Locally managed fisheries in the Western Indian Ocean: a review of past and present initiatives
Locally managed fisheries in the Western Indian Ocean: a review of past and present initiatives

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Introduction

This report served as a background situation analysis for the project “Designing a Regional Network for Western Indian Ocean Local Fisheries Management to Build Community Capacity and Governance Frameworks”, funded through the MacArthur Foundation, which aimed to design a regional network for locally managed fisheries in the Western Indian Ocean (WIO), and ran from April 2014 to February 2017. The purpose of such a network would be to facilitate wider and more rapid uptake of effective and replicable local fisheries management approaches.

Small-scale coastal fisheries are vital for the livelihoods, food security and well-being of coastal communities throughout the WIO, yet they continue to be challenged by over-exploitation, mismanagement, ecological degradation and climate change. Small-scale fisheries supply 93 – 98% of the marine catch and are the principal income generating activity for a large number of coastal households (Samoilys et al., 2015). Industrial offshore fisheries on the other hand, contribute to export revenues accounting <15% of the national economy (Walmsley et al., 2006). In addition, despite the high dependence of coastal communities in the WIO on these fisheries, coastal communities have historically had limited participation in their management. This situation is changing as governance of natural resources changes from top-down management to co-management.

The project was designed to prepare the groundwork for the establishment of a WIO network, which would create a forum for region-wide small-scale fisheries (SSF) discussions and training opportunities. Experience from other established networks, such as that in the Indo-Pacific, has shown that information flow and opportunities for peer sharing and learning exchange are major benefits appreciated by members. In addition, a network could serve as a hub of influence enhancing the profile of local action and ability for participation in the regional SSF agenda. Ultimately, the objective in the WIO is to create a regional network, which would improve fisheries management efforts at local levels and provide a mechanism for scaling-up and replicating successful fisheries management initiatives.

In this review we briefly describe the nature of small-scale coastal fisheries in the WIO, the issues and problems that they face, provide some historic perspective by country, and explain the legislation behind their management. We then present case studies of successful local fisheries management approaches. We finish with discussing these in the context of the potential for a regional local fisheries management network in the WIO. It is anticipated that a regional locally managed fisheries network may contribute to addressing conservation and management needs associated with unsustainable fishing practices through facilitating the more rapid uptake of effective and replicable local fisheries management approaches.

Study Objectives

This report addresses Objective 1 of the Project: Assessment of existing local fisheries management initiatives at local, national and regional level, including an assessment of their effectiveness and needs of the Project.

The project’s purpose was to investigate the options for a local fisheries management network for the WIO to facilitate wider and more rapid uptake of effective and replicable local fisheries management approaches. Should a regional network be established, this would serve to share limited resources (i.e., funds and expertise) across the region, and to create a forum for region-wide SSF discussions and training opportunities. The project drew on lessons learned from existing regional locally managed marine area (LMMA) networks such as that in the Pacific, and aligned with the developing MIHARI (MItantana ny HArena an-dRanomasina avy any Ifotony), a national local fisheries management
network for Madagascar, and drew on recent local management initiatives in the region, notably the rapidly emerging number of co-management arrangements such as the community closures, community conservation areas or “tengefu” in Kenya, the Community Managed Protected Areas or LMMAs in Madagascar, Fishing Community Councils in Mozambique, and Collaborative Fisheries Management Areas (CFMAs) or Community Management Areas (CMAs) in Tanzania (Rocliffe et al., 2014). In addition, this project contributed knowledge and experiences to several regional initiatives that are underway such as the Resilient Coasts Programme being spearheaded by IUCN and partners which seeks to improve local capacity and governance in the WIO; the Northern Mozambique Channel Initiative being led by WWF, CORDIO and partners which seeks to improve management efforts in a multi-national seascape of global importance; the Implementation of the Strategic Action Programme for the protection of the Western Indian Ocean from land-based sources and activities (WIO-SAP) with components on strengthening community engagement in resource management; the EU Biodiversity project and several national level projects such as the government-led Kenya Coastal Development Project (KCDP) and a MASMA funded project that is being coordinated by WCS and partners in Kenya and Tanzania which seeks to strengthen co-management capacity for SSFs.

The goal of the MacArthur project was to investigate the feasibility of establishing a mechanism that supports long-term sustainability of SSF productivity, particularly those fisheries important for local food security and human well-being, while maintaining the health and viability of coastal ecosystems and their biodiversity. The project focused on the planning, development and design of a local fisheries management network for the WIO for subsequent region-wide implementation.

Study area and scope

This report focuses on five countries in the WIO and details locally based management approaches in the small-scale coastal fisheries that operate in these countries.

Geographic coverage

The WIO region encompasses the African coastal states of Somalia, Kenya, Tanzania, Mozambique and South Africa, and the Island states of Comoros, Madagascar, Mauritius and Seychelles, together with the French overseas departments of Mayotte and Réunion (Figure 1). The WIO mainland coastline is 13,000 km long while islands have a pooled coastline of 6,360 km (Rocliffe et al., 2014). The region is rich in biodiversity with at least 2,200 coastal fishes, 3,000 mollusc and 450 crab species (Samoilys et al., 2015). Local communities are highly dependent on marine resources with over 48.3 million people living within 100 km of the coast (Rocliffe et al., 2014; Van der Elst et al., 2005).
This study focused on the developing countries: Kenya, Tanzania, Madagascar, Mozambique and Comoros but also drew on lessons from the more developed WIO nations (Seychelles, Mauritius, South Africa and Reunion (France)) where local level fisheries are either minimal or coastal fisheries are more successfully managed.
Fishery types
This study is limited to those fisheries that are operated by local fishing communities; generally these equate with artisanal fisheries (see Definitions section below). These are briefly listed here by country.

Kenya
The marine fisheries of Kenya include the artisanal coastal fisheries and offshore fisheries. Nearly 80% of the total marine products are derived from shallow coastal waters and reefs, with only 20% from offshore fishing (Fondo, 2004). Dominant catches in the artisanal fishery include: marbled parrotfish (*Leptoscarus vaigiensis*), rabbit fish (*Siganus sutor*), sky emperors (*Lethrinus mahsena*) and common ponyfish (*Leiognathus equulus*) (McClanahan and Mangi, 2004; Maina et al., 2013). The fisher densities are between 4-22 fishers/km²/day with yields estimated at between 5 and 6 tons/km²/yr (McClanahan et al., 2008; Samoilys et al., 2017). Fishing effort has been increasing in recent years including the number of fishers, fishing gears and gear efficiency (State Department of Fisheries Frame Survey, 2012). Different management measures are applied in the management of marine resources. Common measures include gear restrictions (ban of spear guns and beach seines), area restrictions through establishments of marine protected areas (MPAs) and co-management through local institutions.

Tanzania
The marine fisheries of the Republic of Tanzania include the artisanal and commercial fisheries of mainland Tanzania and Zanzibar (the offshore islands of Pemba and Unguja) and Mafia Island. The estimated marine production is ~ 68,000 tons for mainland Tanzania and ~28,000 for Zanzibar (Jacquet and Zeller, 2007) and 95% of this production is from small scale fisheries. Commercial fisheries focus on prawns, lobsters, octopus and sea cucumbers. Foreign fishing vessels also exploit resources offshore in the EEZ. There are approximately 20,000 fishers and collectors on the mainland and an equivalent number in Zanzibar using traditional fishing vessels (dugout canoes, small dhows or boats, outrigger canoes (ngalawa), and larger dhows) and simple fishing gears such as traps, hook and line, gillnets, seine nets and spear guns (Jiddawi and Ohman, 2002). Unfortunately fishing using dynamite continues to be used despite being illegal. Apart from supporting fishers, the fishery also supports the livelihoods of several other fisheries resource users including collectors, processors, traders and people that repair boats and gear. The fisheries are managed by separate entities in mainland Tanzania and Zanzibar and the main management measures include gear restrictions (ban on beach seines, dynamite and spearguns), mesh size restrictions, marine protected areas and community fisheries management areas (CFMAs), restricted fishing zones and closed seasons (Mngulwi, 2003).

Mozambique
The marine fisheries sector contributes 3 % of total gross domestic product and consists of industrial, semi-industrial and artisanal fisheries. Artisanal fishing is carried out from small craft, 3 to 8 m in length and includes gears such as traps, beach seines and gillnets. The semi-industrial fishery is worked mainly by small trawlers and gillnetters, 10 to 12 m long. The national industrial fishery is for the moment exclusively a shrimp fishery, and it is expected that the Mozambican fleet will fluctuate...
in the near future between 40 and 50 units (IDPPE, 2009; Blythe et al., 2013). The total catch since 2000 is estimated at 115,000 to 140,000 tonnes per year of which artisanal fisheries contributes 87% (Afonso, 2006; Jacquet and Zeller, 2007). The artisanal catch is estimated at a value of at least USD 200 million (Swennenhuys, 2011). There are about 280,000 artisanal fishermen using 42,300 fishing gears, comprising surface gill nets (42%), hand lines (23%), beach seines (18%), traps, spear guns and gleaning. The catch is predominantly composed of finfish, crustaceans, mollusks, sea cucumbers, shark and squid. Apart from the national and provincial entities that are mandated to manage fisheries in Mozambique, there are three other institutions: the national fisheries research institute (IIP), the national institute for the development of small-scale fisheries (IDPPE; recently restructured and renamed IDEPA), and the Fisheries School. Management measures for the artisanal fishery include licensing, gear restrictions, marine protected areas and co-management committees called Community Councils of Fisheries (CCPs). There are about 315 CCPs, engaged in the participatory management of fisheries (Swennenhuys, 2011).

Comoros
The fisheries of Comoros are largely artisanal operated using hand lines and trolling lines on wooden dugout canoes and fiberglass boats (Hauzer, 2011). Artisanal fishing takes place in an area of over 160,000 km². Fishing communities in the country are interconnected and highly dependent on fishing and 20% of their total protein requirements are met from fish (Hauzer, 2011). As such fisheries knowledge is widely shared among community members and customary rules are employed that differ between different islands and villages. National legislation was revised in 2004 (Talla et al., 2004) and management measures include gear, season and time restrictions as well as marine protected areas (Cunningham and Bodiguel, 2006).

Madagascar
Three types of fisheries have been described for Madagascar: traditional, artisanal and industrial fisheries, which differ in terms of fishing gear technology. Traditional fishing is done on foot or in a dugout canoe as opposed to artisanal fishing, which is done using motorised boats with engines not over 50 horsepower (hp). Industrial fishing was characterised by the use of engines over 50 hp (De Young, 2006). In this review we focus on Madagascar’s traditional fisheries using De Young’s definitions. The 50hp division between artisanal and industrial fisheries appears somewhat arbitrary and we prefer to use a socio-economic definition whereby artisanal fisheries involve the gear owner being involved in the fishery, and are also largely using traditional gears (see Definitions below). Management of traditional fisheries encompasses measures such as a ban on the use of explosives, toxic substances, dive gears and electrical devices to stun the fish. Firms seeking to engage in traditional fisheries must seek authorisation from the Faritany Executive Committee President (De Young, 2006). By 2004 the traditional fisheries sector contributed 53 % of the total Malagasy marine catch.

Local communities are involved in the management of fisheries through fisher associations or groups. Traditional fishermen land about 30 % in volume of the total prawn resource, as such they are encouraged by the Ministry of Marine Resources and Fisheries (MRHP) and the Ministry of Agriculture and Rural Development (MADR) to create associations to ensure sustainable exploitation and management of prawn resources (De Young, 2006).
Background

Artisanal fisheries in the western Indian Ocean

Artisanal fisheries are the main source of dietary protein and employment for coastal populations in developing countries of the WIO (Van der Elst et al., 2009). Landings from artisanal fisheries constitute a high diversity of fish including sharks, fish, crabs, lobster, prawns, bivalves, octopus, sea cucumbers and other reef associated resources. Contribution of artisanal fishing to national landings varies between countries: Tanzania – 90 - 95%, Mozambique at least 75%, Comoros - 100%, and Madagascar - 73% (Van der Elst et al., 2009; Jacquet and Zeller, 2007).

Artisanal fisheries make valuable economic contributions to the livelihoods of the coastal communities in the region. In Tanzania for instance, artisanal fisheries employ more than 177,500 full time fishers with over four million people engaged in various fisheries related activities; notably fish processing, fish trade, fish marketing, fishing gear repair, and boat building and maintenance (MLFD, 2011; Sobo, 2012). However, current fishing practices in the WIO are largely unsustainable and in many areas finfish stocks are on the decline (Kaunda-Arara et al., 2003; McClanahan et al., 2008) while invertebrate fisheries such as sea cucumbers are on the point of collapse in most countries (Muthiga and Conand, 2014). Destructive fishing techniques further threaten ecosystem functioning particularly that of coral reefs when fishing with dynamite and beach seines (McManus et al., 1997; Samoilys et al., 2011a; McClanahan et al., 2011). This situation in the WIO reflects global patterns where artisanal fisheries continue to expand despite long-standing policy support for industrialisation of fisheries (Allison and Ellis, 2001). Action to address these problems on the ground in the WIO is still piecemeal, slow and on a scale that is too small to be of much consequence at an ecosystem level. The problem is exacerbated by lack of alternative income generating activities, poverty (Cinner et al., 2009) and the additive and synergistic effects of fishing and climate change (Cooley et al., 2009; Griffith et al., 2011).

Coastal ecosystems across the WIO region have also suffered from extensive habitat degradation from other direct human activities including pollution, coastal development, as well as stresses associated with recent extreme thermal events (Pereira, 2000; Conand and Muthiga, 2007; Carvalho and Gell, 1998; Van der Elst et al., 2005). Considering the predicted population increases in the region and increase in extreme climatic disturbances, this trend is most likely to continue (Maina et al., 2008; McClanahan et al., 2007; Christensen et al., 2007) further undermining the integrity of the WIO’s marine ecosystems and associated ecosystem services.

Nevertheless, there are a number of country-specific local approaches and strategies dating back to the 1990s that have improved the management of artisanal fisheries in the WIO. Some of these approaches are enshrined in global regulatory frameworks that support involvement of resource users in fisheries management. They include the FAO’s Code of Conduct for Responsible Fisheries (1995) and the Ecosystem Approach to Fisheries Management (EAFM), a framework that has been formally adopted by several governments, organizations and agreements since the 1990s (FAO, 1995; House of Lords, 1996; U.S. National Marine Fisheries Service, 1999; Garcia, 2003; Pikitch et al., 2004; Bianchi et al., 2008; Skern-Mauritzen et al., 2015). Currently FAO are producing Guidelines for Securing Sustainable Small-scale Fisheries which build on the Code for Responsible Fishing but within the context of small scale fisheries in developing countries, the rights of coastal people to food and nutrition and as a guide for empowering fishing communities to participate and take responsibility in decision making. Countries in the WIO have in the last decade increased community involvement in marine fisheries management and this can be seen in national fisheries and environmental legislation (see section on legislative context below). However, the level of participation by local communities is often subject to the prevailing local conditions and systems (Sobo, 2012) and can take considerable time to evolve. This is due to a variety of factors including poor capacity and poor access to technical information at the coastal community level.
Customary marine tenure

Traditional approaches to natural resource management such as through customary marine tenure, where total or partial protection has been practised for centuries (Johannes, 1981), have often been hailed as the answer to marine conservation (Johannes, 1978). In the Pacific this was viewed as the basis for community engagement in marine resource management and the importance of using traditional and other local ecological knowledge for devising management strategies was recognised (Berkes et al., 2000). However, present day examples of where this is working are few (Ferse et al., 2010). It seems such approaches are invariably foiled by more recent political and developmental events which override customary norms (Foale, 1998; Foale and Manele, 2004; Cinner and Aswani, 2007).

The few documented successful examples of bottom-up community-based approaches to marine protected areas (MPAs) can offer lessons, though none are from the Indian Ocean. These come from the Philippines (Lowry et al., 2009) with over 1100 MPAs, most of which are locally implemented; Brazil’s Marine Extractive Reserves (MERs, Diegues, 2008) and the Locally Managed Marine Areas (LMMAs) network in the Pacific (Govan et al., 2008). The primary factors that appear to have made these initiatives successful are: recognition of rights and responsibilities of local communities, transparent and unambiguous roles for participating authorities which requires supportive government legislation, and appropriate incentives for local ecosystem users (Ferse et al., 2010). Difficulties lie in the fact that no one set of solutions is appropriate for every location – the local context will drive the requirements (Ferse et al., 2010).

The development of the LMMA network in the Pacific

Marine areas where the local community has full or partial control over the management of marine resources in the area are usually termed “Locally Managed Marine Areas” or Local Marine Management Areas (LMMAs). The LMMA network in the Pacific draws its origin from Fiji when Ucunivanua LMMA was established in 1997, to address overfishing (Govan et al., 2009; UNDP, 2012). In the late-1990s, LMMAs spread rapidly largely because of a pilot programme that was implemented until 2001 by the Biodiversity Conservation Network (UNDP, 2012). In 2001, project stakeholders1 established a network that brought together all communities implementing LMMAs in order to share their methods and results. This network was called Fiji Locally-Managed Marine Area (FLMMA) and was responsible for planning and facilitating the programme (UNDP, 2012). The Network also aimed at:

- encouraging collaboration between key stakeholders to better manage fisheries resources;
- engaging in collective advocacy for LMMAs;
- creating joint policy briefs based on collective learning;
- encouraging the use of adaptive management as a key to achieving best practice.

By 2005, the Network included about 60 LMMAs, comprising 125 communities and covering about 20% of Fiji’s inshore fishery. In 2009, membership to the Network had grown to 250 LMMAs covering 10,745 km². Moreover the network had incorporated 235 management tools (e.g. MPAs) and 208 management plans (UNDP, 2012). While offering a network of support and guidance to local communities, recognition of the autonomy of local communities in the management of marine resources was part of the FLMMA network’s fundamental approach.

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1 NGOs, research institutes, government departments and community leaders
The LMMA network grew largely through a fisher’s forum that sought to create a peer-to-peer atmosphere where participants can share ideas, challenges and provide comments towards resource management in an open manner. The forum enables LMMA representatives (communities, NGOs, donors) to discuss common challenges the communities face in relation to resource sustainability; and share solutions that may be used to overcome the challenges. The network followed a set of steps in its establishment:

i) Developing a common goal; with clear objectives of the network.

ii) Developing the vision and mission of the network in a participatory manner.

iii) Drafting LMMA network activities and its implementation plan.

iv) Highlighting membership recruitment process and constitutions (Full members, provisional, etc.).

v) The LMMA Network should have a proper and simple strategic plan and governance structure portfolio (highlighting regular management, meeting schedules, funding mechanisms).
Definitions

A number of terms are used in this report which are defined below for ease of reference and clarification.

Table 1. Definitions of terms used in the report

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
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<tr>
<td>Artisanal fisheries</td>
<td>Those that operate using traditional fishing gears within coastal waters and the gear owner is involved in day-to-day operations (SDF, Kenya). Traditional fisheries involving fishing households (as opposed to commercial companies), using relatively small amount of capital and energy, relatively small fishing vessels (if any), making short fishing trips, close to shore, mainly for local consumption.</td>
</tr>
<tr>
<td>Coastal waters</td>
<td>Within 12 nautical miles of the shoreline.</td>
</tr>
<tr>
<td>Co-management of fisheries</td>
<td>When fisheries management frameworks involve fishers (community), government and other stakeholders.</td>
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<tr>
<td></td>
<td>“an arrangement where resource users and the government share responsibility in the management of fishery resources (Baticados and Agbayani, 2000) or “a partnership arrangement in which government, the community/local resource users (fishers), external agents (non-governmental organizations, academic and research institutions), and other fisheries and coastal resource stakeholders (boat owners, fish traders, money lenders, tourism establishments, among others) share the responsibility and authority for decision making over the management of a fishery (Pomeroy, 2001)”.</td>
</tr>
<tr>
<td>Commercial fisheries</td>
<td>Fisheries undertaken for profit and with the objective to sell the harvest on the market, through auction halls, direct contracts or other forms of trade (FAO, 2005)</td>
</tr>
<tr>
<td>Industrial fisheries</td>
<td>Capital-intensive fisheries using relatively large vessels with a high degree of mechanization and that normally have advanced fish finding and navigational equipment (FAO, 2005).</td>
</tr>
<tr>
<td>Locally managed fisheries</td>
<td>Involvement of local fishing communities in the management of a fishery: the extent of involvement may vary.</td>
</tr>
<tr>
<td>Small-scale fisheries (SSF)</td>
<td>Labour-intensive fisheries using relatively small crafts (if any) and little capital and equipment per person-on-board. Most often family-owned (FAO, 2005).</td>
</tr>
<tr>
<td>Spawning aggregation</td>
<td>A repeated concentration of conspecific marine animals, gathered for the purposes of spawning, that is predictable in space and time. The density/number of individuals is at least 4 times that found outside the aggregation. The spawning aggregation results in a mass point source of offspring (Domeier, 2012).</td>
</tr>
<tr>
<td>Traditional fishing gear</td>
<td>Made from organic materials traditionally used for centuries.</td>
</tr>
<tr>
<td>Locally Managed Marine Area; Community Managed Areas (CMA); Community Conservation Areas (CCA), Tengefu</td>
<td>An area of nearshore waters and coastal resources that is largely or wholly managed at a local level by the coastal communities, land-owning groups, partner organizations, and/or collaborative government representatives who reside or are based in the immediate area (Govan et al., 2008).</td>
</tr>
<tr>
<td>Marine Protected Area</td>
<td>A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (Dudley, 2008).</td>
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<tr>
<td>Sustainable Management</td>
<td>A resource management practice that seeks to replenish natural resources as fast as they are depleted and help prolong the life span of such natural resource in perpetuity.</td>
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<tr>
<td>Ecosystem Approach to Fisheries</td>
<td>To plan, develop and manage fisheries in a manner that addresses the multiple needs and desires of societies, without jeopardising the options for future generations to benefit from the full range of goods and services provided by the aquatic ecosystems (FAO, 2003).</td>
</tr>
<tr>
<td>Dina (effected by the GELOSE of Madagascar)</td>
<td>Community law generally communicated through oral tradition and customs though written down in some cases (Rakotoson and Tanner, 2006).</td>
</tr>
<tr>
<td>Beach Management Unit</td>
<td>An organization of fishers, fish traders, boat owners, fish processors and other beach stakeholders who traditionally depend on fisheries activities for their livelihoods.</td>
</tr>
<tr>
<td>Community Council for Fisheries (CCP – Conselho Comunitario de Pescas)</td>
<td>A local co-management structure established under the Marine Fisheries Regulations, 2003 (in Mozambique) with responsibility of supporting the sustainable management of the artisanal fisheries resources and with the right to establish the boundaries of the fishing area of the community, develop use and access rights (Swennenhuis 2011).</td>
</tr>
<tr>
<td>Indigenous Knowledge (Used synonymously with traditional and local knowledge)</td>
<td>Knowledge that is unique to a culture or society. This knowledge is passed across generations usually by word of mouth and traditional rituals. It is knowledge stored in peoples (men and women) memories and expressed in cultural values, beliefs, myths, proverbs, agricultural practices and materials (Grenier, 1998).</td>
</tr>
<tr>
<td>Payment for Ecosystem Services (also recognized as Conditional Credit/Cash Transfer)</td>
<td>A voluntary transaction where a well-defined environmental service (ES) (or a land-use likely to secure that service) is being ‘bought’ by a (minimum one) ES buyer from a (minimum one) ES provider if and only if the ES provider secures ES provision conditionally (Wunder, 2005).</td>
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History

Kenya

In pre-colonial times (before the 1920s) coastal fishers in Kenya performed several forms of traditional and customary practices considered as some form of fisheries management measures (McClanahan et al., 1997; Aswani et al., 2012). The practices were largely associated with alleviating any anxieties of dangers at sea and most importantly of preventing the spirits from directing fish away from the community (Glaesel, 2000a). By virtue of their authority and influence over where and how day-to-day fishing activities happened in fishing grounds, the elders were in charge of traditional management systems. These encompassed a suite of taboos such as prohibiting the use of poison to capture fish, dissent over capturing of juvenile fish, and not catching more fish than could be used (McClanahan et al., 1997; Alidina, 2005). They specifically regulated access to fishing grounds by demanding compensation fees from alien fishers in exchange for authorisation to fish in an area (McClanahan et al., 1997). In some cases, access to fishing and trading of fisheries produce was also controlled through kinship and clan affiliation (Horton, 1996, in Aswani et al., 2012). Such measures were understood to be critical in conserving fish stocks (Glaesel, 2000a) though control of access to fishing sites proved increasingly difficult (Alidina, 2005).

During the colonial and post-colonial period, the role of customary fisheries management was drastically reduced as the government took over fisheries management (Aswani et al., 2012; Cinner et al., 2012). Both the colonial and the Kenya government after independence employed the western style fisheries management model that did not take the traditional rules and regulations of local communities into consideration. This led to abandonment of indigenous management strategies that were once used in the management of small-scale fisheries. The role of elders was further weakened by inter-generational conflicts and the emergence of relatively new gears such as beach seines and ring nets, which are controversial because of their damaging impacts, but are widely preferred by younger fishers for a variety of socio-economic reasons (Glaesel, 2000a; Obura et al., 2002; Samoilys et al., 2017). This has weakened the existence of informal fishing access arrangements. A lack of formal tenure of fishing grounds by traditional management units, the overlap in the use of fishing grounds by fishers operating from adjacent landing sites, and varying degree of respect for the elders mostly by migrant and younger fishers (Alidina, 2005), have also all helped weaken traditional approaches. Key impediments to traditional fishery management frameworks are thus gear use, age and origin of fishers (Glaesel, 2000b).

Comoros

Pre-Islamic traditional beliefs and practices related to fishing are an important component of management of local fisheries in Comoros, but are gradually being replaced by Islamic beliefs (Hauzer, 2011). Islamic rituals related to fishing comprise Koran reading and conducting prayers to ask Allah to: sustain fish catches, provide protection against evil spirits found at sea, and keep the sea peaceful.

Often fisher groups (Organisations Professionnelles de la Pêche, see below) employ customary fisheries management regulations in line with restrictions on gear (e.g. prohibitions on gillnets, dynamite, and the use of an ichthyotoxic [fish poison] plants), area and species (e.g. ban of the use of Skipjack tuna and Indian mackerel as bait). Moreover they are involved in carrying out restrictions that are largely based on social taboos such as catch restrictions (e.g. capturing only what can be consumed or sold daily) and temporal restrictions (e.g. not fishing during prayer days). Local fishers elect their management committee based on criteria of knowledge, skills, and social status. Often the president, the head of the association, is an older, experienced fisher that commands respect of others fishers as well as having strong leadership skills.
Madagascar
Local management of resources can be traced back to the 9th century in Madagascar, when the system of Fokonolism (village councils) developed, allowing village elders in both highland and coastal kingdoms to enact regulations and exert a degree of local control (Rakotoson and Tanner, 2006). Today, Malagasy environmental policy is based on a Charter adopted in 1990 (Billé and Mermet, 2002). Management of both terrestrial and marine protected areas is governed by the Code des Aires Protégées (COAP), though there is a clear bias towards terrestrial ecosystems, given the focus of the environmental sector on terrestrial biodiversity conservation within this island ‘hotspot’ (Cinner et al., 2009). Given this policy framework, early MPAs such as Nosy Antafana and Masoala were initially established through a top-down procedure rooted in terrestrial conservation, largely without community involvement (Cinner et al., 2009).

Following Madagascar’s independence from France in 1960 one of the traditional values recovered was the social code. In rural communities, this social code – known as the dina – is a community law, communicated through oral tradition, though written down in some cases (Rakotoson and Tanner, 2006). In 1996, the Malagasy Government introduced the Gestion Locale generally Sécurisée (GELOSE) framework (law 96-025), a first legal mechanism that is designed to integrate the dina with governmental laws to enable community-based management of natural resources (Rakotoson and Tanner, 2006).

Seven years later, at the fifth World Parks Congress in Durban, South Africa, the Malagasy president recognised the need to protect the country’s unique natural assets and committed to the Durban Vision, a national conservation plan to more than triple the amount of protected area coverage (Durbin, 2007). This was codified into law shortly afterwards as a new decree (Décret d’Application No 848-05) for the existing COAP (Durbin, 2007). The decree set up a System of Protected Areas of Madagascar, or SAPM, which simplified and redefined the legal process used in protected area creation (IRIN, 2006). Under this more flexible model, community organisations, NGOs and the private sector are permitted to manage protected areas, in addition to the parastatal protected areas agency Madagascar National Parks (formerly ANGAP) (Rabearivony et al., 2010). During the World Parks Congress in November 2014 in Sydney, Madagascar’s President promised to triple the number of MPAs in Madagascar. The President also announced plans to establish a legal framework to help secure community based management and to protect community management of fishing grounds.

Tanzania
During the pre-colonial period, fisheries were primarily artisanal and controlled by customs, taboos and traditional ownership of resources (Mbilinyi et al., 2007; Masalu et al., 2010). The traditional management system was based on communal rights vested in a community or clan leaders and often extended to the landing beaches. A review of indigenous knowledge regarding fisheries and marine habitats in Tanzania (Masalu et al., 2010) showed a wealth of traditional practices that either directly played a role in the management of fisheries resources or that had a potential to impact fish stocks and the marine habitat, but that have been eroded over time. For example, customary marine tenure existed and to some extent still exists in the form of area restrictions on fishers and guarding. Restrictions included limits on the number of gears in an area creating an informal limited access within a fishing ground, limits on youth fishing where elders fish, and known areas limited to specific fishers. There were also agreements that served to limit competition amongst and between gears such as agreements amongst basket trap fishers to deploy traps in such a way as to reduce conflict and destruction of gear as well as zoning to separate trap and net fishers to limit competition between the two types of gears. In addition, there were many taboos and customs that potentially limited fishing pressure and protected fish habitats. These included dietary restrictions due to religious and customary beliefs such as not eating species like sea turtles that live both on land and in the sea, species that should not
be eaten by pregnant women, and so forth. There are also numerous taboos that led to restrictions on fishing, for example, restriction on fishing before the burial of a village member, and using unclean gear and vessels. There was also evidence of the management of single stocks such as octopus, where seasonal closures, control of gears and limits of ‘outside’ fishers were used to manage the stock. Fishing was also limited in places that were considered sacred such as some mangrove forests as well as around some reefs, islands and sandbanks that were associated with evil spirits, and traditional healers were often consulted for guidance on when and where to fish.

Fisheries management shifted to government control during British colonial rule (1920 to 1970) of Tanganyika regulated under the colonial Fisheries and Trout Protection Ordinances (Hoza et al., 2005). The ordinances were repealed after independence and replaced by the Fisheries Act No. 6 in 1970 following the creation of a Fisheries Division in the Ministry of Natural Resources and Tourism in 1964. After independence, Tanganyika and Zanzibar became a Union, the United Republic of Tanzania. Fisheries resources in Zanzibar, that became a semi-autonomous state, were managed by the Zanzibar Department of Fisheries and Marine Resources under the Zanzibar Fisheries Act of 1988. In the 1980s, major restructuring of the economic and political systems in Tanzania led to more market-based and collaborative approaches. The management of fisheries was then devolved through the National Fisheries Sector Policy and Strategy Statement (1997) from government to communities. Fisher communities were thus assured involvement in policy formulation and implementation, responsibility over landing sites and formulation of by-laws for exploitation of fisheries resources. This was further strengthened through the initiation of a co-management system that was formalised under the Fisheries Act No. 22 of 2003 and Fisheries Regulations of 2005 for Beach Management Units (BMUs). The BMU Regulations provided that village governments and communities would form BMUs, all fishers would be members and licensed, and monitoring and surveillance would be carried out in collaboration with the Division of Fisheries. Co-management in Zanzibar was instituted in 1994 through Village Fisheries Committees (VFCs) that are equivalent to the BMUs in mainland Tanzania and are responsible for managing fisheries resources in collaboration with the Department of Fisheries (Cinner et al., 2012).

**Mozambique**

The fisheries of Mozambique are traditionally defined into four distinct periods (colonialism, periods of war, socialism, and free-market economy) dating back to the 16th century when the Portuguese first arrived in Mozambique (Ehnmark and Wästberg 1963, Blythe et al., 2013). Subsistence fishing has been practiced since the colonial period and was confined to the immediate coastal waters, bordered by villages that were headed by a village head (Secretaria do Bairro) who was often guided by social and cultural practices of coastal communities (Lopes and Gervásio, 2003; Momade, 2005). In the early 1960s, the Portuguese began to recognize the export earning potential of a shrimp fishery (Jacquet and Zeller, 2007). Following an armed campaign that commenced in 1964 by the Front for the Liberation of Mozambique (FRELIMO) that ended ~ 500 years of colonial rule, FRELIMO established a socialist state that nationalized and invested in an industrial fishery (Menezes et al., 2011). The trawling ban that was imposed by the colonial fishery law was overturned allowing the development of a semi-industrial fishery whose fleets were initially owned and operated by crews from Portugal (Menezes et al., 2011; Blythe et al., 2013).
In the early 1980s FRELIMO introduced fishing cooperatives (called *Combinados Pesqueiros* or Combinados de Pesca de Pequena Escala) (Menezes et al., 2009; Blythe et al., 2013) focused on meeting state production targets and as support nodes for small-scale fishers by providing fishing gear, building processing facilities and increasing access to central markets resulting in livelihood security in the small-scale sector (Menezes et al., 2011; Blythe et al., 2013). Little legislation was adopted for fisheries and resource monitoring was limited due to the civil war from 1977 (Afonso, 2006). However, the conflict resulted in many people being displaced from the interior to coastal areas with most of them turning to fishing for their livelihoods, thereby increasing pressure on marine resources (Menezes, 2008; Menezes et al., 2009; Menezes et al., 2011; Azevedo, 2002; Blythe et al., 2013).

Following adoption of the structural adjustment programmes of the International Monetary Fund in 1987 and then amendments to the Constitution in 1990, Mozambique established its first Fisheries Act (Mozambique Ministry of Fisheries, 1995; Blythe et al., 2013). After two decades of war, a ceasefire agreement was signed in 1992 that allowed the country to transform to a free market economy. These economic and political shifts saw a reduction in direct intervention by government through the provision of services, and the creation of local governance institutions as early as the 2000s. Extension programmes focused on establishing saving and credit groups (called poupança e crédito rotativo, or PCR), and community fishing councils led to transformations in the relationship of government with small-scale fisheries. For example, conselho comunitário de pesca, or CCP) were established to enforce fishing regulations and facilitate PCRs (Menezes, 2008; Menezes et al., 2009; Blythe et al., 2013). This period also saw the government strongly promoting fisheries co-management (Mozambique Ministry of Fisheries, 1995).

In summary, during the last few decades, fishers along Mozambique’s coast have witnessed, participated in, and responded to, radical transformation within their socio-cultural systems, and the fisheries are thus characterized into three sectors: artisanal, semi-industrial and industrial.

**Legislative context**

This section briefly summarises current legislation that is relevant to the local management of fisheries in the countries involved in this study. Various forms of locally based management structures are present in the WIO with a number being common in neighbouring countries. Kenya and Tanzania for example, share the concept of co-management through the fisheries departments’ Beach Management Units (BMUs). However, in most instances state power structures adopted a top-down approach towards natural resource management until it became obvious that reforms were necessary to facilitate better management (Ferse et al., 2010). There were inadequacies in existing legal and institutional frameworks, hindering the involvement of local communities in co-management (Samoilys et al., 2011b). Rules have been developed, especially where traditions are lacking, based on emerging issues that needed to be addressed. Conservation of the marine environment is also faced with the lack of separate or clearly defined policy, especially in Madagascar and Comoros (Cinner et al., 2009; Rocliffe et al., 2014). This stems from where the legislation originated from. For instance establishment of early MPAs in Madagascar (Nosy Atafana and Masoala) failed to involve the community and was largely rooted in a terrestrial conservation framework. That said, customary management as informed by indigenous ecological knowledge, has been used to regulate the use, access, and transfer of resources. Country-specific management approaches and legislation relevant to local management of fisheries is summarised in Table 2 below.
<table>
<thead>
<tr>
<th>Fisheries institution</th>
<th>Legislation/regulation/policy</th>
<th>Description</th>
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<tbody>
<tr>
<td></td>
<td>Ecosystem Approach to Fisheries Management of 2009</td>
<td>An extension of conventional fisheries management recognizing more explicitly the interdependence between human well-being and ecosystem health and the need to maintain ecosystems productivity for present and future generations.</td>
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<td></td>
<td>Nairobi Convention (1985)</td>
<td>Provides focus on ecosystem-based management through promotion of sustainable development and sound management of regional coastal and marine resources. Further notes the need for protection through preservation of habitats, protection of species and the careful planning and management of human activities that affect them.</td>
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<td></td>
<td>Ramsar Convention (1971)</td>
<td>Allows for protection of marine sites (to 6m depth at low tide) of international importance. Sites require managing but are permitted “wise” use. The Convention’s mission is “the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world”.</td>
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<td></td>
<td>UNESCO Convention Concerning the Protection of the World Culture and Natural Heritage (1972)</td>
<td>Convention provides for the “identification, protection, conservation, presentation and transmission to future generations of the cultural and natural heritage” of national and international importance by party states.</td>
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<td><strong>Kenya</strong></td>
<td>Ocean and Fisheries Policy, 2008 (under review)</td>
<td>The policy aims “to enhance the oceans and fisheries sector’s contribution to wealth creation, increased employment for youth and women, food security, and revenue generation through effective private, public and community partnerships”. It provides a coordinated framework for addressing the challenges facing the Kenya’s fisheries sector and guidance on the sustainable development of fisheries.</td>
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<td>Ministry of Agriculture, Livestock and Fisheries, State Department of Fisheries</td>
<td>Fisheries Act Cap 378, (Rev. 2012)</td>
<td>The Act places restrictions on certain fishing gears and also provides for establishment of BMUs through the Director of Fisheries, to enable co-management of fishing activities.</td>
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<td></td>
<td>Beach Management Unit (BMU) Regulations, 2007 (Legal notice 402)</td>
<td>The BMU regulation empowers the Director of Fisheries to designate co-management areas where BMUs shall operate in consultation with relevant stakeholders.</td>
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<td>Ministry of Environment, Water and Natural Resources</td>
<td>Forest Act 2005</td>
<td>The Act encourages involvement of local communities in the management of forests including mangroves through formation of Community Forest Associations (CFAs). Section 40 (1) (h) states that indigenous forests shall be managed on a sustainable basis for purposes such as fisheries.</td>
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<td></td>
<td>Wildlife (Conservation and Management) Act 2013</td>
<td>Act has transformed the governance of protected areas, which are now been taken to the county level through the formation of the County Wildlife Conservation and Compensation Committees. Section 36 provides the criteria to be followed for establishment of marine conservation areas including areas rich in biodiversity or harbouring endangered and threatened marine species or consist of a critical habitats for a variety of marine resources.</td>
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<tr>
<td>Fisheries institution</td>
<td>Legislation/regulation/policy</td>
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<tr>
<td><strong>Tanzania mainland</strong></td>
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<tr>
<td>Fisheries Development Division</td>
<td>Fisheries Act No. 22 of 2003 Fisheries Regulations of 2005</td>
<td>Section 18 of the Act provides for the establishment of BMUs (Community Based Collaborative Management Units).</td>
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<td><strong>Zanzibar</strong></td>
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<tr>
<td>Ministry of Livestock and Fisheries</td>
<td>The Fisheries Act No. 7 of 2010</td>
<td>Management and development of fisheries in the Zanzibar territorial waters including promoting research and monitoring, and controlling all fisheries related activities in the artisanal and semi-industrial fisheries of Zanzibar.</td>
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<td>Department of Fisheries Development</td>
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<td><strong>Mozambique</strong></td>
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<td>Ministry of Fisheries National Fisheries Administration Institute for the Development of Small-Scale Fisheries (IDPPE, now IDEPA))</td>
<td>Fisheries Act Marine Fishery Regulation of 2003.</td>
<td>Governs the adoption of an array of fisheries management and conservation measures. Introduced the 3 miles nautical zone for exclusive use by artisanal fishers, as well as the concept of participatory co-management of marine resources through community level fisheries councils (CCP - Conselho Comunitário de Pescas) and the multi-stakeholder Co-Management Committees (CCG – Comité de Co Gestão).</td>
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<td></td>
<td>Fisheries Master Plan (PDP 2012-2019)</td>
<td>One of the objectives of the plan is to ensure the sustainability of exploitation of resources and the preservation of the biodiversity of aquatic ecosystems.</td>
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<td></td>
<td>Fisheries Policy and Implementation Strategy (1996)</td>
<td>Aims to maximise economic benefits whilst ensuring sustainable harvesting of the resource</td>
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<td><strong>Madagascar</strong></td>
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<td>Ministry of Agriculture and Fisheries (MAEP) Directorate of Fishing and Fish Resources</td>
<td>Gestion Locale Sécurisée (GELOSE)</td>
<td>The Act allows communities to define their own goals and develop regulations for resource use and management in the form of by-laws, as long as these rules are consistent with national policy. Through GELOSE, communities, as the main resource users, have the right to manage terrestrial resources (mangroves are the only marine resources where management is transferred to communities) over a 3 years renewable contract.</td>
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<td></td>
<td>Fady and dina</td>
<td>Fady are taboos constraining a particular (coastal) activity in a particular location. Dina is a local law, which is grounded on Malagasy social code and used to regulate coastal resource use.</td>
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<td><strong>Comoros</strong></td>
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<tr>
<td>National Research Institute on Agriculture, Fisheries and the Environment</td>
<td>National Decrees on globally significant species: Coelacanth (Arret no 074 – 029 of 12 Feb, 1974) Marine Turtles (Decree no 79 of 9th April, 1979) Shells (Arret no 89-027 of 27th November, 1989)</td>
<td>These decrees are specific for the protection of globally significant species of coelacanths, marine turtles and shells.</td>
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<td></td>
<td>Foreign Vessels law no 82 015</td>
<td>Specifies conditions of fishing activities in Comorian waters, placing systems of licensing, procedures and fines for foreign vessels.</td>
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</table>
Kenya and Tanzania

The concept of BMUs was initiated in the three countries bordering Lake Victoria (LVFO, 2005); they emerged in Tanzania in 1998 and thereafter dispersed to Kenya and Uganda. The BMUs were structured in a manner to maximise support from all stakeholders to enable management of fisheries (Vaccaro et al., 2013). The Beach Management Unit (BMU) is defined as an organisation of fisher folk at the landing site (i.e. boat crew, boat owners, managers, fish processors, fish mongers, local gear makers or repairers and fishing equipment dealers) within a fishing community. BMUs are specifically involved in co-management of fisheries resources within fishing grounds adjacent to the beach landing site. Through this approach, management is de-centralised from the government (Kamau et al., 2007). Responsibilities for management of fisheries resources are shared with the coastal communities/resource users who then actively participate in decision-making, implementation, and monitoring. In essence, BMUs provide a framework to bring together all stakeholders involved and who show an interest in fisheries resource management. The approach links both ecosystem and human aspects endeavouring to achieve sustainable fisheries utilisation as enshrined in the “ecosystem approach to fisheries management”.

The BMU structure consists of an assembly, an elected executive committee and one or more thematic sub-committees. The legal mandate for the operationalization of BMUs in Kenya was issued in 2007, but the Fisheries Policy (National Oceans and Fisheries Policy, 2008) that will guide the management of fisheries within Kenyan territorial waters has been in review since 2010. In Tanzania the National Fisheries Sector Policy and Strategic Statements (1997) also promotes conservation, development and sustainable management of the fishery resources for the benefit of present and future generations. This policy is also undergoing review in light of changes in fishing technologies (Mbilinyi et al., 2007).

Mozambique

Two types of local co-management structures exist in Mozambique encapsulated under the Marine Fisheries Regulation of 2003: the Community Council for Fisheries (CCP – Conselho Comunitário de Pescas), and Committee for Co-Management of fisheries resources (CCG – Comité de Co-Gestão) (Swennenhuis 2011; Roccliffe et al., 2014). CCPs are responsible for supporting the sustainable management of artisanal fisheries and establishing the boundaries of the fishing area of the community including developing use and access rights. The process of establishing CCPs is facilitated by the National Institute for the Development of Small Scale Fisheries (IDPPE)’s artisanal fisheries support programme. The CCGs are formed at various levels. Those formed at district and local levels are mainly responsible for artisanal fisheries. A CCG is made up of various stakeholders involved in fisheries, notably government, communities and the private sector. Noteworthy are the associations of fishers, which preceded the CCPs and CCGs in their establishment and play almost similar roles as the CCPs, though they are formally registered as associations (Swennenhuis, 2011). The overall coordination of Mozambican fisheries is vested with the Ministry of Sea, Inland Water and Fisheries created by Presidential Decree nr. 1/2015, of 16 January, and repealing Presidential Decree nr. 1/2000 of 17 January. (Mozambique, 2015).

Madagascar

Previous management of marine resources was largely top-down despite the general lack of a distinctly defined national policy for the marine environment and for biodiversity conservation (Cinner et al., 2009). Sharing of responsibility of natural resource management between government
and Malagasy resource users was legally recognized in 1996 through establishment of Gestion Locale Sécurisée (GELOSE). The law permits communities to come up with their own goals and develop rules for resource use and management. The developed rules (i.e. by-laws) should be consistent with national policy. For instance one is not permitted to pass a law that permits the use of a gear that is banned by the national legislation. Before GELOSE policy becomes effective a signed agreement between three entities is needed: a competent technical service in charge of natural resource (decentralized representatives of the Ministry concerned with the resource management), the Mayor of the administrative territorial subdivision (e.g. rural municipality), and the newly created management committee that represents the group of resource users (Antonna et al., 2004; Cinner et al., 2009; Rakotondrazafy, 2015).

**Comoros**

Management of fisheries is informally shared at three levels: state fisheries departments, national and island fishing syndicates, and village fishing associations. At a local level Comorian fishers are organised in village fishing associations (Organisations Professionnelles de la Pêche). These associations also build cohesion and provide financial assistance to members. The creation of user groups is permitted under Comorian legislation, though they are not allowed to devise and legally enforce management regulations. The Organisations Professionnelles de la Pêche play a pivotal role in managing fisheries in their own communities by assuming the collective roles of designing, monitoring and enforcing local regulations (Hauzer, 2011). With poor national level capacity due to limited staff, resources, expertise and funding, the Organisations Professionnelles de la Pêche is the main tool involved in implementation of fisheries management strategies and regulations such as gear restrictions, monitoring, and penalising violators of the rules (Hauzer, 2011). These management strategies are usually adaptive and based on low-cost practical solutions and decisions made on the basis of local knowledge and experience.

**Local fishery institutions**

There are several informal local fishery institutions that exist in the WIO that are not captured in legislative frameworks which include cooperatives, informal fisher groups and Community Based Organisations (CBOs). Not surprisingly, it is difficult to find documentation on these institutions. The few samples presented below illustrate their existence and activities.

**Fishing Cooperatives**

Rasini Fishermen Cooperative in Faza, Pate Island, Northern Kenya, is one of the few fisher cooperatives on the Kenyan coast with about 150 members out of the approximate 500 fishermen in the area (FiD, 2004, Maina et al., 2011). It appears to be strong, well governed, organised and active.

**Community Based Organisations (CBOs)**

Several community based organisations have been active in setting up local LMMAs in the region. For example in Kenya the Lamu Marine Conservation Trust (LamCot) helped set up Kiweni Reserve in Pate; the Kuruwitu Conservation and Welfare Association (KCWA) helped set up the first coral reef marine community conservation area in Kuruwitu, just north of Mombasa.
Case studies: Local approaches to managing fisheries

One of the primary mechanisms for local fisheries management that has emerged in the last decade in the WIO is the establishment of LMMAs by coastal communities (Rocliffe et al., 2014). LMMAs in the WIO are defined as near-shore areas, largely or wholly managed by local people, often in collaboration with local government. LMMAs in the region have often been established through a fisheries management body such as the Beach Management Units (BMUs) in Kenya and the Community Fisheries Councils (CCPs) in Mozambique, or through governance systems that combine both customary and national level law as seen in the System of Protected Areas of Madagascar (SAPM). While Kenya and Madagascar are leading the way in the region with the largest number of LMMAs, Tanzania, Mozambique, Comoros, and Mauritius are increasingly embracing this concept (Rocliffe et al., 2014).

Other fisheries management initiatives that have been implemented recently include fishing gear modifications, local level efforts to remove illegal and destructive fishing gears and the protection of spawning aggregations of target fishery species. Most of these are at early stages or are small pilot scale initiatives. In this section we document case studies of successful local fisheries management approaches, many of which are still poorly documented but are locally heralded as positive initiatives. The following sections describe these various initiatives in detail and Figure 2 shows where the case studies are situated.

Figure 2. Map showing the locations of case studies in the western Indian Ocean.
Locally Managed Marine Areas (LMMAs)

In the WIO, coastal communities have started to become actively involved in inshore management of marine resources through co-management partnerships with governments and non-state actors (Cinner et al., 2012; Roccliffe et al., 2014). In Kenya for example, coral reef-based LMMAs (referred to variously as Community Managed Areas (CMAs), Community Conservation Areas (CCAs) and *tengerfu*), have increased from one in 2006, to 13 by 2011 (Maina et al., 2011), to 19 by 2015 (Kawaka et al., 2015; McClanahan et al., 2016; see Figure 3). Similarly in Madagascar LMMAs have taken off since a government decree set up a System of Protected Areas of Madagascar which simplified and redefined the legal process used in protected area creation (IRIN, 2006). Under this more flexible model, community organisations, NGOs and the private sector are permitted to manage protected areas (Rabearivony et al., 2010). Since then, several LMMAs have been established along the coast by NGOs working with local communities (see Madagascar case study). In Tanzania co-management was first tested in Tanga under the Tanga Coastal Zone Conservation and Development Programme (TCZCDP) that established collaborative management areas (CMAs) over a 12-year period (Wells et al., 2007). TCZCDP has been central to coastal zone management in Tanga region, and is one of the first coastal management programmes in the WIO to make livelihoods improvement a central objective, and one of the first to take a community-based approach to planning as well as implementation (Wells et al., 2007; Samoilys and Kanyange, 2008). Like Kenya, the country also restructured fisheries management institutions and small-scale fisheries are managed by communities through BMUs (in mainland Tanzania) and Village Fishing Committees in Zanzibar.

![Figure 3. Map showing the location of 24 LMMAs in Kenya, of which 5 are mangrove board walks. (Source: Kawaka et al., 2015).](source)
Fisheries closures in Kenya

Closures of some sort have existed on the Kenyan coast since the first marine national parks, Malindi and Watamu Marine National Parks, were established in 1968 (Muthiga, 1998; IUCN, 2004). These closures however, were established specifically for marine or biodiversity conservation although they had the potential to positively impact fisheries stocks. Up until the 1990s, fisheries management was state-led with little involvement of local communities but this shifted in the 2000s due to structural and political changes in Kenya (Cinner et al., 2012). The subsequent restructuring of national institutions under the Public Sector Reform process in Kenya (Kobia and Mohammed, 2006) ultimately resulted in the rationalisation of government organisation to services and legislation that was more responsive to the development needs of citizens. The Beach Management Units Regulations (2007), for example, empowered fishing communities to manage their fishing grounds and allowed the implementation of management measures including area closures in the form of by-laws conforming to the Fisheries Act and its subsidiaries.

These area closures, locally called *tengefu* in Kiswahili, have proliferated since the mid-2000s stimulated in part by WCS’ Fishers’ Forum (see below) and an exchange visit organized by the East African Wildlife Society for the KCWA to visit the TCZCDP in Tanzania where communities had been managing closures within designated collaborative management areas since the mid-1990s (Wells et al., 2007). The KCWA subsequently established a closure in 2006 (Figure 3), which has in turn stimulated other communities to establish closures (Kawaka et al., 2015). Experiences from the evolution of the “*tengefu movement*” and their social and ecological outcomes show the effectiveness of these management systems (Cinner and McClanahan, 2015; McClanahan et al., 2016). Most of these have been enabled through the new approaches of fisheries co-management (Cinner et al., 2012) based on the legally established and formally recognised local institutions, the BMUs.

There are currently 24 community closures that are at different stages of development along the Kenyan coast, mainly concentrated in southern Kenya (Figure 3; Kawaka et al., 2015) of which 19 are coral reef-based. Thirteen of these *tengefu* have been supported by WCS and have followed a similar planning process. This starts when communities, often led by the BMU leaders, indicate an interest in establishing a *tengefu*, usually at the annual Fishers’ Forum (see below). Consultations are then carried out within the community and with other stakeholders in the area to gauge initial interest and willingness to establish a *tengefu* and to discuss the potential area of closure. Once an area is identified and while consultations continue, ecological and socio-economic assessments are conducted and the site is subsequently included in WCS’ monitoring programme. Once agreement is reached amongst the community, a participatory mapping exercise is completed and the area is demarcated for closure. The *tengefu* becomes operationalised after all these steps are completed and a caretaker committee is formed. The next step in the harmonization of the *tengefu* is the incorporation of the *tengefu* into the BMU by-laws. This requires the development of co-management plans and the County Fisheries offices have pledged to start undertaking this process in the coming year. Because the BMU regulations require all artisanal fishers to be licensed and to be members of a BMU, it is hoped that all landing sites along the coast will eventually be incorporated within BMUs and all BMUs will be registered and managed under a co-management plan. Ultimately, all *tengefu* will therefore be incorporated into the by-laws of the BMUs within which they occur. A broadly similar process has been followed by all marine community conservation areas in Kenya (Murage et al., 2010; Maina et al., 2011) which has been described in five phases in a recent review by CORDIO and partners: i) Conceptualisation, ii) Inception, iii) Implementation, iv) Monitoring and Management; and v) Ongoing adaptive management (Kawaka et al., 2015). A community closure needs to pass through all five phases before it is fully established and operating. The review found all community conservation areas lack strategies for education and awareness, marketing, financing and monitoring. Management structures were also generally fairly weak. Confusion over the legal basis of community conservation areas was also apparent. Legislative guidelines are a vital component of the national guidelines on LMMAs currently under development in Kenya. Most community conservation areas have tackled this issue late in the establishment process.
Kenya’s *tengifu* ranged in size from 0.12 to 0.7 km$^2$ to 2014, but in 2015 The Nature Conservancy (TNC) and partners established large marine conservancies in the north of Kenya which are 9 to 17 km$^2$; all are coral reef-based and nearshore. The communities have selected areas with healthy coral cover and most *tengifu* have higher coral cover on average than the national marine parks but have very low fish biomass (McClanahan et al., 2016). Annual monitoring of the oldest *tengifu*, Kuruwitu, showed increased coral cover and finfish biomass indicating the effectiveness of this closure. Kuruwitu *tengifu* has received support not only from NGOs such as EAWLS and WCS but also from donors and a local landowner in the Vipingo area, which has greatly enhanced the ability of this community to manage the closure. However, despite the overall enthusiasm for establishing *tengifu* in Kenya, there remain several challenges, chief amongst which is the lack of management capacity. WCS with funding from MASMA and the Darwin Initiative is now working with ten *tengifu* focusing on training in adaptive management. In addition, because the main impetus for the establishment of *tengifu* is fisheries recovery and the potential for revenue generation through tourism, there is a need to work with development partners on alternative livelihoods.

**Controlling fishing practices**

Customary measures applied by local communities globally in the management of tropical fisheries include limiting the spatial areas of fishing (spatial restrictions), restricting fishing activities during specific time periods (temporal restriction), prohibiting the use of particular fishing gears (gear restrictions), limiting who is allowed to fish (effort restriction), prohibiting harvest of certain species (species restrictions), and restricting the quantity of fish to be harvested (catch restrictions) (Cinner and Ashwani, 2007). Many of these are found in the WIO. For example, gear restriction through customary rules played a major part in exclusion of a destructive illegal gear, beach seines, in some south coast landing sites of Kenya (McClanahan et al., 2008). In Kiweni Reserve off Pate village in the north of Kenya, the local community prohibits the use of any fishing gear within the reserve. Gleaning using spears is the only fishing technique allowed in the LMMAs in the south west of Madagascar. These LMMAs enforce regular closures of around a quarter of a community’s gleaning grounds for 2-4 months (http://blueventures.org/). Taboos (*fady*) in Madagascar are inflexible (Cinner, 2007), which gives room for an effective gear restriction. In Nosy Berafia, taboos have restricted the residents to only using fishing traps. The fishing community around Moheli Marine Park in Comoros has prohibited the use of poisons, drift nets, spears, dynamite, and fishing at low tide on the reef (Granek and Brown, 2005), though this is not strongly enforced (MS pers. obs., 2009).

In Kenya an innovative approach to gear modification is being considered in the basket trap fishery. The basket trap fishery accounts for over 40% of the fish landed in Kenya (Ministry of Fisheries Development, 2012; Maina et al., 2013). Although traps are used to target commercially valuable fish, they often retain all the fish that enter the trap leading to high bycatch rates of juveniles and non-target species including ecologically important herbivores. This has the potential to cause over-exploitation even at low fishing effort (Hardt, 2008). Experiments in Kenya and Zanzibar have shown that modifying basket traps (Figure 4) with escape gaps - gates constructed along the arms of traditional basket traps - reduces bycatch of juveniles and key herbivores (Gomes et al., 2013; Mbaru and McClanahan, 2013). In addition, the catch in the modified traps was composed of larger and heavier fish thus enhancing the quality and economic value of the catch because larger fish fetch disproportionately higher prices. By enabling fishers to trap larger fish and higher proportions of high value fish, the long-term sustainability of the fishery is improved as well as enhancing food security.
Figure 4. Illustration of a traditional basket trap (control trap) and a trap with escape gates (Gated trap).

The trap modifications are inexpensive and easy for local communities to implement and therefore have the potential to be used widely across the region. However, before escape gap traps can be used as a fisheries management tool for large-scale use, there is a need to test them at the level of the whole fishing ground and at different fishing grounds. This would provide important comparisons between fishing grounds and landing sites since they have different ecological and socio-economic characteristics as well as provide information from a large group of fishers on the conditions that allow effective adoption of new technologies by small-scale fishers in Kenya. In addition, the socio-economic outcomes of using these traps need to be determined as well as the training needs for the BMUs that would ultimately further the adoption of this technology. Such studies would provide invaluable lessons on the social, ecological and management conditions that provide the best results. WCS is currently testing the modified trap at the whole fishing ground level within the Mombasa Marine Reserve (Jomo Kenyatta Beach). Fishers at several other BMUs indicated a willingness to trial the traps during the 2014 Fishers’ Forum (see below) at sites that are adjacent to long-term WCS ecological monitoring sites. In addition the Fisheries component of the government led World Bank funded Kenya Coastal Development Project (KCDP) provided escape gap traps to fishers in the south coast (Mwandamo, Munje, Mwaembe, Mkuguni). The results from these trials should provide adequate technical knowledge to inform the adoption of this trap in other basket trap fisheries in the WIO.

Restricting destructive gears

Beach seines are large nets that are used in shallow water seagrass and coral reef habitats across the WIO. This gear which is reported to be highly destructive to the habitat and the fishery (high juvenile and bycatch), was not used traditionally in the artisanal fishery and is often associated with migrant and foreign fishers (McClanahan et al., 1997; WIOMSA, 2011). Beach seines have been banned in some countries in the WIO yet continue to be used and their numbers are increasing; for example the 2012 marine frame survey in Kenya reported a 56% increase from the 2008 survey.

Some progress has been made in controlling this gear on the south coast of Kenya, where a removal process started in the 1990s through a partnership between fishers, the Fisheries Department, WCS and other stakeholders in the Diani-Kinondo area. This was initiated as a response to the failure of the establishment of the Diani marine national reserve that was established primarily for tourism and to reduce degradation of the reefs in the area (Glaesel, 1997; McClanahan et al., 1997). In order to find alternative fisheries management solutions to the impacts of fishing, meetings with users were
organized to discuss the fisheries and coral reef conservation issues in the area (see section on Fishers’ Forum below; McClanahan et al., 1996; Obura et al., 2001). Studies were then conducted by WCS to gain an understanding of the perceptions towards the use of different gears, the finfish selectivity and competition between different gears, and the effect of seine nets and their removal on fish catches. The perception study asked resource users and managers to scale gears by their belief in the ability of the gears (fence traps, traps, gill nets, shark nets, beach seine and spear guns) to sustain fisheries. Beach seines and spear guns scored very low on sustainability by all respondents, regardless of gear use (Figure 5; McClanahan et al., 2005).

Figure 5. The perception of users and managers of gear sustainability based on scores of perception of sustainability (maximum of 10) for common fishing gears based on a) all respondents combined and (b) each respondent by their profession or gear use (modified from McClanahan et al., 2005).
Gears were then evaluated to determine their catch rates, species selectivity, body sizes, and mean trophic levels of the catch to establish if findings coincided with user perceptions of sustainability. Beach seines and small traps were found to be the least sustainable because of overlap in species selectivity and small size of fish caught compared to the other gears. Evidence from studies in other beach seine-dominated fishing grounds also suggested that the catch per unit area was lower than in areas less frequented by these gears (McClanahan et al., 1997; McClanahan and Mangi, 2001). This information was consistent with the perceptions about beach seines by the users and upon presentation at subsequent meetings (see section on Fishers’ Forum below), provided the motivation to start joint community and fisheries department-led beach seine removal operations in the Diani-Kinondo area, initially in 2001, then sporadically over the years as gear use re-organization occurred. The initial response after beach seine removal was a reversal in the catch that had been measured since 1995. The catch stabilized in the fishing grounds where beach seines were not in use and continued to decline then stabilized in beach seine dominated fishing grounds (Figure 6).

The main lessons learned from this management intervention were that fishers have the capacity to regulate fisheries but require the support of the management agency. Although perceptions on the unsustainability of beach seines was similar across landing sites in the Diani-Kinondo area, differences in the level of tolerance of beach seines led to a patchwork of responses with some landing sites accepting their use and others totally prohibiting their use. This type of social organization is likely to continue unless a concerted effort is made by the management agency in enforcing the ban on the use of beach seines.

Figure 6. The fishing effort (kg/fisher/day) at landing sites under different levels of management. The arrows indicate the year beach seines were removed from fishing grounds adjacent to the landing sites at Kinondo, Tradewinds and the Nyali, Reef, Marina landing sites (McClanahan, 2010; WCS catch monitoring unpublished data).
Further work is needed to better understand the drivers maintaining this illegal fishery. For example, it is important to understand the unintended consequences of beach seine removal such as increasing fishing effort in areas where fishing intensity was previously low or the negative consequences of removal on the livelihood of female fish processors who depend on the cheap fish from beach seines (Yang, 2013). As many beach seine users are migrant fishers (Fulanda et al., 2009; WIOMSA, 2011), there is a need to better understand the behaviour of migrant fishers especially their unwillingness to adopt other gear and their propensity for rule breaking (Crona et al., 2010).

**Economic incentives and payment for ecosystem services schemes**

For many of the 1.4 billion people who live around tropical coasts, forgoing fishing in protected areas represents too severe an economic sacrifice and too significant an opportunity cost, particularly when the promised ‘spill¬-over’ benefits of marine protection can be slow to accrue. This challenge is particularly great among small-scale fishing communities in the WIO, where a high degree of coastal poverty results in strong dependence on fishing as a primary or sole source of food and income, and where high discount rates (fishers’ time preference for immediate versus delayed reward) can constrain long term planning (Da Rocha et al., 2012). In this economic context, marine conservation goals are commonly at loggerheads with local needs and may be perceived as disenfranchising local resource users.

Reconciling the interests of the conservation and fishing sectors requires new approaches that overcome the opportunity costs of surrendering fishing in a protected area, in timeframes that work for communities. Recent years have seen a growing focus among conservation practitioners in the WIO region to seek ‘incentive-based’ approaches to help lower the perceived opportunity cost of marine protection, in order to generate meaningful economic benefits in timeframes that are acceptable to communities.

Identifying the right incentives is often considered the holy grail of protected area design and management for two key reasons. Firstly incentives can play a defining role in catalysing local engagement in conservation, where benefits are sufficient to motivate sustained behaviour change. Secondly, such approaches may provide a mechanism for the long term sustainable financing of conservation efforts, decoupling conservation programming from outside donor dependence and creating a potential pathway for broader replication wherever similar incentives can be created. The search for viable incentives to underpin local marine management efforts has traditionally focused on highlighting the ecosystem goods and services that can flow from well-managed or protected fisheries and marine resources within managed coasts and oceans.

Marine and coastal eco-tourism has for many years been a strong focus of such ‘market’-based approaches to marine conservation, with a number of long established operator-community partnerships in the WIO region illustrating both the strengths and pitfalls of eco-tourism models. Importantly however, the scalability of tourism-based approaches to funding marine conservation is constrained by the size of the ecotourism market, which remains a niche sector in the broader industry and whose scope is inherently limited to those sites exhibiting the combined attributes of requisite services, logistics, security and natural environments – inevitably only a small subset of the broader coastal zone.

Beyond eco-tourism, the search for incentives in community-based marine management in the WIO has extended to other livelihood-based approaches. These include fisheries enhancement initiatives, through which communities may reap fisheries benefits from improved marine management (for example pulse fishing around periodic closures of key fast-recovering invertebrate species; see Madagascan octopus fishery management case study below); livelihood diversification initiatives (such as marine aquaculture, see below); and efforts to market other ecosystem services, including the carbon sequestration value of marine vegetation (termed ‘blue carbon’, see below).
Payment for ecosystem services

Payment for ecosystem services (PES) also referred to as conditional cash transfers (CCTs) refers to payments offered to offset the opportunity costs of a particular conservation action. The PES approach operates in a manner that allows the beneficiaries of improved ecosystem services (e.g. through fisheries management) to give funds that compensate the direct resource users (e.g. fishers) for lost opportunity costs. In a nutshell, application of marine PES would seek to “pay” fishers for loss of income, encourage restoration of marine habitats for continue provision of ecosystem services, safeguard protection of endangered species by providing incentives and promote sustainable fishing practices.

Few examples exist on the application of PES in the marine environment, although its potential to help support the changeover to alternative livelihood activities as well as buffer the foregone income is acknowledged by marine practitioners (Begossi et al., 2011; Samoilys, 2011; Ellis-Jones et al., 2015).

In Kenya, a PES-like mechanism has been applied in Tiwi on the south coast, in Kiweni north of Lamu, and in Kuruwitu on the north coast (Ellis-Jones et al., 2015). The Tiwi case study involved three actors: a fishermen’s association, a hotel owner, and tourists. The fishermen established a fishing closure that prohibited fishing activities but allowed recreational activities. They also bought snorkeling gear, which through informal arrangements with the hotelier enabled them to hire them to tourists. The hotel owner received the funds and paid the local fishermen on condition of adherence to the closure. The funds raised through renting the snorkeling gears were used to purchase a freezer and additional income paid its running costs. No monitoring was conducted, however anecdotal evidence suggests some improvement in reef health. In the Kiweni case study, a local non-governmental organisation (LamCot) together with BMUs operating in the area were involved in establishing a 3 km² gear restriction LMMA, off Pate village in the Lamu Archipelago. The PES mechanism involved tourists paying USD 5 per head to visit the LMMA; funds were collected by the BMU from the tourist boat captains. The amount raised is shared among the BMUs operating around the LMMA. Kuruwitu Conservation and Welfare Association established a 2 km² no-take zone. During the six-month trial period, an international NGO provided funds to compensate fishermen for not fishing in the area. However its long term financial sustainability was then dependent on tourism which has proved to be inadequate recently due to the current insecurity in Kenya. A common challenge of the three case studies was dependence on tourism as the payment mechanism.

A payment scheme for sea turtle protection in Tanzania was driven by the need to conserve threatened species through direct protection. The scheme pays communities for finding and reporting a nest to an appropriate project monitor (Ferraro and Gjertsen, 2009). Gear exchange programmes would be considered as part of PES schemes. For instance in their effort to ban illegal and destructive fishing practices and cutting of mangrove trees for commercial purposes, Mnazi Bay/Ruvuma Estuary Marine Park (MBREMP) provided fishers with large mesh sized gillnets in exchange for illegal nets and also initiated alternative income generating activities, notably bee keeping and sustainable aquaculture (Maina and Samoilys, 2011; Samoilys, 2011). Elsewhere, in Brazil fishers have participated in a PES scheme by adhering to the prohibition by the government to fish during the fish reproduction season in return for receiving a ‘salary’ that is equivalent to the minimum wage (Begossi et al., 2011).

Legal provisions exist in pieces of legislation that support economic incentive schemes, albeit included in terms such as conservation trust funds. Such funds provide steady long-term financing for marine and coastal conservation and sustainable resource use. World Bank commissioned a study in Tanzania for the design of such. Moreover, the Western Indian Ocean Conservation Challenge is exploring how a conservation fund can be applied in marine conservation (McClennen et al., 2013). The National Environmental Policy calls on the state of Mozambique to provide incentives for the sustainable use of natural resources (Mazivila, 2009). The policy integrates environmental issues into economic planning, recognizes the role of the communities in environmental management and monitoring, and acknowledges a role for the private sector in managing the environment.
Blue carbon
The WIO’s mangroves are exceptionally productive ecosystems, not only for the globally important biodiversity that they support, but also for the host of benefits, critical to the well-being of millions of coastal people, that they provide. These include coastal protection from storms, shore stabilisation, water filtration, building materials and fuelwood. They also support important fisheries, including shrimp and crabs, which are crucial to the livelihoods and food security of coastal people (Jones et al., 2014).

The value of mangroves, or ‘blue forests’, to coastal communities is matched only by the extraordinary amount of carbon stored in their biomass and sediments, known as ‘blue carbon’. This carbon has a value on international carbon markets. If this value can be realised and transferred to the people whose livelihoods depend on the exploitation of mangroves, it could incentivise and finance community-led mangrove management, and help safeguard the fisheries that mangroves support. However, blue carbon has not been fully included in emissions accounting, and standards for blue carbon markets are still in their infancy.

Notwithstanding these challenges, generating blue carbon credits through the sustainable management of mangroves could help to alleviate poverty and support biodiversity conservation in the WIO’s coastal areas. A number of pilot initiatives are underway in Madagascar with Blue Ventures support, to prepare the ground for future blue carbon projects aiming to incentivise community-led mangrove management (Jones et al., 2014). These initiatives require considerable preparatory research to quantify greenhouse gas emission reductions that can be achieved through mangrove conservation, and understand the socio-economic impacts of mangrove conservation.

Alongside research, realising community carbon projects necessitates establishing the underlying management support required to build the capacity of local management associations to protect their mangroves, and make community-led, rights-based blue carbon projects a reality.

Other Blue Carbon projects that are active in the WIO are:
  i) A mangrove conservation and carbon offset project (Mikoko Pamoja) implemented by Kenya Marine and Fisheries Research Institute (KMFRI)
  ii) Assessing Mangrove Carbon Pool in the Zambezi Delta being implemented by WWF
  iii) GEF Blue Forest Project Interaction in Mozambique implemented by WWF

Even when feasible, carbon projects generate no revenue for several years and present time horizons and a degree of uncertainty that subsistence communities cannot afford to work within. Thus, PES schemes that bring tangible benefits to the community on a short time horizon to offset the initial opportunity costs associated with mangrove conservation are necessary, to build broader community support for the longer term mangrove management required for carbon projects.

The mangrove forests of Madagascar provide critical nursery grounds for commercially valuable crab and shrimp species, which are targeted by both traditional and industrial fishers. When coupled with sustainable fisheries management, the mangrove conservation activities of carbon projects could attract financial rewards from the commercial fisheries sector to communities, in return for sustainable management of commercially important stocks. These schemes also have the potential to incentivise sustainable fisheries management in areas where levels of forest exploitation do not warrant a carbon project.

Community-based aquaculture
Community-based aquaculture (CBA) initiatives focus on providing coastal people with new sources of income, allowing improved access to food and education, while alleviating pressure on fisheries and marine biodiversity. However, successful examples are few in the WIO. This section is included to raise the potential for CBA.
The global aquaculture sector has seen rapid development in recent years, offering an alternative source of fisheries production (FAO, 2014) in response to the decline in fisheries landings and a rapidly growing human population accompanied by an increased demand for fish and other marine products (Bongaarts, 2009). Aquaculture is now considered the fastest growing food production sector (>10% annually), accounting for almost 50% of global fish production, a trend that is expected to continue and reach about 2/3 of global aquatic food production by 2050. Although much of this rapid growth is accounted for by freshwater production, mariculture has also increased considerably in recent years, particularly in Asia (89%), while Africa’s contribution to global production remains extremely low (2.2%) (Rouhani and Britz, 2004; FAO, 2014), with Egypt contributing to the bulk (68.9%) of production (FAO, 2014). Despite small and sometimes erratic growth in Africa, the sector is considered to offer great potential, given the continent’s favorable climate and marine resources (Brummett and Williams, 2000; Brummett et al., 2008).

Community-based aquaculture (CBA) is often proposed as a potential supplementary or alternative income generating activity for marine resource dependent coastal communities, and has attracted considerable attention from governments, international donors, social entrepreneurs, conservation groups and development agencies. Yet despite the WIO having favourable environmental conditions for aquaculture, the CBA sector in the WIO is underdeveloped relative to other regions of the tropical Indo-Pacific. Moreover, little is known about the degree to which CBA activities have resulted in favourable community development and conservation outcomes. The challenges faced and lessons learned during aquaculture development projects are often poorly documented, and in many cases the socio-economic, environmental and other impacts of the CBAs remain unclear.

Constraints documented for expansion of CBA include shortage of seed and feed supplies, low investment, limited technical capacity and insufficient political support with countries often lacking a clear strategy for aquaculture development. These limitations are commonly compounded by a lack of engagement by local stakeholders in the decision making process regarding CBA project development, with project planning commonly directed by donors, development agencies and private sector partners. A focus on production, especially in seaweed farming, with little consideration of improving value-chains, has also limited local revenues and sector growth. Many donor-driven projects are designed along unrealistic timeframes with low probability of achieving their end goals of financial sustainability in an entirely new market and supply chain.

**Temporal fishery closures – managing octopus fisheries in Madagascar**

Unlike Madagascar’s early MPAs, the primary management objective of the LMMAs was not biodiversity conservation per se, but rather improving the sustainability of small-scale subsistence and artisanal fisheries. Rather than focus on the protection of key habitats within permanent no take zones, these LMMAs have sought to prioritise fisheries management and improvement, with a focus on prohibition of destructive fishing gears, and the establishment of short-term ‘periodic’ closures of certain areas for key fisheries.

This strategic emphasis on fisheries management has evolved in large part through recognition of the challenges of gaining community support for closing areas of important fishing grounds permanently through no take zones designed for biodiversity conservation outcomes. By focusing on management interventions that are perceived to carry a much smaller opportunity cost for fishers, Madagascar’s LMMAs seek to demonstrate tangible fisheries benefits for local resource users in the short term, thus strengthening local support for continuation of management efforts.
As well as broadening management planning beyond ‘conventional’ marine reserves, the LMMAs make use of Madagascar’s social code to enable decentralised community-based decision making for fisheries management. Recognising the limitations of centrally planned marine conservation efforts in Madagascar and elsewhere (which have often disenfranchised traditional resource users), Madagascar’s LMMAs seek to empower communities for fisheries management by employing customary governance mechanisms such as dina to govern resource management (including gear prohibitions and the location and duration of closed areas). By building fisheries management decision making from the level of individual village communities, these LMMAs have benefited from a strong degree of local buy in and compliance. Additional benefits resulting from these fisheries management experiences have included enhanced cooperation between communities working together to manage fisheries within the same LMMA, and improved local support for the establishment of permanent marine reserves.

**Velondriake**

The Velondriake Community Managed Protected Area in southwest Madagascar is the country’s oldest LMMA, established in 2006 (Harris, 2007), spanning 678 km² of coral reefs, mangroves, lagoons, beaches and sea grass beds. Home to approximately 10,000 semi-nomadic Vezo people, Velondriake unites 25 coastal villages in the co-management of local marine resources (Harris, 2011; Westerman and Gardner, 2013). It is legally recognised as an IUCN category V MPA and was granted definitive protected status by inter-ministerial decree in late 2012 (Westerman and Gardner, 2013). Velondriake’s origins began as an initiative to improve the sustainability of the octopus fishery in the central coastal village of Andavadoaka. Octopus is the primary export fishery for the region, providing the cornerstone of the regional coastal economy (Benbow et al., 2014). Andavadoaka’s early experiences of periodic fisheries closures proved successful, resulting in dramatic increases in landings, which prompted Andavadoaka’s fishers to continue with subsequent closures, and neighbouring communities to replicate the approach (Benbow et al., 2014). Impact analyses show that the *O. cyanea* closures have resulted in significant fishery benefits, including increases in production and fisher income (Benbow et al., 2014). The approach also benefits from broad support from fisheries stakeholders and authorities throughout the supply chain, with fishers and buyers in certain villages making direct financial contributions to the costs of establishing fishery closures.

Velondriake was borne out of an effort to coordinate these expanding fisheries closures between adjacent communities along 45km of coastline, with each village electing a representative to one of three sub-regional Velondriake committees. Since 2006 management efforts within Velondriake have diversified beyond fisheries closures to encompass community-based aquaculture and the designation of 6 permanent no-take marine reserves (totalling over 7 km²) (Harris, 2011; Westerman and Gardner, 2013).

The initiative is largely guided and managed by local communities, with technical and financial support provided by the British NGO Blue Ventures. Resource use and access rights within the area are governed by a legally recognised *dina*, which bans destructive fishing practices including beach seining and poison fishing and regulates temporary and permanent closures (Andriamalala et al., 2010; 2013). The dina also grants conflict resolution and enforcement powers to local communities, allowing them to impose fines and utilise the regional court system in cases where conflict resolution is unsuccessful (Harris, 2011; Westerman and Gardner, 2013).

**Expansion and evolution of community-based fisheries management**

Velondriake’s perceived success in pioneering community-based fisheries management has triggered widespread replication of the periodic closure model, initially in the southwestern Atsimo Andrefana and Menabe regions, and subsequently elsewhere in western, northern and southeastern Madagascar. The broader application of the model has been supported in large part by conservation NGOs working in close partnership with communities, with community exchanges proving to be a highly effective approach to sharing experiences of this management model between adopting communities (Rocliffe et al., 2014). These exchanges continue to take place throughout Madagascar and beyond.
Having witnessed the effectiveness of this approach in improving octopus production in the early Velondriake closures, the government of Madagascar passed new fisheries legislation in 2005 to close the *O. cyanea* fishery for 6 weeks from mid-December each year, a national management measure that continues in parallel with the more ad hoc locally-led closures. This national closure model has since been adopted by the neighbouring Mauritian island of Rodrigues, with island-wide fishery closures established annually between August to October since 2012.

Interest in the applicability of this model to other fisheries and ecosystems has resulted in the adoption of this approach by communities in mangrove crab (*Scylla serrata*) and spiny lobster (*Palinurus*) fisheries in western and southeastern Madagascar respectively (Table 3).

**Fisheries management catalysing conservation**

As a result of the NGO-community partnerships underlying fisheries management efforts in Madagascar, in a majority of cases these village-scale community-led fisheries closures have evolved into the establishment of larger multi-village LMMAs, where the use of periodic fisheries closures is seen as a key ‘first step’ fisheries management intervention to help improve fisheries productivity, while also building community support for conservation.

To date, more than 70 LMMA have been established along Madagascar’s northern, western, eastern, and southern coasts. Taken together, these initiatives presently cover 11.8% of Madagascar’s continental shelf, 11,377 km², with more than 148,920 beneficiaries (MIHARI unpublished data). Although their management effectiveness is undocumented and undoubtedly variable, this scaling up is unparalleled in the WIO, yet it has been achieved at relatively low cost, in large part through the support and partnership of conservation NGOs, without financial support from central government (Harris, 2011). With severe constraints continuing to inhibit the country’s capacity for environmental governance, Madagascar’s LMMAs offer an encouraging and locally acceptable solution to the challenges of marine resource management.

Since 2012, Madagascar’s growing LMMA network has been united within an informal network known as MIHARI, established to provide a framework for community exchange and dialogue to share local experiences of community-based fisheries management and conservation. MIHARI’s membership comprises 124 discrete marine environmental management associations, and distributed across over 12 degrees of latitude, from both the Indian Ocean and Mozambique Channel coasts of Madagascar. Community leaders meet annually in a national LMMA forum convened and supported by NGO partners.

As a preparation to these national forums, regional forums are organized in the 4 regions of Madagascar in which MIHARI works, namely: North West, North East, Middle East and South. Exchange visits between pairs of LMMA are also organized annually. Blue Ventures is working to reinforce and develop this nascent network by improving coordination of LMMA activities nationwide, developing new, and shared training and educational tools and resources and establishing a coordinated system for monitoring LMMA effectiveness. As a result of this project, the MIHARI network will be developed into a functional support platform capable of providing practical technical assistance and guidance to communities engaged in marine conservation and playing a lead role in advocating for the interests of LMMAs at national and regional levels.

Table 3: The number of periodic fisheries closures that has taken place annually in Madagascar since 2004.

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<tr>
<th>Year</th>
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<th>Mangrove</th>
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**Spawning aggregation closures**

A new community-based fisheries management approach, which combines LMMAs and the occurrence of temporary spawning aggregations of fishes, has started in Kenya. The example comes from Msambweni on the south coast and builds on a scientific research programme, funded through the WIOMSA-MASMA funding programme, on the phenomenon of site specific spawning aggregations in reef fishes that are important in local fisheries (Robinson and Samoilys, 2013a).

Spawning aggregations in reef fishes are well known globally and their vulnerability to overfishing has been well documented (Sadovy de Mitcheson and Erisman, 2012; Sadovy and Domeier, 2005). The following is a recognised definition: *A spawning aggregation is a repeated concentration of conspecific marine animals, gathered for the purposes of spawning, that is predictable in space and time. The density/number of individuals is at least 4 times that found outside the aggregation. The spawning aggregation results in a mass point source of offspring* (Domeier, 2012). The research in Kenya took three years (2009-2011) and was participatory in nature involving local fishing community members and their knowledge of these spawning aggregations. The research resulted in the verification of the location and timing of spawning aggregations in two species: the spinefoot rabbitfish, *Siganus sutor* (Samoilys et al., 2013a, Maina et al., 2013) and the brown-marbled grouper, *Epinephelus fuscoguttatus* (Samoilys et al., 2013b), and the production of a book detailing the findings (Robinson and Samoilys, 2013a). The research also assessed the vulnerability of these two species to targeted fishing during spawning times and explored management options (Robinson and Samoilys 2013b). This was particularly pertinent to the rabbitfish since it is a major component of the coastal fisheries (McClanahan and Mangi, 2004; Maina et al., 2013), and prior to this research, spawning aggregations in this species and the implications of fishers targeting these aggregations were unknown in Kenya.

Interactions between researchers and the fishing community in Msambweni revolved primarily around CORDIO East Africa (the research team) and Mkunguni Beach Management Unit (BMU), though other stakeholders were also involved, particularly the State Department of Fisheries (SDF) and the government’s fisheries research institute (Kenya Marine and Fisheries Research Institute). Three aggregation sites were located within the Mkunguni BMU’s governing area of sea. Once the research was finished CORDIO went through a feedback process of giving seminars to the BMU to present and discuss the results, supported by FAO (CORDIO, 2012). CORDIO followed this with developing a 5-day in–residence seminar series for fishing communities (primarily BMU members) on fisheries co-management approaches. This covered a wide range of topics and included ecosystem based management, concepts of no-take zones (NTZs) and multiple use zones, issues around species vulnerability and targeted fishing of spawning aggregations, and the importance of fishing communities engaging in decision making and management of their resources (Samoilys, 2012).

In 2013 Mkunguni BMU decided to close one of the rabbitfish spawning aggregation sites to fishing within their co-management area. They call this site “Arusha” and referred to it as a community conservation area (CCA), or *tengefu* in Kiswahili. They stipulated this NTZ approach in the by-laws of their co-management area, which were approved by SDF in 2013. Mkunguni BMU then approached CORDIO to help them to set up this CCA at Arusha, and this work was enabled through a UNDP-GEF-SGP grant to CORDIO which started in December 2014. In February 2015, Mkunguni established a NTZ around one of the spawning aggregation sites for the rabbitfish, and this has been written into the co-management area plan that has been submitted to the Director of Fisheries for approval in the next month (Figure 3). The community decision to protect a spawning aggregation of a key fishery species, despite the concomitant loss in catch during the spawning period, was undoubtedly stimulated by community involvement in the research and the subsequent efforts put into research feedback and fisheries management education to the community (Kawaka et al., 2015).
It should be noted that the vulnerability assessment of targeted fishing of *Siganus sutor* spawning aggregations made it quite clear that protecting one spawning site will not be sufficient to address the problems of overfishing and the high fishing pressure taking place on this species all through the year, and in areas outside the spawning aggregation sites (Robinson and Samoilys, 2013b). Further, the life history of rabbitfish and the operations of their fisheries do lend themselves to allowing fishing of spawning aggregations sustainably if managed properly (Robinson et al., 2011). Nevertheless, the understanding of the spawning aggregation phenomenon in rabbitfish provided an entry point for a fishing community to target their management and conservation efforts. It also allowed them to justify the introduction of a NTZ into their fisheries co-management area to the wider community, and this has in fact led to the introduction of another NTZ close to shore (Figure 7).

Figure 7. Co-management area plan for Mkunguni BMU with the Arusha no-take zone shown.

**Fishers’ consultative forum in Kenya**

In tandem with the sectoral changes that were occurring in Kenya in the past two decades, communities had also started taking an interest in improving management of their fisheries resources as a result of NGO support and involvement. The Coral Reef Conservation Project (later a project of the Wildlife Conservation Society) had started a series of meetings in partnership with the Fisheries Department on the south coast of Kenya in 1996. The meetings were called to discuss the declining catches in the reefs of the area due to the use of destructive fishing gears such as beach seines and the possible solutions (McClanahan et al., 1996; Obura et al., 2001). The meetings subsequently evolved into an annual event ‘the Fishers’ Forum’ where issues related to fisheries management are discussed and results of the WCS long-term monitoring of coral reefs and fisheries catches are presented. The Fishers’ Forum includes representatives from BMUs, State Department of Fisheries, and NGOs. The idea of fisheries closures was first introduced at the Fishers’ Forum in 2005 as a measure to
encourage the recovery of fisheries where beach seining had devastated the stocks. At the Fishers’ Forum of 2006, the term ‘tengefu’ (meaning ‘set aside’ in Kiswahili) was adopted as a descriptor of community led closures. The State Department of Fisheries has been supportive of the Fishers’ Forum and the “tengefu movement” since its inception. At the Fishers’ Forum of 2011, the then Director of Fisheries requested a report detailing the progress made and the geographic positions in order to harmonize with the registration of coastal BMUs that was underway. The report was submitted in 2012 (WCS, 2012). At the same time, the EU funded ICZM Programme “ReCoMap” funded a profiling assessment of the tengefu that was completed in 2011 (Muthiga et al 2011). At subsequent Fishers’ Forums, the State Department of Fisheries as well as the County Fisheries Offices continued to support the tengefu movement.

Discussion and synthesis

The following discussion points are mentioned briefly here to stimulate further discussion around the case studies presented, the context of artisanal fisheries in the WIO, and the potential for a network of communities and practitioners engaged in locally managed fisheries. The national workshops for stakeholder consultations have provided a platform for presenting and discussing this report, and outcomes from those consultations have been reported separately.

Common themes

The success of community based approaches are invariably linked to: “recognition of rights and responsibilities of local communities, and transparent and unambiguous roles for participating authorities, which requires supportive government legislation and appropriate incentives for local ecosystem users” (Ferse et al., 2010). In artisanal fisheries in the WIO some of these elements of success are seen in the BMUs in East Africa, strong governmental support in Kenya for LMMAs by the State Department of Fisheries, and coastal communities viewing LMMAs as a financial benefit, usually through links with eco-tourism initiatives. However, this perception of financial benefit is not always substantiated by reality and financial sustainability is still a problem (Kawaka et al., 2015).

Locally managed fishery approaches have in some places resurrected customary approaches but combined these with current knowledge and technology and institutionalised co-management. There are however several constraints to some of the existing legislation which requires further action.

Finding entry points to communities to engage them in community based fisheries management approaches has often been an important trigger. For example, in Madagascar, as a result of the NGO-community partnerships underlying fisheries management efforts, in a majority of cases the village-scale community-led fisheries closures evolved from the use of periodic fisheries closures as a key ‘first step’ intervention to help improve fisheries productivity, while also building community support for conservation. The village scale closures have then evolved into the establishment of larger multi-village LMMAs. A similar “first step” is seen in the spawning aggregation closure in Kenya (Mkunguni) – where the concept of a NTZ for protecting a spawning aggregation of rabbitfish was a major incentive for the fishing community to establish an LMA. It also allowed them to justify the closure to the wider fishing community and has led to the introduction of another NTZ closer to shore.

Most examples of successful locally managed fisheries initiatives come from South East Asia and the Pacific Islands, with less than 5% of published studies coming from the Indian Ocean (Wamukota et al., 2011). Elsewhere, LMMAs Networks have been formed with the vision of changing and improving the lives of those communities represented within the networks. There is every reason to believe that this is likely to evolve in the WIO (Rocliffe et al., 2014).
A combination of traditional (dina in Madagascar) and co-management fisheries regulations (BMUs in Kenya and Tanzania, CCPs in Mozambique) have given enforcement rights to fishing communities to ban destructive fishing practices including beach seining and poison fishing, and to regulate temporary and permanent closures (Andriamalala et al., 2010; 2013).

A number of examples of local networks have been presented in the review such as the Fishers’ Forum and the networks of BMUs in Kenya, and MIHARI in Madagascar. These networks can provide a basis for establishing a WIO level network of communities and practitioners engaged in local management approaches to fisheries. The local networks’ approaches and their successes and challenges need further exploration.

**Challenges to local communities in fisheries management**

Several challenges were also noted in this review and require further discussion with stakeholders. They must be considered in future initiatives aiming to improve and support local fisheries management approaches in the WIO.

Common challenges in WIO countries:

- Inadequate local management capacity - most local communities in the WIO have weak or inadequate capacity to effectively manage their marine resources.
- Dependence on external support – there is limited access to technical, managerial and financial resources thus hindering effective monitoring and management of LMMAs. The overdependence on partner NGOs has been noted as a major challenge to governance of LMMAs.
- Over dependence on marine resources - pressure on marine resources is increasing due to increasing human population, which calls for diversification of income sources to subsequently reduce pressure on the environment.
- Poor governance – a high proportion of marine environments are public resources. This has created a unique opportunity for communities to manage the resources in a collaborative manner, however few fishing communities have embraced this.
- Conflicting legislation - hinder communities from managing their marine environments.
- Migrant fishing activities – may limit adherence to locally established gear and spatial restrictions.
References


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