



Challenges and opportunities for sustainable development and management of marine recreational and sport fisheries in the Western Indian Ocean

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ABSTRACT

In the Western Indian Ocean (WIO) region, information and data on marine recreational fisheries (MRF) is lacking, which undermines efforts towards their sustainable development. Our paper reviews the challenges and opportunities for sustainably developing marine recreational fisheries in the WIO. We identified several challenges that are discussed in two broad categories: (i) governance and (ii) socio-cultural and economic. We also show that addressing these challenges requires a holistic understanding of the socio-ecological complexities and the multi-scale nature of WIO MRF. Realizing the potential for sustainable development of this sector calls for the involvement of coastal communities in the sharing of benefits and decision-making. Further, coordinated efforts between the multi-government agencies and non-governmental organizations is critical for integrating recreational fisheries into local and national agendas. We conclude that the sustainable development of MRF in the WIO region is possible. Still, such growth will be dependent upon the sustained capacity building of coastal communities and indigenous fishers, collaboration from stakeholders, and the long-term sustainability of the resource.

1. Introduction

In times of growing interest in the sustainable development and management of fisheries in the Western Indian Ocean (WIO) region, limited studies actively explore the definitions, challenges and opportunities surrounding marine recreational fishing (MRF). Recreational fishing, commonly referred to as sportfishing or angling, is defined as fishing primarily conducted by an individual largely for leisure, and the catch may constitute a source of nutrition to some extent but is not meant to be sold [1–4]. In the WIO region, this activity is mostly carried out using rod and reel with hook and line to catch fish and has a long history in places such as Kenya and South Africa [5–8] and can be a significant contributor to coastal economies [9,10]. However, in common with the global situation [11], MRF in many WIO countries remain understudied and under-represented in conventional discussions on the

role of fisheries in development agendas and sustainable fisheries management, with the exception of South Africa [12–15] and Kenya to some extent [6,16–18,66,116].

Through this perspective article, we seek to add to the ongoing discussion on the role of MRF in development agendas (e.g., [19,20]), by focusing on the WIO with emphasis on selected countries. The objectives of this paper are to: examine the challenges facing MRF in the quest for their sustainable development and management; and discuss the opportunities that MRF present in the discourse around sustainability and future of fisheries in the WIO.

The WIO region is home to diverse fish species supporting a multitude of fisheries resource user groups including small-scale, industrial and recreational fisheries sectors [21,22]. Several million people across the WIO region depend on marine fisheries resources as a source of food and for socio-cultural and economic well-being [23–25], yet most

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fisheries resources are increasingly becoming depleted [26,27]. The WIO population is expected to rise by nearly 50% to about 306 million by 2030 [24,28,29] and this growth will likely increase the dependence on marine fisheries resources for livelihood support [30]. Despite considerable efforts such as gear-restrictions and temporary fishery closures to reduce fishing effort and increase conservation measures, the diversity and complexity of fisheries resource users is a challenge facing many WIO fisheries [31–33,113].

The governance of fisheries resources and resource user groups is further complicated by the open-access nature of many WIO fisheries [31]. Artisanal fisheries, for instance, can generally fish at any time and place, with limited controls on gear and effort, which may cause conflicts with other resource users who have a strict code of conduct [16]. Herein, we define artisanal fisheries as those fishers who use a variety of

basic fishing gears, ranging from traditional to modern types, which are operated from small to medium-sized fishing vessels ([16,115,118]; <http://www.wiofish.org>). Additionally, the perceptions and motivations for fishing may differ among various fisher groups (e.g., recreational vs. commercial, and conservation vs. consumptive use) [34]. Thus, MRF are not immune to conflicts when considering the growing demand for fish and fisheries products [73]. Consequently, there is a need to evaluate and address the socio-cultural, economic, ecological and governance challenges associated with MRF [3,35–37]. Otherwise, the sustainable development and management of MRF in the WIO will remain a challenge for fisheries resource users, policymakers and related stakeholders.

Overall, this paper contributes to the body of knowledge on MRF in the WIO. Further, by consolidating the information on the status of the



Fig. 1. The Western Indian Ocean: Somalia, Kenya, Tanzania, Mozambique, South Africa, Madagascar, Mauritius, La Reunion, Mayotte and Comoros. Note: only part of South Africa’s east coast waters (bounded by 30° S and 45°E) fall into FAO area 51.

fishery, and its challenges and opportunities, we provide the knowledge necessary for prioritizing and designing strategies that can contribute to the sustainable development and management of MRF in the WIO. The insights offered in this paper can inform practice for this sector in other parts of the world, which may face similar challenges. Information was gathered from a range of sources including, but not limited to, information requests to relevant government departments, peer-reviewed articles, government documents and grey literature.

2. Overview of MRF in the WIO

The WIO region, which falls within FAO Fishing Area 51, comprises 10 countries: Somalia, Kenya, Tanzania (including Zanzibar), Mozambique, South Africa, Madagascar, Seychelles, Comoros, Mauritius and the French territories of La Reunion and Mayotte (Fig. 1).

Various names are used interchangeably to refer to marine recreational fisheries in the WIO region (Table 1; <http://www.wiofish.org>). In Kenya, MRF is also referred to as big game fishing/sportfishing/sea angling which is predominantly boat-based [8,16]. In Mozambique, recreational fishing and sport fishing are considered distinct; the former is mainly for leisure from a boat or the shore, while the latter is mainly boat-based and involves fishing for competition, organized by a club or a group of individuals that sets standards for participants [38]. In South Africa, MRF includes shore or boat-based line fishing, including spearfishing, and charter boat fishing, as well as competition fishing [48, 49,112] (Table 1). Thus, there is no regionally accepted single definition of what constitutes MRF. However, there seems to be a consensus that WIO marine recreational fisheries refer to non-commercial harvesting, motivated by catching for leisure, food, fun, competition, sport or camaraderie, and the catch is not meant for sale. An exception is in La Reunion where sport fishing charter operators are referred to as professional operators and may sell their catch [8].

Table 1
Examples of terminologies and characteristics of marine recreational fisheries in selected Western Indian Ocean countries.

Country	Characteristics	Terminologies	Gear
Kenya	Fishing for leisure; catch is not for sale. Includes competitions and social activities	Sport fishing Big game fishing Recreational fishing Sea angling Charter or private sport fishing	Mainly rod and line from a boat
Mozambique	Fishing for leisure and to supplement food. May include competitions; for non-commercial purposes	Domestic recreational fishing Sport fishing/ angling Tourist fishing	Spear Rod and line Nets and handlines from boat or shore
South Africa	Fishing for leisure and in some cases for food; may include competitions. Includes shore anglers, spearfishers and boat anglers	Shore-based fishing Spearfishing Boat-based fishing	Spear Rod and line Handline
Seychelles	Fishing for leisure which may include competition	Charter boat fishing Angling Charter sport fishing Private sport fishing	Mainly rod and line from a boat; some handline
La Reunion	Fishing for leisure although they may sell their catch Fishing competitions	Professional or non-professional boats	Handline Rod and line From a boat

There are few estimates of the numbers of marine recreational fishers in the WIO, apart from in South Africa, where the estimated ca. 480,000–550,000 (total country) MRF participants [9,108,111] far outnumber those in any other fishing sector in that country [39]. Remarkably, this is close to the estimated 500,000 small-scale marine fishers in the WIO [40,41], although this latter is an underestimate, not accounting for unlicensed fishers (Temple et al., 2015). In Mozambique, numbers of recreational fishing licenses in 2017 were over 6000 [42]. Artisanal fishery landings in the WIO region account for 75–85% of marine landings [43], so it may be expected that WIO recreational fisher numbers are substantially lower than the small-scale or artisanal sector. An important point to consider is that there is often confusion between a recreational angler and a subsistence angler. One may not be formally acknowledged as a subsistence angler but because recreational licenses are cheap and open access in countries such as South Africa, a fisher that fishes to supplement their food supply may buy an annual recreational fishing license to fish legally rather than going through a complex process to get small-scale fishing rights.

Not surprisingly, given the wide fish diversity in the WIO, the MRF sector is characterized as multi-species; for example, over 250 fish species are caught in the South African recreational line fishery [39, 107]. Families commonly caught in the WIO by recreational fishers include tunas (Scombridae), sharks (Carcharhinidae), billfish (Xiphidae and Istiophoridae), trevally (Carangidae), barracuda (Sphyraenidae), groupers (Serranidae), snappers (Lutjanidae), sea breams (Sparidae), tunas (Scombridae) and rabbitfish (Siganidae) [38,39, 44–46]. In addition to fish, recreational harvest of inshore invertebrate bait items as well as rock lobster species, for instance, in South Africa form a substantial part of the recreational fishery. The WIO region is renowned as having world-class recreational fishing destinations, with organized charter and guided fishing operations in several countries such as Kenya, Mozambique, Tanzania, Seychelles, and South Africa (e.g., [18,47,48,113]).

Apart from South Africa, estimates of recreational fish catch in the WIO are limited [104]. The compilation of WIO catches by Pauly and Zeller [43] from 1950 until 2014, excluding South Africa, only has recreational catches from Kenya, Seychelles, Mayotte and Mauritius; these amount to ca. 86,000 t (< 0.5% of total catches) over this period. Annual catches in 2009–2010 from boats on the east coast of South Africa were estimated to be ca. 450 t [49], and ca. 260 t from the shore [50]. Together, these catch quantities were similar to the annual commercial boat fish catch from the South African east coast [49]. Albeit approximations, and assuming that they are at least correct within an order of magnitude, WIO recreational catches are not insubstantial, though much less than those from regional artisanal and industrial/commercial fisheries [21,43].

Due to many recreational anglers fishing for pleasure and not to supplement their diet, there is often a propensity of fishers to in certain circumstances display pro-environmental behavior. Catch and release fishing by recreational anglers is common, particularly for gamefish and elasmobranchs [51–53], and there are two long-standing tag and release citizen science programmes in the WIO region associated with recreational angling. The African Billfish Foundation (ABF), a private organization based in Watamu, Kenya, began overseeing billfish tagging in East African waters during the late 1980s to advance the conservation and research of these species. The aim of the ABF tagging program was to determine patterns in billfish movement (e.g., how far do these species travel?) in the coastal East African waters, using traditional tags. Through collaboration with recreational fishing clubs and the Kenya Sea Anglers Association (KASA), about 95% of billfish caught on boats that voluntarily participated in the tagging program have been tagged and released [6,45]. Over 55,000 individual fish have been tagged and about 3000 of these have been recovered by artisanal, recreational and industrial commercial fisheries with the WIO region (African Billfish Foundation, unpublished data). For instance, some of the billfish tagged fish off the Kenya coast have been recaptured off Mandapam,

India, the Arabian Gulf, La Reunion, and South Africa [6,45]. The ABF through collaboration with the Kenya sport fishing community and the International Game Fish Association (IGFA) deployed the first pop-up archival satellite tags on marlin off the East Coast of Africa between 2012 and 2013 [103]. This advancement from conventional to satellite tags allowed the collection of real-time information about billfish, allowing insights on migration, habitat preferences, and diving activities. Like ABF traditional tagging data, Kenya's first-time satellite tagging results revealed that billfish, particularly marlin, are highly mobile and thus travelling great distances such as to the Gulf of Eden and Mozambique. In recent years, results from a large-scale satellite tagging study on striped marlin (*Kajikia audax*) off the Kenyan coast showed that individuals covered horizontal distances of to 9187 km over a period of about 6 months, which were influenced by seasonal dynamics [54].

Tagging by recreational fishers has also been conducted in South Africa through the Oceanographic Research Institute (ORI), a not-for-profit NGO, which implemented a tagging program (ORI-Cooperative Fish Tagging Project) incorporating recreational fishers' efforts in the 1970s [55,106]. As of 2018, over 330,000 fish have been tagged, ca. 28,000 have been recaptured and there are ca. 6400 members of the program [56]. Individuals and clubs from other WIO countries such as Seychelles, Tanzania, Mozambique, Mauritius and La Reunion have also deployed tags from these two programmes [8,45], as well as from other global programmes such as The Billfish Foundation (TBF).

3. Challenges of WIO MRF

We identified several challenges which are associated with resource users, fisheries managers and researchers, policy makers, and other relevant stakeholders. The challenges for marine recreational fisheries are discussed in two broad categories: (i) governance in respect of management, (ii) economic and socio-cultural. In this section, we distinguish marine recreational fishing as fishing primarily with hook and line for pleasure, relaxation, camaraderie or competition and does not include sale of catch.

3.1. Governance challenges in the sustainable development of MRF

3.1.1. Limited capacity to adequately assess and develop marine recreational fisheries

Several countries in the WIO (e.g., Kenya, Tanzania, Mozambique, Madagascar) have insufficient capacity to monitor MRF which creates difficulties for the countries and coastal communities to sustainably develop and benefit from recreational fisheries [8,27,38,57]. Specifically, sustaining recreational fishing is challenged by the lack of a definitive system to determine how many licenses should be issued, and who should be licensed as a recreational or sport fisher, exacerbated by the variations in the definition of a recreational angler within the WIO. As a result, discussions regarding the potential of MRF in the WIO and the need for their development at regional scale are generally of a 'one-size fit all' perspective and fail to account for the nuances that can impede the growth of this fishery at country level.

Monitoring, control and surveillance (MCS) for recreational fisheries is also lacking among various WIO countries, for instance, in Seychelles, Mozambique, Madagascar and Tanzania despite historical evidence of the presence of MRF. There have been efforts to establish and implement MCS in the region, but these have largely been focused on the industrial commercial sector [58]. The inadequacy in the delivery of monitoring services limits the ability to establish information about recreational fishing operations. The lack of representation data on those who engage in MRF in turn makes it difficult to explicitly assign and spearhead effective governance/management systems that promote the discourse on the sustainable development of the fishery.

3.1.2. A lack of well-equipped and integrated governance structures at multiple levels of management

In many WIO countries there is a general lack of synergy among the different management systems that cover marine recreational fisheries; management is often fragmented, with multiple levels of jurisdiction. In Kenya, for example, recreational boat fishing falls under various governance structures such as the Kenya Fisheries Service, Kenya Wildlife Services, Kenya Maritime Authority, Kenya Tourist Board, and Kenya Association of Hotelkeepers & Caterers. The implication is that recreational participants are required to obtain several different licenses (tourism, fishing, maritime, and in some cases, a boat docking permit if the area is within a marine park or reserve) [8]. A similar situation pertains in South Africa, with management being the responsibility of the Department of Environment, Forestry and Fisheries, although fishing licenses are issued by the national Post Office; boats and skippers are licensed by the South African Maritime Safety Authority, and fishing in a Marine Protected Area requires a separate permit. In the Seychelles, recreational fisheries are managed by both Seychelles Fishing Authority and Seychelles Ministry of Tourism [8], but no license is required [59]. In Mozambique, the Ministry of Sea, Inland Waters and Fisheries is responsible for the inspection of recreational and sport fishing, but the sector has its own regulations for recreational and sport fishing.

The different facets and overlapping mandates of recreational fisheries' management bodies may potentially result in a disconnect between the resource users and government agencies. Several challenges are likely to occur because of overlapping roles and weak governance systems. First, a lack of synergy between government agencies may potentially result in conflicting management objectives and policy. Secondly, the reporting framework can be decentralized hence data and information are not clearly shared with relevant bodies. Third, too many management structures can also cause excess complexity or an overload of regulations and poor fisheries management, thus discouraging or limiting the sustainable development of recreational fisheries. Conflicts of interest among different stakeholders may also influence governance. For example, conservation agencies may be more concerned with overall reductions in fishing effort and preservation of species, while the commercial fisheries sector may be more concerned about overall profitability, and the recreational sector is likely to support measures that promote preferential access to species.

3.1.3. A lack of data collection and reporting systems for recreational fisheries in the WIO region

The diverse and diffuse nature of marine recreational fisheries, combined with heterogeneity in fisher behavior, complicates the development of an integrated data collection system and protocol particularly for national fisheries institutions in the WIO [8,60,61]. Recreational fishers are often highly mobile and highly dispersed and thus localized data collection may not be feasible. It is also difficult to determine how best to aggregate recreational fishers into management units, because they are so diverse. A general observation across WIO countries (e.g., Kenya, Mauritius, Tanzania, and Seychelles) is that recreational fishing is often associated with tourism or fishing-directed tourism. As a result, the number of fishers is usually difficult to determine because of the nomadism of the participants - which in turn is based on factors such as availability and desirability of target species, seasonal changes and prevailing cost of travel to fishing destinations [62,63]. The collection of data and monitoring is often limited in time and space [64,65], and the limited structural and functional information about the fishery makes it difficult to determine strategies for data collection and to monitor on a local and/or regional scale. For example, despite the existence of a marine recreational fishery in Tanzania whose existence can be verified from historical records ([117]) and recent informal communications on social media platforms, no official landings have been reported to FAO. Additionally, management structures may not be in place and personnel may lack the training required to monitor recreational fisheries.

In addition, no standardized data collection protocols exist for recreational fisheries in the majority of WIO countries. While some data types are common to all fisheries sectors (e.g., date and duration of outing, amount and type of landed catch), recreational fisheries often include elements that differ from other sectors e.g. whether the fisher is a member of a club, are they on a charter boat, did they release fish, etc. The lack of standardized and centralized data collection systems may compromise the quality of data and continuation and consistency of data collection, and hence management decisions. For instance, in 2016–2017, the Indian Ocean Tuna Commission (IOTC) attempted to facilitate the acquisition of sportfishing data from the WIO region [8], but the initiative was not fully embraced by most national fisheries institutions because of the lack of capacity to use a regional standardized database.

3.1.4. Inadequate research and scientific information on marine recreational fisheries

Other than in South Africa, scientific knowledge and research opportunities regarding MRF are limited. Some authors have attempted to describe the recreational sector in various WIO countries (e.g., in Kenya [8,16,66,67], in Seychelles [8,68], in Mauritius [8,69,70], in Madagascar [27], and in Mozambique [71,72]). However, there is inadequate scientific research on, and knowledge of, MRF in WIO countries, and marine recreational fishers are understudied and under-represented in mainstream discussions regarding sustainable development and management of fisheries in most WIO countries. This issue is problematic in two ways: First, without data on MRF, it is impossible to assess the impacts of this sector on species and habitats. Second, the lack of information and scientific knowledge on key socio-ecological concepts of recreational fishing hinders effective management of fish resources, ecosystem structures, and the fishery itself.

3.1.5. Occurrence of multiple resource user conflicts

Recreational fishers may interact with other fishing sectors or resource users which can cause competition for target species and fishing grounds [16,73]. As described earlier, most participants in WIO fisheries are from the small-scale sector, yet competition for resources may lead to user-conflicts between recreational and artisanal fishers, such as those involving billfish in Kenya [16,74], and between these sectors in a large estuary in South Africa [75]. For highly migratory species such as billfish, there is heightened potential for conflict among the multiple sectors (industrial, small-scale, recreational) that catch billfish in WIO countries. In this case, notwithstanding the different motivations of these sectors (profit, subsistence, pleasure), they have a common purpose - to catch a desirable fish - so it is almost inevitable that there will be accusations and blame laid at the door of the other sectors when a sector's aspirations are not met [73,109,110]. While perceptions of over-exploitation by a particular sector exist, it takes formal investigation in order to determine whether that sector is responsible for the demise of a particular species. For example, in South Africa, recreational fishers have been shown to be more responsible for the demise of two hook and line-caught fish species than the commercial boat-based sector [76,77]. As a caution, though, temporal context is important - while a particular sector may be assessed as being currently responsible for a species' stock status, another sector may have precipitated an earlier decline [78].

3.2. Economic and socio-cultural challenges to locally developing and sustaining MRF

3.2.1. Limited participation of indigenous people in marine recreational fishing

There are very few studies from the WIO indicating levels of participation of indigenous people in recreational fishing. A recent study in Kenya revealed that artisanal fishers occasionally switched to recreational charter fishing which include offering inexpensive charters to

tourists [16]. In South Africa, an early study suggests that MRF is negligible in comparison to other activities such as picnicking, swimming and sporting events [79]. Everett and Fennessy [80] observed < 2% participation by indigenous people in a survey of recreational shore anglers in a large estuary on the east coast of South Africa, and none were encountered amongst recreational boat anglers in this estuary [81]. A nationwide South African study also observed the predominance of Caucasians amongst recreational anglers, and concluded that, since people of Caucasian origin were in the upper income brackets, it was unsurprising that > 90% of recreational anglers have incomes in the highest two quintiles of the distribution of household incomes [10]. In several WIO countries, the history of marine recreational fishing for billfishes in particular coincides with the establishment of colonial rule (e.g., [82,83]; Williams, 1972). In some parts of the WIO, recreational fishing is overwhelmingly undertaken by non-residents. For example, in Mozambique, it is dominated by South African tourist fishers [72]. In Kenya, recreational fishing began as a luxury of rich, privileged settlers and foreign tourists; currently less than 10% of recreational fishing boats are owned by indigenous Kenyans, and the demographics of most participants are predominantly Caucasian Kenyans or foreigners, with very few indigenous people or other ethnicities participating (ABF, unpublished data; Kadagi pers. comm). Ownership and involvement in charter boat fishing in particular and MRF in general is associated with the privileged. In contrast, while most indigenous people use natural resources for recreation, such resources are primarily considered useful for subsistence purposes; while outdoor recreation is perceived positively, basic needs such as education, housing and farming are prioritized [84].

While there are no formal regulations that preclude the involvement of indigenous people in MRF, membership of sport fishing clubs, for instance, exhibits exclusivity and social clustering based on nomination, expensive annual fees, ethnicity, and membership benefits that are not affordable to low-income communities. Exclusivity and social clustering are also upheld by the cost of recreational fishing itself, particularly boat fishing, which requires purchasing and maintaining an adequately equipped boat. Consequently, indigenous people often lack the financial capacity to be involved in MRF, although it may be of economic benefit to the local economy. Indeed, the per-unit value of recreationally-caught fish can sometimes far exceed that of small-scale or commercial fisheries [85].

Even though the presence of recreational fisheries may provide a source of employment for some local inhabitants such as crewmen, the socio-economic benefits accrued from recreational fishing may not be evident on a local scale. This is particularly true in cases where recreational charter fishing operations operate as private entities with little to no association with local businesses and the profits are retained by a few, possibly absentee, beneficiaries. As a result, there is a notion of 'parasitism' which is attached to the recreational fishing sector and a 'dependency complex'. 'Parasitism' is where the socio-economic benefits from a sector are siphoned out of the local economies and do not largely benefit the local communities directly ([86,87,119]), while a "dependency complex" is associated with reliance on the limited job opportunities that are directly or indirectly related to a given sector [83,86] even when these job opportunities do not necessarily prioritize the long-term needs of indigenous communities. Notably, 'parasitism' is the biggest factor limiting the economic benefits of recreational fisheries in Africa. 'Parasitism' creates economic leakages, which is defined as capital or income that exits an economy or system rather than remaining within it, resulting to insignificant contributions to socio-economic security [65]. For example, if a fishing lodge is foreign owned and attracts foreign clients the only money that is going back into the local economy is probably that of wages to staff, a small amount to non-imported locally purchased foods. Boats and fishing equipment are probably imported, and profits exit the country with the owner. Despite several economic fishery evaluations, many of these assessments fail to take these leakages into consideration and therefore over value a recreational fishery. 'Parasitism' can lead to resentment from local communities (e.g., <https://www.4x4community.co.za/forum/showthread.php/224581-Mo>

zambique-fishing-tournaments). The economic exclusion of indigenous people from recreational fisheries is likely to result in conflicts in resource use [16,88]. Further, coastal East Africa has been known over the years as a big gamefish destination, especially for billfish species [18], but information on the socio-economic importance of MRF to indigenous or local communities is often lacking. Consequently, there are limited strategies being pursued and no consensus is in place for creating socio-economic benefits to support local livelihoods while simultaneously ensuring the sustainability of the fishery.

3.2.2. Volatility in the tourism market for recreational fishing

Many WIO countries rely disproportionately on tourism for contributions to GDP (up to 63% in the case of Seychelles), yet there are many disruptive factors which cause fluctuations in tourist numbers [89]. Many recreational fishing operations in the region, particularly boat-based charter operations, rely greatly on international tourist clientele, although there are very few data available to quantify this. A review of billfish tagging records from Kenya indicates that about 65% of the participants are international tourists, 20% of participants are non-residents or expatriates, and 15% are domestic tourists and residents ([16]; ABF, unpublished data). Further, a review by Ndegwa [67] reported that recreational fishers made about 22,000 fishing trips between 1990 and 2008 in Malindi, Kenya. However, the numbers of recreational trips declined from 1600 per year in the 1990s to about 1200 in 2008 [67]. Thus, a drop in the number of tourists may potentially compromise the economic viability of the recreational sector. Given these fluctuations, sport fishing charter operations are likely to be affected by, *inter alia*, unstable markets, exchange fluctuations and political instability, resulting in a reduction in the number of visiting recreational fishers. Further, insufficient market penetration combined with a small market scale may be limiting factors, especially in places where recreational fishing is an uncommon leisure activity.

The current COVID-19 pandemic will further exacerbate this issue of the volatile reliance on international tourism for WIO countries. There has been a drop in the number of marine sport fishing charter operators and anglers with the closing of the borders and implementation of lockdown measures resulting in economic losses (Kadagi, pers. Comm; Duarte, pers. Comm). Put simply, the overall concept of sustainable MRF in the WIO may fail to materialize given the over-reliance on international tourist clientele as sport fishing anglers. With such complexity in the market stability and representation of participants, an important challenge to overcome will be developing marketing strategies that are locally-oriented, inclusive and affordable to potential in-country participants. If MRF is to be sustainably developed in the WIO as an alternate livelihood, then there is need to consider options for artisanal fishers to own fishing vessels and gear suitable for recreational use which provide opportunities for generating income.

4. Opportunities and future directions

The challenges discussed above underscore the need to address the issues affecting MRF in the WIO from a multi-scale and socio-ecological context taking into account the human dimensions, the target species and their habitats, and governance structures. More importantly, sustainably developing and managing MRF in the WIO will require a systematic understanding of the dynamics of this fishery, the anticipated changes in societal values, and the cooperation of multiple stakeholders. In the face of lack of information about the nature and quantity of catches, representation of participants and the socio-economic benefits of MRF, advancing the knowledge about the fishery creates an opportunity for formulating relevant policies. Our perspective reveals an important aspect on the extent to which MRF are exclusive in most WIO countries. Thus, to develop sustainable MRF that are inclusive of indigenous communities, it would be useful to consider the changes needed at societal level to motivate equitable participation and ownership. Further, the inherent linkage between different ecological and

human dimensions requires the involvement not only of fishers, but also other stakeholders, such as associated business interests, policy makers and the general public. We discuss the various opportunities and future options in the following section.

4.1. Develop well-equipped and integrated governance structures at multiple levels of management

An opportunity exists for the recreational fishing community to work closely with WIO national fisheries institutions in fisheries data collection, research and monitoring [108]. One similarity observed among the countries is that some most recreational fishing boat owners and skippers are members of sport fishing clubs or associations [8,10,16]. Thus, governance structures can work with recreational fishing clubs and organized groups to address information gaps through data collection which will improve our understanding of MRF. Practical examples exist, in the form of a boat launch site system managed by the responsible authority which oversees the launch site, with a compulsory launch register indicating the reason for the launch (fishing, diving, etc.), the intended destination, duration of outing etc. (e.g., [39]). But there may be challenges for both sides: First, there is a need for recreational groups to be willing to be a part of the processes and to work effectively with government entities, and second, there is a need for governance structures that recognize recreational groups in a manner that contributes and works towards sustainability of recreational fisheries and fisheries in general. While such arrangements may not be as formal, some examples exist between fisheries departments and industrial fisheries (e.g., Groupement des Armateurs à la Pêche Crevettière de Madagascar), or as envisaged for recreational fisheries management organizations in developed countries [90]. Collaboration between governance entities and recreational fisheries participants can assist in reducing costs of compliance enforcement and monitoring, alleviating user-conflicts, and producing greater economic benefits.

There is a need to address institutional barriers that may prevent sustainable management and development of MRF. Regulatory structures may play a role in reducing conflict management and thereby stimulating the improved performance of regulatory mechanisms through dialog with stakeholders. This can be achieved through ensuring communication between government entities that are responsible for managing the recreational sector, establishing stakeholders' communication and feedback regarding the status of the fishery and management.

4.2. Strengthen research and scientific information on MRF

Developing strategies for enhancing data collection and reporting, as well as engaging the wider audience may increase the availability of information, research opportunities and scientific knowledge regarding marine recreational fisheries in the WIO [114]. Some of the possible interventions include working with the existing recreational fishing associations and tagging programmes [103]. This has been successful in South Africa and Kenya where recreational fishing data have been obtained from anglers and clubs through voluntary data collection efforts, as well as conventional and satellite tagging initiatives. Given the difficulties in collecting fishery independent data from this sector, promoting citizen science and awareness is necessary to encourage the assistance of fishers in data collection.

Funds from recreational license fees could be used for training fisheries management personnel and fishers (e.g., creating education materials regarding collecting and sharing standardized data, developing research priorities, and developing and implementing monitoring programs). Dedication of such funds, though, would require negotiation with the countries' finance ministries. Training of fishers and enumerators is necessary to improve the quality of data collection and reporting. Such training would include accurate recording of data, such as catch number, and size, weight, sex, and species of the fish caught,

among other important parameters; independent verification of data collected would be required. Modern methods such as angler mobile applications can be used to complement and supplement traditional data collection methods such as logbooks, creel surveys, and interviews, especially where there are limited fisheries management personnel. For example, effort data from a popular smartphone application for anglers in Canada was found to be analogous to creel and mail survey data on regional and seasonal scales [120]. More generally, there is plenty of evidence for the benefits of collaborative efforts from all stakeholders to improve data collection (e.g., [91–93]).

Systematically identifying training needs through communication with stakeholders will be beneficial in providing scientific and technical knowledge that will improve the development and governance of recreational fisheries. Additionally, there is a need to engage tertiary learning institutions about MRF in order to increase recognition of the sector as a socio-ecological system.

4.3. Reduce and address multiple resource user conflicts

There is a need for increased recognition of user rights and development of allocation criteria between competing user groups [94–97]. One way to reduce multiple user conflicts would be to conduct spatial mapping for fisheries resources (e.g. fishing grounds, fishing landing sites); in several WIO countries, spatial partitioning already occurs to separate industrial trawling and small-scale fisheries [98,114], so adding a recreational fishing component is feasible. Other options would be to designate certain species for recreational use only [12], or to compel recreational fishers to release their catch [99]. All of these require surveillance to ensure compliance, with associated costs.

Assessing the causes of conflicts among resource users would help in developing conflict management strategies [16]. In doing so, conflicts arising from competing interests would be mitigated because of inclusivity of multiple resource user groups, permitting interaction and discussion.

4.4. Increase opportunities and participation of local people in MRF

Local investors should be encouraged to participate in the fishery through the creation of awareness and education activities that include information on how the fishery works, the infrastructure and maintenance needs, equipment and tackle requirements, financial implications, seasonality, type of clients, and the rules and regulations of engagement. Increased awareness and education about the significant contribution of recreational fisheries to local economies has potential to increase inclusivity [100]. Government structures would need to work together with these local investors to monitor the fishery and ascertain its contribution to their social, cultural and economic wellbeing [105,108]. An economic valuation of recreational fisheries within the WIO region to understand the economic leakages associated with the establishment of formal recreational fishing enterprises, particularly when they are owned by foreign investors is necessary in developing strategies to address weaknesses in the system, improve the contribution to local economies, and support for the wellbeing of indigenous fishing groups.

Stakeholders' perceptions are important in the development and successful management of recreational fisheries. Hence, there is a need to engage coastal communities by developing community-based strategies for economic empowerment through recreational fishing. This can be through (i) promoting the participation of local user groups in the sector instead of fishing for subsistence, and (ii) providing alternative ways to generate income as well as supporting community business ventures. Initiatives to promote and develop recreational fisheries should thus facilitate opportunities for indigenous communities to participate – for example by providing crewing opportunities on boats, or for procurement of bait, or use of local fishers as fishing guides. Coastal fishing communities can be actively engaged in the management process to help understand the need and value of sustainable

management; to some extent this happens in some WIO countries already, via the Beach Management Units [101], but needs to be expanded. Approaches to engaging these communities may also include training on data collection, reporting, and assessing the need for monitoring fishers. Further, fisheries resource user groups, managers and scientists can seek cooperation in mapping fishing zones and identifying causal factors that might hinder shared resource use, as well as in developing communication platforms across different scales. Data collection tools such as smartphone applications can be used to promote citizen science effectively. Making available information such as weather, location, prices of fish, markets and time could be an incentive to encourage user participation. Mobile applications would also help by assisting data to be captured and relayed in real time while reducing costs and delays in reporting as compared to the use of data forms. Incorporating local communities would be beneficial to recreational fishing associations and tourist fishing clients by strengthening social and cultural values among different resource users.

5. Conclusion

While this discussion recognizes that the challenges and opportunities mentioned are not exhaustive and may vary from one country to another, this review nevertheless represents a first step in the discourse regarding MRF in the WIO. The information gathered is critical for different stakeholders, namely governments, fisheries bodies, research institutes, and the fishers, whether artisanal, recreational or commercial, for sustainably utilizing stocks and optimizing economic benefits.

Further, the discussion recognizes that multi-level and diverse complexities exist when dealing with multiple fisheries sectors in the WIO region – recreational and sport fisheries cannot be dealt with in isolation. It is important to acknowledge the ongoing national and regional efforts to obtain recognition for, and improvement of, the sustainability and management of marine fisheries in the region. One notable example is the development of a regional project in 2016–2017 by the Indian Ocean Tuna Commission (IOTC) to enhance the acquisition of size and effort data from sport fisheries in the Western Indian Ocean [8,16]. As such, national fisheries institutions and stakeholders in the recreational and sport fishery sector should collaborate to advance data collection and monitoring. Along with efforts to improve data collection and monitoring, various issues such as a lack of expertise in data analysis, socio-cultural and economic differences need attention as they may hamper the sustainable development and management of this sector in the WIO.

The question then becomes, how can MRF contribute to sustainable development in the context of the Western Indian Ocean region? Entities engaged in the recreational sectors must consider the involvement of local communities in decision making and benefit sharing. Likewise, coordination in the multi-government agencies and multi-government and non-government efforts would be critical in integrating the recreational fisheries in the local and national agenda. Commissioning a socio-economic valuation of the recreational sector at a national and regional level would be useful in understanding the contributions and implications of MRF and facilitating local solutions for developing recreational fisheries through sound governance and community involvement. There is a growing interest for African coastal and island nations to explore the potential of their ocean resources, including the fisheries [105,121,122]. Okafor-Yarwood et al. [102] note that a successful African Blue Economy will rely on the ability of nations to integrate local communities in their decision-making and implementation processes. Our perspective builds upon this work by emphasizing the need to recognize the role of indigenous communities in redefining MRF in the WIO. Relatedly, we acknowledge that there are no simple fixes to the massive systemic challenges due partly to the scale of focus in the paper and partly to the highly diverse and complex nature of recreational fisheries, particularly in data-poor regions. Country-specific reviews will be required to more clearly identify opportunities to advance

sustainable MRF which benefit coastal communities equitably and maximize value; recreational fisheries in the WIO are too diverse to have a one-size-fits-all approach.

To succeed, effective management of fisheries in the WIO must consider the active involvement of MRF given their relevance at national and regional level. The South Africa example demonstrates the potential for developing recreational fisheries in the WIO region. Still, such a development will be dependent upon the sustained capacity building of local communities and fishers, collaboration from stakeholders, and the long-term sustainability of the fisheries resource.

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Author statement

NIK and NW conceptualized the perspective. NIK, NW and SF wrote the initial manuscript. MA and RA contributed to the amendment of sections in the initial and revised drafts. NIK, NW and SF reviewed primary and secondary sources of information and data. All the authors contributed to the revising of the manuscript.

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