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POLICY PERSPECTIVE

Incentivizing co-management for impact: mechanisms driving the successful national expansion of tonga's special management area program

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Abstract

The expansion of coastal marine protected areas can suffer from two key drawbacks: (a) the difficulty of incentivizing local communities to manage areas for conservation when their livelihoods also depend on resource use; and (b) that many protected areas get situated residually, or in locations with limited value for either biodiversity conservation or livelihoods. Here, we discuss and analyze key characteristics of Tonga's Special Management Area (SMA) program, including both the mechanisms that have motivated its successful national expansion and its ability to configure no-take reserves in areas that are considered to have high value to resource users. Granting communities exclusive access zones in exchange for implementing no-take reserves has encouraged conservation actions while fostering long-term relationships with resources. Ensuring no-take reserves occurred within the boundaries of exclusive access zones enabled communities to protect areas of greater extractive values than they would have otherwise. We conclude that the success of this program offers a way forward for achieving targets in the global expansion marine protected areas.

KEYWORDS

community-based management, conservation, marine protected areas, residual conservation, South Pacific, TURF

1 | INTRODUCTION

Food security and biodiversity are increasingly threatened by the depletion or collapse of marine resources (Díaz et al., 2019), and many proposed management strategies fail at scaling up to achieve meaningful national or international conservation results (Mills et al., 2019). Marine resources are also notorious for suffering from the "tragedy of the commons" (Hardin, 1968), whereby individuals or groups of individuals overexploit a resource and behave contrary to the common good of all users (Ostrom, 1999). While many marine management strategies have been

implemented, each comes with its own suite of caveats (Ban et al., 2011; Jupiter, Cohen, Weeks, Tawake, & Govan, 2014). A key goal of conservation policy and management research is to identify solutions to the specific issues that limit the effectiveness of various management strategies (Diaz et al. 2019).

Protected areas are expanding globally as a key management strategy to address both declining food security and biodiversity (Diaz et al., 2019; Mills et al., 2019). While their management often takes the form of centralized governments gazetting areas for conservation, in practice, they are often compromised by a lack of resources for monitoring and enforcement (Gaymer et al., 2014). In response to continuing fisheries declines despite centralized management, governments of many developing countries are increasingly focusing on decentralized, community-based, or co-management approaches, which in many instances were already in place through customary marine tenure (Cinner et al., 2012; Govan et al., 2009; Webster et al., 2017). Here, we consider community-based management to be natural resource or biodiversity management by, for, and with the local community (as defined by Western & Wright, 1994) and co-management as situations where communities share responsibilities for making and enforcing natural resource management rules with governments, civil society, and/or academia (Cinner and Huchery, 2014).

Implementing protected areas is often met with resistance unless local communities can be offered incentives to manage areas for conservation when their livelihoods depend on the resources within them (Brockington & Schmidt-Soltau, 2017; Ferraro & Hanauer, 2011). Typically, managers and conservationists argue that the long-term food security of an area and its biodiversity value outweigh immediate requirements for continued resource use (Hutton & Leader-Williams, 2014). However, offering long-term assurances of increased food security and ecosystem health might not always be important for people for whom finding food or making a living are immediate concerns (Hutton & Leader-Williams, 2014). The strategy of excluding resource extraction has attracted criticism from social scientists and human rights advocates for resulting in the forced displacement of populations and loss of food security (Cernea & Schmidt-Soltau, 2006). While compensatory incentive-based programs do exist, such as direct payment concessions for protected areas, they likely provide limited benefits to biodiversity conservation unless they are conditional on defined conservation actions (Mills et al., 2019; Sachedina & Nelson, 2009).

A second problem with the global expansion of protected areas is that many are residual, defined as being situated in locations with limited value for extractive activities, and have correspondingly small conservation impact (Devillers et al., 2015; Ferraro & Hanauer, 2011; Joppa & Pfaff, 2011). Ultimately, protected areas are effective only if they change human behavior (Pressey, Weeks, & Gurney, 2017). Therefore, to achieve impact they must be configured to influence either present day or potential future actions (Smallhorn-West, Bridge, Malimali, Pressey, & Jones, 2019). However, given the importance of involving local stakeholders in the planning process (Hutton & Leader-williams, 2014), it seems inevitable that resource users will aim to configure protected areas to minimize overlap with their current or planned activities.

The responsibility of identifying solutions to incentivize protected area implementation and ensure they are situated to achieve impact should lie with planners as well as conservation policy and management researchers. Individual communities may have little choice but to prioritize their immediate needs for food and/or income. The question raised is therefore: "Is it possible to align the requirements of communities with the goal of building sustainable use and biodiversity conservation into the future?"

Here, we address this question by discussing the recent rapid expansion and successful implementation of Tonga's co-management initiative, the Special Management Areas (SMA) program, at a national level. We use this program as a case study to identify solutions to the aforementioned problems of providing community incentives for conservation, and ensuring conservation actions are non-residual. In a relatively short time (15 years), Tonga's SMA program has expanded from a few communities to over 50, covering roughly half of all coastal communities in the country and aiming to include 100% by 2025. Furthermore, SMAs are situated in places that are considered to have high value for resource users. We argue that, by providing the right balance of incentives, the SMA program has successfully avoided key pitfalls associated with protected area implementation, which has enabled the program to expand to a national level in a way that is non-residual. Specifically, we: (a) describe the background and key characteristics of the program; (b) identify mechanisms by which the program has avoided problems that have constrained the effectiveness of other protected areas, including (i) provisioning of appropriate incentives and (ii) avoiding conserving only residual areas; and (c) discuss potential limitations of the program and its expansion to other regions. We conclude that the success of this program offers insights into the successful expansion of protected areas globally.

2 | BACKGROUND OF TONGA'S SPECIAL MANAGEMENT AREA (SMA) PROGRAM

Fisheries management in Tonga was historically open access, with little to no effective regulations. A civil war in

FIGURE 1 Map of a typical Special Management Area (SMA) in Tonga. The yellow denotes the SMA area, in which only members of the community are allowed to fish, similar to a territorial user rights fishery (TURF). The red denotes the Fish Habitat Reserves (FHR), which are permanently closed to all fishing. Given that this SMA included both exposed and sheltered fringing reefs, this particular community (Ha'atafu) opted to implement two no-take FHRs instead of one

the mid-1800s resulted in the then king, King Taufa'ahau Tupou I, abolishing all tenure—a key difference between Tonga and many other Pacific island nations where customary marine tenure is in place. The King also proclaimed that: (a) all Tongans had equal fishing access to all Tongan waters; and (b) that any traditional claims of local control or management authority over fishing areas were abolished (Gillett, 2017). In modern times, this open-access approach has collided with commercial realities and the inability of inshore resources to sustain harvests (Gillett, 2017). Due to growing concern over the potential depletion or collapse of marine resources, several forms of centralized management and protected areas were attempted in the late 20th century (Smallhorn-West & Govan, 2018). However, due to the limited capacity at the time of the Tongan Ministry of Fisheries (MoF), the main government agency charged with monitoring and enforcement, there is no evidence that resource extraction within these managed areas ever changed.

In the early 2000s, growing support for the concept of letting local communities manage their own resources resulted in the Fisheries Management Act 2002 (Gillett, 2017). Funding was provided by Australia to support the Tonga fisheries project and assist in the establishment of the early SMAs. The first, O'ua in the Ha'apai group, was designated in November 2006. While the program has since received funding from many sources (Gillett, 2017), it has largely been the Tongan MoF that has driven its expansion. Tongans are therefore justifiably proud in the fact that the successful implementation of this "home grown" program has largely been due to the efforts of Tongans.

The SMA program is a dual approach to marine management and conservation (Figure 1). First, through legislative action, each community is granted exclusive access to the marine environment adjacent to their village to the 50 m depth contour or 2500 m from shore. Within this area only registered members of the community are permitted to fish and it effectively acts as a territorial user rights fisheries (TURF) (Gelcich, Godoy, Prado, & Castilla, 2008). The role of enforcement is primarily that of the community, with support and training provided by the MoF. Second, in exchange for this exclusive access, a subset of the area must be designated a permanent no-take zone, termed a Fish Habitat Reserve (FHR). The size and location of each FHR are determined by the community and, if desired, communities may implement multiple FHRs. The size and boundaries of each SMA are determined by the MoF in consultation with both the SMA communities and adjacent communities. Within each SMA, management and enforcement are the responsibility of the community, and

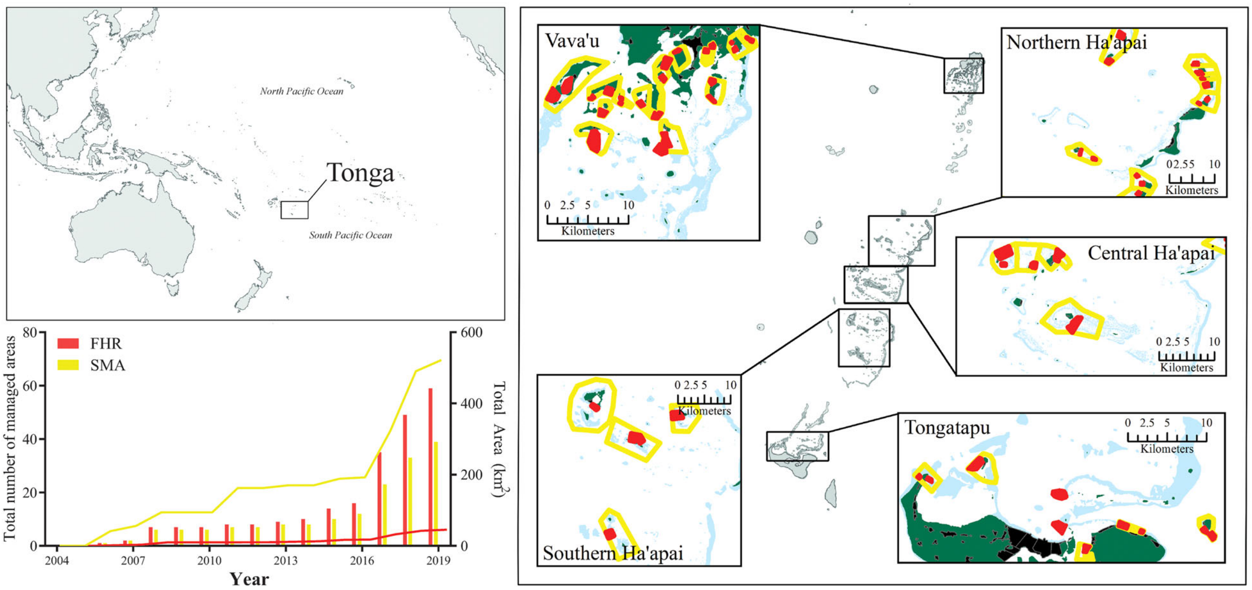

FIGURE 2 Overview of Tonga's Special Management Area program. Yellow denotes Special Management Areas (SMAs), red no-take Fish Habitat Reserves (FHRs), and black communities. Top left: Map of Tonga in the South Pacific. Right: Map of all SMAs and FHRs as of October 2019. Bottom left: Growth of the SMA program, with bars indicating the total numbers of SMAs and FHRs and lines representing the total areas

each must establish a coastal community management committee and a coastal community management plan. Communities, therefore, take the leading role in managing their coastal resources, although assistance is provided by the Ministry as required. Tonga's SMA program has become so popular with Tongan communities that there is more interest from communities than the capacity of the MoF can currently manage (Gillett, 2017). During the decade following the implementation of the first SMAs (2006–2015), the program grew slowly, with 11 SMAs in implemented (Figure 2; Table S1). The slow uptake was largely due to the lengthy process of raising awareness and educating communities and the public about the benefits of marine management. However, as awareness grew, interest in the program expanded exponentially. From 2016 to 2019, 31 new SMAs were established, resulting in roughly half of all coastal communities in Tonga having an SMA. This rapid uptake following 2016 was likely due in part to (a) increased awareness from a "lessons learned" conference in October 2015 implemented by the MoF and Civil Society Forum of Tonga and supported by the Marine and Coastal Biodiversity Management in Pacific Island Countries (MACBIO) project (Tupou Taufa et al., 2016), and, (b) increased financial support from various international donors to implement new SMAs in the Vava'u archipelago (e.g., Asian Development Bank and WAITT Institute). As of September 2019, an additional 46 SMA communities have either been confirmed, submitted to cabinet for approval, written a letter of interest, or been proposed, with the aim of including all coastal communities in the program by 2025 (Table S2).

3 | MECHANISMS BY WHICH THE SMA PROGRAM HAS AVOIDED PITFALLS COMMON IN THE EXPANSION OF PROTECTED AREAS ELSEWHERE

3.1 | Providing community incentives for conservation

The primary consideration of most communities for implementing an SMA is to exclude others from fishing "their" reefs (Figure 3a). Exclusive access rights are a substantial asset for any community, and it is inherently in the interest of each community to establish an SMA. However, given that in exchange for exclusive rights communities must also establish a no-take FHR, the SMA provides the incentive to achieve meaningful conservation results through the FHR. Baseline socio-economic surveys of seven new SMA communities in the Vava'u island group demonstrated that there was strong support (>90%) for the implementation of the SMA program, including the FHRs, which provides evidence to suggest that this is the case (Parks, 2017). The perceived effectiveness of management efforts, including both SMAs and FHRs were also very high, specifically as a way to improve livelihoods (94% support), lead healthier lives (94% support), adapt to climate change (91% support), improve marine resources (94% support) and improve community ability to manage marine resources (96% support) (Parks, 2017). Considering the popularity of the program, the SMA incentive, therefore, appears to provide ample compensation to communities for giving up the fishing grounds within the FHRs.

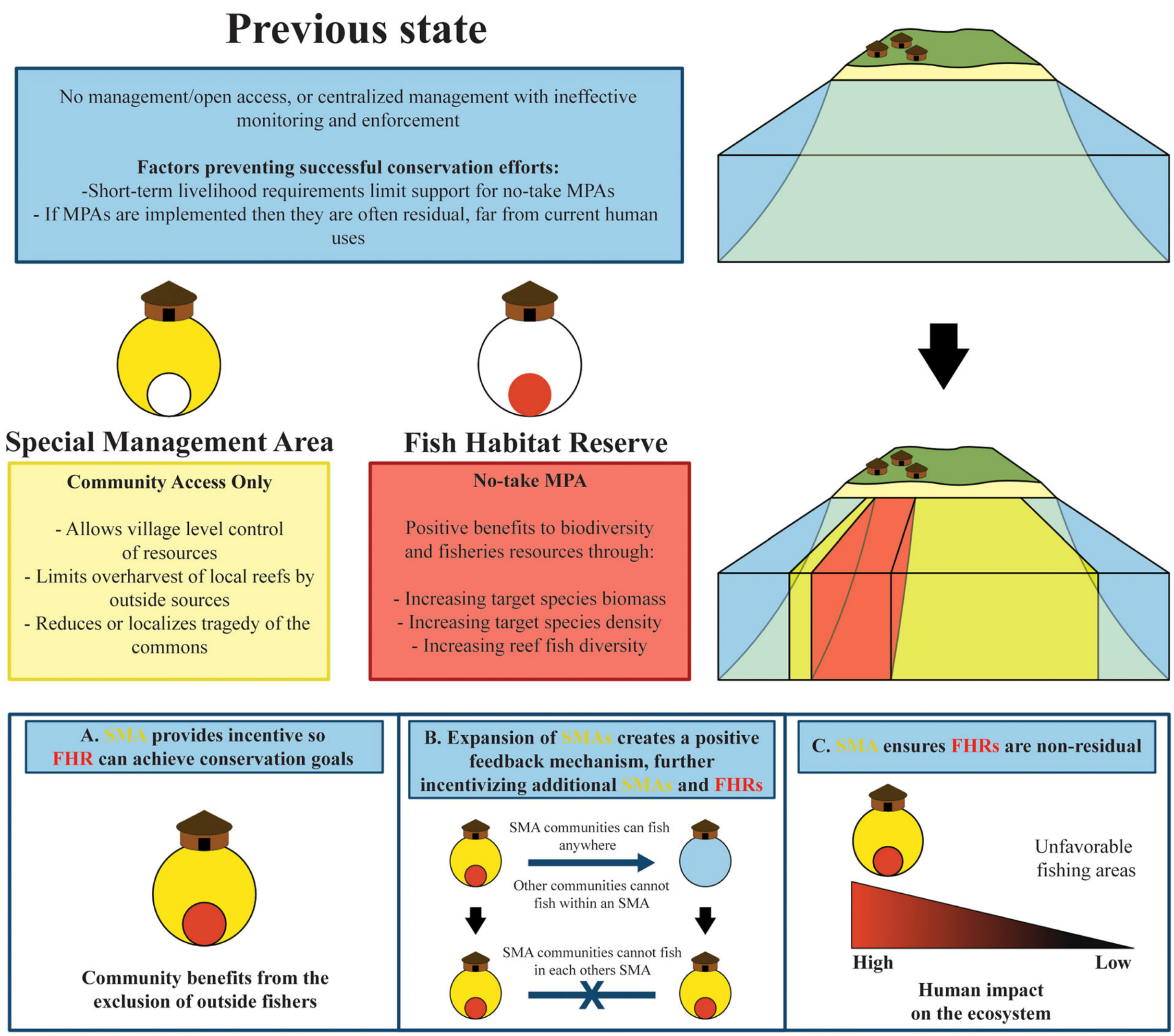

FIGURE 3 Conceptualization of Tonga's Special Management Area (SMA) program. The top row represents the state prior to the implementation of the program including problems with open access systems and factors preventing successful conservation efforts. The middle row represents the SMA program, with the expected outcomes of the SMAs and FHRs. The bottom three boxes represent key mechanisms by which the SMA program has avoided problems that have constrained the effectiveness of other protected areas

Another mechanism by which community incentives have driven the expansion of the SMA program is through a positive feedback loop that increases pressure for remaining non-SMA communities to apply (Figure 3b). While SMA communities can fish both inside and outside their SMAs, non-SMA communities are blocked from fishing inside nearby SMAs. At the program's inception, when only a small number of SMAs were in place, this would not have been of huge consequence to non-SMA communities. However, as the program has expanded, each additional SMA implemented has further reduced the fishing grounds for non-SMA communities while leaving their coastal areas vulnerable to fishing by all other communities. This increased loss of fishing grounds has therefore created a positive feedback mechanism which increases their incentive to establish an SMA.

As with TURF systems established elsewhere (Villaseñor-Derbez et al., 2019), many communities have also developed a sense of pride and ownership over their SMAs and FHRs as well as the program as a whole, and encouraged a sense of belonging and the development of long-term connections with 'their' reefs. Within Tonga these assertions are supported by (a) two socioeconomic assessments of the effects of the SMA program that demonstrate strong local support for the program within SMA communities (Malimali, 2013; Parks, 2017) and (b) statements from community members and fishers in five SMA communities (personal communications). In addition, Gillett (2017) suggests that the "home grown" development of the SMA program by Tongans into its current form has been critical to maintaining a local sense of ownership and pride. These implications also align

more broadly with the academic literature on support for local management, particularly in the Indo-Pacific (e.g., Bartlett, Pakoa, & Manua, 2009; Johannes, 2002; Pollnac, Crawford, & Gorospe, 2001).

3.2 | Avoiding residual conservation

Residual conservation is now a well-recognized concern with protected areas globally (Devillers et al., 2015; Ferraro & Hanauer, 2011). We tested for the presence of systematic biases in the placement of SMAs and FHRs, compared to open areas, by assessing whether they were located in regions with a low value to resource users across four metrics known to influence the configuration of protected areas (Devillers et al., 2015).

The primary resource associated with Tonga's SMA program is the reef fish fishery (Parks, 2017). We therefore converted all reef areas in Tonga into 100 m^2 raster cells in ArcMap (10.4.1) and labeled these as either SMA, FHR, or Open based on their configuration as of October 2019. Four socio-environmental variables were selected to test for systematic biases in the placement of SMAs and FHRs: distance to village, distance to land, long-term fishing pressure, and wave energy. Details on how these variables were calculated are available in the Supporting Information (Section S3). The fishing pressure metric represents a value of relative long-term fishing effort throughout the region calculated as the weighted abundance of commercial and subsistence fishers from each village adjusted for differences in catch and extrapolated across available fishing grounds with decay ratios determined from key informant interviews. Fishing pressure inside management areas represents fishing pressure prior to management. These four variables, which were previously calculated for the entirety of Tonga's coral reef habitat, were chosen because they are: (a) known to influence the configuration of protected areas; and (b) are based on spatially continuous data across the region. For the whole of Tonga, null models were created of equal area to both total area of SMAs and total area of FHRs, but randomly sampled from the total reef area in Tonga (including SMAs and FHRs). These two null models were resampled 1000 times and the difference for all four metrics calculated between the actual SMA or FHR extent and each null model. In addition, to determine whether FHRs were systematically biased within SMAs, the same method was applied but only to the total combined area of FHRs and SMAs. One sample t-tests were then used to determine whether the bootstrapped differences varied significantly from 0. All analysis was conducted in R (V.3.5.3) (R core team, 2017).

With the exception of fishing pressure inside the SMAs, both FHRs and SMAs were biased towards areas of greater extractive value than expected by chance (Table 1, Figure 4). Distance to village, distance to land, and wave energy were all significantly lower within FHRs and SMAs than null models. Fishing pressure was greater within FHRs, but lower in SMAs. In addition, within SMAs, FHRs

TABLE 1 The relationship between four socio-environmental metrics and the presence of Fish Habitat Reserves and Special Management Areas in Tonga. LCL and UCL represent 95% lower and upper confidence limits respectively from 1000 bootstrapped samples. Negative estimate values indicate that values inside the management areas are lower than in areas open to fishing and positive estimate values indicate that values inside the management areas are greater than in areas open to fishing

Fish Habitat Reserves						
Variable	**Estimate**	**LCL**	**UCL**	***t***	***df***	***p*-Value**
Distance to land	−2048.59	−2055.93	−2041.25	−547.8	999	<.05
Distance to village	−5353.65	−5366.11	−5341.2	−843.36	999	<.05
Fishing pressure	6.59	6.55	6.62	352.31	999	<.05
Wave Energy	−855.94	−858.05	−853.84	−798.6	999	<.05
Special Management Areas						
Variable	**Estimate**	**LCL**	**UCL**	***t***	***df***	***p*-Value**
Distance to land	−1627.38	−1630.25	−1624.51	−1111.6	999	<.05
Distance to village	−4242.97	−4247.68	−4238.26	−1767.7	999	<.05
Fishing pressure	−5.03	−5.05	−5.02	−809.19	999	<.05
Wave Energy	−367.79	−368.52	−367.06	−988.86	999	<.05
Fish Habitat Reserves within Special Management Areas						
Variable	**Estimate**	**LCL**	**UCL**	***t***	***df***	***p*-Value**
Distance to land	−365.01	−370.27	−359.75	−136.16	999	<.05
Distance to village	−963.84	−972.53	−955.15	−217.67	999	<.05
Fishing pressure	11.07	11.04	11.09	846.45	999	<.05
Wave Energy	−339.33	−340.71	−337.96	−484.21	999	<.05

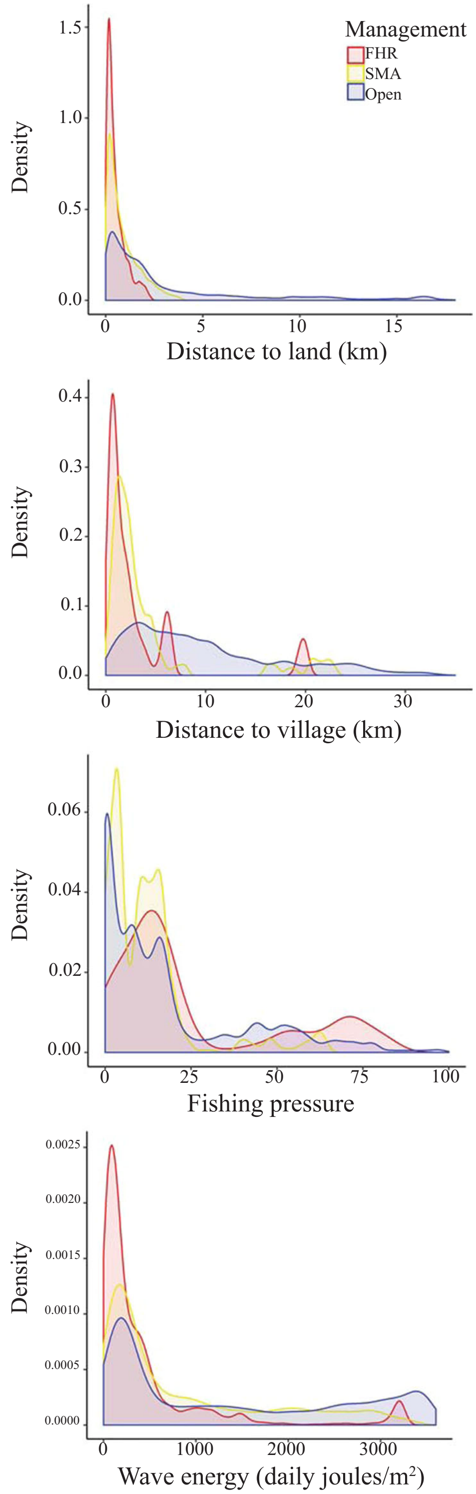

FIGURE 4 Density plots of overall differences in four socio-environmental variables between no-take Fish Habitat Reserves (FHR), Special Management Areas (SMA) and open areas in Tonga

were also more likely to be configured in areas of higher fishing pressure, lower wave energy, and closer to villages and land than the null model.

These results demonstrate that while Tonga's SMA program does have systematic biases in its configuration, they are in the opposite direction to those commonly observed for protected areas. Rather than being residual, management areas in Tonga are systematically less likely to be placed in areas of low extractive value than by chance. This demonstrates that the SMA program has been able to avoid residual biases in protected area placement because no-take FHRs must be situated only within the boundaries of each SMA, and SMAs are implemented only near villages, where resource use is historically high (Figure 3c).

4 | LIMITATIONS OF THE PROGRAM AND ITS EXPANSION TO OTHER REGIONS

At the outset, while it is clear that the implementation of Tonga's SMA program has been successful with respect to its rate of expansion, this does not demonstrate any difference made to the stated objectives of improving coastal fisheries resources or biodiversity conservation. Ultimately the success or failure of the SMA program is based on its impact, or the difference it makes compared to taking no action. However, determining impact relies on having an accurate understanding not only of the present state, but also counterfactual conditions that would be expected if management had never occurred (Pressey, Visconti, & Ferraro, 2015). While most SMA communities are enthusiastic about the benefits of the program, there is little quantitative evidence of any changes in ecosystem state and, ultimately, coastal fisheries resources (Gillett, 2017). Several studies conducted in 2010 on five SMAs began to examine the impacts of the SMA program, with basic control-impact methodology (Malimali, 2013; Richardson, 2010). However, they were completed when most SMAs were still too young for discernible changes to have occurred. Webster et al. (2017) compared community-based catch data with community perceptions of change in the oldest SMA in Tonga, although their methodology did not test the impacts of the FHR and used data of questionable quality. While a large body of evidence supports the notion that the no-take FHRs should provide positive impacts (Smallhorn-West et al., 2019), given that fishing is still allowed inside the SMAs, albeit potentially at a lower rate, it is unreasonable to expect large changes in ecosystem state within SMAs.

While acknowledging the caveats associated with protected area targets (Pressey et al., 2017), it should also be noted that the present spatial coverage of no-take FHRs in Tonga is low and unlikely to make significant contributions to national protected area commitments. Currently, total FHR coverage is 45 km^2, or 6.82×10^{-5} % of Tonga's EEZ, and 3.26 % of Tonga's coral reef habitat. Furthermore, given widely reported problems with misreporting

protected area targets in the South Pacific (e.g., Smallhorn-West & Govan, 2018), SMAs could easily be mislabelled as no-take protected areas and give the false impression that Tonga is reaching its international commitments. Lastly, the large coastal coverage by SMAs, where fishing is still permitted, might also limit additional spatial planning and no-take marine protected areas not associated with the SMA program, or relegate them to areas far from population centers and with less conservation impact.

The establishment of an SMA effectively sequesters the tragedy of the commons at the village level, where ongoing resource conflicts might continue to persist, albeit within the community. However, in 2015 a project by MACBIO gathered community members from existing SMAs to discuss "lessons learned" (Tupou Taufa et al., 2016). Two key points raised were: (a) to "acknowledge that there will always be community members who disagree; thus communities should move forwards after adequate consultation and majority agreement even if not 100% consensus"; and (b) that "where possible, include dissenting voices in the management of the SMAs". Therefore, while acknowledging that resource conflict might continue to exist within communities, it is at a level that should allow for better communication and collaboration between dissenting viewpoints. However, one caveat to this consideration is that the dispersal scales of target species are likely greater than the scale of individual management, resulting in a 'partial commons' (Almany et al., 2013; Costello, Quérou, & Tomini, 2015). An additional caveat, and one that requires further investigation, is the degree to which gender and social status may limit the ability of certain groups to contribute to decision-making without outside interventions. Within this context, local management of individual SMAs is meant to be supported by the Tongan government through the MoF, although it is unclear at this stage the degree to which marginalized groups are able to have their voices heard, and this is a key area for further research.

Lastly, it is important to note that the successful expansion of the SMA program in Tonga has relied largely on the fact that, prior to its inception, Tonga was entirely open access. Re-establishing a form of customary tenure has therefore been the prime incentive for strong engagement. A key consideration in expanding this program to other countries would be that support may be greatest in areas where existing management is weakest. For example, the SMA program in its current form might provide little incentive for groups in Vanuatu to implement no-take zones, where strong customary tenure already exists (Govan, 2009). However, other incentives such as providing formal recognition of customary tenure through legislation could provide similar enticements in these places.

5 | CONCLUSIONS

The dual approach of Tonga's SMA program provides key insights into mechanisms by which to avoid known pitfalls in protected areas expansion. First, providing immediate incentives (e.g., exclusive access zones) that also foster long-term relationships with resources encourages groups that otherwise may be against management and conservation to implement protected areas. Then ensuring that protected areas occur within the boundaries of these exclusive access zones entices groups to protect areas of greater extractive value than they would likely do so otherwise. Applying this framework successfully to other regions will rely on understanding the specific local incentives that will ultimately foster the greatest long-term engagement in management and conservation.

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DATA AVAILABILITY

Raw data for spatial analysis is available in the supplementary materials.

AUTHOR CONTRIBUTIONS

P.S.W. conceived and wrote the manuscript. J.S. aided with graphical analysis, in country support, and idea development. S.M. and T.H. contributed to in country support and critical background information about the program. T.B., R.P., and G.J. supervised the project and developed the ideas. All authors contributed to the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflicts of interest

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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