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1. Introduction

The concept of resilience has been widely applied since its original characterisation as “the capacity to absorb disturbance and reorganize while undergoing change as so as to still retain essentially the same function, structure, identity, and feedbacks” [17]. It has been used to examine the responses of both human and natural systems to change, disruption, and shocks. The term “social-ecological resilience” has been increasingly employed to holistically capture changes and impacts in and around protected areas [23]. Whilst critiqued by some for its “depolitised language”, neglecting the role of macro-scale economic or environmental drivers of change [20], resilience has served as a “boundary object” unifying otherwise disparate disciplines in seeking to understand or manage complex systems [3].

The ongoing disruption to economic, social, and environmental systems worldwide associated with the COVID-19 pandemic represents a transformative event or “rupture” [25] exceeding the capacity of systems to adapt and absorb its impacts. This unprecedented disruption has led to resilience being re-conceptualised beyond Folke et al.’s (2005) emphasis on “absorbing change” to one which envisages new policies, institutions and practices being adopted and transformed to address inequalities in power and failures in development policy. “Equitable resilience” has been described as resilience which recognises structural issues such as vulnerability, access to power and resources, and how circumstances must change in order to avoid an imbalance of power in the future [27]. This interpretation is congruent with the more nuanced understanding of resilience in a post-COVID-19 context, emphasising the need to empower stakeholders to identify trade-offs and priorities in governance decisions and enabling adaptation to arise through individual choices rather than de facto institutional processes [38].

The COVID-19 pandemic underscored the fragility of many global industries as their abrupt cessation undermined the social-ecological resilience of the destinations in which they operated. Destinations dependent on the tourism industry in particular were affected, with data indicating that international tourism numbers averaged 72–73% below those of the pre-pandemic period for the 24 months ending December 2021 (WTO, 2022). The impacts of international travel restrictions on visitor revenues accruing to protected areas has been significant, leading in some cases to a cessation of essential management activities along with staff redundancies and wide-ranging economic impacts in local...
communities dependent on tourism-related income [42].

Given the importance of tourism for the financing of protected areas, it is critical to examine its place within the future of Marine Protected Area (MPA) management. Beyond financing, tourism can alter the social and ecological underpinnings of an MPA, thus affecting social-ecological resilience [25]. There is an urgent need to ensure that principles of equitable resilience are embedded in “build back better” strategies. This study will provide a review of such initiatives and illustrate their potential with reference to a case study MPA in eastern Indonesia. It asks: “How has COVID-19 impacted the social-ecological resilience of MPAs worldwide? What implications and opportunities has it had for equitable resilience in MPAs?”

2. Materials and methods

This paper uses a combination of methodologies to achieve two objectives: 1) To compare and examine emerging findings of the impacts of the COVID-19 pandemic on the social-ecological resilience of MPAs around the world through a systematic literature review; and 2) To illustrate the resulting challenges and opportunities for achieving equitable resilience by examining a case study from an MPA in Indonesia. The two specific methodologies are described below.

2.1. Literature review

The systematic review assessed published literature on marine reserves since the COVID-19 pandemic began in order to analyse procedural and substantive changes and outcomes in park management. The Scopus database was used to conduct an electronic literature search in May 2021, limited to peer-reviewed articles written in English. Search terms were selected after a series of tests to demonstrate adequate sensitivity of search parameters [11]. The following keyword combinations were searched using Boolean operators:

\[
\text{TITLE-ABS-KEY("marine reserve" OR "marine protected area" OR "MPA" OR "national park") AND TITLE-ABS-KEY("COVID-19" OR "coronavirus" OR "COVID" OR "pandemic") AND PUBYEAR > 2019 AND SRCTYPE(j) AND LANGUAGE(english)}
\]

The review included predefined inclusion criteria, keyword searches in research databases, and data extraction and analysis following a PICO structure (Populations, Interventions, Comparators, Outcomes) (van den Bosch & Ode Sang, 2017). The PICO structure was utilized to define the

![PRISMA Flow Diagram](image)

**Fig. 1.** PRISMA Flow Diagram for Systematic Reviews.

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed.1000097
populations, interventions, comparators, and outcomes to be included or excluded from the review, which can be viewed in detail in Supplementary Materials 1 [5]. The screening for inclusion in the subsequent analysis process can be seen in the PRISMA [30] flow diagram in Fig. 1; ultimately ten articles were included in full thematic analysis. The first author conducted this analysis using the software NVivo, which included attaching thematic codes to statements, passages, and phrases in the literature, used to reorganize data to enhance analysis [15,43]. A summary table of NVivo codes is included in Supplementary Material 2; studies analyzed in the final review are included in Supplementary Material 3.

Content analysis was then used to sort these thematic codes under four core domains as identified by Gill et al. [18] and later adapted into a framework by Phua et al. [33]. These domains include: 1) appropriateness of management activities (procedural effectiveness); 2) justice or fairness of management (procedural equity); 3) achievement of desired MPA outcomes (substantive effectiveness); and 4) distribution of MPA costs and benefits (substantive equity). This framework was chosen due to its focus on both social equity and MPA effectiveness, both critical aspects of long-term and equitable social-ecological resilience of MPAs. Equitable resilience requires “starting from people’s own perception of their position within their human-environmental system” [27], and changes in social-ecological systems must account for societal perceptions of equity, fairness, and efficacy of MPAs. The findings demonstrate how equitable resilience can be strengthened when local voices are better incorporated into transparent governance structures.

Primary data collection.

A series of semi-structured interviews were carried out in person (n = 42) from October 2019 to March 2020, and remotely via Zoom (n = 15) in April 2021 with respondents in the Wakatobi National Park (WNP) located in Southeast Sulawesi, Indonesia (Fig. 2). The WNP encompasses 13,900 km² of land and sea across four major islands and is home to some 100,000 people [21]. The WNP was officially designated in 1996 and has experienced a range of management initiatives, including being identified as a “platform site” within the broader Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI-CFF) [40]. The WNP has seen considerable involvement from NGOs and outside donor agencies, in addition to its inclusion in the government’s so-termed “10 New Bali’s” strategy prioritizing tourism development in the region [48]. With these activities fundamentally altered throughout COVID-19, the WNP is an important case study in illuminating opportunities for enhancing resilience in “building back better” [13,34].

Respondents were selected through a process of purposive and snowball sampling techniques, and semi-structured interviews explored aspects of livelihoods, perceptions of MPA management, and the impact of tourism on the WNP. The first author undertook all interviews which were conducted in Indonesian and lasted from 30 to 60 min. The first author also employed participant observation, residing on the islands of Tomia and Hoga for six months from October 2019 to March 2020. Two focus group discussions with a variety of stakeholders were also conducted. Remote interviews in April 2021 focused on the impact of the COVID-19 pandemic on livelihoods and MPA management. Respondents were aged from 18 to 65, with occupations ranging from fishermen to National Park officials to guest house owners. Notes were made during and after each interview which were then coded for subsequent analysis using the themes identified via the literature review. In the results, interview quotes from the October 2019 to March 2020 period are presented as “IC#” and the April 2021 period as “Respondent #”.

3. Results

A description of key themes identified through the literature review is presented, followed by detailed illustration using primary material from the WNP. These are organized into four MPA management topics as proposed by Gill et al. [18] and adapted by Phua et al. [33]: 1) appropriateness of management activities (procedural effectiveness); 2) justice or fairness of management (procedural equity); 3) achievement of desired MPA outcomes (substantive effectiveness); and 4) distribution of MPA costs and benefits (substantive equity).

![Fig. 2. Location map of Wakatobi Marine Park, Southeast Sulawesi (dotted line represents park boundaries).](image-url)
3.1. Part 1: Literature Review

3.1.1. Procedural effectiveness

The systematic review reveals that across terrestrial and ocean habitats, protected area managers are facing similar challenges regardless of status, budget, or area. Phua et al. [33] found that COVID-19 impacts on MPAs were two kinds: those affecting livelihoods and local communities and those which affect MPA management and governance. A decrease in visitation and user fees, as well as general economic hardship for many national and local governments, resulted in budget shortfalls for many MPAs and reduced patrolling and enforcement. As a result of this, the role of NGOs in the management and enforcement of MPAs became increasingly important and apparent during the pandemic.

There have been some undoubted benefits for marine species and environments due to COVID-19, including the cessation of many marine-based recreational activities, a decline in noise pollution as maritime shipping has been disrupted, and a reduction in commercial fishing pressures due to falling prices and market closures [24]. In the case of MPAs, reviews have indicated mixed COVID-19-related impacts, including in some cases an increase in illegal fishing and/or use of destructive techniques as pre-existing food supply chains were disrupted, tourism-related incomes declined, and enforcement activities were scaled back [33].

3.1.2. Procedural equity

While equitable governance of MPAs and fair benefits sharing is of growing importance to stakeholders and managers, many MPAs fail to incorporate inclusive governance processes [18,33,47]. As COVID-19 has made apparent, public health is inseparable from functioning ecosystems; thus, siloed approaches resulting from lack of interaction among formal institutions involved in ecosystem management, public health, or economic development should be phased out going forward. Greater community involvement can help integrate these institutions while reducing funding requirements. In Belize, for example, the integration of fisheries and protected area management has resulted in greater representation for fishers in management decisions in exchange for secure resource access [33]. In other areas, COVID-19 has opened up opportunities for building new connections and social capital across institutions and community groups in co-producing management decisions, with the potential to resolve future conflicts and increase the adaptive capacity of local communities [39].

Top-down state governance is required in order to legally recognize MPAs in many countries. However, in some instances, the pandemic has revealed the importance of devolved governance to both local communities and private enterprises: community patrol officers have allowed park officials to concentrate on enforcement in distant areas, while the Misool Eco Resort in Indonesia, funded by tourism and private donors, has maintained a critical no-take zone that has seen a 250% biomass increase over the past decade [36]. With community and private sector buy-in, MPAs can be made more resilient and effective in deterring illegal and outside fishing.

3.1.3. Substantive effectiveness

The ability for MPAs to achieve desired social and ecological outcomes has been severely impacted over the course of the COVID-19 crisis; budget cuts, reduced funding, and increased fishing pressure were noted in almost all of the studies in this review, including in the WNP. However, many opportunities arose from these challenges, particularly in regard to diversifying funding streams for more sustainable and resilient MPA financing. Worldwide, protected areas are largely underfunded, with tourism supplementing large portions of MPA management budgets [4]. Tourism losses over the pandemic in areas like the Galápagos amounted to more than half of park management annual budgets, highlighting the danger of overly relying on tourism to fund conservation [12]. Nevertheless, a suite of options including diversifying MPA financing to lessen the reliance on tourism income, building new food supply chains utilising sustainable local produce, and innovative low-cost automated monitoring systems have been identified as components of recovery in a post-COVID-19 environment [4].

Studies indicated that reduced visitors improved ecosystem health in the short term, emphasizing the importance of careful spatial planning that accounts for social equity and access to protected areas [22]. Furthermore, many private foundations and trust funds were able to supply emergency funding for MPAs, but more innovative funding solutions such as conservation trust funds, “blue” bonds, and payments for ecosystem services are necessary in the future [4,36]. This will engage protected area decision makers in a complex discussion around trade-offs, that must be approached with a political and social lens, understanding who gains and who benefits from different sources of financing [39].

3.1.4. Substantive equity

A key issue to emerge in this review is that the inequitable distribution of MPA benefits and livelihood opportunities hinders management capacity and makes marine reserves less likely to succeed in the long-term [33]. Poor benefit-sharing mechanisms between protected area authorities and communities have resulted in leakages from the local economy and benefits accruing in the hands of elites, both in the WNP and in other studies in this review [4]. NGOs and park officials should improve adaptive co-management approaches, co-production of knowledge, and transparent benefit-sharing arrangements with local communities to more equitably distribute MPA benefits and increase the likelihood of meeting conservation goals [22].

Several studies indicated an early shift from viewing MPAs as more than just an environmental effort, but also as a national security and public health priority [12]. In Malaysia, border security was identified as a national pandemic priority, and increased coordination between enforcement agencies in the Tun Mustapha Park resulted in a reduction in illegal blast fishing [33]. As government priorities shifted to focus on health care and COVID-19 response, so too did the purpose of many national parks shift as places critical to the mental and physical health of residents [29]. The Galápagos Biosecurity Agency, for instance, shifted its focus from preventing invasive species to conducting COVID-19 testing [33]. This is perhaps an early indication of a shift in how MPAs are valued and designed: shifting from a “visitor economy” to “resident economy”, with everything being assessed “through the lens of health” and general resident well-being [19,36,39].

3.2. Part 2: Wakatobi National Park case study

3.2.1. Procedural effectiveness

In the WNP, while the National Park office reported a decrease in overall budget and ability to conduct patrols in the wake of COVID-19, many respondents interviewed in April 2021 said that management and patrolling remained stable and consistent over the course of the past year. This may be due to an already low number of patrols in previous years; field research in 2019 revealed that when funding from WWF and TNC decreased in 2014, the park authority managed under 20 consistent patrols per year. With a lack of funding from these NGOs, the WNP officials reported they were unable to conduct any ecological monitoring or public engagement efforts over the course of 2020. However, a shift to online and remote working has presented more opportunities for public engagement among both residents and visitors, and has the potential to transform how citizen science and conservation education are conducted [29].

Tourism enterprises themselves have filled a critical role in the governance and management of the WNP, with a total of 52 accommodation providers in 2019 (IC28). The presence of two foreign dive operators on the islands of Tomia (Operator A) and Hoga (Operator B), both established prior to the National Park itself, is significant, with both operators having substantial influence over the management and design
of the park. Data collected by Operator B in 1996 prior to the helped to designate the initial zoning of the National Park. These operators have thus filled an important role in the management and overall effectiveness of the WNP, with important implications for long-term social-ecological resilience in the area. As one resort manager put it: “The government doesn’t have to respect us, but they do have to learn from us” (IC5). Similarly, in the words of one of the resort owners (IC24):

“We are more consistent than the government. The government comes to change every few years, but still we are here. We now have employees that are born knowing [Operator A]. They did not know anything before us. We have been such a stable presence in this region.”

These sentiments of tourism operators, documented immediately prior to the start of the pandemic in February 2020, reveal how tourism has positioned itself as both a source of financing for the WNP and an actor engaging in the governance of the park. With a 100% decrease in international tourism arrivals in April 2020, these tourism operators were unable to remain either active or passive enforcers of MPA rules, thus raising questions of the role of tourism in shaping more resilient and effective MPAs.

3.2.2. Procedural equity

The perceived justice or fairness of management decisions within the WNP has long-term implications for its resilience, and opportunities for transformation following the COVID-19 pandemic. Management to date has focused largely on the eradication of destructive fishing methods through detection and punishment, rather than engaging genuine participation (Julian [7,41]). Western conservation NGOs and private tourism operators have sought to reinforce language used throughout the wider CTI-CFF endeavour, explaining that communities have seen participation (Julian [7,41]). Western conservation NGOs and private tourism operators have sought to reinforce language used throughout the wider CTI-CFF endeavour, explaining that communities have seen their lives improve after “buying into” top-down impositions of marine conservation [41]. Certain communities within the WNP, particularly the Bajau ethnolinguistic group once living a nomadic seafaring lifestyle across the CT region, have been ineffectively integrated into the management structure of the park (Julian [6,35,37]). A minority ethnic group that permanently settled in the WNP at the end of the 20th century, the Bajau are commonly labelled as perpetrators of destructive fishing practices by the majority Bugis ethnic group, and thus have often been the subject of various development and conservation activities, but rarely participants in designing such interventions (Julian [8,9,10,26]).

While meaningful devolution of responsibilities for management to local communities have not yet occurred, private tourism operators have often taken on this responsibility despite a lack of coordination with government officials. For example, National Park official in the WNP expressed her desire to speak with one operator: “We would like to know what [Operator A] thinks of us. [The owner] doesn’t speak to us” (IC22). Operator A’s owner later stated: “We are here in spite of the government, not because of it” (IC24). Operator A also accused other tourism operators of not “playing the game” of conservation while simultaneously excluding local engagement in the tourism industry that sought to shape governance in the WNP. While local dive boats often reported exclusion from the reefs managed by Operator A—one accused of being a pencari, thief, by resort security—so too did the Bajau people become excluded from this new form of park management, shaped by the interests of tourism. As the Village Head of Sampela, a majority Bajau Laut settlement, noted: “We are just the observers of tourism. We are not active or involved with it yet. No one has asked us” (IC41).

Ultimately, the exclusion of certain local voices in favour of powerful tourism operators resulted in many participants scrutinizing for whom WNP management was beneficial, with a distrust of decision-making in governance of the park. This has implications for how equitable resilience can be achieved in light of the pandemic. One former senior government official stated: “When [Operator A’s owner] goes to ask the government for something, it is only important for him (kepentingan dia). So why should we listen? We follow other recommendations from researchers at [Operator B] or WWF, but not them” (IC25).

3.2.3. Substantive effectiveness

Prior to the COVID-19 pandemic, tourism had become an increasingly important source of revenue for the WNP. Indonesia’s 2010–2025 National Tourism Masterplan, sometimes referred to as the “10 New Balis” plan [48], set investment and marketing targets in ten destinations around the archipelago, including the WNP. In interviews with the regional tourism office (Dinas Parawisata) in February 2020, the director noted: “[In tourism] we find balance between economy and ecology. Culture is safeguarded, nature is safeguarded (budaya terjaga, alam terjaga).” The vision they had set for the WNP was to grow from 20,000 visitors in 2019–100,000 by 2025; no carrying capacity or other ecological assessment had yet to be carried out to determine the potential impact of this increase (IC27). The absence of coherent tourism policies between national and local governments had opened the potential for environmentally or culturally harmful forms of development to occur. The regional director for tourism noted: “Bali grew because investment grew. There was a multiplier effect. We can’t do business unless there is a Grand Hyatt to pave the way” (IC27).

With the systematic review and WNP case study reveal the challenges of achieving genuine MPA objectives when powerful private interests, such as tourism, influence governance and management decisions. Tourism will continue to represent a huge factor in protected area financing and management, and it was an important motivator for achieving MPA outcomes in the WNP. For example, one respondent noted, “If tourism is not useful to people, then people will think, ’Why do we have to protect the coral reefs?’” (IC14). However, an over-reliance on this industry to guide MPA management—in particular an increased focus on “high-end” or luxury tourism—has left communities with decreased social and human capital assets and less resilient as a result [25].

3.2.4. Substantive equity

The costs and benefits associated with the management of the WNP are not well distributed across the region, particularly following the disruption caused by the COVID-19 pandemic. In Wakatobi, National Park employees reported that patrolling efforts had ceased alongside a decrease in external funding from donor NGOs like WWF and TNC (Respondents 10, 2). Operator B, a research tourism organization, saw many long-term monitoring and restoration projects abandoned because local staff were not adequately trained in scientific research methods (Respondent 1). As the COVID-19 pandemic has shown, it is possible to deliver effective remote technical assistance and training for local field assistants, and to conduct critical research remotely. Such efforts could empower community surveillance groups and increase vital information sharing with state-led enforcement agencies [33].

Despite the cessation of tourism activities caused by the COVID-19 pandemic, tourism operators remain highly effective at enforcing rules within the MPA given their long-term presence in the region. However, the ways in which the costs and benefits of such enforcement is distributed should be examined. Operator A routinely pays each of the 17 villages around Tomia US $150–500 per month in exchange for avoiding fishing on dive sites and halting destructive fishing practices such as the use of dynamite or cyanide [28]. Operator B also employed a similar scheme with the neighbouring village of Sampela, a predominantly Bajau settlement, but gave up after a year due to widespread non-compliance with restrictions (IC44). While the funds have been used to develop village infrastructure such as schools, mosques, and electricity, the average villager does not have a say over how the funds are distributed, resulting in “elite capture” in which those with privilege and power in society are capable of making decisions on behalf of everyone [6]. However, the high-end tourism model also enabled Operator A to tap into greater financial reserves and continue management activities to a greater extent than Operator B and even the WNP authority throughout the pandemic, thus underscoring the importance of private actors in achieving management objectives despite an inequitable distribution of costs and benefits.
4. Discussion

Beyond the current pandemic, tourism will continue to represent a huge driver for conservation and protected area management: the World Travel and Tourism Council (WTTC) estimates global wildlife tourism generates US $120 billion and 21.8 million jobs annually [46]. The platform Linking Tourism & Conservation estimates that a mere 5% of the annual global tourism turnover would be needed to fund a complete network of protected areas [44]. However, findings in this research—from both the systematic review and WNP case study—indicate that MPAs which relied heavily on tourism as a source of financing were overall less resilient and able to adapt than those with more diversified sources of financing. Additionally, MPAs that favour the interests of tourism risk undermining the substantive effectiveness of management, especially when communities perceive the interests of tourism operators as favoured over the interests of local people, as in the case of the WNP.

Achieving effective and equitable social-ecological resiliency within any protected area is extremely challenging. However, MPA managers must continuously strive to achieve this, given the many “ruptures” local communities are likely to face in the near future. Beyond COVID-19, climate change will radically transform MPAs and the lives of people dependent upon them. Rigorous monitoring of ecological factors to inform management decisions will continue to be essential; however, the literature increasingly recognizes the importance of integrating social-cultural metrics into MPA management, to better illustrate the nature of trade-offs and winners and losers in contested decision-making processes. Conveying MPA benefits to local communities is also critical, identifying what societal challenges exist and how the MPA can help to solve them.

Murray (2016) highlights the danger of valuing only what can be quantified, economically or environmentally, suggesting ways to better incorporate social data into decision-making processes around marine social-ecological systems [31]. Socio-cultural metrics are challenging to incorporate into MPA planning and management procedures; however, there are emerging standards for incorporating such metrics across the managed area [28]. Discourses that illustrate the cultural diversity of a “social-ecoregion” rather than just the biological diversity can help better situate the human within the environmental [1]. This can also enable environmentalists and the resources they confer to provide important legitimacy to communities and the activities they seek to implement [26]. With more robust social-cultural monitoring, these activities can be further validated and incorporated into wider regional-scale frameworks like the Coral Triangle Initiative.

Finally, a common theme emerging from both the systematic review and the WNP case study is the importance of diversified sources of protected area financing. Case studies from around the world, including the WNP, recounted how monitoring and patrols halted drastically due to a drop in funding from NGOs or other conservation partners. Likewise, tourism vessels that once served as an informal deterrent against illegal fishing could no longer operate during the pandemic. A blend of finance from tourism, NGOs, government, and other more innovative sources such as carbon financing, conservation trust funds, or “blue” bonds have the potential to enhance the resilience of MPAs. New forms of funding also present different opportunities to engage with local communities in a transparent and equitable way, as stakeholders co-design a shared strategy for the long-term management of an MPA.

5. Conclusion

The COVID-19 pandemic has altered nearly every aspect of modern society. Its impacts on conservation and protected area management will likely not be fully realized for years. This review has revealed the ways in which innovative approaches to collaboration, financing, benefit sharing, enforcement and management within MPAs has emerged over the COVID-19 pandemic [39]. Climate change, global biodiversity loss, mounting food shortages, and impending ecosystem collapse were all critical threats to global security prior to the pandemic, and efforts to implement solutions such as MPAs have been largely ineffective at halting such crises. Rather than seeking to manage MPAs for resilience and their ability to “bounce back,” more attention should be paid to the opportunities for transformation and equity as driven by local communities. Better integrating community perspectives and needs is an important first step. Future monitoring efforts for MPAs around the world, including the WNP, should attempt to acknowledge and address inherent social complexities as opportunities rather than obstacles for sustainable resource management. As Majors [26] argues, this can only be achieved when both social and biological limits to resource management are understood, with local knowledge paradigms valued by and incorporated into scientific knowledge and practice.

As illustrated through an exploration of the WNP case study, favouring powerful interests such as tourism over the voices and needs of local people are likely to result in less equitable and effective governance of MPAs, thus affecting its long-term social-ecological resiliency. In order to transform this reality, this research recommends that more focus be given to the political aspects of resilience, to understand how power and legacies of oppression or inequality can be reinforced through the same institutions protected area authorities seek to strengthen [14]. For instance, focusing on maintaining such top-down management structures in the WNP post-COVID-19 may prevent devolved and equitable community-led governance from emerging. As new systems and practices emerge, emphasis should be on recognizing and integrating the transformations that the pandemic has wrought, rather than returning to a state of “normal” that has so far failed to conserve our global oceans. By acknowledging local politics, power dynamics, and potential trade-offs among stakeholders— reflexively engaging with who gains and who loses from a more resilient system—MPA management can better embrace opportunities for transformation necessary to meet global conservation objectives.

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CRediT authorship contribution statement

Chloe King: Conceptualization, Methodology, Formal analysis, Writing – original draft. Dedi S Adhuri: Resources, Writing – review, Supervision. Julian Clifton: Writing – review & editing, Resources, Visualization, Supervision.

Declaration of Interest

None.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.marpol.2022.105093.
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