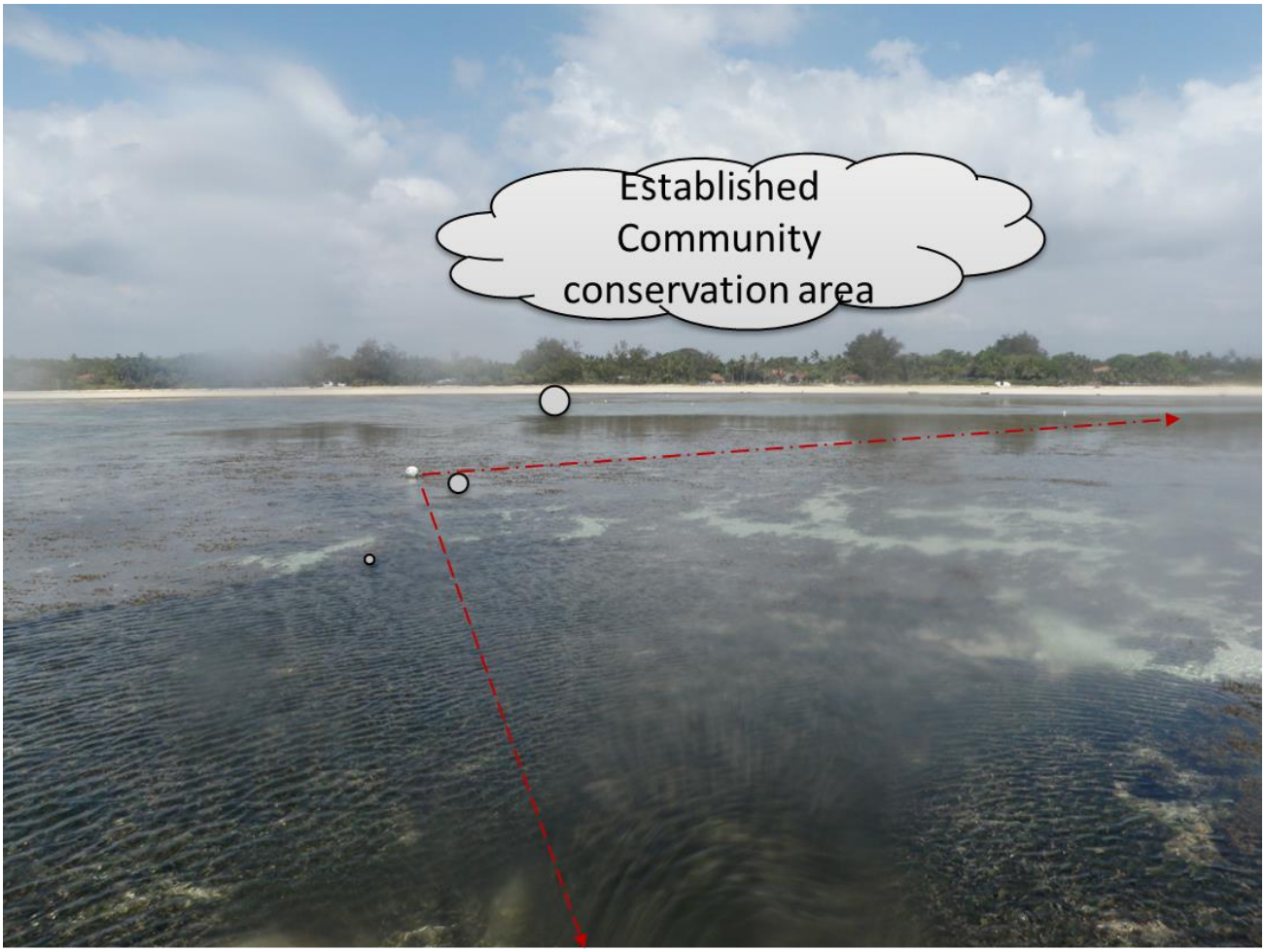

Participatory assessment of the effects of community conserved areas (CCAs) on coral reefs to support enhanced adaptive management practices

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Abstract

Coastal communities in Kenya are highly dependent for food and livelihoods on coral reefs, yet these ecosystems are especially vulnerable to damage due to over exploitation and use of destructive and unsustainable fishing methods. Community conservation areas (CCAs) have gained increasing favour and efforts have been at the forefront of establishing them as means of protecting coral reef's biodiversity and enhancing associated target fisheries. However, it is important to assess the impact of such community-based management tools and to demonstrate their benefits to local people involved in such endeavours. The study undertook participatory underwater surveys within and outside CCAs, in order to evaluate their performance with regard to conserving biodiversity, particularly target fisheries.

Overall, the effect of CCAs on biodiversity and target fishery species was more pronounced at only two CCAs (Iweni and Kuruwitu), with older CCAs set on desirable reefs (i.e. high coral cover) performing better than younger ones set at habitat with less coral cover. This study shows that CCAs effectiveness is likely dependent on a suite of factors, particularly age and size of delineated area. It has also provided evidence in favour of the continued support of CCAs in Kenya and other parts of East Africa region. This participatory research project has been successful in terms of building monitoring and management capacity, increasing key stakeholders buy-in and stewardship needed to ensure CCAs initiatives achieve their desired objectives.

Keywords: Adaptive management, community conserve areas (CCAs), Coral reef, reef fish and Kenya

Introduction

Coral reefs are an essential component of the ecological system providing important geophysical functions of shoreline stabilization and prevention of damage from ocean waves, and their high biodiversity and productivity makes them the target of many coral reef-related activities (i.e. artisanal, commercial fishing and tourism)(Obura and Mwaura 2001,,Obura *et al*., 2002). Artisanal fishing is one of the main activities carried out by Kenyan coastal communities particularly in coral reefs and associated ecosystems. However, these ecosystems are especially vulnerable to damage due to over exploitation and use of destructive and unsustainable fishing methods (Obura *et al*., 2002; McClanahan and Mangi 2004; Mangi and Roberts 2006). Overexploitation is widely acknowledged as the primary cause of reef fish population declines (Newton *et al*., 2007) as well as a principle threat to coral reef diversity, structure, function and resilience (Jackson *et al*., 2001). There is thus a need to develop and advance viable solutions to effectively manage and sustain coral reef fisheries and their linked human communities. This requires going beyond problem identification and towards exploring a diversity of potential solutions and their efficacy in different social and ecological contexts (McClanahan 2011).

No-take marine reserves, areas where all forms of resource extraction are permanently banned, have widely advocated as a precautionary, pragmatic management tool for protecting marine biodiversity, habitat, fisheries and ecosystem services (e.g. NCEAS, 2001; Palumbi, 2002; United Nations, 2002). Kenya has used MPAs as a conservation tool for over four decades, with nine national marine parks and reserves established between the late 1960s and the Mid 1990s covering an estimated 10.4% of territorial waters (Samoilys and Obura 2011). Although Kenya's established MPAs have proven effective in restoring fish abundance (Watson *et al*., 1996; McClanahan *et al*. 2007), their establishment was largely a top-down approach with minimal community involvement leading to some resentment and opposition from the adjacent communities dependent on the marine resources contained within them (Obura 2001; McClanahan *et al*., 2005).

New initiatives including co-management in form of community conserved areas (CCAs) are being embraced by many coastal communities along Kenyan coast to support conservation and management of coral reefs in unprotected areas (Murage *et al*., 2010; Maina *et al*., 2011). They are relatively new and evolving community-based management system over the last six years within a changing legislative context in which the Government of Kenya has

been encouraging co-management of coastal and marine resources (Samoilys *et al*., 2011). Globally, CCAs are well known from the pacific with their origins in Fiji in the early 1990s where they are popularly called local marine management areas (LMMAs (Govan *et al*., 2008; Sivo 2011). Their proliferation in recent decades reflect the widespread understanding that effective management of coral reefs in developing nations is only possible with buy in and support from local communities (Alcala and Russ 2006; Pollnac *et al*., 2006). The original CCA initiative in Kenya started with Kuruwitu in 2006 and a number of them are increasingly set up along the coast as tools for protecting coral reefs while increasing the social and ecological benefits. CCAs are being established by setting aside a designated area that was previously used as fishing grounds for protection. Concurrent with the interest in establishing CCAs has been a growing '' awareness raising'' and information to those affected by the loss of communities needs towards their establishment and socio-political and environmental factors affecting their success to achieving desired goals.

Demonstration of the effects of CCAs through participatory research can represent an imperative approach that can help generate valuable social and ecological information on natural resource systems and advance stakeholder engagement and other social processes that are believed to be important pre-requisites for successful co-management arrangements (Chuenpagdee *et al*. 2004, Wiber *et al*. 2004; Karisa *et al*., 2011).

Study goal and objectives

The main aim of this study was to use fish population count data from seven community conservation areas located along Kenya coast, in order to understand the impacts community-managed protected areas have on economically important fish populations.

The specific objectives

1. Test the performance of community conservations areas by comparing reef fish populations within and outside protected conditions.
2. Understand how performance of community conservation areas is affected by various attributes such as size and age of closure**.**
3. Facilitate education and awareness towards enhancing adaptive management practices and policies in support of CCAs.

Methods

Study sites: The study was undertaken within and around seven community-conserved areas (Wasini, Kibuyuni, Mwarembo, Mradi, Bureini, Kuruwitu and Iweni-Lamu) located along the coast of Kenya(figure 1). The CCAs are primarily set on patch reefs located 0-1500m from shoreline. CCAs are basically rectangular in shape and vary in age of protection/closure (1-6 years) and size (from 5.2 to 100 ha.). All the CCAs were established by local communities in consultation with Fisheries authorities, Conservation donors, and are managed either by community based organisation (CBOs) or each management unit (BMU) committees.

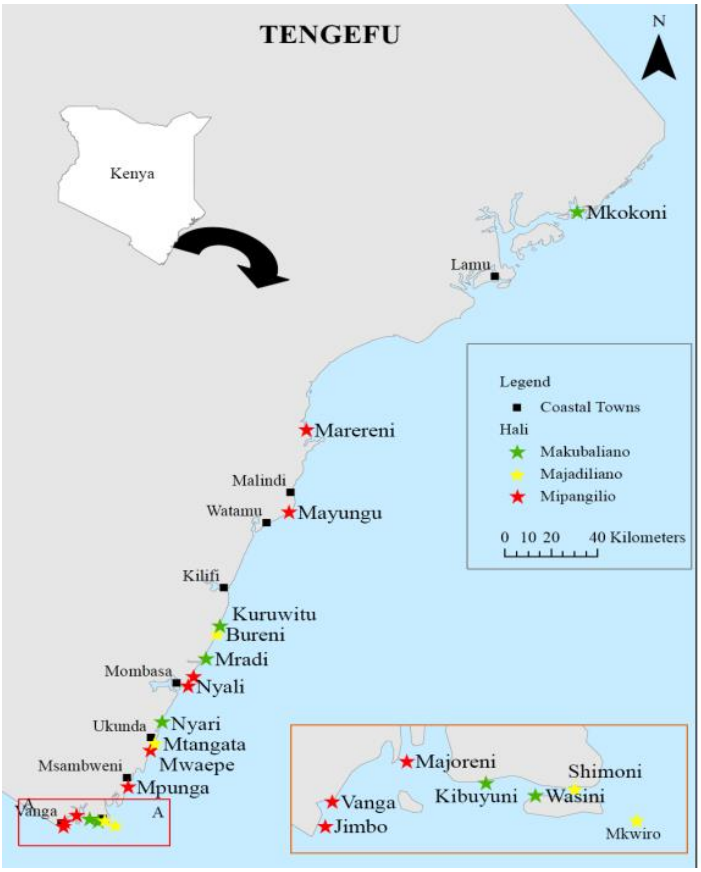


Figure 1. Map of Several CCAs locally known as ''Tengefu'' established along the Kenya coast. Different colours indicate the level stage level of development: Green (fully established and operational); Yellow (established but not yet operational); Red (either established and later collapsed or not yet established).

Table 1. Seven community-conserved areas surveyed: county governing area, total area, year established and level of management effort.

Community conserved Area	Kibuyuni	Wasini	Mwarembo	Bureini	Mradi	Kuruwitu	Iweni
County	Kwale	Kwale	Kwale	Kwale	Kilifi	Kilifi	Lamu
Total area (ha.)	27.5	31	0.22	5.2	12.5	29	100
Year established	2010	2008	2011	2010	2009	2006	2010
Management level	medium	high	low	low	low	High	high

Data collection

The underwater biodiversity is conducted with full participation of trained community members from each of the selected CCA.

Middle photo-Seated at the front: Mr. Jelvas Mwaura (holding two slates), with Mr. Famau (Group project manager). Seated behind; Dishon Murage (Red-black T-shirts), is assisting in documenting CCAs management status and next to him is Mr. Atwa, who is the county minister for Fisheries in Lamu.

Reef benthic assessment

At each site, the cover of coral and other benthic cover types was quantified using four replicate 25-m transects. Once the transect lines were laid on the reef bottom, an observer swam slowly over the transect and recorded the lifeforms that encountered under the tape. Corals and other benthic cover types were identified to the lowest taxonomic level possible.

Photo 4: Mr. Katana Ngala (trained community member from Kuruwitu) is helping out count and record fish along a 50m belt transect line.

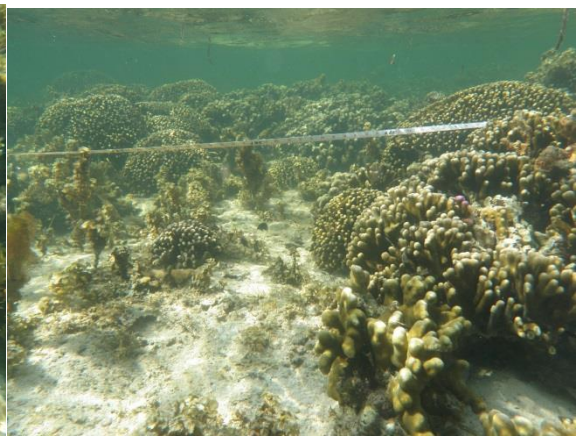
Fish surveys

Fish surveys were done using 50m × 5 m belt transects giving a total area of 250m^2. Four replicate transect were laid in representative habitats at each site. In order to minimize the effects of deploying transects on fish activity, at least two minutes were taken after the transect line had been laid and before counts commenced, with observers backing away from the end of the transect line to allow fish to settle. The observer swam slowly along transects, counting all target species within 2.5 m on either side of the transect tape.

Table 2. Fish family surveyed with their common name, and their status as fishery targets for food and relative financial value

Family	Common name	Target	Value
Acanthuridae	Surgeonfish	Target	Medium
Chaetodontidae	Butterfly fish	Non-target	low
Haemulidae	Sweetlips	Target	High
Holocentridae	Soldierfish	Non-target	Medium
Labridae	Wrasse	Non-target	Medium
Lethrinidae	Emperor	Target	High
Lutjanidae	Snapper	Target	High
Mullidae	Goatfish	Target	High
Pomacanthidae	Angelfish	Non-target	Low
Pomacentridae	Damsel	Non-target	Low
Scaridae	Parrotfish	Target	Medium
Serranidae	Groupers	Target	High
Siganidae	Rabbitfish	Target	Medium
Scorpaenidae	Scorpionfish	Non-target	low
Balistidae	Triggerfish	Non-target	Medium

Benthic habitat inside CCAs



Benthic habitat outside CCAs

Overall effect of CCA age to target fish species: Inside vs outside areas

Overall, we found that target fish species were substantially higher inside CCAs than distant outside areas. In particular, the older CCAs showed high abundance of target fisheries resources.

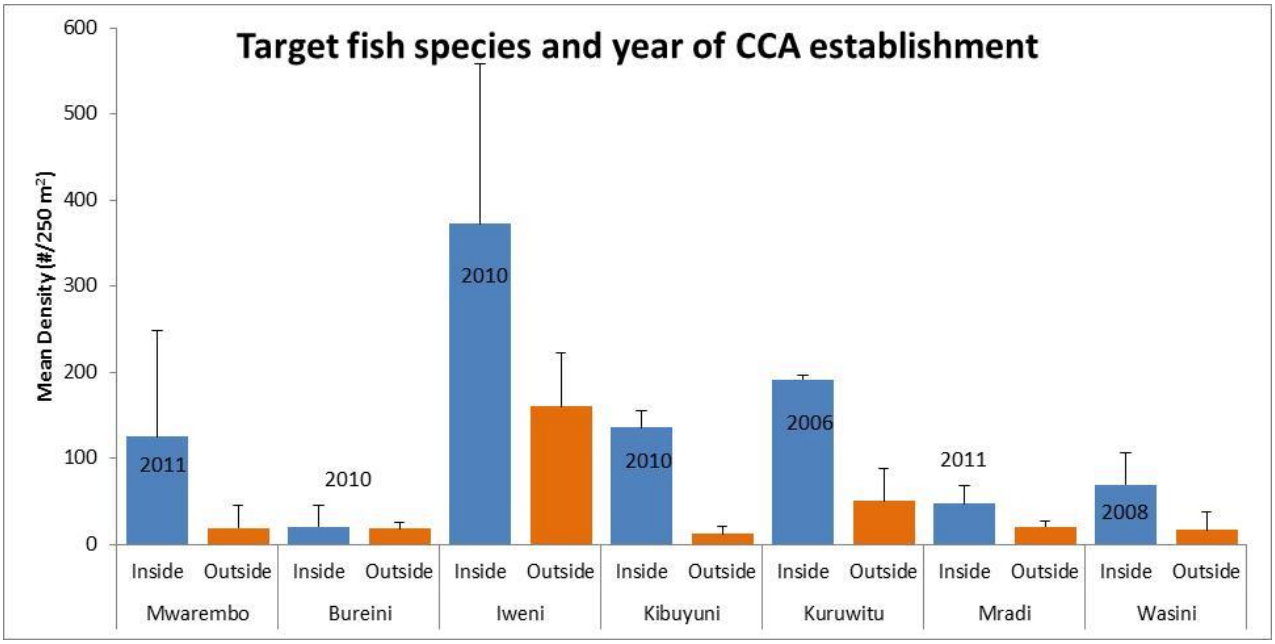


Figure 2. Mean abundance of target fish communities from seven community-conserved areas (inside and outside).

Overall effect of CCA size to target fish species: Inside vs outside areas

Two CCAS-Iweni and Kuruwitu- harboured substantially more of target fish than their distant outside CCA areas. These two CCAs are older than the rest.

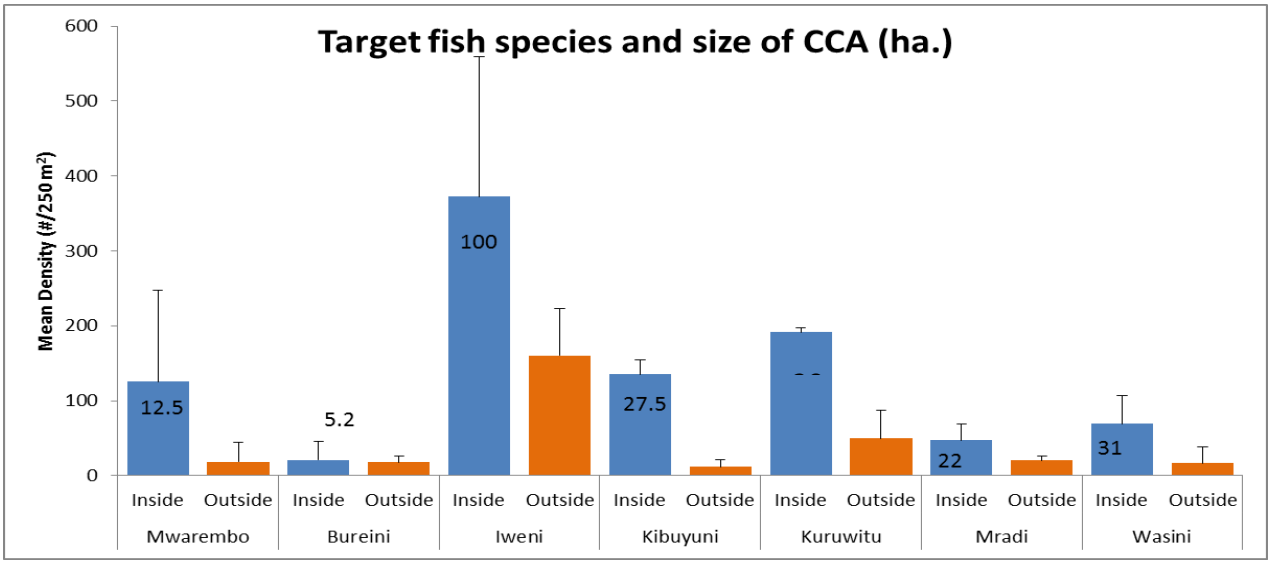


Figure 3. Mean abundance of target fish communities from seven community-conserved areas (inside and outside).

Coral cover

Average coral cover did not differ substantially among CCAs but was shown to be low in areas outside CCAs. According to widely accepted coral reef health criteria, live coral cover (LCC) is used as a health indicator of coral reefs (Brown, 1988). Reefs were evaluated according to their linear percentage coverage such that only those reef with >75% live coral cover are considered to be excellent health condition. Reefs with 50-75% live coral cover are considered to be in "good" health condition; with 25-50% live coral cover in "fair" condition; and those with < 25% live coral cover, in "poor". According to this classification, the reefs within CCAs fall under the category of fair condition(25%-50%) whereas reefs outside CCAs are in poor health condition, with an average live coral cover (hard coral (HC) of < 25%.

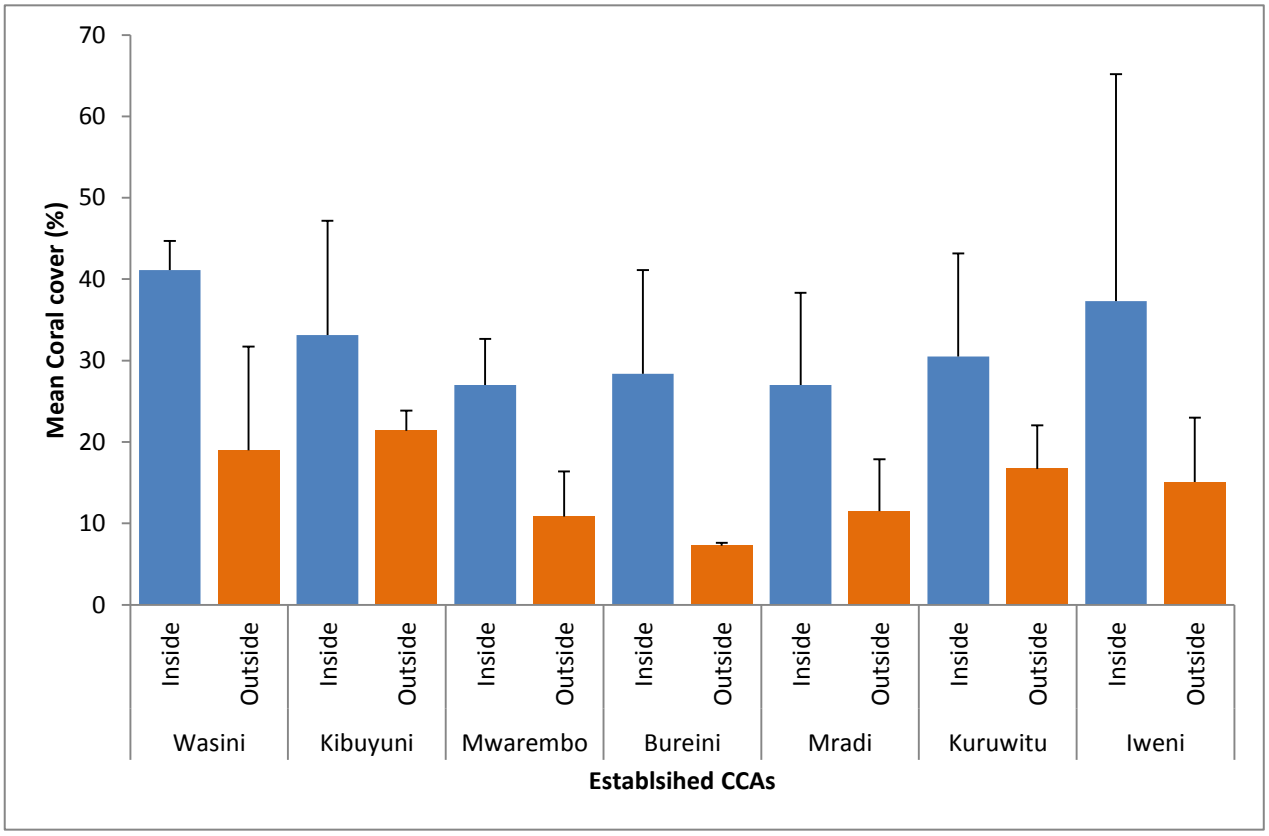


Figure 4. Mean percentage cover of hard coral from seven community-conserved areas (inside and outside).

Discussion

This study provides empirical evidence of the beneficial effects of community-managed marine reserves in form of community-conserved areas for target fish species taken by local fisheries and coral cover, but also shows that effects vary considerably due to some important variables. The overall higher abundance of target fish species inside CCAs supports previous studies demonstrating abundances increases of predatory fish in response to protection (McClanahan and Arthur 2001; Russ and Alcala 2004; Russ2005; Ormond, 2005). Top trophic species such as groupers, sweetlips and snappers are thought to respond well to protection as they are highly vulnerable to fishing pressure due to their commercial value. This study also indicates that top-trophic level fish within larger CCAs have a higher positive impact to protection than fish within smaller CCAs. Overall, CCAs effects were most apparent with target fish species and coral cover, suggesting that cessation of direct fishing mortality and protection of habitat from destructive practices were important to recovery of economically important fish communities.

Conclusion

In conclusion, this participatory resource assessment provides support for the beneficial impact of community-conserved areas on target fish communities in Kenya, and forms a clear message to feedback to the local communities who are ultimately affected by potential degradation of fishing grounds if exploited unsustainably. The study has also shown that effectiveness of community-conserved areas on fish communities may be dependent on a suite of variables, particularly the age and size of delineated area. it is expected that empirical evidence observed and shared at the dissemination workshop should inform the translation of improved practices to the management of community-conserved areas in Kenya and will be applicable across East Africa region. In addition, this participatory research provides useful information needed to improve knowledge and awareness on issues facing coral reefs among decision makers, management authorities, donors and the communities that depend on them. This should ultimately strengthen continued support in the process of institutionalization and formalization of community-conserved areas as effective methods towards better conservation of reef biodiversity and enhanced targeted fisheries.

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