc. as practical tools to decouple the pursuit of societal wellbeing from energy and material use. Synergistic and scaled-up intervention (effectively, more integrated planning for decarbonization and sustainable resource management across the terrestrial land use, marine, energy, and other sectors) is advocated by Morrison et al. (2020) to escape the governance trap.

Confecting matters of fact

There is a plausibility to many of these arguments; a plausibility that derives at least in part from their accordance with what Latour (2004a, 229) refers to as popularized versions of social critique – familiar rationales for scepticism rooted in the hidden forces of discourse, knowledge/power, capitalism, and so on. Such critique is not concerned with carefully building or examining facts but with exposing their hidden agendas and unreliability. It is taken as self-evident from such a perspective that proponents of assisted adaptation have fetishized technology, accepted conflicts of interest, and failed to see the dynamics of capitalism and corporate hegemony at play. Our uneasiness with these arguments is based on the veracity of evidence and reasoning presented in opposition to assisted reef adaptation, and on the systematic neglect of evidence, explanations and, most importantly, voices, inconsistent with critics' pronouncements on ecological and political risk.

There is no inherent contradiction in the proposition that restoration and adaptation interventions risk failure both to produce measurable ecological change and of unintended but severe ecological harm. Complexity and uncertainty represent enduring challenges for climate risk calculation and decision-making (Wong and Lockie 2020). It is a proposition, however, that should provoke more questions. Wouldn't it be reasonable to ask, for example, whether research can reduce uncertainty in relation to the potential impacts (positive and negative) of assisted adaptation in a timely manner? Whether the implications of 'doing nothing' are understood? Whether regulatory and governance arrangements are suitable for managing intervention risks? And whether any kind of social consensus is possible on risk management in light of the probability some uncertainty will endure?

Absent, however, from assertions about the risk of catastrophic failure (whether to have any ecological impact at all or to compromise natural ecological processes) is consideration of how assisted adaptation research might support innovation in intervention design, deployment, targeting and risk assessment.[5] Equally absent is consideration of how intervention research, field trials and deployment are regulated, of work underway through research and governance institutions to align regulatory regimes with intervention risk, and of engagement with First Nations, local communities and other stakeholders to ensure risk management is sensitive to social and cultural values.[6] Instead, critics rely on hyperbolic language and spurious associations to imply a cavalier approach to risk-taking – casually dismissing assisted adaptation

options as extreme and unproven analogues of carbon capture and storage and space-based geoengineering (Morrison et al. 2022). While Hughes et al. (2023, 661) claim that 'some environmental ethicists have criticized the lack of public deliberation prior to the premature application of unsafe or unproven restoration trials' implies empirical evidence of reckless risk-taking by adaptation researchers, the source cited in support of this claim is misrepresented. What philosophers Filbee-Dexter and Smajdor (2019) actually argue is that assisted evolution research is ethically justifiable but debate over its implementation should consider whether consequences are understood and alternative options exhausted.

This draws us back to the question of moral hazard and whether assisted adaptation encourages or legitimates inattention to the root causes of ecosystem degradation – a question also asked, we should stress, by many of the restoration practitioners and scientists we have spoken to in our own research (Paxton, Lockie, and Backhaus 2024). As McConnell (2020) notes, government attempts to manage the politics of difficult policy problems by addressing only their most obvious symptoms risk criticism for lacking ambition and leadership. However, actions to relieve the symptoms of difficult policy problems might also be considered important to: (1) reduce their downstream social and environmental impacts; (2) buy time for interventions targeted at underlying causes to take effect; (3) build public support for those interventions; and/or (4) provide a path forward despite recognition that some problems may ultimately exceed governmental capacity to resolve[7] (McConnell 2020). There is no guarantee action to reduce the impacts of climate change on coral reef or other ecosystems will legitimate lack of action to reduce greenhouse gas emissions. In fact, it is possible that investing resources and involving reef communities in assisted adaptation will increase pressure on government for strong parallel emission reduction measures, for institutionalizing an enduring commitment to reef adaptation, and for extending this commitment to other ecosystems and sectors. Increased pressure on government would be consistent with surveys demonstrating increased concern about climate change and/or commitment to reducing personal emissions among respondents presented with information about solar geoengineering (Burns et al. 2016). Our point here is not that adaptation measures are free of moral hazard but that a range of political motivations and outcomes are possible and warrant critical attention.

Is convincing evidence put forward that investment in assisted adaptation is crowding out policy alternatives? In short, no. The assertion Australian governments are funnelling money into coral restoration and adaptation when they should be investing in renewable energy, terrestrial and coastal ecosystem rehabilitation, land-based aquaculture, and so on (Morrison et al. 2019; see also Nyberg, Wright, and Bowden 2022), elides the fact that expenditure in most of these areas far exceeds that spent on reef restoration and adaptation.[8] It's true Australia has been slow to adopt ambitious national targets for emission reduction but critics draw an exceptionally long bow when attributing a meaningful role to adaptation programs in the legitimation of inaction. Adaptation has rarely featured in the culture wars dogging climate policy (Boykoff 2024; Wilkinson 2021) and, when adaptation has featured, it has been in inconsistent and contradictory ways (Atkins 2023). When the Australian Government adopted adaptation rhetoric in the wake of catastrophic bushfires in 2019–2020, for example, it drew attention to its poor record on climate change (Holman 2022) via, among other things, well-publicized calls from senior emergency service personnel to intensify their commitment to both mitigation and adaptation (Wilkinson 2021). Inaction on climate change went on to feature as one of three leading issues behind voter discontent and a change of government at the 2022 national election (McAllister 2023).

The possibility that participation in stewardship and management activities could provide social benefits such as reinforced cultural identify, strengthened local agency, and enhanced hope is acknowledged by Bellwood et al. (2019) and Hughes et al. (2023). The potential for similar social outcomes are evident in many of the exemplars of integrated, multi-scalar intervention proposed by Morrison et al. (2019, 2020) as alternatives to placebo policies. These acknowledgements have at least two major implications. First, if innovative partnership and governance arrangements have the potential to address local and global policy imperatives in parallel by building positive synergies between food and energy security, livelihoods, terrestrial and coastal ecosystem rehabilitation, carbon sequestration etc. and decarbonization, there is no *a priori* reason to assume synergies cannot also be built with marine ecosystem restoration and with assisted ecosystem adaptation more generally. Second, if public deliberation, multi-stakeholder collaboration, and cross-boundary coordination offer possibilities to resolve the scalar challenges posed by climate change (see also Morrison et al. 2017), it behoves scholars to respect First Nations and community voices. Such voices, however, are almost entirely absent from critiques of restoration and adaptation in the scholarly literature.[9]

Towards a generous debate

By contesting the evidence and logic laid out by critics, we risk reinforcing the representation of assisted adaptation as a binary choice between rejection and

acceptance – a choice between warring factions and their competing assertions of fact. We will thus come back to the importance of taking critics' concerns seriously. Ultimately, however, our concerns stem less from critics' use and interpretation of evidence than they do from the 'world-making effects' of critical practices based on asserting exclusive forms of authority (Latour 2004b; Puig de la Bellacasa 2011). Empirical short-cuts and the truncation of complex issues into simple questions of right and wrong, good and bad, are emblematic of practices that are inherently subtractive: ones that seek to dismiss competing claims, control alternative possibilities, and marginalize other voices (Latour 2004a).

What if critique is conceived not as a process of casting doubt or revealing truth but of finding better facts and better possibilities? A substantial body of (mostly feminist) literature considers the opportunities that shifting from smooth, risk-free 'matters of fact' to tangled 'matters of concern' open for additive forms of scholarship (e.g. Despret 2006, Puig de la Bellacasa 2011, Stengers 2005). For Latour (2008), this is not about treating knowledge as less real but as less fixed. To treat knowledge as a matter of concern is to treat it as historically contingent, fragile, provisional; a collective achievement made durable through the care with which it is created and maintained. The same care, moreover, the same curiosity, rigour, and attention to detail, needed to create and maintain knowledge allows for its testing, extension and revision (Hinchliffe 2008). Treating knowledge as a matter of concern suggests a positive approach to critique that is not about deconstructing knowledge to reveal the truth of its social and political bias but about making it more robust, timely and relevant.

Within this critical practice, the possibilities identified by critics of assisted adaptation must be taken seriously – not as facts to be accepted/rejected *tout court* but as questions to be asked, and asked again, as answers prove incomplete, contradictory, and temporary. We should no more discount fear of perverse social and environmental outcomes than we should be open to the realization of positive outcomes.

Latour's (2004a, 246) assertion that the 'critic is not the one who debunks, but the one who assembles . . . [the one] who offers the participants arenas in which to gather' reflects the conceptualization of knowledge as a collective achievement. It follows that critique requires care, collaboration, and creativity; opening space for people and things to engage in dialogue and collective experimentation, to assemble new possibilities (see also Cardwell and Waterton 2019; Latour 2004b). This provides a powerful rationale for research and scholarship that supports participatory and deliberative processes – democratizing ecosystem adaptation R&D and fostering collaboration in the myriad experiments in ecosystem adaptation undertaken by First Nation and community groups, natural resource-dependent businesses, government agencies, etc.[10] It is not a rationale for limiting the purview of the social sciences (nor of any science) to explicitly participatory and deliberative methods. There are far too many examples of ostensibly participatory planning and decision-making processes managed to limit possibilities for democratization (Araos 2023); and of opportunities for participation in science circumscribed by narrow conceptualizations of 'the public' (Berseth et al. 2023). The notion of critique as an act of assemblage does, however, call for critical self-reflection on who we invite to gather; on the relationships, politics, and ways of seeing things our various approaches to scholarship foster (Puig de la Bellacasa 2011).

Conceptualizing critique as a careful, collaborative and generative practice is by no means a rationale for ignoring power and domination. Indeed how, Puig de la Bellacasa (2011, 95) asks, 'is commitment to care . . . not a suspicious debunking that finds power everywhere?'. Approaching matters of concern as what she refers to as 'matters of care' brings their affective and ethical dimensions into sharper relief and encourages us to address the processes of inclusion and exclusion that define such matters (Puig de la Bellacasa 2011). Analytically, this draws attention to the ways in which some actors, perspectives, and emotions are privileged while others are rendered invisible, but it denies us the comfort of critical distance and demands attention to the exclusionary potential of our own scholarly practice (Puig de la Bellacasa 2011, 2012; Tozzi 2021). We have already commented on the absence of First Nations and community perspectives in critiques of assisted adaptation so we will not labour the point. What though might an alternative approach to critique might look like?

Acknowledgement and respect for divergent perspectives is an important starting point. Thinking with care, as Puig de la Bellacasa (2012) puts it, is not about indifference to power or shying away from conflicting perspectives but about being alive to the consequences of our own scholarship. Ethically and politically, these include both the disempowering effect of polemicized critique (see Puig de la Bellacasa 2011, 92) and the possibility, instead, of dialogue and relationship-building. In a matter as complex as climate adaptation, there is an epistemological consequence here too, the inclusionary impulse of care bringing more experiences and expertise to bear while subjecting knowledge claims to testing and revision from more perspectives.

Challenging inequality requires more, however, than respect for difference. Puig de la Bellacasa (2011) call to engage in care as a speculative project about the possible focuses attention on how different ways of seeing and doing open new possibilities for action. This has at least two implications for our

consideration of climate interventions. First, while adaptation to climate change has become necessary, the 'specific arrangements of people, technologies, places, natural processes, histories, emotional engagements and disengagements' implicated in any given adaptation project 'are always situated and provisional' (Tozzi 2021, 159). Whose ways of seeing and doing then are to shape possibilities for adaptation in coral reefs? Are the aspirations and insight of First Nation and local communities to be respected, for example, when they seek to engage with, not to disrupt, market mechanisms? Second, the responsibility to care is enduring. It is not just that adaptation is a long-term project but one that must anticipate and respond to the non-linear, discontinuous and often abrupt nature of climate change (Lockie 2024). As scholars we have a clear responsibility to help communities engage with uncertainties inhering in climate change and facilitating careful deliberation over appropriate adaptive responses.

Conclusion

Behind critiques of assisted coral ecosystem adaptation lie important questions about the social and ecological implications of novel climate interventions and about how we ought to approach the possibilities they offer epistemologically and ethically. We should no more rush into coral reef adaptation than we should the genetic manipulation of forests and fish (Berseth 2023; Berseth et al. 2024), the translocation of vulnerable plants and animals (Hagerman, Kozak, and Dalrymple 2021), or the eradication of pests using gene drives (Devos et al. 2022). However, sweeping factual claims about assisted ecosystem adaptation functioning to legitimate inaction on greenhouse gas mitigation and reinforce corporate hegemony are, at best, premature. At worst, they serve as contrived expressions of scientific authority, the effect of which is to control and contain rather than to care. The problem here is less that critics get some facts wrong than that, by treating the complex moral and scientific terrain of climate adaptation as a straightforward matter of fact, opportunities are lost to offer more participants arenas in which to gather.

Conceptualizing critique as an act of construction or assemblage means neither reflexive dismissal of technological interventions nor their spontaneous acceptance. Neither scientists nor lay people involved in small-scale restoration or experiments in assisted adaptation need telling their efforts won't 'fix' the world's reefs; nor their efforts will count for little if greenhouse gas emissions aren't brought under control. Mobilizing critique as an act of creative and just assemblage requires reframing claims, rather, about novel climate interventions as fragile and provisional, before considering how they can be used to open new possibilities for action.

Notes

1. Our choice of words here is influenced by Haraway's (2008) metaphor of 'eating well together' to signify empirical practices committed to the flourishing (and nourishing) of difference and respect for the multiple agencies and actors that are our 'messmates' at the collective table.
2. Social scientists already demonstrating such curiosity include Suggett et al. (2023), Blue, Davidson, and Myles (2022), Blue and Davidson (2021), Pelai, Hagerman, and Kozak (2021), and Sovacool et al. (2023).
3. The Reef Trust Partnership arrangement through which public funding for RRAP was administered between 2018 and 2024 supported reef restoration and adaptation science (AUD$100 million), water quality programs (AUD$201 million), crown-of-thorns starfish control and innovation in control methods (AUD$57.8 million), First Nations participation in reef protection (AUD$51.8 million), community engagement in reef protection (AUD $10 million), and improvements in ecosystem monitoring and reporting (AUD$40 million). This is not exhaustive of all Australian or Queensland Government expenditure on reef research and management, but it has attracted considerable interest due to the devolution of funds through a private foundation tasked with coordination, contract management, and raising additional private sector investment (e.g. Nyberg, Wright, and Bowden 2022).
4. Coral bleaching is not isolated to the Great Barrier Reef. The US National Oceanic and Atmospheric Administration reports four global bleaching events over the last decade and a similar shift to resilience-based management and restoration worldwide. See www.noaa.gov/news-release/noaa-confirms-4th-global-coral-bleaching-event.
5. A similar point is made by Suggett et al. (2024), who argue there is increasing evidence coral restoration aids ecological recovery. Suggett et al. (2024) go on to argue that criticisms of restoration focused on its alleged poor cost effectiveness are based on: (1) invalid extrapolations from small-scale experiments; and (2) unacknowledged normative evaluations of value. This is not to deny the significant investment required for restoration at meaningful scales and the equally significant work required to develop appropriate financing mechanisms (Suggett et al. 2023).
6. This is despite the availability of considered reviews of current regulatory arrangements, their strengths and weaknesses in relation to the regulation of emerging technologies, and their articulation with First Nations governance arrangements (e.g. Fidelman et al. 2019; Hartley, Taitingfong, and Fidelman 2022; Shumway et al. 2023). Scholarly and policy work on risk assessment for assisted adaptation is at a more preliminary stage but, importantly, is proceeding ahead of proposals to trial adaptive interventions (see for example Lockie, Graham, et al. 2024).
7. Unilateral action by Australian governments, for example, cannot solve the climate crisis but Australian publics expect meaningful action, regardless, to protect the Great Barrier Reef from the impacts of climate change (Bartelet et al. 2025; Lockie, Bartelet, et al. 2024).
8. As per Note 3, adaptation science comprised less than a quarter of all expenditure through the Reef Trust Partnership, the balance of funding being directed

toward water quality, biosecurity, and First Nations and community-based projects.

9. Nyberg and Wright (2024) do report on a qualitative study of stakeholder perspectives on adaptation initiatives in the Great Barrier Reef. While the sample size ($n = 34$) is not unusual for a study of this nature, the failure to include any Traditional Owners, or First Nations, with rights and interests in the Reef, nor to include any Reef managers, is deeply problematic.
10. We are reminded of an anecdote told by coral adaptation pioneer Dr Ruth Gates about a view she expressed to prominent critic of assisted evolution, Prof Terry Hughes, that communities impacted by catastrophic reef degradation will not wait on his permission before trying it for themselves (Braverman 2016).

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