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# Opportunities and challenges in achieving co-management in marine protected areas in East Africa: a comparative case study

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## ABSTRACT

As marine ecosystems decline globally, scientists recommend increasing the coverage of marine protected areas (MPAs), but many are not effectively managed to deliver benefits. Community integration into decision-making can increase effectiveness by supporting behavior change, but this poses implementation challenges. We examine differences in adaptive capacity, community engagement, and perceived MPA benefits using interviews and focal groups in two fishing communities from MPAs with different management strategies and geographic settings: a centrally managed MPA in Kenya and a co-managed MPA in Tanzania. Far fewer Kenyan community members (37%) felt they benefited from the MPA compared to Tanzanian community (95%). Agency, trust, and MPA support were largely similar. Both systems had challenges that reduced collaborative action including: low staff-community interaction and communication, leadership challenges, and social conflict. We identified pathways towards improved co-management that transcend systems: institutional prioritization of community integration, investment in community leadership, mapping social networks, and adequate MPA budgets.

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## Introduction

With ocean ecosystems increasingly threatened, marine protected areas (MPAs) are expected to achieve numerous conservation and socio-economic goals (Watson et al., 2014). Scientists now recommend increasing the global area of oceans in MPAs to 30% (Hawaii Commitments). However, it is estimated that two-thirds of global MPAs are not effectively managed and are thus not delivered promised ecological and societal benefits (Hargreaves-Allen et al., 2011; Kelleher, 1996). Ineffective management is considered the single largest issue facing the world's terrestrial and marine protected area systems (Anthony et al., 2015). National establishment of Marine Protected Areas

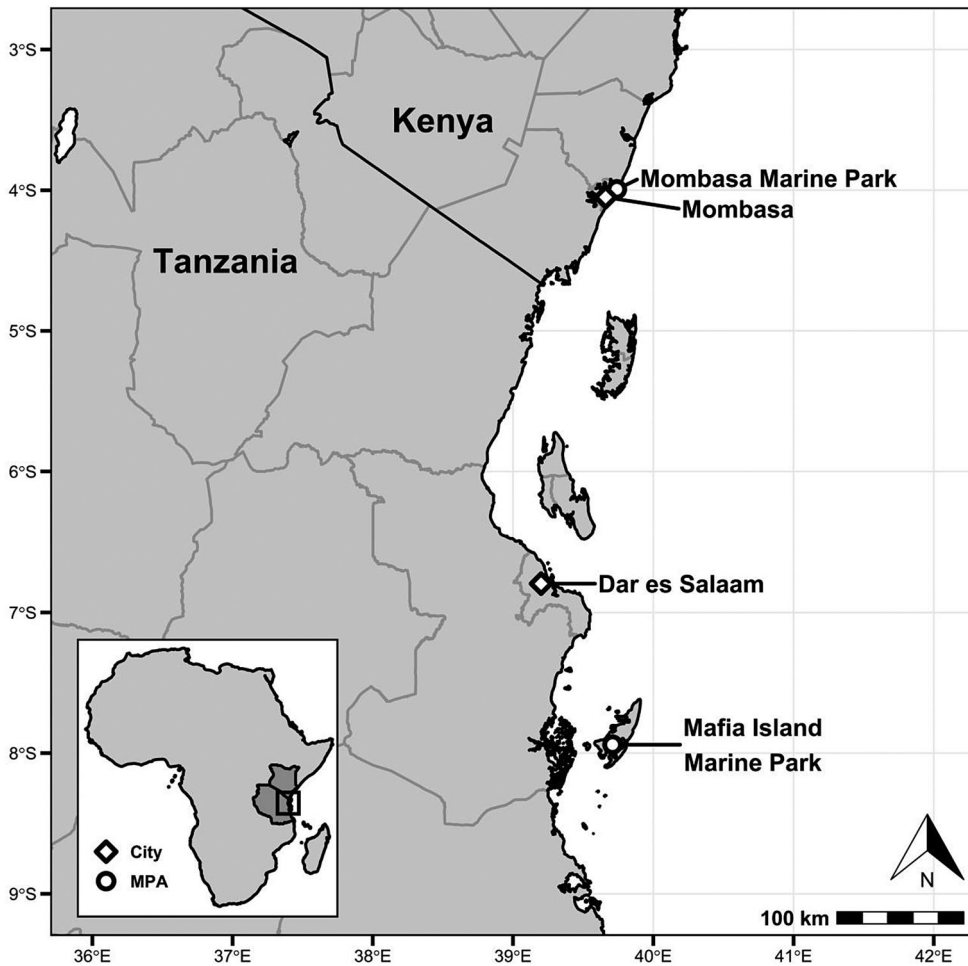
(MPAs) can thus showcase increased commitment for environmental protection, but it sometimes provides a false sense of security (Mora et al., 2006).

A key part of effective management is participatory governance. This concept aligns strongly with the eight United Nations principles of 'good governance' and is a global priority under the United Nations' Sustainable Development Goals (Goals 10 and 17). Participatory management practices and policies have emerged in fisheries, agriculture, forestry, protected areas, wildlife, ecosystem service, and water management across rural to urban environments (Bennett et al., 2018) and involve stakeholders working jointly to balance resource conservation and use (Machumu, 2012). Co-management involves some form of shared management authority between state-level institutions and resource users at the local level (Armitage & Plummer, 2011; Ayers & Kittinger, 2014; Lockwood, 2010), and can empower communities by providing greater influence over the allocation and use of their resources and access to information which can facilitate learning (Barnes et al., 2019).

The Western Indian Ocean (WIO) along East Africa has >100 MPAs to protect oceans under intense small-scale fishing and limited fisheries management. Increasing MPA management capacity is a regional priority (Wells et al., 2007). There is a strong need to advance equitable co-management of MPA systems with communities. In most MPAs, managers include the community in *ad hoc* ways and have not worked to evaluate how effectively communities are incorporated into management. Kenya and Tanzania are adjacent nations off the coast of East Africa with MPA networks that were first instituted in the 1960s (Figure 1). However, the nations have taken a different approach to co-management with Kenya adopting a centralized decision making (top-down) approach ensuring adequate MPA protection and Tanzania adopting a co-management approach.

Several marine reserves were legislated in Tanzania in the mid-1970s, but no specific management mechanisms were put in place until the Marine Parks and Reserves Act (Act 29) of 1994, which provided a legal framework for conservation, management, and use of coastal and marine resources (Machumu & Yakupitiyage, 2013). The management approach of Tanzania Marine Parks and Reserves Unit (MPRU) is intended to be participatory and involves co-management whereby stakeholders are represented by an Advisory Committee and Village Liaison Committees. Village Liaison Committees are elected democratically by village councils and participate in various MPA conservation activities such as monitoring and surveillance. The Advisory Committee members represent various stakeholders including hoteliers, fishers, district counsel, conservation NGOs, research institutes, and the Ministry of Fisheries. The Board of Trustees develops policies and oversees all administration and management issues.

In Kenya, MPA management is under the Kenya Wildlife Service (KWS), a state corporation whose mandate is to conserve the country's flora and fauna. The KWS is responsible for securing resources, conducting research, education and awareness, community and stakeholder engagement, tourism promotion and marketing, as well as reporting and advising the government on conservation issues. The KWS is made up of a disciplined wing (uniformed/paramilitary) and a civilian wing. Kenyan MPAs were first established in the 1960s and management of all protected areas in Kenya fall under the disciplined wing. KWS is mandated to combat poaching inside and outside of protected areas, ensure security for visitors (tourists), secure KWS property, and maintain law and



**Figure 1.** Map of marine parks (circles) examined in this case study in relation to the nearest urban centers (diamonds; Dar es Salaam in Tanzania, and Mombasa in Kenya).

order within and around protected areas. Currently, KWS is undertaking policy and legislative reforms to catalyze the transition toward inclusivity in protected area management.

This study took place as part of a larger initiative to improve MPA management by helping MPAs use an adaptive and evidence-based decision-making approach (see [www.smartseas.org](http://www.smartseas.org)). This study was part of an exchange conducted between an urban MPA in Kenya (Mombasa Marine Park and Reserve) and an island MPA in Tanzania (Mafia Island Marine Park) exploring the dynamics of co-management in different settings and nations. Through pre-exchange interviews and focal groups during the exchange, we evaluated the fishing community's relationship with the MPA and adaptive capacity: the ability of groups or institutions to anticipate and respond to change and take advantage of new opportunities (Cinner et al., 2018; Grothmann & Patt, 2005).

Adaptive capacity involves five elements: flexibility, social organization, agency, knowledge/learning, and assets (Cinner et al., 2018). Flexibility includes innovation,

willingness to take risks and to try new things (Jones et al., 2010), and is important because management often requires changes in behaviors or norms. Social organization includes attachment to place, social networks, and trust. Attachment to place provides a sense of belonging that contributes to a collaborative mindset and collective action (Alexander et al., 2018; Bakker et al., 2019), and can shape attitudes and intentions (e.g. Newman et al., 2017), as well as provide motivation to support conservation strategies (van Putten et al., 2018). Social networks enable peer-to-peer learning and learning between communities and government institutions (e.g. MPAs). Trust is a key co-management building block, enabling exchange of information and improving collaboration in joint decision-making (Nenadovic & Epstein, 2016), and social cohesion can be one of the drivers of co-management success (Gutiérrez et al., 2011). Agency (or empowerment) includes the degree to which individuals feel they have control of their lives and ownership of local resources and processes (Berkes, 2004), and increased agency is associated generally with increased participation in governance (Andrade & Rhodes, 2012). Learning and knowledge help indicate what communities believe to be important and can help evaluate whether co-management focuses on community interests and needs. We were not able to assess financial assets in the context of this work, though increased financial assets can lead to higher community ability to adapt to change (Cinner et al., 2018).

We used individual interviews to assess current attitudes toward and interactions with government MPA institutions under two government systems, and assessed community flexibility, social organization, agency, and learning as factors that might contribute to environmental citizenship and successful co-management. We hypothesized that perceptions of MPA benefits and MPA support would be higher in the more collaboratively designed system in Tanzania, and supported by greater agency, MPA interaction, and trust, as well as an increased MPA focus on community interests and needs. We brought together participants from fishing communities and MPA agencies to review interview results, discuss the current status of co-management, and identify barriers and pathways forward. We used this information to determine approaches through which MPAs can increase effective co-management.

## Materials and methods

### *Study site: Mafia Island marine Park, Tanzania*

The Mafia Island Marine Park (hereafter called Mafia MPA), on Mafia Island off the coast of Dar es Salaam, Tanzania, is part of the Tanzania Marine Parks and Reserves Unit (MPRU) system (Figure 1; Table 1). Two parts of the current Mafia MPA, Kitutia reef and Chole Bay, were declared marine reserves (closed to fishing) in the 1960s. Co-management was taken onboard during the early process of establishing the larger Mafia MPA in the early 1990s. An Advisory Committee at the Park level and Village Liaison Committees in all villages within the MPA were established and given the task of establishing the Marine Park after the community repeatedly reported destructive gear use in the area and associated declines in fisheries resources. The committee convened several public forums to discuss establishing the park, paving the way for gazettelement of the Mafia MPA in April 1995 (under Act 29).

**Table 1.** (a) Summary of MPA characteristics for the MPAs in the study: Mafia Island Marine Park in Tanzania and Mombasa Marine Park in Kenya; (b) Demographics of study participants at each site.

Characteristic	Mafia Island Marine Park, Tanzania	Mombasa Marine Park & Reserve, Kenya
<b>(a) MPA characteristics</b>		
Setting	Rural island MPA	Urban MPA
Date of establishment	Parts of the current area (Chole Bay and Kitutia reef) were gazetted as marine reserves in the mid 1970s with extractive use of resources strictly prohibited. Full area gazetted as a marine park in 1995	1986
MPA size	821 km <sup>2</sup>	210 km <sup>2</sup>
Management approach	Co-management	Centrally managed by government
Size and type of staff	~15 non-armed staff	~40 staff and >50% armed for security and enforcement
Revenue sharing with community	20% net revenue goes back to community, and 10% net revenue to local government (District council).	For boat operators only: 1 in 10 boats is not charged.
Communities living in MPA	Yes (12 villages, 5 sub-villages and about 24,000 people)	No (but 400 registered users)
Includes terrestrial area	Yes (25% terrestrial)	No
Fisheries closure zone	Core zone (no extraction) 5% of the total area = 40 km <sup>2</sup>	Park (no extraction) = 10 km <sup>2</sup>
Sustainable fishing zone	Specified use zone 25% = 164km <sup>2</sup>	Reserve = 200 km <sup>2</sup>
Open zone (all legal fishing)	General use zone = 617 km <sup>2</sup>	None
Entry Fee	\$25 USD/day (whether in marine or terrestrial areas, regardless of activity).	\$17 USD non-residents, \$1.30 residents if entering on boat or using snorkel
<b>(b) Demographics of study participants in pre-exchange surveys (n=21 per MPA system)</b>		
Gender	76% male (16), 24% female (5)	71% male (15), 29% female (6)
Age	20–60 (76% between 31 and 50)	20–60 (81% between 31 and 50)
Education Level	No education: 1 (5%)	No education: 8 (38%)
Head of household	Primary School: 19 (90%) Secondary School: 1 (5%)	Primary School: 11 (52%) Secondary School: 2 (10%)
Leadership Position in community	20 (95%) 3 (14%)	19 (91%) 6 (28%)
Years in community	18–51 years (mean 35)	1–50 years (mean 20)
Perception of economic status	Improving: 96% (29% greatly) No change: 0% Declining: 4% (0% greatly) all: 10% (2)	Improving: 38% (5% greatly) No change: 43% Declining: 19% (10% greatly) all: 0% (0)
Household protein from fishing	most: 62% (13) about half: 10% (2)	most: 38% (8) about half: 38% (8)
Fishing gear types used	some: 19% (4) 44% handheld gear (7)	some: 24% (5) 13% handheld gear (2)
Boat ownership	6% mobile net (1) 50% stationary net (8) 94% own boat (13% with motor)	67% mobile net (10) 20% stationary net (3) 71% own boat (14% with motor)

The Mafia MPA is 821 km<sup>2</sup> and includes both marine (75% of the area) and terrestrial areas (25%). There are 14 villages and 23,000 people within the boundaries of the MPA (Based on 2012 census). Up to 50% of the residents rely on exploitation of marine resources for their livelihoods and another 10-15% rely on extraction of resources from the Mlola Forest within the MPA. After its establishment, the Mafia MPA adopted a zoning scheme intended to strike a balance between conservation of ecosystems and utilization of resources by local communities living within and adjacent to the Park areas to attain sustainability. The park is zoned into core zones which prohibit extractive uses (40

km<sup>2</sup>), specialized use zones (164 km<sup>2</sup>) which allow only sustainable gears (e.g. basket traps, hook/line), and general use zones (617 km<sup>2</sup>, the majority of the MPA).

There are reported MPA challenges relating to increasing human populations and fishing pressure, and low community understanding of the MPAs importance and role, especially among migrant fishers and youth (Machumu, 2012). The development of a small-scale, but economically important tourism industry within the MPA has added socio-economic complexity and some local jobs. Although most hotel owners (considered MPA investors) are not from Mafia Island, tourism is key for MPA revenue and supports both MPA operations and community development initiatives. The Mafia MPA gives 20% of its net revenue back to the community in the form of community projects that build infrastructure and (e.g. wells, office space for leaders, schools, etc.) and 10% of net revenue to local authority (district council located within MPA jurisdiction). When co-management fails to stop MPA violations, the MPA staff have legal mandate to search and arrest violators, however, they need support from police or government lawyers in prosecution.

There are not many published studies showing pre- and post-MPA establishment conditions in Mafia. A 2003 study examined coral reef communities at 11 sites and found mean live coral cover of 14% (Garpe & Öhman, 2003). However, some sites now have a very high coral cover and have been increasing over time (United Republic of Tanzania, 2018). For example, Kitutia reef (no-take zone) had a coral cover increase from 32% in 2009 to 58% in 2018 (United Republic of Tanzania, 2018). Underwater fish surveys conducted prior to the establishment of the Mafia MPA (in 1995) and again in 2006 and 2011 indicate a decline in groupers initially and then no change (Gaspare et al., 2015). However, another type of fish, blackspot snapper (*Lutjanus fulviflamma*) was assessed in a 2004 study and had over four times more numerous and its biomass was six to ten times higher on reefs within the MPA than in adjacent fished areas (Kamukuru & Mgaya, 2004).

### ***Study site: Mombasa marine Park and reserve, Kenya***

The Mombasa National Marine Park & Reserve (hereafter Mombasa MPA) was established in 1986, covering 210 km<sup>2</sup> of marine nearshore waters and is managed by the Kenya Wildlife Service (KWS; Figure 1; Table 1a). The MPA is zoned into a 10 km<sup>2</sup> park (no-take area with tourism allowed) and a 200 km<sup>2</sup> reserve (multiple-use area). Within the reserve, fishing is allowed with hook and line, nets with >1 inch mesh opening, and basket traps. Seaweed harvesting, octopus fishing, and crab and lobster harvesting are also allowed in the reserve. Banned reserve activities include the use of drag nets (beach seines, ring nets), shell collection, aquarium fishing, speargun fishing, coral harvesting, and mangrove harvesting. The MPA faces several threats including overfishing, pollution from beach users and adjacent hotel and impacts of climate change. MPA management issues include weak enforcement of some MPA regulations and increasing resource use conflicts. Fishing pressure and resource use conflicts have increased over time since the creation of the MPA, partly due to the increasing number of fishers which has grown from just about 40 in 1986 to > 300 in recent years. Documented conflicts are between fishers and tourism operators, between KWS and fishers over MPA boundaries, and



between different fishers over space and gear use (Frontani, 2006; McClanahan et al., 2005; Tuda et al., 2014).

Stakeholder communities are diverse and include fishers and fish vendors, as well as boat operators and different groups of beach vendors. Since 2008, the fishers and fish vendors in the community are organized under the Kenya Fisheries Service into Beach Management Units (BMUs), which allows a forum for KWS to engage with the community. The three BMUs within the MPA have a total of ~400 registered members currently, comprised of ~300 fishers and ~100 fish vendors/traders. The BMUs have their own constitutions and have a disciplinary committee to act on offending fishermen. The management of different uses within the Mombasa MPA is also under a variety of government agencies, often with overlapping and evolving mandates. These include the Fisheries Department, the Kenya Ports Authority, the National Environmental Management Authority, the Kenya Maritime Authority, the Kenya Navy and the County government. Existing sector regulations are fragmented and are not well understood or integrated by the fisher community and other resource users.

Despite challenges, the Mombasa MPA had improvements in coral cover and fish biomass increased during the first 10 years of its establishment (McClanahan & Kaunda-Arara, 1996). In the early years after establishment, Mombasa coral cover was higher than that of fished reefs, with cover increasing to >30% (McClanahan, 2014a). However, after the 1997–1998 bleaching event, coral cover dropped nationally at all sites, removing differences with fished reefs, and with Mombasa dropping to ~13% (McClanahan, 2014a). Mombasa coral cover increased to 30% by 2008, but then declined to ~22% by 2011 (McClanahan, 2014a) and has thereafter remained at that level. The cessation of fishing resulted in a recovery of fish biomass over a period of about 15–20 years (McClanahan, 2014b). Spillover of fish from the park to adjacent artisanal fisheries has been attributed to better enforcement of park use regulations (McClanahan & Mangi, 2000), and results in revenue and income for fishermen (Darling, 2014; McClanahan, 2010). The MPA also provides important areas for tourism, with economic benefits for community boat operators. Historically, there was no mandated financial benefit sharing between KWS and communities. However, a new financial benefit-sharing scheme targeting boat operators was introduced recently, whereby boat operators receive 1/10 of revenue accruing from MPA visitation fees.

### ***Individual interviews (Pre-exchange)***

Prior to the exchanges involving fishing community members and MPA staff, we carried out individual interviews of the Mafia and Mombasa MPA fishing communities (survey is accessible at <https://doi.org/10.5061/dryad.tdz08kpxg>). We used MPA staff to conduct interviews using a pre-established questionnaire. To avoid bias in conducting the surveys, we had an MPA staff member from Mafia conduct the surveys in Mombasa and vice versa, which also allowed staff to gain perspectives from community members in another system. Two MPA staff members were trained in survey techniques and practiced giving surveys to peers prior to conducting surveys in the communities. No personal or identifying information was collected. Participants consented to the sharing summarized versions of the surveys for use in MPA management and in publications.



Interviews were conducted in the Mafia MPA between July 28–30, 2017, with 21 community members (Table 1b) from the villages of Utende, Kiegeani, and Miburani within the boundaries of the MPA. Surveys were conducted in the Mombasa MPA from July 26–29, 2017 with 21 community members (Table 1b) from four fish landing sites adjacent to the MPA reserve: Bamburi, Nyali, Marina, and Mikoroshoni. In both cases, fishers were informed by the MPA prior to the interviews that they would be taking place, and the fishing community determined who could be available at the time of the interviews. The surveys took between 1 and 2 hours to administer, and the participants were given an open opportunity to discuss any MPA or marine-related topics at the close of the interview.

The surveys were comprised of 40-questions, which were either open-ended (respondents were free to give their own answers) or close-ended questions (yes/no or answers provided on a 4-point Likert scale). Survey questions were either derived from past surveys co-designed with a social science researcher from the Stockholm Resilience Center or were derived from Glew, Mascia, & Pakiding, 2012, a globally used monitoring protocol designed by the World Wildlife Fund and academic partners for use in developing countries, and published in Gill et al., 2017. We asked eight background questions (general demographics) and then seven questions on fishing practices and use of MPA to describe the population (questions 1–8 and 19–27). Our key response variables were based on commonly used questions (Bragagnolo et al., 2016) on: attitudes toward the MPA (question 29: Do you support the MPA) and perception of MPA-related benefits (question 30). We asked these as yes/no questions followed by an open-ended ‘why?’ question to elicit the widest range of community responses on these without adding any questioner bias. To understand level of community interaction with the MPA system, we asked one 4-point Likert scale question about frequency of communication with the MPA (question 16). We then asked a yes/no question about personal involvement in making decisions about the management of the MPA (question 27d), with management described as ‘setting/marking boundaries, making rules about harvest, assigning responsibilities for protecting/improving marine resources, surveillance, and deciding who can access resources.’

To understand attributes that might explain responses and differences between the two MPAs and associated fishing communities in the study, we asked questions about elements of adaptive capacity and environmental stewardship: flexibility, social organization (place attachment, trust, social conflict, and mentorship), agency (in the community and in the MPA) and learning (in terms of areas of perceived threats and how much these are focused on by the MPA). We asked a series of four-point Likert scale questions on: flexibility (8 questions; questions 10a – 10h), place attachment (8 questions; questions 9a – 9h), trust (4 for community and 3 for the MPA; questions 11a – 11g), agency in the community (8 questions; questions 13a–13h) and agency in the MPA (9 questions; questions 14a – 14i).

To further assess the social asset base (which could be related to MPA engagement if MPA staff are mentors), we asked participants to note the names and professions of people who had served as mentors in their careers (question 12). We evaluated what group mentors were associated with (e.g. fishing community, MPA staff, government, NGO). To understand potential challenges for collective action, we asked whether social conflict in the MPA is increasing or decreasing (one 4-point Likert scale question,

question 28). To understand current knowledge and areas of action, we asked an open-ended question about community perceptions of current threats to the marine environment and then asked about areas of engagement in actions to resolve threats (questions 34–39).

Because we asked multiple Likert-scale questions on each theme, we assigned answers a numeric score such that strongly disagree was a  $-1$ , somewhat disagree was a  $-0.5$ , somewhat agree was a  $0.5$  and agree was a  $1.0$ . We then averaged responses for each question across all participants of each MPA and averaged all questions to create an average index score for each MPA for place attachment, flexibility, agency in community, and agency in MPA. With question-level index scores as samples, we assessed whether there were differences between parks using Student's *t*-tests for each question category in R (R Core Team, 2018). We adjusted *p*-values for multiple comparisons using the Benjamini & Hochberg method for controlling the rate of false discovery (Benjamini & Hochberg, 1995). We also performed select comparisons between parks for questions with binary responses (e.g. support for MPA yes/no and benefit from MPA yes/no) using a binomial logistic regression. We calculated *p*-values for these comparisons using likelihood ratio tests (Neyman & Pearson, 1933).

### ***Exchange and focal group discussions***

We brought together a group of 17 fishing community members (fish vendors and fishers) and six MPA staff to (a) add depth to interview question responses, (b) discuss the challenges in and opportunities for co-management in the Kenyan and Tanzania MPA systems, and (c) develop new co-management approaches. The participants gathered in two 3-day meetings: in Mombasa (November 13–15, 2017) and in Mafia (November 27–29, 2017). Prior to the exchange, the staff from each MPA introduced the exchange program concept to the MPA communities and we (authors) requested that communities choose the representatives to attend with equal gender representation. We did not impose any further criteria for selection of representatives (other than community choice and equal gender representation).

In the Mafia MPA, the eight community participants for the co-management program were identified from two communities that the MPA staff selected: Kiegeani and Miburani. The Mafia MPA decided to suggest the names of participants to the village councils of the two communities based on the following criteria established by MPA staff: demonstrated strong commitment in various conservation activities under Mafia Island Marine Park, above 18 years old, and ability to read and write. The screening of possible candidates was done in an MPA staff meeting and thereafter, shortlisted names were sent back to the village councils for review and approval. The Mafia MPA found that it was difficult to find females who were willing to travel, and thus the group only had two female members.

In the Mombasa MPA, the nine community participants were selected from the Beach Management Units (BMUs) bordering the MPA (Nyali, Bamburi and Marina). The MPA staff allocated four slots to Bamburi BMU which borders both the park and the reserve because they entirely rely on the MPA for fishing. The Nyali and Marina BMUs use a small portion of MPA and were allocated two slots each. The remaining slot was offered to the community field supervisor from the Fisheries department, who represents all BMUs, as this person is

critical in moving co-management forward. After the slots were allocated, a BMU leadership committee held a meeting with the BMU members and explained the co-management exchange program. The BMU leadership committee proposed exchange participants based on leadership and engagement in each BMU. The BMU members then voted to approve these names, which included five women.

During the first meeting, we shared the survey results with focal group participants (six MPA staff and 17 fishers/fish vendors) and held an open group discussion about results of each question to gain further insight into community engagement and dynamics with each MPA. We held focal group discussions (mixed nations then individual nations) to generate ideas of how co-management could be improved. Between the two meetings, participants presented their ideas on improving co-management to their respective broader communities. During the second meeting, participants reported on community reception of ideas, discussed potential obstacles, and further refined plans to improve co-management.

## Results

### *Individual interview and focal group discussion on survey results*

We present the results for the first set of interviews together with focal group discussions on survey results. For comparison purposes, we evaluate scores of each MPA in contrast to the other MPA. Our intent was not to explicitly compare the MPAs. However, as there is no 'standard' score against which to compare scores, comparisons between the MPAs identify areas where there are key differences.

### *Interviewee demographics*

Survey participants from both MPAs were primarily male: 76% male in Mafia and 71% male in Mombasa (Table 1b). There are more fishers than fish vendors, and proportions of male and female participants roughly represent proportions present in these communities. In Mafia, all males interviewed were fishers and all females were fish vendors. In Mombasa, there was one male fish vendor interviewed in addition to six female fish vendors. Ages of survey participants ranged from 20 to 61+ (Table 1b). Most participants were between 31 and 50 years old (76% in Mafia and 81% in Mombasa). The number of years participants had lived and worked in their community ranged from 18 to 51 years in Mafia (mean of 35), meaning that most had spent their whole life in their community (Table 1b). In contrast, in Mombasa, time in community ranged from 1 to 50 (mean of 21), indicating that more people have moved there from elsewhere as adults compared to Mafia (Table 1b). During focal groups, fishers from Mombasa commented that few fishers (especially younger ones) are from areas near the Mombasa MPA because older people have not introduced their children to fishing. Many fishers are immigrants who have come to seek opportunities.

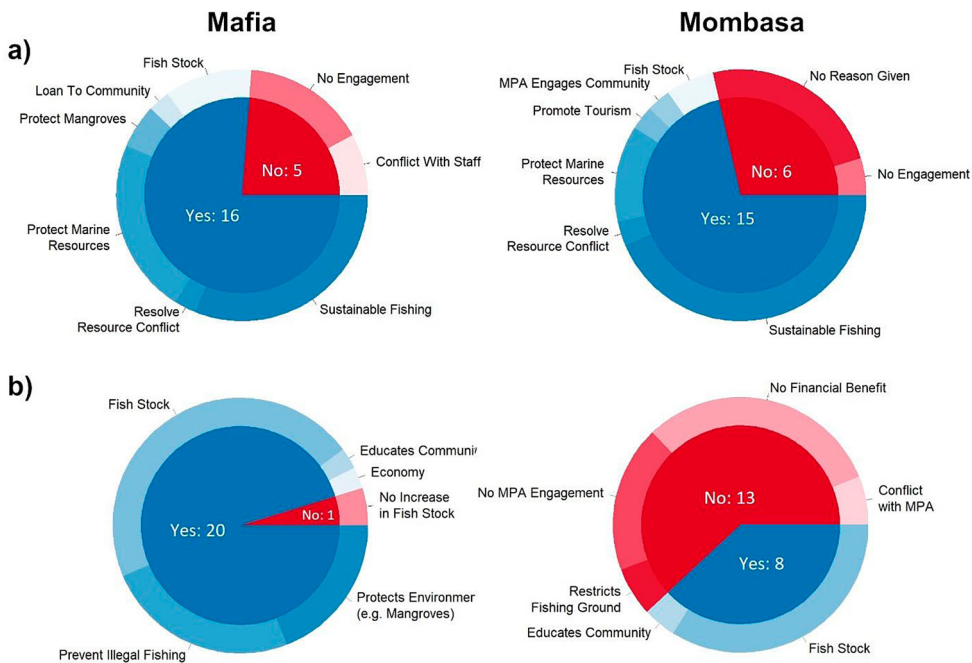
More households in the Mafia fishing community received the majority of their protein from fish (71%) than in the Mombasa fishing community (32%). Gear used is different between these communities: Mombasa has a higher percentage of people using beach seines (67%) which damage the environment and are illegal in the MPA, while Mafia

has a higher percentage of people using handheld gear (44%) and stationary gill nets (50%; Table 1b). Boat ownership was relatively high in both communities (>70%) but ownership of boats with motors quite low (<14%; Table 1b).

When asked how economic status is changing most people (96%) in Mombasa indicated improvements (Table 1b). In contrast in Mafia, only 38% indicated improvements while 43% indicated no change, and 19% indicated a worsening economic status (Table 1b). Reasons indicated for improvement were similar across MPAs and including increased demand for fish and increased harvest. Reasons for declines were also similar and included decrease in catch, poor markets, and lack of access to fishing gears. In Mombasa, there was a feeling that the demand for fish has increased, leading to more business. However, in Mafia, most of the catch is sold to private companies and the focal group participants did not feel there was any trend of increased income over time. All fishers and fish vendors agreed that fishing is their main source of livelihood, though in Mafia, many also participate in small-scale farming. However, it was noted that the success of Mafia coconut farming has declined, increasing fishing pressure and reliance.

**MPA attitudes and interactions**

Support for both MPAs was high, and MPA support did not differ significantly between MPAs (76% in Mafia and 71% in Mombasa;  $\chi^2(1) = 0.12, p = 0.3$ ; Figure 2(a)). Reasons for supporting the MPA were focused on increased fish stock, protection of marine resources,



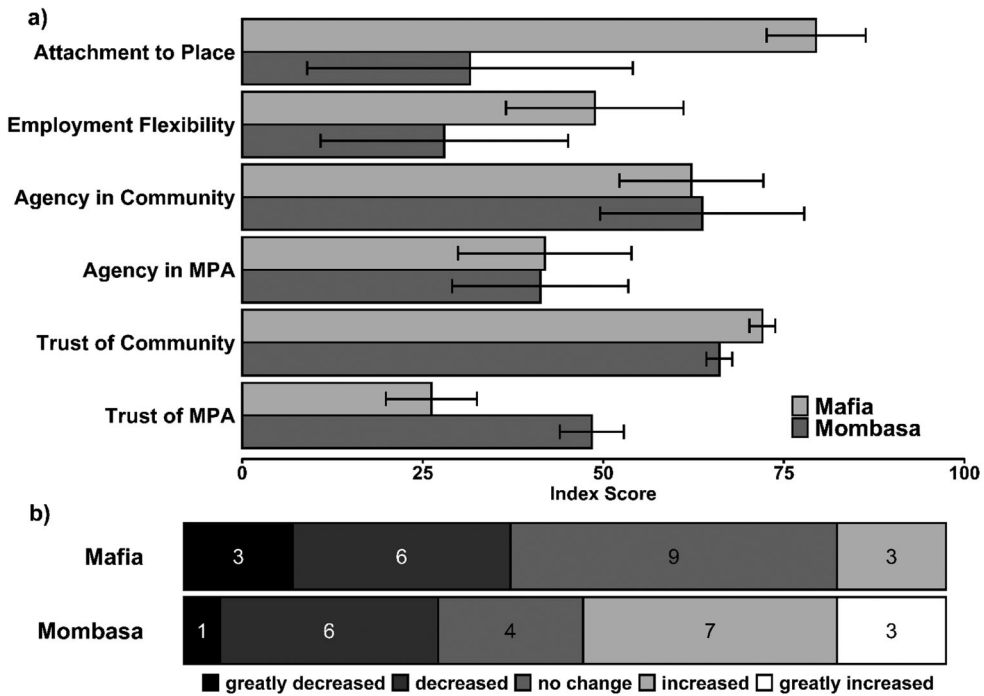
**Figure 2.** (a) Fishing community support of the MPA and reasons behind responses and (b) Fishing community perception of MPA benefits and reasons behind responses. Numbers in each response category (yes/no) are the number of interviewees with that response.

resolving resource conflicts, and sustainable fishing. In Mombasa, most people did not give a reason for lack of support, but the few respondents indicated no engagement between the MPA and community. Reasons for not supporting the MPA in Mafia were no engagement between MPA and community and conflict with staff. In an open comment period at the end of the surveys, lack of engagement and perceived harassment by staff also surfaced with 20% of participants in Mombasa and 30% of participants in Mafia mentioning harassment, and 20% of participants in Mafia mentioning low engagement. Though level of support for the MPA was similar in Mafia and Mombasa, perceived benefits received from the MPA differed significantly: 95% of participants from Mafia felt they received benefits, while only 37% from Mombasa felt they received benefits ( $X^2(1) = 17.5, p < 0.001$ , [Figure 2\(b\)](#)). Both MPAs indicated increased fish stock and education to community as benefits, and Mafia also mentioned prevention of illegal fishing. In Mombasa, major reasons for perceived lack of benefits included no financial benefit and no MPA engagement.

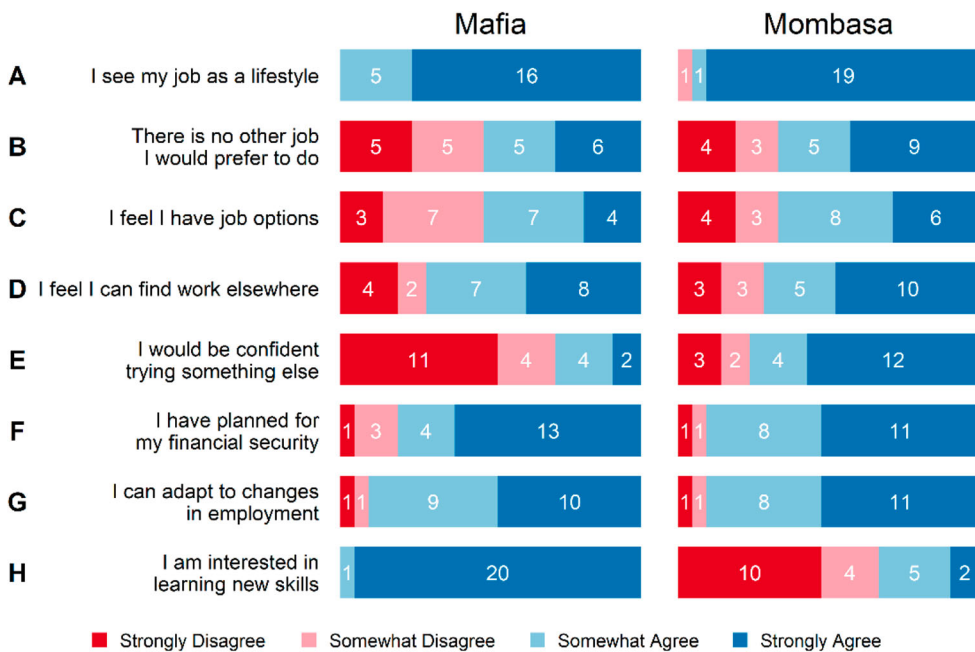
In the last 12 months, 38% of respondents from Mafia and 24% in Mombasa indicated that they had helped make a management decision in their MPA ([Appendix 2: Table A1](#)). In Mafia, participants indicated that decisions were focused on enforcement and outreach to villagers on issues with the use of destructive gears. In Mombasa, no respondents provided a clear example of engagement in decisions. In Mombasa, most people indicated monthly (50%) communication with the MPA, with some weekly (22%) or daily (11%) communication ([Appendix 2: Table A1](#)). In contrast, most people in Mafia noted yearly communication (38%) followed by monthly (33%), with few people mentioning weekly communication (10%), nobody mentioning daily communication, and 19% indicated no communication ([Appendix 2: Table A1](#)). The exchange participants from Mafia indicated that communication from MPA staff goes only to the Village Liaison Committee, but that this committee does not share the information with the broader community. Funds were also mentioned as an obstacle in both MPAs by MPA staff (e.g. no funds to hold meetings frequently).

### *Flexibility*

Mafia had an index score for flexibility at 0.49 compared to 0.28 for Mombasa, though this difference was not statistically significant ( $t(14) = 0.99, p = 0.51$ , [Figure 3\(a\)](#)), and both MPAs scored in the positive range (on a scale of +1 to -1). Mafia had relatively negative scores for questions on 'being confident trying something else' (-0.48 compared to +0.43 for Mombasa; [Figure 4\(E\)](#)) but also had higher 'interest in learning new skills' (0.98 for Mafia compared to -0.34 for Mombasa; [Figure 4\(H\)](#)). Mombasa participants indicated feeling contented with no need to change jobs and an appreciation of getting daily income. Some participants commented that low literacy may increase fear of new ideas and change. Participants from Mafia indicated that job options are reducing with increased population. In addition, it was felt that Mafia fishers are born into fishing families and have few outside skills, and would like to explore other options. Job satisfaction was relatively neutral in both MPAs ('there is no other job I'd rather do'; [Figure 4\(B\)](#)), but participants from both MPAs felt relatively strongly that their job represents a lifestyle (0.88 for Mafia and 0.90 for Mombasa; [Figure 4\(A\)](#)).



**Figure 3.** (a) Average results from Likert-scale questions that were transformed to index scores ranging from -1 to +1 (-1, -0.5, 0.5, 1) in each MPA. Error bars show standard error. (b) Perceived change in social conflict over the last 12 months. Numbers show numbers of participants with different answers.



**Figure 4.** Responses to eight questions on flexibility in Mafia and Mombasa. Numbers indicate number of respondents with that answer (questions 10a – 10 h).

### ***Social cohesion: attachment to place, trust, social conflict, and mentorship***

Mafia had a relatively strong attachment to place with an overall score of 0.79 (Figure 3a). Mombasa had a lower overall score of 0.32 (Figure 3a), though also in the positive range, and these scores were not significantly different ( $t(14) = 2.03, p = 0.123$ ). For Mafia, the lowest scoring question about place attachment was desire to stay in Mafia (Appendix 1 Figure A1), with a score of 0.36. In the focal group meeting, participants from Mafia MPA indicated that supporting families in Mafia has become more difficult due to human population increases on the island. There are now more people depending on the sea for income, leading to competition and degradation of resources. However, fishers indicated that inheritance of land in Mafia makes it likely that people will not move away. In Mombasa, there was a strong negative response for desire to stay (score of  $-0.81$ , Appendix 1: Figure A1(F)) and for Mombasa being a 'part of me' ( $-0.45$ , Appendix 1: Figure A1(E)). Compared to Mafia, there were also more negative responses to 'feeling at home' (0.09 index score versus 0.81 for Mafia, Appendix 1: Figure A1(B)). In the focal group meeting, Mombasa participants indicated that this is likely due to the immigrant nature of the fishing population. Life in Mombasa is seen as expensive, and people try to relocate to less costly locations. Further, it was felt that in Mombasa, fishers and fish vendors are not well respected. Despite these differences, both MPAs had an equally high interest in being engaged in the affairs of the place (Appendix 1: Figure A1(H)).

Overall trust scores for other community members were relatively high: 0.72 for Mafia and 0.66 for Mombasa (Figure 3a, Appendix 1: Figure A2). Trust was lower for MPA staff (0.26 in Mafia and 0.48 in Mombasa), but scores were not significantly different ( $t(4) = -2.89, p = 0.12$ ). In the Mafia MPA, the 21 participants listed 48 mentors (Appendix 1: Table A2). Most of these (40%) were other fishers or fish vendors, but MPA staff were mentioned as 23% of the mentors. In Mombasa, the 21 participants listed 36 mentors. Of these, 36% were other fishers, representing the most common group. Only 2 mentors were MPA staff, representing 2%.

More people from Mombasa perceived an increase in social conflict (49%) compared to Mafia (14%; Figure 3b; Appendix 2: Table A2). Participants from Mombasa felt that conflict and breach of trust is due largely to lack of trust of leaders and that government funds and concern that donor money to support fishers is embezzled. There was also concern that there is no clear way for the government (or the KWS) to support the communities, and there was a conflict between fishers using different gears. Use of illegal beach seines has caused conflict between the fishers and the government (Kenya Fisheries Service and KWS). Mombasa focal group participants expressed a feeling that the fisheries officers do not understand the local fisheries issues, yet they are responsible for fisheries management. Finally, participants from Mombasa felt that they are not informed or asked to participate in MPA activities. In contrast, participants from Mafia felt that conflicts emanate mainly from people outside the MPA (e.g. the community adjacent to the MPA, Jibondo).

### ***Agency within community and the MPA***

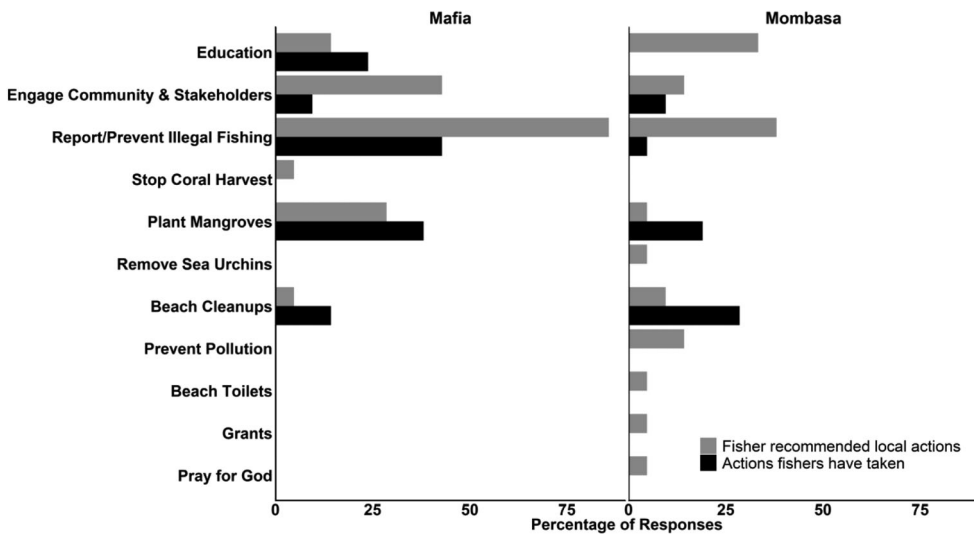
In both sites, perceptions of agency were higher within the community (0.62 for Mafia and 0.64 for Mombasa) than within the MPA (0.42 for Mafia and 0.41 for Mombasa; Appendix



1: Figure A3) but both were in the positive range and scores were similar. There were lower scores regarding control over personal destiny (0.14 for Mafia and -0.24 for Mombasa; Appendix 1: Figure A3(D), Appendix 2: Table A2). Mombasa respondents indicated less influence over decisions within the MPA than those from Mafia (-0.12 versus 0.38; Appendix 1: Figure A3(A)). Focal group participants from Mafia indicated lack of communication and interaction with the MPA as a major barrier to building agency within the MPA. Mombasa focal group participants indicated issues around community members not being willing to attend meetings with the MPA unless they are paid for their time, and mentioned the need for disciplinary decisions to be made jointly with community leaders.

**Knowledge and actions**

Perceived threats to the marine system were focused mainly on fishing, harvest impacts, climate, and pollution (Appendix 1: Figure 4a). There was a relatively higher proportion of fishing community members mentioning pollution in urban Mombasa (67% versus 10% in Mafia), and a somewhat higher proportion of people mentioning destructive fishing methods in Mafia (76% versus 52% in Mombasa). Impacts of fisheries harvest focused mainly on sea urchins in Mombasa (which has been shown to occur when predatory fish are diminished; O’Leary & McClanahan, 2010) and mangrove harvest in Mafia. Suggestions about actions that could be taken to protect the environment were focused on reporting and preventing illegal fishing in both MPAs (especially in Mafia), education, and engagement of community and stakeholders (Figure 5). In Mafia, planting mangroves was also frequently mentioned as an action idea. However, in both MPAs, fewer fishers indicated participating in reporting/preventing illegal harvest than mentioned this as an idea. Further, in both MPAs, many participants indicated the need to engage the community and stakeholders, but few participated in this.



**Figure 5.** Fishing community suggested actions to protect/preserve the environment (light gray) and actions participants have participated in recently (within one year dark gray).

### ***First exchange and focal group discussion on co-management***

At the start of the meeting, the group defined co-management as 'A strategy where the local communities are directly involved with the MPA staff in all the process of management including planning, research and monitoring, enforcement, and decision making.'

In mixed working groups including fishers, fish vendors, and MPA staff from both nations, five pathways emerged the participants felt could enhance co-management:

- Improved communication
- Capacity building (MPA to communities)
- Leadership within communities
- Need for funding (and self-financing)
- Streamlined legal frameworks

Each nation's focal group developed an idea they would pursue over the coming months to attempt to improve co-management. The Mafia MPA group focused on jointly raising awareness in the broader community about the purpose of the MPA and rationale for its regulations through a joint MPA-community committee to increase conservation participation in the MPA. The Mombasa MPA group independently planned the formation of a conservation committee that would increase linkages between the MPA and the fishing community. Neither group arrived at specific projects or issues that they or the proposed committees might tackle, but decided they would present the idea of co-management committees to their respective communities, and return with feedback.

MPA staff brought up the challenge of bringing fishers to meetings if there are not funds to compensate the fishers for their time (e.g. fishers won't come without payment). However, fishing community members proposed that quarterly meetings might be made compulsory. It was also felt that providing an office for the fishing community within the MPA would make it easier for fishers to gather. The Kenyan fishing community participants felt that the BMU's themselves should fund meetings, to reduce that barrier as MPA budgets are often not able to cover this expense. There was also a discussion about politics within communities and BMUs: that some individuals are very influential and subvert attempts to hold meetings with MPA staff. It was felt that holding public meetings frequently (e.g. quarterly) could provide an open opportunity to discuss these issues.

During the first exchange meeting, we took all participants to see the coral reefs and seagrass beds in Mombasa. One key thing participants emphasized is that for many of them (all fish vendors from both MPAs) this was their first chance to ever see coral reefs and seagrass beds. Participants requested that MPAs make efforts to help other community members see the resources MPAs seek to protect.

### ***Second exchange and focal group discussions on options to improve co-Management***

Both MPA communities had a chance to take some initial steps in the 10 days between exchange meetings. Mafia participants spent four days providing feedback to their villages based on the first exchange meeting. The villages expressed strong support for improving co-management and requested continued awareness raising efforts in all 10

villages of the MPA. Villagers asked the team to engage with people during non-fishing hours to ensure maximum outreach. However, the community indicated that MPA staff should always attend the meetings with the new community conservation committee so that they can address issues raised. They also noted that some fishers do not have interest in attending meetings, and that fishers often demand cash to attend meetings. This might be resolved by having an outreach team come to each village. The group felt that it is very important to educate the fishing community, rather than give out cash as past NGOs have done. They feel that cash is not empowering the community, and that education on sustainable management is key. They also indicated that there is a negative influence from local politicians and NGOs, who give false information about the MPA, and that this has been a long-term problem. It was noted that certain NGOs have told fishing communities that the MPA is restricting fishing grounds and this has caused negativity. Increased outreach from the MPA may help clarify some misinformation.

In Mombasa, the participants worked toward establishing a conservation committee. They met with the chairs from all three BMUs and 17 other fishers and shared lessons learned. They developed a procedure and bylaws for the formation of a Conservation Committee. With the BMU chairs, they planned four roles for the Conservation Committee: (1) help KWS in conservation of corals, mangroves, beaches, and sea turtles, (2) help prevent unsustainable gear use through outreach and by vetting members, (3) work with the MPA to enforce regulations, and (4) spearhead community projects. The Mombasa group noted that some fishers and BMU leaders were concerned about the historic relationship between KWS and the fishing community, and felt that this might be a trap. There were initial fears that KWS would use a relationship with fishers as a vehicle to get funds that might not benefit fishers. However, after some discussion, the reception of these ideas was positive, and the BMU leaders wanted to see the ideas expanded further and indicated that this initiative should have been done long ago. The larger group of fishers and BMU leaders suggested that the conservation committee be a place to review violations with BMU members before taking members to court, felt that a committee member should be involved in KWS patrols, and that the community could form a network to help patrol the MPA. They also noted challenges in bringing people together for meetings, largely due to finances. With the larger group of fishers, the team decided to start collecting contributions toward running a Conservation Committee at \$2 USD/person). They stressed the need for representation from every BMU, landing site, and stakeholder group, and the need to have leaders who lead by example.

## Discussion

Co-management of protected areas is intended to incorporate local users' knowledge and produce more effective and equitable solutions to management challenges, while enhancing the legitimacy of regulatory regimes and therefore compliance (Christie & White, 2007; Hoffman, 2009). While MPAs are increasing in number globally, equitable management and inclusively is often assumed rather than tested (Gill et al., 2017). We found that support for MPAs was equally high across the two MPA management systems evaluated, but with perception of MPA benefits much greater in the Mafia system. We did not find evidence that the co-management intent of the MPA system in Mafia was supported by or generated greater adaptive capacity (our hypothesis) and rather found that most

differences in adaptive capacity were likely attributed to geography (urban versus rural communities). Despite major differences in MPA management regime and social geography, neither system is practically operating with inclusive decision making on a regular basis. In both MPA systems, we found that social factors including poor local leadership and barriers to MPA communication, along with low MPA resources for co-management, are deterring effective practice.

### ***MPA support and perceptions***

The attitude of fishing communities toward an MPA can influence how receptive or resistant they are to participatory processes and external interactions (Bennett, 2016; Gelcich et al., 2008; Rydin & Holman, 2004). The level of MPA support was similarly high across the two systems, but with a significantly higher perception of MPA benefits in the Mafia MPA in Tanzania, which contrasts with a prior study earlier in Mafia's history (McClanahan et al., 2008a) showing that heavily fishing dependent communities within Mafia did not perceive MPA benefits. Thus, our finding may represent a perception shift over time. Surprisingly, MPA revenue sharing in Mafia did not surface as a benefit in interviews or focal group discussions. Instead, fishing community members from Mafia cited similar benefits as Mombasa relating to environmental protection, prevention of illegal fishing, and fish stocks. There may be other factors contributing to the higher perceived benefits. Mafia MPA staff frequently cited community engagement as a top priority during focal group sessions. In addition, in Mafia, a much higher percent of fishing community mentors were MPA staff. Agency emphasis on the importance of stakeholder engagement with staff may provide motivation to strongly engage. When this emphasis is absent, it can work in the reverse to decrease trust and perceptions of benefit (e.g. Hoffman, 2009). However, the Mafia fishing community also had a stronger connection to place than Mombasa which could also be associated with care for the local environment and thus perception of MPA benefits.

### ***Social cohesion***

Social cohesion contributes to the development of shared views, perceptions, behaviors, and norms that bring communities together in management (Alexander et al., 2018). High social cohesion can thus reduce transaction costs, facilitate social learning, and build trust in responding to environmental or management change (Ostrom, 1990, 2009). Of the four elements of adaptive management we measured, we found that social cohesion had the greatest difference between the two systems.

As might be expected, rural Mafia had a stronger place attachment than Mombasa and less perceived social conflict. Participants from Mafia felt that conflict emanated from people outside the MPA (e.g. the community adjacent to the MPA, Jibondo or newcomers from urban Dar es Salaam), whereas Mombasa participants indicated that social conflict was from within. The urban nature of the MPA in Mombasa with its reported increase in social conflict and lower attachment to place poses specific management challenges that may be difficult to overcome without significant investment. The Mombasa MPA community is highly diverse both within the fishing community (people from different backgrounds and using different fishing gears) and includes multiple user groups

beyond fishers (tourism operators as well as food and curio vendors catering largely to domestic tourists). In other geographies, challenges in achieving co-management have increased as population and diversity of stakeholders increases (e.g. Hawaii: Tissot et al., 2009). Studies have shown that social identity is linked with effectiveness at sharing of experience, knowledge, and resources (e.g. Alexander et al., 2018; Crona & Bodin, 2006). Living in close geographic proximity can be another driver of social tie formation (e.g. Lusher et al., 2012), and in Mombasa, the presence of multiple groups who do not live together due to the urban nature of the MPA may be reducing social cohesion, with impacts for co-management.

The issue of poor community leadership surfaced in both MPA systems. Community leaders can serve to bring people together for collective action (e.g. Crona et al., 2017) or can be involved in elite decision-making and disproportionately improve their access to benefits (*sensu* Alexander et al., 2018). In both MPAs, there is evidence of elite decision-making. Numerous papers have indicated that bridging actors can help facilitate communication (e.g. Bodin & Crona, 2009; Horowitz et al., 2018). However, there are also cases (like this one) where the community did not feel represented by community leaders leading to increased social tensions (e.g. Mexico, Hoffman, 2009; and Philippines Mudge, 2018). If power asymmetries within the local community are not addressed by the co-management scheme, the most powerful actors can have greater influence on co-management (d'Armengol et al., 2018). Weak community leadership can result from failing to build strong community institutions at the launch of the MPAs (Pomeroy & Berkes, 1997), and this step may have been missed in these MPAs. In nearby Pemba, Mozambique for example, fishers already associated with community or conservation groups had more positive views of spatial closures and other management restrictions (McClanahan et al., 2013).

Trust can play a major role in whether fishers comply with regulations (Hønneland, 2000; Pollnac et al., 2010), and could help managers reduce illegal fishing when resources to apprehend violators are low (Battista et al., 2018). Contrary to our expectations, trust of the MPA staff was similar in centrally-managed Mombasa as in Mafia (designed for co-management). On average, participants from Mafia had much less contact with MPA staff than Mombasa, and this might erode trust despite agency emphasis on co-management. Other co-management studies have also shown that limited communication between stakeholders and MPA staff results in divergent ideas on resource management needs (e.g. Camargo et al., 2009; Horowitz et al., 2018). Enforcement dynamics may also play a role in trust. Mombasa staff are more equipped to make arrests and prosecute violators. This could be a source of tension, but might also provide more confidence in management, given that the fishing community expressed concern over harmful fishing methods.

### **Flexibility**

Flexibility was in the positive range for both MPAs and does not seem to be influencing differences in MPA perception of benefits or MPA interactions. However, it should be noted that the fishing community in both systems expressed some challenges to mobility out of the fishing sector, which can be an important part of adaptive capacity (Cinner et al., 2018). Communities with few options and low flexibility may not be able to

comply with regulations around resource access (McClanahan et al., 2008). In rural Mafia, fishers and fish vendors were less confident trying new things but were more willing to do so than urban Mombasa fishers and vendors, who had low interest in learning new skills. Participants from Mafia reported declining income and no other job options, along with a decline in farming possibilities. In contrast, in urban Mombasa, the fishing community incomes were stable or increasing. From an MPA management perspective, efforts to train fishers in alternative livelihoods are likely to be supported by the fishing community in Mafia and align with fisher interests, but are not likely to serve the Mombasa fishing community or be met with support (despite this being a widely touted strategy to conservation; McClanahan et al., 2008a).

### ***Agency***

We hypothesized that there would be a larger power imbalance in Mombasa with lower agency scores given the top-down nature of patrolling and apprehension of violations. Agency was higher within communities than within the MPA in both systems, indicating room for improvement, but with no clear difference between the MPAs. Thus, agency does not seem to have been impacted by the co-management or top-down MPA design. Achieving greater community agency within MPAs would involve local people as partners in all stages of research and management (Gerhardinger et al., 2009), and this does not seem to be happening in either MPA system.

### ***Knowledge and actions***

Actions recommended by the fishing community far outweighed actions fishers have participated in, with the exception of beach cleanups and education (where more people took action than suggested this as a needed action). MPAs could improve community support of management by directly engaging in areas of community interest. This would likely serve to further boost perceptions of MPA benefits. This seems especially important in Mombasa where fewer fishers mentioned participating in fewer actions. Several of the focal group ideas around improving co-management centered around joint activities in areas of mutual interest.

### ***Prospects for co-management under different management systems***

The ideas generated by the MPA-community teams to improve co-management converged around finances, legal frameworks, communication, capacity, and leadership. Communication, capacity, and leadership link well with processes leading to adaptive co-management (Berkes, 2010): deliberation, visioning, building social capital, trust and institutions, capacity-building, and action-reflection-action loops for social learning. Streamlining legal frameworks is critical at a national level and is one of Ostrom's (1990) design principles, but is likely beyond the scope of individual MPAs and fishing communities. Financial challenges of MPAs appear to be a major barrier to successful co-management in these two systems. Tanzanian MPAs are much larger than Kenyan MPAs (e.g. Mafia is ~800 km<sup>2</sup> compared to Mombasa's 200 km<sup>2</sup>) and are expected to generate their own revenue. They are understaffed for the size of the MPA (e.g. Mafia has ~10

staff compared to ~40 in Mombasa) and have financial challenges reaching dispersed communities (e.g. petrol for vehicles and staff time). Given the restricted budgets of the MPA, supporting the community financially may represent a financial tradeoff that reduces the MPAs capability to effectively integrate community in management decisions. Lack of funding has proved a barrier to stakeholder participation in MPA and fisheries management in other geographies (e.g. Europe; Berghöfer et al., 2008; Hogg et al., 2017) and may be widespread. In Mombasa, communication is much more frequent (monthly communication), but engagement in decision-making and management activities remains low. In both systems, MPA staff also cited major financial challenges in engaging with fishing communities, who tend to require payment to attend meetings or events. This also raises issues about the equity of asking communities to volunteer their time in government MPA managed systems. Globally, MPA staff capacity and adequate budgets were found to be the biggest challenge facing MPAs (Gill et al., 2017).

Given the financial challenges of MPA operation, it is important to identify where collective action is feasible without additional finances. Identifying and acting on areas of shared interest can increase community investment in working collaboratively with the MPA. The fishing community in both Mafia and Mombasa perceived threats to the marine system to be related primarily to overfishing and use of non-sustainable gears. Bringing fishers into the patrol and enforcement system will therefore likely have major benefits. This could help apprehend offenders with less conflict and could allow community participation in the process of determining penalties. Simultaneously, new social norms may develop in the communities (Bennett et al., 2018; Cinner et al., 2018), shifting toward sustainable fishing practices and increased community reporting of violations. Further, the communities are requesting that the MPA provide capacity building. MPA investment in training communities in MPA staff skills (e.g. marine monitoring, enforcement) could help improve trust, connectedness, and provide communities with new ways to participate. This would be especially effective if capacity building also incorporates leadership and organizational culture (McConney & Pena, 2012).

## Conclusions

Co-management can have positive effects on legitimacy of decisions, individual incentives for cooperation, transaction costs, and can develop collective learning capacities (Léopold et al., 2019), but has been challenging to effectively implement. In this case study, there seems to be a positive legacy of the more community-centered approach adopted in Tanzania with higher perception of MPA benefits in the Mafia MPA system, though this may also relate to societal dynamics. However, revenue sharing in Tanzania may come at a cost if it decreases the MPA ability to adequately reach out and integrate communities due to funding shortages. Lack of community social cohesion, which may be more prevalent in urban centers like Mombasa, represents an MPA challenge that could benefit from an explicit MPA management approach with dedicated resources. As MPAs are increasingly established globally, social network analysis could define how management structures and approaches might need to differ in urban settings, and these analyses should be prioritized prior to MPA establishment. Even in systems with relatively high social cohesion (e.g. Mafia), weak community leadership can create gaps between



managers and communities that must be bridged, and both MPA fishing communities demonstrated a strong desire for bridging actors and committees.

We identified some lessons that appear to transcend geography and governance system differences. MPAs should emphasize community engagement, and low-cost methods such as scheduled meetings, mentorship of community members, and management focus on areas of community priority could lead to major benefits. Many fishing community members had never previously been seen the MPAs underwater, demonstrating a large gap in experiential learning that could be addressed with participatory monitoring and enforcement. Investing in community capacity building around leadership is critical for co-management to succeed, and should begin at MPA establishment. Finally, there should be a recognition that co-management requires resources, and MPA systems require greater financial and staffing resources than available in most MPAs (Gill et al., 2017) to make effective co-management a reality.

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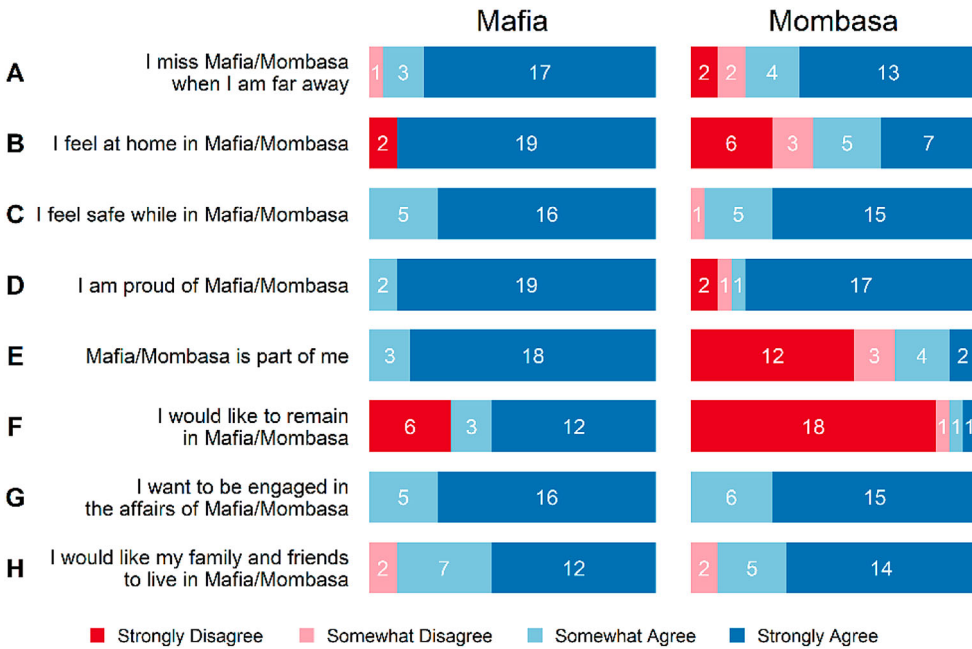
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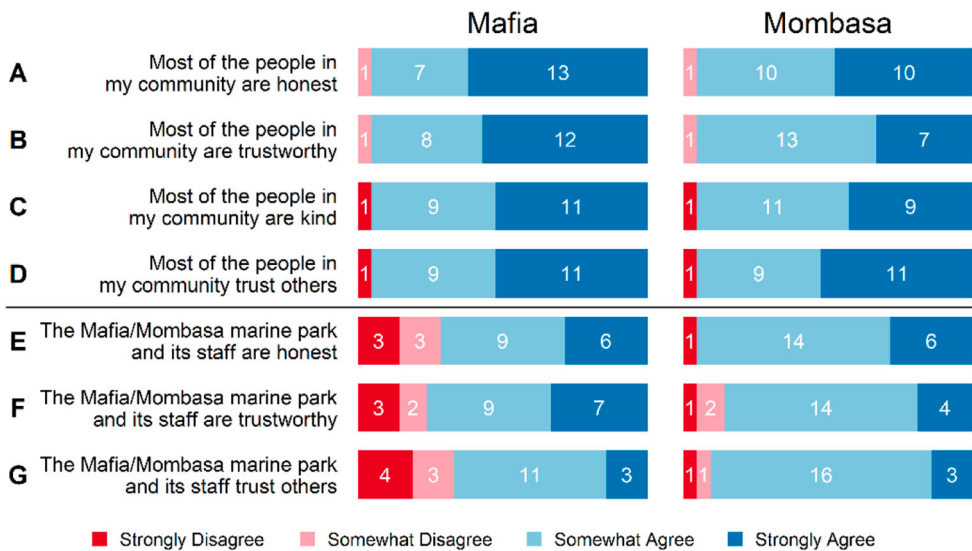


## Appendices

### Appendix 1



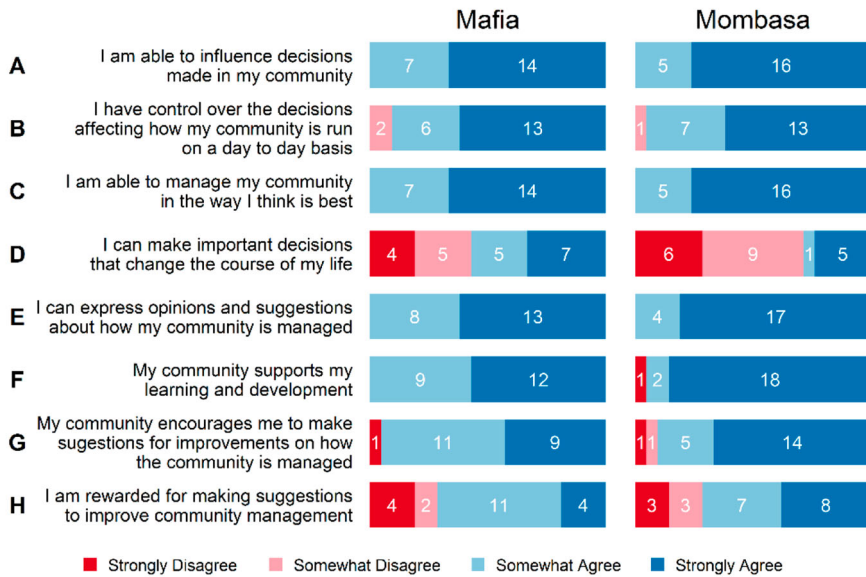
**Figure A1.** Answers to questions on attachment to place (questions 9a – 9h). Numbers indicate number of participants with a certain answer.



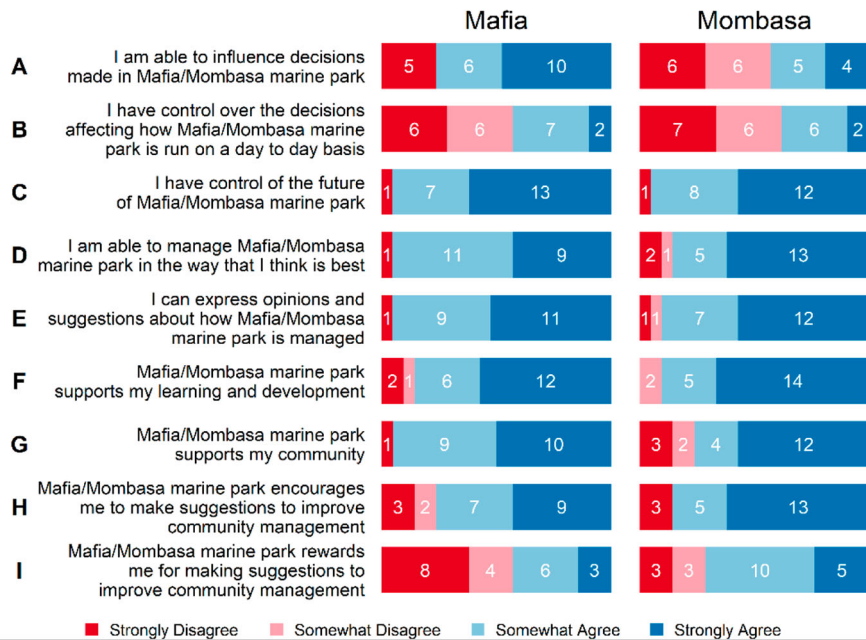
**Figure A2.** Responses to questions on trust of community and MPA. Questions A-D (above the line) are about the community and questions E-G are about the MPA (questions 11a – 11g).



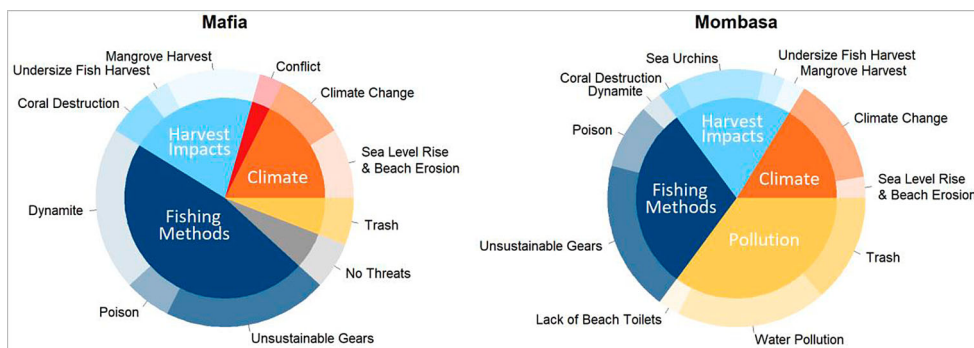
a) Agency in the community



b) Agency in the MPA



**Figure A3.** (a) Responses to eight questions on agency (empowerment) in the fishing community in Mafia and Mombasa: (a) in the community (questions 13a – 13h) and (b) in the MPA (questions 14a – 14i). Numbers indicate number of respondents with that answer.



**Figure A4.** Fishing community perceptions of local threats.

## Appendix 2

**Table A1.** Questions on interaction with MPA, mentorship, and social conflict ( $n = 21$  per MPA per period). Number of respondents is in parentheses following the percent.

	Mafia Island Marine Park, Tanzania	Mombasa Marine Park & Reserve, Kenya
<i>Frequency of Communication with MPA</i>		
Never	19% (4)	5% (1)
Daily	0% (0)	11% (2)
Weekly	10% (2)	21% (4)
Monthly	33% (7)	47% (9)
Quarterly	0% (0)	0% (0)
Yearly	38% (8)	11% (2)
Other	0% (0)	5% (1)
<i>Frequency of Communication with Community</i>		
Never	0% (0)	5% (1)
Daily	5% (1)	33% (7)
Weekly	19% (4)	19% (4)
Monthly	48% (10)	38% (8)
Quarterly	0% (0)	0% (0)
Yearly	29% (6)	5% (1)
Other	0% (0)	0% (0)
<i>Contributed to MPA Decisions (in the last 12 months)</i>		
Yes	38% (8)	24% (5)
Type Decision	Enforcement, outreach	None given
<i>Mentor Identified by Community Members</i>		
Per Person (mean)	2.3	1.7
MPA Staff	23% (of 48 mentors)	6% (of 36 mentors)
Fisher/Vendors	42% (of 48 mentors)	42% (of 36 mentors)
<i>Social Conflict (over marine resources, last 12 months)</i>		
Greatly Increased	0% (0)	14% (3)
Increased	14% (3)	34% (7)
Unchanged	43% (9)	19% (4)
Decreased	29% (6)	29% (6)
Greatly Decreased	14% (3)	5% (1)

**Table A2.** Adaptive Capacity Scores ( $n = 21$  per park).

Composite Question Scores Range: $-1$ – $1$ , $n = 21$ per park	Mafia Island Marine Park, Tanzania	Mombasa Marine Park & Reserve, Kenya
<i>Flexibility</i>	0.49 ± 0.12	0.28 ± 0.17
Confident can get other work	0.31 ± 0.17	0.38 ± 0.17
Interested in new skills	0.98 ± 0.02	-0.36 ± 0.17
More likely to adapt	0.62 ± 0.11	0.64 ± 0.12
No job I would rather do	0.05 ± 0.18	0.29 ± 0.18
Have job options	0.05 ± 0.16	0.21 ± 0.17
Planned for financial security	0.6 ± 0.14	0.64 ± 0.12
Comfortable trying other jobs*	0.43 ± 0.16	-0.48 ± 0.17
Job is a lifestyle	0.88 ± 0.05	0.9 ± 0.07
Attachment to Place	0.79 ± 0.07	0.32 ± 0.23
Proud of	0.95 ± 0.03	0.71 ± 0.14
Feel at home*	0.81 ± 0.13	0.1 ± 0.19
Feel safe	0.88 ± 0.05	0.81 ± 0.08
Miss when away	0.86 ± 0.08	0.57 ± 0.15
Want to be engaged	0.88 ± 0.05	0.86 ± 0.05
Want friends/family here	0.69 ± 0.1	0.74 ± 0.1
Would like to stay*	0.36 ± 0.2	-0.81 ± 0.12
Place is part of me	0.93 ± 0.04	-0.45 ± 0.17
<i>Trust within Community</i>	0.72 ± 0.02	0.66 ± 0.02
Good and kind	0.69 ± 0.1	0.64 ± 0.1
Honest	0.76 ± 0.08	0.69 ± 0.08
Trustworthy	0.74 ± 0.08	0.62 ± 0.08
People trust others	0.69 ± 0.1	0.69 ± 0.1
<i>Trust within MPA</i>	0.26 ± 0.06	0.48 ± 0.04
Honest	0.29 ± 0.16	0.57 ± 0.09
Trustworthy	0.36 ± 0.15	0.43 ± 0.11
Staff trust others	0.14 ± 0.15	0.45 ± 0.1
<i>Agency within Community</i>	0.62 ± 0.1	0.64 ± 0.14
Influence decisions	0.83 ± 0.05	0.88 ± 0.05
Can manage the community as I think best	0.83 ± 0.05	0.88 ± 0.05
Rewarded for suggestions	0.21 ± 0.16	0.33 ± 0.16
Can express opinions	0.81 ± 0.05	0.9 ± 0.04
Have the power to change life*	0.14 ± 0.18	-0.24 ± 0.17
Control of decisions	0.71 ± 0.1	0.76 ± 0.08
Encourages suggestions	0.64 ± 0.1	0.71 ± 0.12
Supports learning/development	0.79 ± 0.06	0.86 ± 0.1
<i>Agency within MPA</i>	0.42 ± 0.12	0.41 ± 0.12
Influence decisions	0.38 ± 0.18	-0.12 ± 0.17
Can manage the MPA as I think best	0.64 ± 0.1	0.62 ± 0.14
Can express opinions	0.69 ± 0.1	0.67 ± 0.12
Control over future	0.74 ± 0.1	0.71 ± 0.1
Control over decisions	-0.17 ± 0.16	-0.24 ± 0.16
Encourages suggestions	0.4 ± 0.16	0.6 ± 0.15
Rewarded for suggestions	-0.19 ± 0.17	0.26 ± 0.15
Supports learning/development	0.6 ± 0.14	0.74 ± 0.1
Supports my community	0.68 ± 0.1	0.48 ± 0.17

Notes: Mean index scores ( $\pm$ SE) are given at the category level, with index scores at the question level. Index scores for questions with asterisks (\*) were inverted (e.g. 'I feel at home in Mafia/Mombasa' was originally asked as 'I feel like a foreigner in Mafia/Mombasa').

**Table A3.** Results of Student's  $t$ -tests comparing index scores between parks.  $P$ -values are adjusted for multiple comparisons using the Benjamini & Hochberg method.

Category	Mafia	Mombasa	$T$	df	$p$
Agency in Community	0.62 ± 0.1	0.64 ± 0.14	-0.09	14	0.97
Agency in MPA	0.42 ± 0.12	0.41 ± 0.12	0.04	16	0.97
Attachment to Place	0.79 ± 0.07	0.32 ± 0.23	2.03	14	0.12
Employment Flexibility	0.49 ± 0.12	0.28 ± 0.17	0.99	14	0.51
Trust of Community	0.72 ± 0.02	0.66 ± 0.02	2.36	6	0.12
Trust of MPA	0.26 ± 0.06	0.48 ± 0.04	-2.89	4	0.12