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Early steps for successful management in small-scale fisheries: An analysis of fishers', managers' and scientists' opinions preceding implementation

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ABSTRACT

This study analyzes fishers', managers' and scientists' opinions on management measures to facilitate the initiation of management processes towards more sustainable small-scale seagrass fisheries in Zanzibar, Tanzania. The results show that most fishers and managers agreed on the need to include seagrasses specifically in future management. There was further agreement on dragnets being the most destructive gears, and the use of dragnets being a major threat to local seagrass ecosystems. Gear restrictions excluding illegal dragnets were the favored management measure among fishers. Differences between fishers and managers were found concerning seaweed farming, eutrophication and erosion being potential threats to seagrass meadows. A majority of the interviewed fishers were willing to participate in monitoring and controls, and most fishers thought that they themselves and their communities would benefit the most from establishing seagrass management. Co-managed gear restrictions and the inclusion of different key actos in the management process including enforcement are promising starting points for management implementation.

1. Introduction

To maintain, or ideally to improve people's livelihoods by sustainably managing the resources they depend on, is one of today's biggest challenges. The degradation of marine resources due to intense fishing pressure and the use of non-sustainable gears is a global concern (Jackson et al., 2001; Myers and Worm, 2003; Berkes et al., 2006). However, in fisheries management, the positive outcomes managers strive for when designing protected or restricted areas are often not reached after implementation (McClanahan, 1999; Pitcher and Lam, 2010). It has been highlighted that participation of fishers in planning, decision-making and governance is crucial for the success of management schemes which restrict access to fishing grounds (Jentoft and McCay, 1995; Jentoft et al., 1998; Berkes, 2009; Jentoft et al., 2012). Further, perceptions and common values and goals among stakeholders and resource users have been pointed out to be of highest importance for sustainable management (McClanahan et al., 2005b; Gelcich et al., 2006; Gelcich et al., 2007). The chances of management to be successful increase when fishers and managers share preferences for certain management measures and cooperate on their implementation (Jentoft et al., 1998; Defeo and Castilla, 2005), and shared attitudes can improve compliance and reduce the costs of enforcement (McClanahan et al., 2004). These attitudes, perceptions and actions which fishers and managers share or which deviate from each other, are in turn based on values, images and principles which shape their worldviews (Song et al., 2013). The more diverse the stakeholders' and managers' images are, the more complex to govern are the fisheries (Jentoft et al., 2012). In many cases, the images and perceptions of resource users may deviate substantially from those of managers, which can lead to misunderstandings, confrontations and even challenge the overall governability of a fishery system (Jentoft and Chuenpagdee, 2009; Song et al., 2013). Attitudes to management can also differ between and within groups of fishers, for example with varying management experiences (Gelcich et al., 2005) or between different gear users (Blyth et al., 2002; de la Torre-Castro and Lindström, 2010). In such situations, it is valuable to explore the priorities of the different stakeholder groups, which can build respect and trust and can help to identify areas of agreement (Hicks et al., 2013). Therefore, the assessment and comparison of perceptions and opinions is a constructive first step towards communicating, rationalizing and bringing them into convergence for implementation (McClanahan et al., 2005b; McClanahan et al., 2009; Jentoft et al., 2012).

Most studies on attitudes and perceptions of resource users are conducted *after* new rules or restrictions already have been implemented.

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However, studies of fishers' and managers' opinions preceding management implementation can be a valuable first step, as they might help to decide how to proceed and may be decisive for the outcome of the management process (Chuenpagdee and Jentoft, 2007).

Seagrasses fulfill a key role in the marine environment (e.g. Short and Green, 2003) and the global importance of seagrass-associated small-scale fisheries as social-ecological systems has recently been highlighted (Cullen-Unsworth et al., 2014). This study was conducted in Zanzibar, Tanzania, where seagrass-associated fisheries play an explicitly important role for the livelihoods of local communities (Gullström et al., 2002; de la Torre-Castro and Rönnbäck, 2004; Nordlund et al., 2010). For certain fishing communities in Zanzibar, seagrasses have even been shown to serve as the most frequently visited fishing grounds (de la Torre-Castro and Rönnbäck, 2004; de la Torre-Castro et al., 2014). Despite their importance for local livelihoods, seagrass ecosystems receive only little attention in research, management and policy compared to other marine habitats (Duarte et al., 2008). Recent studies emphasize the need for an inclusion of all key ecosystems in coastal management and explicitly seagrasses and their social dimensions (Unsworth and Cullen, 2010; de la Torre-Castro et al., 2014). In Zanzibar, current management efforts of marine resources appear to focus on the protection of corals for tourism benefits rather than fish provision services (de la Torre-Castro, 2012b), and there are to the authors' knowledge currently no national laws, rules, regulations or management plans focusing on or including seagrasses specifically.

The background of Zanzibar's small-scale fisheries is, among other factors, shaped by weak resource user participation in management, low compliance, negative experiences from past management efforts, lack of seagrass-specific incentives and newly planned efforts on monitoring and enforcement. We consider the need for improved management in the area, and act on the assumption that management is more likely to be successful if resource users support it. Consequently, the main objective of this study is to assess agreements as well as differences in fishers' and managers' attitudes and opinions towards management of seagrass-associated small-scale fisheries *a priori* rather than after management implementation. We identify areas of congruence and/or disparity between fishers' and managers' views, which can contribute as a basis for communication among stakeholder groups, which in turn enables the process of reaching equitable solutions for future seagrass management. The four specific aims were to assess and compare the fishers' and managers' opinions concerning i) the importance, current state and eventual need for management of local seagrass ecosystems, ii) the present threats to seagrasses and measures to lessen them, iii) the readiness of fishers to adopt different management measures and iv) the fishers' willingness to participate in monitoring as well as the perceived distribution of benefits of seagrass management. The results of this study contribute insights for a valuable step towards the co-management of seagrass fisheries in Zanzibar, where fishers are not only at the receivers' end, but are active players in the implementation and preceding steps (Chuenpagdee and Jentoft, 2007).

2. Methods

2.1. Study site description

The data was collected in Unguja Island in the Zanzibar Archipelago, situated ca. 50 km outside of Tanzania (hereafter referred to as ‘Zanzibar’). Typical for Zanzibar's coastlines are shallow lagoons with coral reefs, seagrass beds and in certain areas mangrove forests. As in coastal East Africa in general, small-scale fisheries are of highest importance as a source of food and income for Zanzibar's population (Jiddawi and Öhman, 2002; DoFD, 2010; de la Torre-Castro, 2012a; Thyresson et al., 2013). In Tanzania including Zanzibar, 95% of all marine catches originate from small-scale fisheries (Jiddawi and Öhman, 2002), and a big part of Zanzibar's population is directly dependent on fisheries resources (DoFD, 2010). Many fishers are marginalized and live close to the extreme poverty line of US$ 1.25 per day (de la Torre-Castro et al., 2014). Local finfish-fisheries employ roughly 34,000 people, the majority of which are men, are predominantly low-tech and generate low income (Jiddawi and Khatib, 2007; DoFD, 2010; Frocklin et al., 2013). Due to the dominance of low-technology gear and non-motorized fishing vessels, most fishers operate in shallow inshore waters at patchy and fringing coral reefs and seagrass beds, resulting in a heavy fishing pressure on these ecosystems (de la Torre-Castro et al., 2014). Typical fishing vessels used are dugout canoes, outrigger canoes or wooden boats with sails but also engine-driven wooden boats or fiberglass boats are used to some extent (Jiddawi and Khatib, 2007). A high variety of fish species is targeted and fishing gears used are mainly of traditional character (including ‘madema’ basket traps, smaller nets and handlines), but also more modern gears are used (like larger gillnets, beach seines or spear guns (DoFD, 2010). The fish catches are used for own consumption as well as sold to local markets and fish traders, restaurants or hotels (Thyresson et al., 2013). Fisheries related activities like processing and trading employs another 2900 people (Lange and Jiddawi, 2009), whereof many women (Frocklin et al., 2013).

In many areas of Zanzibar's coast, local fishing communities used traditional systems for self-regulation to avoid overexploitation (Jiddawi, 1998). Due to population growth, migration, few employment opportunities, growing tourism and the open access fisheries character however, the demand for marine resources is growing and signs of overexploitation of near-shore ecosystems have been reported (Tobisson et al., 1998; Jiddawi and Öhman, 2002). The use of destructive gears like dragnets and nets with small mesh-sizes (which dragnets often are) endangers, among other factors, a sustainable provision of marine resources due to their damaging effect on habitats like seagrasses and corals or catches of undersized fish (McClanahan and Mangi, 2001; Jiddawi and Öhman, 2002; Mangi and Roberts, 2006). The fishing communities in Zanzibar are heterogeneous e.g. in terms of used fishing gears or attitudes and opinions concerning the government (Lindström, 2012). As managing small-scale fisheries is a complex endeavor (Jentoft and Chuenpagdee, 2009), shortcomings in local fisheries management have also been described for Zanzibar (de la Torre-Castro, 2012a; Lindström, 2012). These are for example illustrated in the use of illegal gears or conflicts over gears and fishing grounds in certain areas (de la Torre-Castro and Lindström, 2010). De la Torre-Castro (2012b) describes that the “dominating focus on conservation, the lack of a holistic approach and failure to consider resource users seriously” have led to unsuccessful management, and that current management plans often miss the context of poverty and resource dependency. Promising approaches for the management of such small-scale fisheries have been suggested to be the seascape approach in combination with co-management and ecosystem stewardship, and a focus on resource users as central actors (Chapin et al., 2010).

In Zanzibar's National Integrated Coastal Management (ICM) Strategies, an emphasis is put on community involvement in fisheries management (ICM, 2003). For the time being however, the communities' participation is mainly regulated in top-down fashion (Lindström, 2012) rather than through self-organization and –mobilization which has been emphasized as an essential starting point for successful fisheries co-management (Chuenpagdee and Jentoft, 2007). However, de la Torre-Castro and Lindström (2010) describe cases of self-organization, but on the purpose of defending fishing gears, fishing grounds and fishing rights in times of conflict rather than to act for environmental conservation. Beach recorders, called “Bwana Dikos” in local Swahili, are monitoring agents and build, together with village fishery committees, the links to higher levels of organization like the government and its' ministries and agencies or to international organizations (de la Torre-Castro, 2006; Lindström, 2012). These local committees representing local people on village level have however been described as to be to a substantial part creations of the government and international organizations (Lindström, 2012), and it can be

Fig. 1. Zanzibar (Unguja Island) and the study sites.

questioned to which degree they are able to independently defend the communities' interests and/or serve as extensions of the law (de la Torre-Castro, 2006).

2.2. Interviews

The data collection was conducted between November–December 2013, and was based on a triangulation of methods to collect both quantitative and qualitative data. The methods comprised interviews with individuals representing three groups: fishers, managers and scientists. Further, fishery-related activities at landing sites and fish markets were observed. A total of 108 fishers were interviewed at seven different landing sites/villages in Zanizbar (Fig. 1): Mkokotoni (n = 17), Kivunge (n = 16), Fukuchani (n = 14), Kendwa (n = 15), Unguja Ukuu (n = 29), Uzi Ngamb'wa (n = 3) and Marumbi (n = 14). With the help of local monitoring agents (beach recorders, “Bwana Dikos”) fishers were informed about the purpose of the study, and those willing to participate were interviewed after giving oral consent. Semi-structured interview guidelines (Kvale and Brinkmann, 1997; Denscombe, 1998) were used, comprising information on demography, fishing practices, income, livelihood preferences, seagrass state and -importance, seagrass threats and -management suggestions, and information concerning fishery legislation, monitoring and compliance. Questions included in the questionnaire were both of open character (e.g. concerning the fishers' own suggestions of seagrass threats and -management) as well as more specified (e.g. concerning the fishers' attitudes on given seagrass threats or management measures). Based on literature from the area, the suggested threats to seagrasses included in the questionnaire were: dragnet fishing, eutrophication, pollution, erosion/sand mining, turbidity, seaweed farming, sea urchin overgrazing and trampling (Gullström et al., 2002; Jiddawi and Öhman, 2002; Eklöf et al., 2006b; Nordlund et al., 2010; Nordlund et al., 2014). Based on literature concerning gear management in Kenya, where closed areas, restrictions on gears and fish size regulations were described as among the most suitable for management (McClanahan and Mangi, 2001; McClanahan and Mangi, 2004), the six management measures suggested in this interview guideline were: no take zones, temporary closures, gear restrictions (meaning the exclusion of dragnets), mesh size restrictions (meaning the exclusions of nets with a meshsize smaller than the legal size of 1.5 in. (RGZ (Revolutionary Government of Zanzibar), 1993), minimum fish size restrictions, and education e.g. on the socio-economic as well as ecological effects of different fishing gears. The fishers were given color illustrations of the different seagrass threats, fishing gears and management measures to facilitate understanding of these more complex questions. All interviews with fishers took place at fishery landing sites or at public meeting points in the villages and were conducted in Swahili with translation services of local interpreters. Answers were noted in the interview guidelines, and later coded for data analysis.

Further, all available managers and scientists were interviewed: eight managers from the Department of Fisheries Development and Marine Resources (Ministry of Fisheries and Livestock Development) and one manager from the department of Environment; five scientists with expertise concerning marine habitats, seagrass and/or fisheries from the Institute of Marine Science (University of Dar es Salaam). An initial inspection of the data showed general similarities in the answers of scientists and managers. Due to this similarity as well as the low numbers of respondents in the managers and scientists groups, these two groups were pooled into one manager/scientist group for data analysis. The interview guidelines covered the same questions concerning seagrass state- and importance as well as seagrass threats and –management. Additionally, questions concerning compliance, monitoring and gear exchange were included.

2.3. Data analysis

To analyze the data quantitatively, the answers were transcribed from the interview guidelines and coded into answer groups. The Fisher's exact test was used to test for statistical differences between groups of respondents: a) between manages/scientists and trap- and dragnet fishers; b) between managers/scientists and all fishers; and c) between trap- and dragnet fishers. The statistical analyses were performed using Stata version 13, considering p-values of < 0.05 as statistically significant. A compilation of the results of all statistical tests can be found in Appendix A. The qualitative data derived from the interviews was pooled in different answer groups, compiled after topic and summarized as percentages of respondents.

3. Results & discussion

3.1. General fishing information

The interviewed finfish fishers were all men, since few women are involved in the harvesting activity (Frocklin et al., 2014). Their age ranged from 18 and 80 years, with a median of 61.5 years. Fishing experience varied from 0.5 to 69 years, with a median of 30.25. All respondents mentioned fishing to be their main occupation, but many had other occupations besides fishing, including farming and carpentry. The main fishing gears used were basket traps (56%; n = 108), dragnets (40%), gill nets (17%), ringnets (5%) and spearguns (2%) (multiple mentions were allowed as some fishers used different main gears depending on season). Eighty-five percent of the fishers mentioned to generally fish on seagrasses, and as many on corals. Fourty-six percent mentioned corals as their mostly used substrate to fish on, followed by 35% mentioning seagrasses.

3.2. Seagrass importance, current state and protection suggestions

All fishers (n = 108) and managers/scientists (n = 14) mentioned seagrasses to be important. This is concordant with earlier social-ecological studies from Zanzibar, which highlight the contributions of

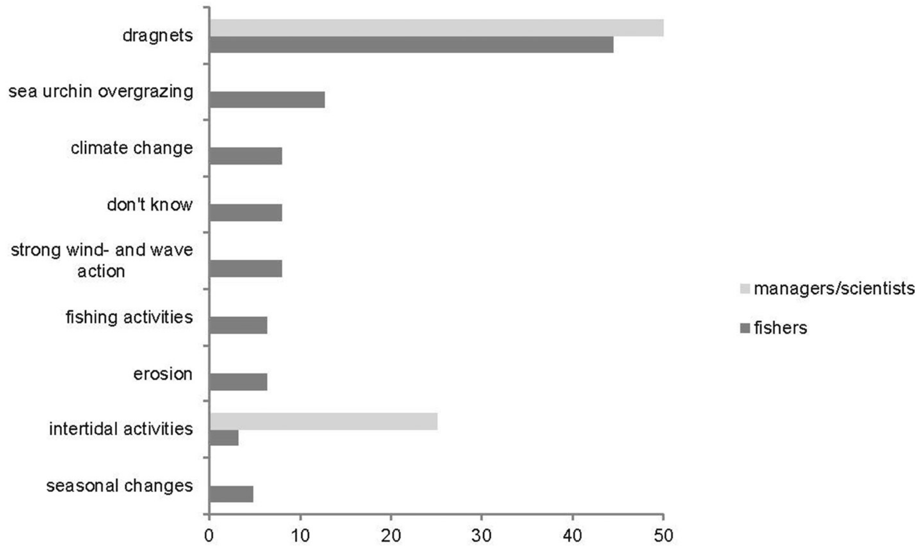

Fig. 2. Reasons for seagrass decrease suggested by managers/scientists (n = 8) and fishers (n = 63). In percent of respondents earlier mentioning a seagrass decrease.

seagrass ecosystems to local livelihoods (de la Torre-Castro and Rönnbäck, 2004; Nordlund et al., 2010). On the subsequent question why seagrasses where important, 44% (n = 108; multiple answers allowed) of all fishers mentioned that they were important as a general habitat for fish (often referring to seagrasses as "houses of the fish"), 34% that they were important as breeding grounds, 28% that they were important as foraging grounds, while 2% mentioned their function for erosion control.

A majority of fishers' and managers/scientists' perceptions accorded with each other concerning a decrease of seagrasses (57% of the managers/scientists, n = 14; and 56% of the fishers, n = 108). Twenty-one percent of the managers/scientists and 27% of the fishers thought there was no change, while 14% of the fishers opposed to none of the managers/scientists thought they were increasing. Dragnet use was the most frequently given reason of both fishers and managers for the perceived seagrass decline (Fig. 2). A few fishers, but no managers/scientists, mentioned sea urchin overgrazing, climate change or strong wind- and wave action as well as fishing activities and erosion as reasons for a seagrass decrease. This shows a high level of awareness and local knowledge among these few respondents as all these factors have been described as seagrass threats in the area (Alcoverro and Mariani, 2002; Gullström et al., 2002; Wallner-Hahn et al., 2015). The second most frequently given answer by managers/scientists (25%), but only by 3% of the fishers, was intertidal activities in general which includes e.g. seaweed farming or gleaning. This difference could be explained by either a lower awareness concerning the impacts of human activities in the intertidal, or a reluctance to point out intertidal activities as destructive due to kinship and loyalty towards family and friends (de la Torre-Castro and Lindström, 2010), as seaweed farming or gleaning are common activities in Zanzibar, especially among women (Nordlund et al., 2010; Frocklin et al., 2014). Seaweed farming has however been shown to negatively influence seagrass abundance (Eklöf et al., 2005) and fish biodiversity within the farms (Eklöf et al., 2006a). There is however no scientific data on the spatial distribution of seagrasses and its' eventual changes in the study sites which the respondents' perceptions could be related to.

In terms of how to respond to the changes in the seagrass ecosystem, 95% of the fishers and 100% of the managers felt that there was a need to protect seagrasses on Zanzibar. The mangers/scientists' and fishers' suggestions for seagrass protection are shown in Fig. 3. The dominating suggestion for seagrass protection from all fishers (40%, n = 100; dragnet fishers: 43%, n = 35 and trap fishers: 43%, n = 60) was to stop dragnet fishing. This was also one of the three top answers from the managers/scientists group: to stop dragnet fishing, education and marine protected areas. This is interesting as it shows a consensus of fishers and managers/scientists on a reduction of dragnets to be one the best approaches for seagrass protection. A quite large proportion of the dragnet fishers (26%, n = 35) thought that it was impossible to protect seagrasses, which could imply that they perceive dragnets as a problem for seagrasses, but don't see a way to protect them as they are dragnet users themselves.

Reasons given for an increase in seagrasses were a perceived decrease in dragnet fishing (mentioned by 44% of the fishers earlier mentioning a seagrass increase; n = 16) and seasonal changes (6%), while 31% did not know what the reason could be.

3.3. Seagrass threats and management

All seagrass threats mentioned in the interview guideline were confirmed by the respondents (Fig. 4A), with fishing gear leading for all respondent groups, followed by turbidity and eutrophication. No major deviations could be seen between the respondents groups, only slightly higher numbers of managers mentioning eutrophication, seaweed farming and erosion compared to trap- and dragnet fishers, which might be explained by their higher level of education, as these threats might not be directly obvious, and kinship might play a role for the answers on seaweed farming (as mentioned earlier). The by far most frequently given most serious threat (65% of all fishers, n = 106) which the three respondent groups agreed on was fishing gear again, although with a slightly lower percentage of dragnet fishers compared to managers/scientists and trap fishers (Fig. 4B), which might indicate a higher reluctance to admit the negative effects of illegal dragnets.

Subsequently, dragnets were identified as destructive to seagrasses by a 100% of managers/scientists and trap fishers, and 80% of dragnet fishers (93% of all fishers, n = 100). Furthermore, only slightly fewer respondents mentioned them to be the clearly most destructive from all suggested gears (Fig. 5AB). This shows a high awareness about the destructiveness of the illegal dragnets as well as a consensus among all respondent groups, including dragnet fishers themselves. A study from Kenya showed similar results: a general agreement between fishers, managers and the government concerning discouraged beach seines, but low compliance as beach seines were used to a high extent (McClanahan et al., 2005b). Factors contributing to the persistent use are a lack of awareness about the socio-economic benefits and sustainability of other gears, low costs associated to dragnet fishing and the general availability of dragnets (McClanahan et al., 2005b; Wallner-

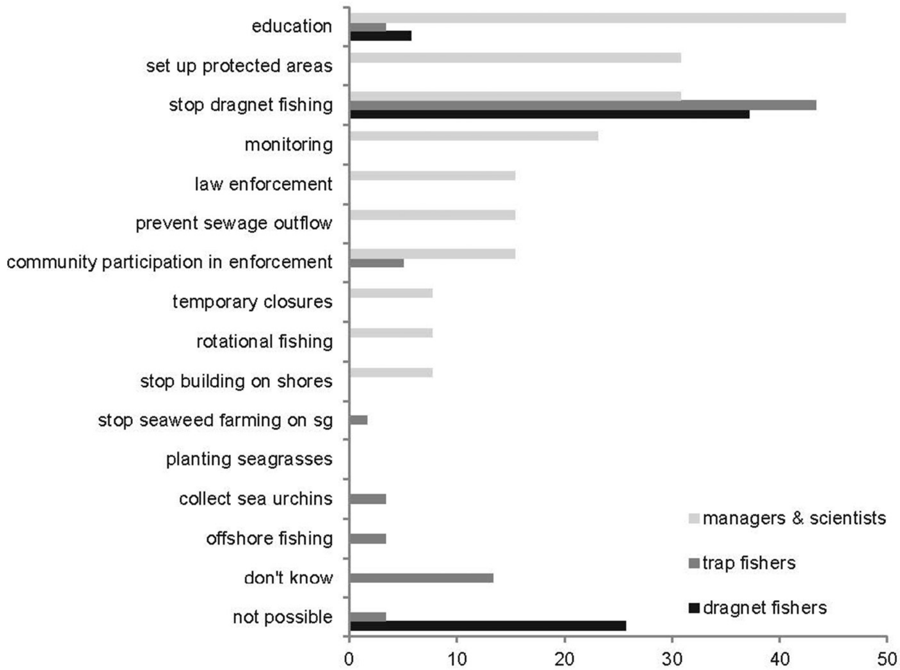

Fig. 3. Seagrass protection suggestions of managers/scientist (n = 13), trap fishers (n = 60) and dragnet fishers (n = 35). In percent of respondent groups.

Hahn et al., 2016). Furthermore, strong cultural factors associated to dragnet fishing may also play an important role for the prevalent dragnet use in the study sites (de la Torre-Castro and Lindström, 2010).

At least 60% of all respondent groups thought that the suggested management measures would have a positive effect on seagrass ecosystems (Fig. 6A), with slight differences between managers/scientists and trap users compared to dragnet users for education as well as temporary closures. The same patterns can be seen in the answers concerning the management measure with best effect for seagrass ecosystems (Fig. 6B), with managers/scientists as well as fishers focusing on gear restrictions and education. Temporary closures ranked on the third place for managers/scientists, while fishers did not support them as much. Instead, more fishers thought that no-take zones would be the best measure for seagrasses.

3.4. Fishers' readiness to adopt different management measures

The willingness of fishers to adopt the suggested management measures, as well as estimations of managers/scientists concerning it, are shown in Fig. 7A. A majority of both gear groups were willing to

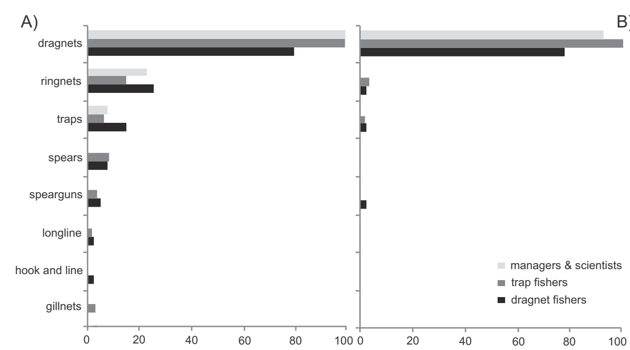

Fig. 5. A) Given fishing gears mentioned to be destructive to seagrasses, yes/no question, multiple answers allowed. B) Fishing gear mentioned to be the most destructive to seagrasses (only one answer allowed). In percent of respondent groups (managers/scientists: n = 13; trap fishers: n = 30; dragnet fishers: n = 40).

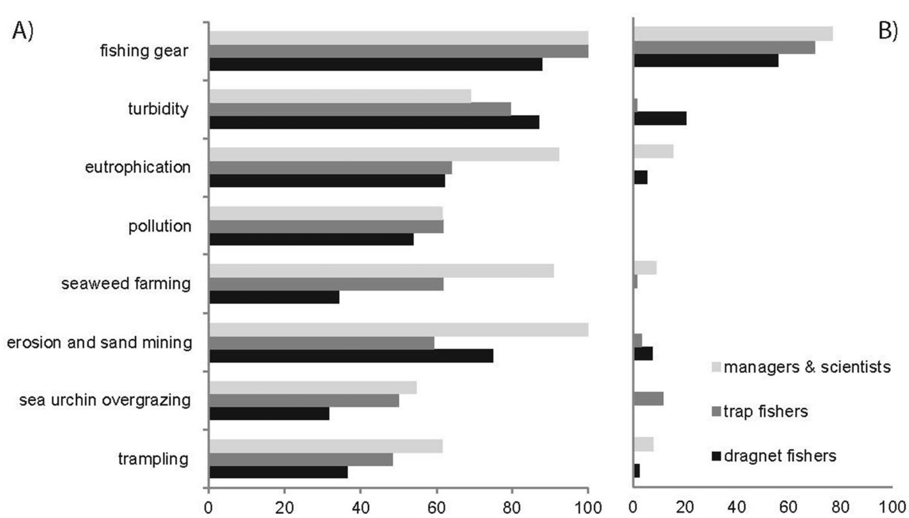

Fig. 4. A) Given seagrass threats confirmed by the respondents. In percent of respondent groups (managers/scientists: n = 13; trap fishers: n = 60; dragnet fishers: n = 41). B) The most serious seagrass threats according to the managers/scientists (n = 13), trap fishers (n = 60) and dragnet fishers (n = 41). In percent of respondent groups, only one answer allowed.

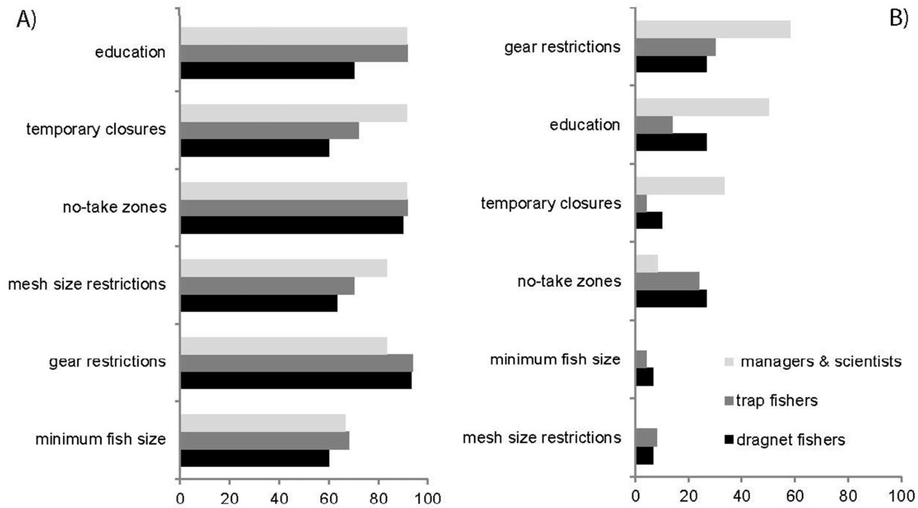

Fig. 6. A) Given management measures with a positive effect on seagrasses confirmed by the respondent groups, multiple answers allowed. B) Management measures with the best effect on seagrasses, only one answer allowed. In percent of respondent groups (managers/scientists: n = 12; trap fishers: n = 50; dragnet fishers: n = 30).

agree to education (93% of all fishes, n = 105), gear restrictions (91% of all fishers) and mesh size regulations (87% of all fishes). Most dragnet fishers emphasized, however, that they only would agree to gear restrictions if they got compensated with legal alternatives, mostly mentioning technologically more developed gears like gill nets, long lines or ring nets for pelagic fishing, as well as motorboats. A compensation of fishers in case of an implementation of gear restrictions is of highest importance, as many fishers, often especially dragnet fishers, are among the poorest of the poor, lacking the economical means to invest in legal gears (Silva, 2006; Cinner, 2009; FAO, 2011; Wallner-Hahn et al., 2016). Stricter enforcement and legal aftermath could therefore have devastating consequences for fishers and their families' well-being.

All managers/scientists (n = 12) thought that there was a need for a gear exchange program on Zanzibar. One of them highlighted that most gears used were legal, but that they were used in an illegal way (e.g. the use of pelagic ring nets in the intertidal zone or dragging), and that nets only should be distributed to fishers who for sure will use them offshore.

Forty percent of the trap fishers mentioned gear restrictions, followed by education as their favorite management type, which is not surprising considering that they use traps which are institutionalized as traditional and sustainable methods (RGZ (Revolutionary Government of Zanzibar), 2010) and conflicts with dragnet fishers have occurred (de la Torre-Castro and Lindström, 2010).

Education was with 35% the most preferred management type for dragnet fishers (Fig. 7B), also followed by gear restrictions (under the terms to be compensated). This support for gear management compared to other management measures was also found in earlier studies from Kenya (McClanahan et al., 2004, 2005a; McClanahan et al., 2005b; McClanahan et al., 2012). Furthermore, the dragnet fishers' general willingness to change gear has also been described in an earlier study from Zanzibar (Wallner-Hahn et al., 2016). Such agreements as here on gear management (the exclusion of illegal dragnets) are promising for positive management outcomes and compliance and should be considered a window of opportunity for gear co-management attempts. The latter study also describes that fishers found the distribution of gears in an earlier exchange program unjust, as not all fishers who were willing to stop using illegal gears were compensated (Gustavsson et al., 2014; Wallner-Hahn et al., 2016). Further, fishers complained that 'friends of the government' who were not fishers themselves, had received gears, and a group of over 20 dragnet fishers complained that they had handed in their illegal gear, but had only received one gillnet in return, which employs five people only.

We want to highlight the need to carefully assess which fishers are affected and to include all of them to equal and transparent terms, as it is of "major importance for the fishers perception of the procedure being fair and the regulation legitimate" (Jentoft, 1989). Previous experiences from Zanzibar show that perceptions of justice have been low concerning different programs addressing fisheries and gear exchange (Gustavsson et al., 2014). It should further be contemplated if also fishers fishing with legal gears should be compensated or benefit in any way, as it could be

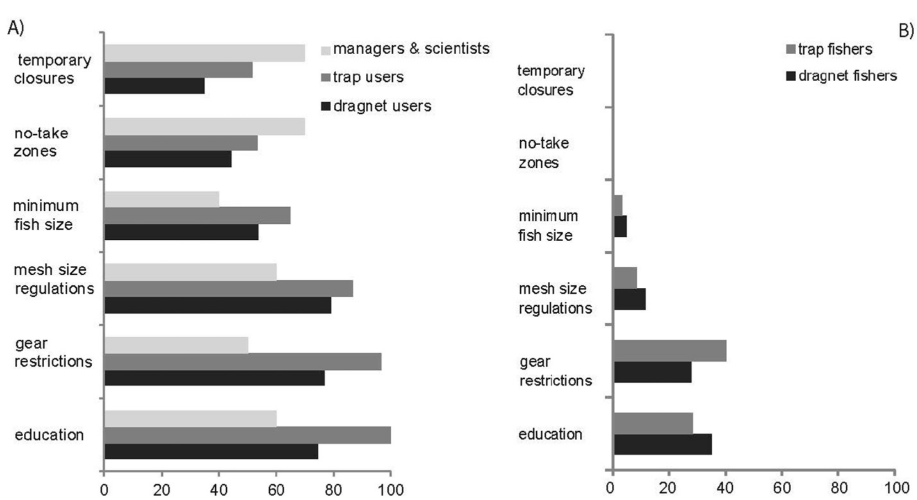

Fig. 7. A) Willingness to adopt suggested management measures (in percent of trap- (n = 60) and dragnet (n = 43) fishers), and the managers/scientists' assumption of fishers' willingness to adopt these management measures (n = 10). Multiple answers allowed. B) Fishers' first choice of management possibilities. Only one answer allowed, in percentages of trap- (n = 60) and dragnet fishers (n = 60).

perceived as unjust to 'reward' only those who are using illegal gears, while the fishers already following the rules are missed out. Further biological studies on gear effects on fish communities and habitats are needed to be able to more accurately assess the effects of gear-exchange endeavors. For seagrass and coral ecosystems, positive effects could be expected from a cessation of dragnet fishing, as dragnets are thought to have a considerable physical impact on seagrass- and coral habitats, as well as indirect ones through fishing of juveniles (Mangi and Roberts, 2006; FAO, 2011). Such indirect effects connected to small fish body sizes are, for example, a reduced grazing function on algae by herbivorous fish on coral reefs (Lokrantz et al., 2008; Lokrantz et al., 2009), or a reduced predation pressure of e.g. triggerfish on sea urchin populations feeding on seagrasses (McClanahan and Muthiga, 1989; McClanahan and Shafir, 1990; McClanahan, 1992).

3.5. Willingness to participate in monitoring and perceived benefits of seagrass management

Eighty-two percent of all fishers ($n = 108$) said they would be willing to partake in patrols and monitoring. This could be a favoring factor for future management, as the direct involvement of fishers in installing and enforcing of new regulations increases the chances of them to accept them as legitimate (Jentoft, 1989). Interestingly, also 56% (n = 43) of the fishers currently using illegal dragnets answering this question were willing to patrol. Totally 97% (n = 58) of the dragnet fishers said they were aware about the general destructive effects of dragnets, and 93% said that that was the reason why they were forbidden. These high degrees of awareness question whether it is education on gear effects which is lacking, and rather shows a need for reminders and continuous education, information as well as communication on sustainable resource use.

Eleven out of 12 managers/scientists thought that fishers generally were aware about fishing rules and regulations on Zanzibar, and nine out of ten thought that the fishers were aware of the destructiveness of dragnets, which conforms with the fishers answers. Concerning eventual benefits from implementing seagrass management, 72% of all fishers thought that they themselves and the associated communities would benefit the most, followed by 9% mentioning the government, and 5% the marine ecosystem. These perceived benefits could increase the chances for participation and adoption of new rules (Jacobson and Marynowski, 1997). The managers/scientist group was asked the question if they thought the current system for monitoring and controls was sufficient. Nine out of 10 respondents answering this question thought that it was not sufficient and should be improved. Insufficient monitoring and controls have also been described in other studies from this area (de la Torre-Castro, 2006; de la Torre-Castro and Lindström, 2010; Wallner-Hahn et al., 2016), showing the need for an improved system, which fishers should be a fundamental part of.

3.6. Analysis of differing opinions

The statistical analysis of differences in opinions between the different respondent groups (managers/scientists and/or the two gear groups and/or all fishers) showed eleven areas of differences between respondent groups (Table 1): whether fishing gear, seaweed farming and erosion are threats to local seagrasses, if turbidity, sea-urchin overgrazing and eutrophication are the most serious threats to seagrasses, whether dragnets are destructive and/or most destructive to seagrasses, and if temporary closures, gear restrictions and education are management measures fishers would adopt.

Concerning the suggested threats to seagrasses, fewer dragnet- than trap fishers mentioned fishing gear as a potential threat. This is also reflected in the subsequent questions about the perceived destructiveness of fishing gears to seagrasses and the mention of the most destructive of them. Here, differences between trap- and dragnet fishers and hence also between trap-, dragnet fishers and managers/scientists were found due to the comparably fewer dragnet fishers mentioning their gear as destructive. However, nearly all dragnet fishers acknowledged their gears to be destructive in a later question, as well as over 90% mentioning dragnets to be banned because of their destructiveness. It could thus be assumed that the differences in perceptions concerning the destructiveness of dragnets between dragnet fishers and the other respondent groups can be neglected, as it may stem from an unwillingness to admit the negative impacts of dragnets.

Close to all managers/scientists thought that seaweed farming is destructive to seagrasses, but fewer fishers of both gear groups, which could, as described earlier, possibly be explained by kinship and loyalty. The same pattern was found for erosion, which could indicate a need to communicate scientific knowledge to the communities.

Concerning the willingness to adopt different management measures, differences were found on temporary closures, gear restrictions and education. Fewer percentages of fishers than managers/scientists assuming, were willing to accept temporary closures. Surprisingly, percentages over 77% for trap- and dragnet fishers mentioned to be willing to accept gear restrictions and education, compared to 50% of the managers/scientists who expected a positive attitude. Among the gear groups, fewer dragnet fishers (77%) than trap fishers (97%) supported gear restrictions. This is not surprising as dragnet fishers would have to leave their gears in case of stricter implemented gear restrictions.

Positive examples from Kenya showing increases in catches and income suggest that gear management is among the most suitable management strategies for small-scale fisheries with characteristics such as those in Zanzibar (McClanahan et al., 2008; McClanahan and Hicks, 2011; McClanahan and Abunge, 2014). In comparison to closed areas, gear restrictions can be adapted to the requirements and the context of the fishery in question without reducing local fishing grounds (McClanahan and Cinner, 2008). Consequently, the fishers' willingness to switch gears, including a cessation of dragnet fishing, is one of the areas which should be focused on for future management. The results of this study show that there is already a considerable support for just and transparent gear exchange under the conditions to compensate current dragnet fishers with more attractive gears. To change fishers minds on gear use towards more traditional gears like traps might however be a complex and long-term endeavor, as gear use is rooted in traditions and norms (Wallner-Hahn et al., 2016). The same pattern of differences between dragnet fishers and trap fishers was found for education, which might also indicate a general reluctance to any management efforts by certain individuals of the dragnet fishers participating in this study.

4. Conclusions

The results of this study contribute to a better understanding of areas of agreement as well as disagreement between fishers' and managers' opinions on the management of seagrass-associated small-scale fisheries in Zanzibar, from a pre-implementation point. The findings are of high value for small-scale fisheries management as they provide realistic and plausible grounds for mutual understanding and convergence among the different actors in the system.

The main findings of this study are summarized as follows:

i) seagrasses are important to all fishers and managers/scientists, more than half of all respondents perceive seagrasses as declining, with about half of them mentioning dragnets as a cause, and close to all respondents think there is a need for seagrass specific management in Zanzibar.
ii) there is a consensus among the majority of fishers and managers/scientists, that dragnet use is the main threat to local seagrasses (but with fewer dragnet fishers agreeing on this), and that all suggested management measures would have a positive effect on seagrasses (with differences in proportions of fishers and managers/scientists

Table 1
Questions where statistical differences in answers between the respondent groups were found. Compared were: a) managers/scientists vs. trap fishers vs. dragnet fishers, b) managers/scientists vs. all fishers and c) trap fishers vs. dragnet fishers. Statistical method: Fisher's exact test. Only p-values < 0.05 were considered to be statistically significant, numbers of respondents answering yes/no are given to describe the differences.

Are the following threats to seagrasses (yes/no)?								
fishing gear			**seaweed farming**			**erosion**		
p-value 0.015	**no**	**yes**	***p-value 0.002***	**no**	**yes**	***p-value 0.006***	**no**	**yes**
managers&scientiststs	0	13	managers&scientiststs	1	10	managers&scientiststs	0	13
trap fishers	0	60	trap fishers	23	37	trap fishers	24	35
dragnet fishers	5	36	dragnet fishers	21	11	dragnet fishers	10	30
p-value 1			***p-value 0.021***			***p-value 0.009***		
managers&scientists	0	13	managers&scientists	1	10	managers&scientists	0	13
all fishers	5	96	all fishers	44	48	all fishers	34	65
p-value 0.009			***p-value 0.016***			**p-value 0.133**		
trap fishers	0	60	trap fishers	21	11	trap fishers	24	35
dragnet fishers	5	36	dragnet fishers	23	37	dragnet fishers	10	30

Which is the most serious threat to seagrasses?								
turbidity			**sea-urchin overgrazing**			**eutrophication**		
p-value 0.004	**no**	**yes**	***p-value 0.059***	**no**	**yes**	***p-value 0.015***	**no**	**yes**
managers&scientists	13	0	managers&scientists	11	0	managers&scientists	11	2
trap fishers	58	1	trap fishers	53	7	trap fishers	58	0
dragnet fishers	31	8	dragnet fishers	41	0	dragnet fishers	35	2
p-value 0.002			***p-value 0.039***			**p-value 0.149**		
trap fishers	58	1	trap fishers	53	7	trap fishers	58	0
dragnet fishers	31	8	dragnet fishers	41	0	dragnet fishers	35	2

Are these gears destructive to seagrasses?		
dragnets		
p-value 0.0007	**no**	**yes**
managers&scientists	0	13
trap fishers	0	60
dragnet fishers	8	33
p-value 0.0005	**no**	**yes**
trap fishers	0	60
dragnet fishers	8	33

Which is the most destructive to seagrasses?		
dragnets		
p-value 0.0002	**no**	**yes**
managers&scientists	1	12
trap fishers	0	60
dragnet fishers	9	32
p-value 0.0002		
trap fishers	0	60
dragnet fishers	9	92

Would you adopt these management scenarios (yes/no)?								
temporary closures			**gear restrictions**			**education**		
p-value 0.002	**no**	**yes**	***p-value 0.010***	**no**	**yes**	***p-value 0.003***	**no**	**yes**
managers&scientists	0	8	managers&scientists	2	6	managers&scientists	0	7
trap fishers	29	31	trap fishers	2	58	trap fishers	0	60
dragnet fishers	26	15	dragnet fishers	8	33	dragnet fishers	7	34
p-value 0.003			**p-value 0.213**			**p-value 1**		
managers&scientists	0	8	managers&scientists	2	6	managers&scientists	0	7
all fishers	55	46	all fishers	10	91	all fishers	7	94
p-value 0.158			***p-value 0.014***			***p-value 0.001***		
trap fishers	29	31	trap fishers	2	58	trap fishers	0	60
dragnet fishers	26	15	dragnet fishers	8	33	dragnet fishers	7	34

concerning seaweed farming, eutrophication and erosion being potential threats).

iii) gear restrictions and education are the favored management measures among all fishers (with comparably fewer dragnet- than trap fishers willing to adopt them), while few managers/scientists predicted these measures to be favored. A majority of managers/scientists expected fishers to adopt temporary closures, which is supported by smaller proportions of fishers.

iv) a majority of fishers are willing to participate in monitoring and controls, and most fishers think that they themselves and their communities would benefit the most from seagrass management.

The agreement of all respondents on the need to specifically manage seagrass ecosystems in Zanzibar, and a high willingness to participate in monitoring as well as the perception of fishers and local communities benefitting from it, might be good prerequisites for future management efforts. Areas of disagreement which would deserve more attention and education for fishers would be seagrass threats (other than dragnets) and the benefits of temporary closures, which were supported by most managers/scientists. Poverty does not allow for longer periods of closures (McClanahan et al., 1997), but temporary closures have been shown to have considerable positive social-ecological effects in the management of species with high turnover rates like octopus fisheries in Madagascar (Benbow et al., 2014). Further, efforts should be made to continuously work with awareness raising on the destructiveness of dragnets, and the benefits of more sustainable gears in socio-economic as well as ecological terms (McClanahan et al., 2005b; de la Torre-Castro and Lindström, 2010; Wallner-Hahn et al., 2016). The identified differences between fishers and managers can be a starting point for increased communication, discussions and mutual learning, that in turn enhance trust and the willingness to collaborate. One focus should be on gear management efforts, with strong respect to the fishers' willingness to participate and their need to be compensated for the loss of their (illegal) gears, which are their main source of income. Management processes towards more sustainable social-ecological ecosystems should be transparent, just and recognize and include existing local ecological knowledge and traditional management as well as scientific approaches (McClanahan et al., 1997; Tobisson et al., 1998). Further, to manage small-scale fisheries like these in Zanzibar in a more sustainable way, a seascape approach incorporating all associated habitats like corals, seagrasses and mangroves is necessary (de la Torre-Castro et al., 2014). And, most importantly, in such closely interlinked social-ecological systems like the seagrass-associated small-scale fisheries of Zanzibar, ‘people ought to be the means and the goals of the management process’ (de la Torre-Castro, 2012b). One promising step would be the implementation of co-management concerning the exclusion of illegal dragnets and an associated gear exchange program.

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Appendix A

Compilation of the conducted statistical analyses and their results on differing opinions. The Fisher's exact test was used to statistically test for differences between the answers of respondent groups (managers & scientists; trap fishers; dragnet fishers; all fishers). The presented results are p-values. Only p-values < 0.05 were considered to be statistically significant (italics).

Potential threat	Fishing gear	Trampling	Seaweed farming	Turbidity	Sea-urchin overgrazing	Pollution	Eutrophication	Erosion
Are the following threats to seagrasses (yes/no)?								
p-Value (Managers & scientists/trap −/dragnet fishers)	*0.015*	0.266	*0.002*	0.301	0.151	0.734	0.113	*0.006*
p-Value (Managers & scientists/all fishers)	1	0.249	*0.021*	0.264	0.529	1	0.056	*0.009*
p-Value (Trap −/dragnet fishers)	*0.009*	0.308	*0.016*	0.419	0.101	0.532	1	0.133
Which is the most serious threat to seagrasses?								
p-Value (Managers & scientists/trap −/dragnet fishers)	0.255	0.095	0.298	*0.004*	0.0595	No mentions	*0.015*	0.546
p-Value (Managers & scientists/all fishers)	0.537	0.216	0.203	0.595	1	No mentions	0.070	1
p-value (Trap −/dragnet fishers)	0.204	0.298	1	0.059	*0.039*	No mentions	0.149	0.391

Gear	Gillnets	Hook & line	Dema	Dragnet	Ringnet	Spears	Spear guns	Longline
Are these gears destructive to seagrasses?								
p-Value (Managers & scientists/trap −/dragnet fishers)	0.621	0.469	0.350	*0.007*	0.359	0.769	1	1
p-Value (Managers & scientists/all fishers)	1	1	1	0.5593	0.717	0.593	1	1
p-Value (Trap −/dragnet fishers)	0.515	0.4	0.192	*0.0005*	0.203	1	1	1
Which is the most destructive to seagrasses?								
p-Value (Managers & scientists/trap −/dragnet fishers)	No mentions	No mentions	No mentions	*0.0002*	1	0.469	No mentions	1
p-Value (Managers & scientists/all fishers)	No mentions	No mentions	No mentions	1	1	1	No mentions	1
p-Value (Managers/all fishers)	No mentions	No mentions	No mentions	*0.0002*	1	0.4	No mentions	1

Management type	No-take zones	Temporary closures	Gear restrictions	Mesh size restrictions	Minimum fish size restrictions	Education

Would you adopt these management scenarios (yes/no)?						
p-Value (Managers & scientists/trap −/dragnet fishers)	0.417	*0.002*	*0.010*	0.665	0.331	*0.003*
p-Value (Managers & scientists/all fishers)	0.322	*0.003*	0.213	0.627	0.715	1
p-Value (Trap −/dragnet fishers)	0.687	0.158	*0.014*	0.776	0.216	*0.001*
Which of these managemet scenarios would you prefer?						
p-Value (Managers & scientists/trap −/dragnet fishers)	0.466	0.218	0.414	0.366	1	0.651
p-Value (Managers & scientists/all fishers)	1	0.157	0.420	0.243	1	1
p-Value (Trap −/dragnet fishers)	0.269	0.712	0.399	0.754	1	0.399

References

Alcoverro, T., Mariani, S., 2002. Effects of sea urchin grazing on seagrass (Thalassodendron ciliatum) beds of a Kenyan lagoon. Mar. Ecol. Prog. Ser. 226, 255–263.

Benbow, S., Humber, F., Oliver, T.A., Oleson, K.L.L., Raberinary, D., Nadon, M., Ratsimbazafy, H., Harris, A., 2014. Lessons learnt from experimental temporary octopus fishing closures in south-west Madagascar: benefits of concurrent closures. Afr. J. Mar. Sci. 36, 31–37.

Berkes, F., 2009. Evolution of co-management: role of knowledge generation, bridging organizations and social learning. J. Environ. Manag. 90, 1692–1702.

Berkes, F., Hughes, T.P., Steneck, R.S., Wilson, J.A., Bellwood, D.R., Crona, B., Folke, C., Gunderson, L.H., Leslie, H.M., Norberg, J., Nystrom, M., Olsson, P., Osterblom, H., Scheffer, M., Worm, B., 2006. Ecology - globalization, roving bandits, and marine resources. Science 311, 1557–1558.

Blyth, R.E., Kaiser, M.J., Edwards-Jones, G., Hart, P.J.B., 2002. Voluntary management in an inshore fishery has conservation benefits. Environ. Conserv. 29, 493–508.

Chapin, F.S., Carpenter, S.R., Kofinas, G.P., Folke, C., Abel, N., Clark, W.C., Olsson, P., Smith, D.M.S., Walker, B., Young, O.R., Berkes, F., Biggs, R., Grove, J.M., Naylor, R.L., Pinkerton, E., Steffen, W., Swanson, F.J., 2010. Ecosystem stewardship: sustainability strategies for a rapidly changing planet. Trends Ecol. Evol. 25, 241–249.

Chuenpagdee, R., Jentoft, S., 2007. Step zero for fisheries co-management: what precedes implementation. Mar. Policy 31, 657–668.

Cinner, J.E., 2009. Poverty and the use of destructive fishing gear near east African marine protected areas. Environ. Conserv. 36, 321–326.

Cullen-Unsworth, L.C., Nordlund, L.M., Paddock, J., Baker, S., McKenzie, L.J., Unsworth, R.K.F., 2014. Seagrass meadows globally as a coupled social-ecological system: implications for human wellbeing. Mar. Pollut. Bull. 83, 387–397.

Defeo, O., Castilla, C., 2005. More than one bag for the world fishery crisis and keys for co-management success in selected artisanal Latin American shellfisheries. Fish Biol. Fish. 15, 265–283.

Denscombe, M., 1998. The Good Research Guide for Small-scale Social Research Projects. Open University Press, Buckingham, UK.

DoFD, 2010. Zanzibar Fisheries Frame Survey Report. Department of Fisheries Development, Ministry of Fisheries and Livestock, Zanzibar, Tanzania.

Duarte, C.M., Dennison, W.C., Orth, R.J.W., Carruthers, T.J.B., 2008. The charisma of coastal ecosystems: addressing the imbalance. Estuar. Coasts 31, 233–238.

Eklöf, J.S., De la Torre-Castro, M., Adelsköld, L., Kautsky, N.S.J., 2005. Differences in macrofaunal and seagrass assemblages in seagrass beds with and without seaweed farms. Estuar. Coast. Shelf Sci. 63 (2005), 385e396.

Eklöf, J.S., DlT-C, M., Nilsson, C.P.R., 2006a. How do seaweed farms influence local fishery catches in a seagrass-dominated setting in Chwaka Bay, Zanzibar? Aquat. Living Resour. 19 (2006), 137–147.

Eklöf, J.S., Henriksson, R., Kautsky, N., 2006b. Effects of tropical open-water seaweed farming on seagrass ecosystem structure and function. Mar. Ecol. Prog. Ser. 325, 73–84.

FAO, 2011. Fishing with beach seines. In: Book Fisheries and Aquaculture Technical Paper. 562 (Rome).

Frocklin, S., de la Torre-Castro, M., Lindstrom, L., Jiddawi, N.S., 2013. Fish traders as key actors in fisheries: gender and adaptive management. Ambio 42, 951–962.

Frocklin, S., de la Torre-Castro, M., Hakansson, E., Carlsson, A., Magnusson, M., Jiddawi, N.S., 2014. Towards improved management of tropical invertebrate fisheries: including time series and gender. PLoS One 9.

Gelcich, S., Edwards-Jones, G., Kaiser, M.J., 2005. Importance of attitudinal differences among artisanal fishers toward co-management and conservation of marine resources. Conserv. Biol. 19, 865–875.

Gelcich, S., Edwards-Jones, G., Kaiser, M.J., Castilla, J.C., 2006. Co-management policy can reduce resilience in traditionally managed marine ecosystems. Ecosystems 9, 951–966.

Gelcich, S., Edwards-Jones, G., Kaiser, M.J., 2007. Heterogeneity in fishers' harvesting decisions under a marine territorial user rights policy. Ecol. Econ. 61, 246–254.

Gullström, M., De la Torre-Castro, M., Bandeira, S.O., Björk, M., Dahlberg, M., Kautsky, N., Rönnbäck, P., Öhman, M., 2002. Seagrass ecosystems in the western Indian Ocean. Ambio 31 (7–8).

Gustavsson, M., Lindstrom, L., Jiddawi, N.S., de la Torre-Castro, M., 2014. Procedural and distributive justice in a community-based managed marine protected area in Zanzibar, Tanzania. Mar. Policy 46, 91–100.

Hicks, C.C., Graham, N.A.J., Cinner, J.E., 2013. Synergies and tradeoffs in how managers, scientists, and fishers value coral reef ecosystem services. Glob. Environ. Chang. Hum. Policy Dimens. 23, 1444–1453.

ICM, 2003. In: Group IT (Ed.), Preliminary Assessment of Coastal Management Initiatives in Zanzibar. National Environment Management Council, the University of Rhode Island/Coastal Resource Center and the United States Agency for International Development.

Jackson, J.B.C., Kirby, M.X., Berger, W.H., Bjorndal, K.A., Botsford, L.W., Bourque, B.J., Bradbury, R.H., Cooke, R., Erlandson, J., Estes, J.A., Hughes, T.P., Kidwell, S., Lange, C.B., Lenihan, H.S., Pandolfi, J.M., Peterson, C.H., Steneck, R.S., Tegner, M.J., Warner, R.R., 2001. Historical overfishing and the recent collapse of coastal ecosystems. Science 293, 629–638.

Jacobson, S.K., Marynowski, S.B., 1997. Public attitudes and knowledge about ecosystem management on department of defense land in Florida. Conserv. Biol. 11, 770–781.

Jentoft, S., 1989. Fisheries co-management – delegating government responsibility to fishermesn organizations. Mar. Policy 13, 137–154.

Jentoft, S., Chuenpagdee, R., 2009. Fisheries and coastal governance as a wicked problem. Mar. Policy 33, 553–560.

Jentoft, S., McCay, B., 1995. User participation in fisheries management – lessons drawn from international experiences. Mar. Policy 19, 227–246.

Jentoft, S., McCay, B.J., Wilson, D.C., 1998. Social theory and fisheries co-management. Mar. Policy 22, 423–436.

Jentoft, S., Pascual-Fernandez, J.J., De la Cruz, Modino R., Gonzalez-Ramallal, M., Chuenpagdee, R., 2012. What stakeholders think about marine protected areas: case studies from Spain. Hum. Ecol. 40, 185–197.

Jiddawi, N., 1998. The reef dependent fisheries of Zanzibar. In: Johnstone, R.W., Francis, J., Muhando, C.A. (Eds.), Coral Reefs: Values, Threats and Solutions. Proc National Conference on Coral Reefs.

Jiddawi, N.S., Khatib, H., 2007. Zanzibar Fisheries Frame Survey, 2007. Department of Fisheries and Marine Resources. Ministry of Agriculture, Livestock and Environment.

Jiddawi, N.S., Öhman, M., 2002. Marine fisheries in Tanzania. Ambio 31 (7/8), 518–527.

Kvale, S., Brinkmann, S., 1997. Den kvalitativa forskningsintervjun. (Studentlitteratur AB).

Lange, G.-M., Jiddawi, N., 2009. Economic value of marine ecosystem services in Zanzibar: implications for marine conservation and sustainable development. Ocean Coast. Manag. 52, 521–532.

Lindström, L., 2012. Governing sustainability: Chwaka Bay in Zanzibar's National Integrated Coastal Management Strategies. In: De la Torre-Castro, M., Lyimo, T.J. (Eds.), People, Nature and Research in Chwaka Bay, Zanzibar, Tanzania. WIOMSA, Zanzibar Town.

Lokrantz, J., Nystrom, M., Thyresson, M., Johansson, C., 2008. The non-linear relationship between body size and function in parrotfishes. Coral Reefs 27, 967–974.

Lokrantz, J., Nystrom, M., Norstrom, A.V., Folke, C., Cinner, J.E., 2009. Impacts of artisanal fishing on key functional groups and the potential vulnerability of coral reefs. Environ. Conserv. 36, 327–337.

Mangi, S.C., Roberts, C.M., 2006. Quantifying the environmental impacts of artisanal fishing gear on Kenya's coral reef ecosystems. Mar. Pollut. Bull. 52, 1646–1660.

McClanahan, T.R., 1992. Resource utilization, competition, and predation – a model and example from coral reef grazers. Ecol. Model. 61, 195–215.

McClanahan, T.R., 1999. Is there a future for coral reef parks in poor tropical countries? Coral Reefs 18, 321–325.

McClanahan, T.R., Abunge, C.A., 2014. Catch rates and income are associated with fisheries management restrictions and not an environmental disturbance, in a heavily exploited tropical fishery. Mar. Ecol. Prog. Ser. 513, 201–210.

McClanahan, T.R., Cinner, J.E., 2008. A framework for adaptive gear and ecosystem-based management in the artisanal coral reef fishery of Papua New Guinea. Aquat. Conserv. Mar. Freshwat. Ecosyst. 18, 493–507.

McClanahan, T.R., Hicks, C.C., 2011. Changes in life history and ecological characteristics of coral reef fish catch composition with increasing fishery management. Fish. Manag. Ecol. 18, 50–60.

McClanahan, T.R., Mangi, S., 2001. The effect of a closed area and beach seine exclusion on coral reef fish catches. Fish. Manag. Ecol. 8, 107–121.

McClanahan, T.R., Mangi, S.C., 2004. Gear-based management of a tropical artisanal fishery based on species selectivity and capture size. Fish. Manag. Ecol. 11, 51–60.

McClanahan, T.R., Muthiga, N.A., 1989. Patterns of predation on a sea-urchin, Echinometra-Mathaei (Deblainville), on Kenyan coral reefs. J. Exp. Mar. Biol. Ecol. 126, 77–94.

McClanahan, T.R., Shafir, S.H., 1990. Causes and consequences of sea-urchin abundance and diversity in Kenyan coral-reef lagoons. Oecologia 83, 362–370.

McClanahan, T.R., Glaesel, H., Rubens, J., Kiambo, R., 1997. The effects of traditional

fisheries management on fisheries yields and the coral-reef ecosystems of southern Kenya. Environ. Conserv. 24, 105–120.
McClanahan, T., Davies, J., Maina, J., 2004. Factors influencing resource users and managers' perceptions towards marine protected area management in Kenya. Environ. Conserv. 32, 42–49.
McClanahan, T., Davies, J., Maina, J., 2005a. Factors influencing resource users and managers' perceptions towards marine protected area management in Kenya. Environ. Conserv. 32, 42–49.
McClanahan, T.R., Maina, J., Davies, J., 2005b. Perceptions of resource users and managers towards fisheries management options in Kenyan coral reefs. Fish. Manag. Ecol. 12, 105–112.
McClanahan, T.R., Hicks, C.C., Darling, E.S., 2008. Malthusian overfishing and efforts to overcome it on Kenyan coral reefs. Ecol. Appl. 18, 1516–1529.
McClanahan, T.R., Castilla, J.C., White, A.T., Defeo, O., 2009. Healing small-scale fisheries by facilitating complex socio-ecological systems. Rev. Fish Biol. Fish. 19, 33–47.
McClanahan, T.R., Abunge, C.A., Cinner, J.E., 2012. Heterogeneity in fishers' and managers' preferences towards management restrictions and benefits in Kenya. Environ. Conserv. 39, 357–369.
Myers, R.A., Worm, B., 2003. Rapid worldwide depletion of predatory fish communities. Nature 423, 280–283.
Nordlund, L., Erlandsson, J., de la Torre-Castro, M., Jiddawi, N., 2010. Changes in an east African social-ecological seagrass system: invertebrate harvesting affecting species composition and local livelihood. Aquat. Living Resour. 23, 399–416.
Nordlund, L.M., de la Torre-Castro, M., Erlandsson, J., Conand, C., Muthiga, N., Jiddawi, N., Gullstrom, M., 2014. Intertidal zone Management in the Western Indian Ocean: assessing current status and future possibilities using expert opinions. Ambio 43, 1006–1019.
Pitcher, T.J., Lam, M.E., 2010. Fishful thinking: rhetoric, reality, and the sea before us. Ecol. Soc. 15.
RGZ (Revolutionary Government of Zanzibar), 1993. Fisheries Law.
RGZ (Revolutionary Government of Zanzibar), 2010. Fisheries Act No. 7.
Short, F.T., Green, E.P., 2003. World Atlas of Seagrasses. UNEP-WCMC, London, UK.
Silva, P., 2006. Exploring the Linkages between Poverty, Marine Protected Area Management, and the Use of Destructive Fishing Gear in Tanzania. World Bank Policy Research Working Paper 3831, February 2006, Book WPS3831.
Song, A.M., Chuenpagdee, R., Jentoft, S., 2013. Values, images, and principles: what they represent and how they may improve fisheries governance. Mar. Policy 40, 167–175.
Thyresson, M., Crona, B., Nystrom, M., de la Torre-Castro, M., Jiddawi, N., 2013. Tracing value chains to understand effects of trade on coral reef fish in Zanzibar, Tanzania. Mar. Policy 38, 246–256.
Tobisson, E., Andersson, J., Ngazi, Z., Rydberg, L., Cederlöf, U., 1998. Tides, monsoons and seabed: local knowledge and practice in Chwaka Bay, Zanzibar. Ambio 27 (8), 677–685 (Building Capacity for Coastal Management (Dec., 1998)).
de la Torre-Castro, M., 2006. Beyond regulations in fisheries management: the dilemmas of the & quot;beach recorders & quot; bwana Dikos & quot; in Zanzibar, Tanzania. Ecol. Soc. 11 (2), 35.
de la Torre-Castro, M., 2012a. Governance for sustainability: insights from marine resource use in a tropical setting in the western Indian Ocean. Coast. Manag. 40, 612–633.
de la Torre-Castro, M., 2012b. Management Challenges in Chwaka Bay, Zanzibar, Tanzania: historical development and future prospects. In: De la Torre-Castro, M. (Ed.), People, Nature and Research in Chwaka Bay. Zanzibar, Tanzania, Zanzibar Town, WIOMSA.
de la Torre-Castro, M., Lindström, L., 2010. Fishing institutions: addressing regulative, normative and cultural-cognitive elements to enhance fisheries management. Mar. Policy 34, 77–84.
de la Torre-Castro, M., Rönnbäck, P., 2004. Links between humans and seagrasses—an example from tropical East Africa. Ocean Coast. Manag. 47 (2004), 361–387 (47:361–387).
de la Torre-Castro, M., Di Carlo, G., Jiddawi, N.S., 2014. Seagrass importance for a small-scale fishery in the tropics: the need for seascape management. Mar. Pollut. Bull. 83, 398–407.
Unsworth, R.K.F., Cullen, L.C., 2010. Recognising the necessity for indo-Pacific seagrass conservation. Conserv. Lett. 3, 63–73.
Wallner-Hahn, S., de la Torre-Castro, M., Eklof, J.S., Gullstrom, M., Muthiga, N.A., Uku, J., 2015. Cascade effects and sea-urchin overgrazing: an analysis of drivers behind the exploitation of sea urchin predators for management improvement. Ocean Coast. Manag. 107, 16–27.
Wallner-Hahn, S., Molander, F., Gallardo, G., Villasante, S., Eklof, J.S., Jiddawi, N.S., de la Torre-Castro, M., 2016. Destructive gear use in a tropical fishery: institutional factors influencing the willingness-and capacity to change. Mar. Policy 72, 199–210.