The challenges of management: Recent experiences in implementing fisheries co-management in Lake Victoria, Kenya

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Abstract

This study examined the efficacy of community-level fishery co-management organizations called Beach Management Units (BMUs) along the Kenyan shores of Lake Victoria. BMUs were established to enhance sustainable Lake Victoria fishery management through increasing the level of community participation to assist in the administration of fisheries rules and regulations by, and for, the fishers. Inefficiencies have emerged, however, inhibiting the effective execution of sustainable fisheries management by the BMUs. Data were collected from 36 BMUs along the Kenyan shores of Lake Victoria. Descriptive and inferential analyses were performed using SPSS Version 20.0. The results indicated that BMUs are successful at educating fishers and that they are aware of fishing rules and regulations. Nevertheless, high violation rates were also observed, suggesting BMUs have limited impact on fisher decisions to comply with regulations. Data suggest that the failure to comply may be due to lack of adequate financial and equipment resources for monitoring, control and surveillance (MCS) operations, making them unable to control illegal fishing in their areas of jurisdiction. Furthermore, financial mechanisms, which would allow BMUs to sustainably fund their administrative and MCS operations, are weak, thereby reducing the BMUs ability to effectively function. The data from this study highlight two activities illustrating significant indices of good performance, namely resolving disputes and receiving visitors. The data also suggest the creation of BMUs has not ensured successful implementation of co-management of Lake Victoria fisheries. BMUs are successful at activities of a social nature, but have poorly undertaken their core functions related to enforcement and compliance with fishing rules.

Key words

Beach Management Units, co-management, Kenya, Lake Victoria, Nile perch fishery.

INTRODUCTION

Lake Victoria is the world's second largest freshwater lake and the largest tropical lake, with a total surface area of 68 800 km^2 (Witte & van Densen 1995). The lake's surface areas are shared by three countries; Tanzania (51%), Uganda (43%) and Kenya (6%). Lake Victoria is a multi-use resource, valued for its immense socio-economic and ecological benefits, including its critical role as a source of food and potable water, transportation, irrigation water, power production and tourism (LVFO 2008a). The lake has been transformed into the largest freshwater fishery in the world over the last 30 years, producing annual catches of over 1 000 000 tonnes that are worth about US $590 million (Kolding *et al.* 2014; LVFO 2014). The lake's fisheries support approximately

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two million people with household incomes and meet the annual fish consumption needs of almost 22 million people in the region (LVFO 2014).

The current fishery is dominated by two introduced species, including Nile perch (*Lates niloticus* L.) and Nile tilapia (*Oreochromis niloticus* L.), and one native cyprinid (*Rastrineobola argentea*) (Pellegrin, 1904) (Balirwa *et al.* 2003; Njiru *et al.* 2008). Nile perch is by far the highest valued species in the lake's fishery, supporting a multi-million dollar export industry that provides the three East African countries with about US $350 million in export earnings per year (Marshall & Mkumbo 2012; Njiru *et al.* 2014). Nile perch is not the only valuable fish species in Lake Victoria. *Rastrineobola argentea* is now the most important catch from the lake in terms of weight, contributing almost 61.5% of the total fish landings (10 339 tonnes) in Kenyan waters, with ex-vessel value of total fishers' earnings of approximately US $2.5 million (Ojwang *et al.* 2014). The catch of Nile tilapia is now estimated to be around 70 000 t per annum, valued at US $38 million (Abila *et al.* 2008; LVFO 2008a).

The lake has experienced some of the most extreme ecological perturbations and negative impacts over the past century from a variety of interlinked anthropogenic activities, including population growth, intense fishing, increased land cultivation, introduction of exotic species, industrial pollution, eutrophication and, more recently, climate change (Hecky *et al.* 2010; Muyodi *et al.* 2010). Indeed, the overfishing and continuing unchecked eutrophication could lead to a catastrophic loss of productivity in this now immense fishery (Kolding *et al.* 2008; Hecky *et al.* 2010). According to Ogello *et al.* (2013), the uncontrolled access to the lake is largely to blame for both the ecological and environmental issues impacting the Lake Victoria fishery. Although enormous resources have been used for management and conservation of the lake and its vast resources, very little success has been realized to date.

Prior to the late 1990s, Lake Victoria fisheries management was conducted through centralized state-controlled fisheries authorities (Kundu *et al.* 2010), with little or no provision for involving fisheries stakeholders in the fishery decision-making process (Lwenya & Abila 2003; Ogwang *et al.* 2009). This management system, however, failed to sustain the fisheries for those dependent on the resource for their livelihood (Geheb & Crean 2003; Lawrence & Watkins 2011). The continuous deterioration of ecological integrity of the lake, and declining fish catches, necessitated a 'paradigm shift' from a top-down management approach to a collaborative or 'co-management' approach involving stakeholders at all levels (Njiru *et al.* 2008). Co-management involves sharing roles and responsibilities for resource management between the government, resource users, civil society institutions and private sector stakeholders. For Lake Victoria, the fishing communities participate in co-management through organizations called Beach Management Units (BMUs). According to the Lake Victoria Fisheries Organization (LVFO), which is the fishery co-management coordinating body for Lake Victoria, a BMU is defined as 'an organization of fisher folk at the beach (boat crew, boat owners, managers, charterers, fish processors, fishmongers, local gear makers or repairers and fishing equipment dealers) within a fishing community' (LVFO 2007). A key piece of legislation (The Fisheries (Beach Management Unit) Regulations, 2007, under the Fisheries Act (Cap 378) – Legal Notice No. 42), – was passed in Kenya in 2007, giving BMUs the rights to manage resources at a particular landing site (GoK 2007), with guidelines being prepared for the constitution and operation of BMUs (Ogwang *et al.* 2006).

Formation of BMU structures in Kenya started in 2004, and by 2006, most of the BMUs had been established. Establishing the BMUs built on beach committee arrangements in existence since the early 1960s (Abila *et al.* 2009). BMUs can comprise one or more landing sites. To qualify for registration as a BMU, however, a landing site needs to have a minimum of 30 boats among other requirements (Ogwang *et al.* 2006; Cinner *et al.* 2009). The spatial jurisdiction of a BMU constitutes a defined geographical area that has been surveyed, its boundaries clearly delineated, and marked as a fish landing station by the Director of Fisheries. The BMU functions within their area of jurisdiction include recording fish landings and enforcing fisheries regulations (Cinner *et al.* 2009). BMUs are required to make their own rules, in the form of by-laws to govern their internal operations, examples being restricting certain gears or establishing a fisheries closure, although final approval rests with the Director of Fisheries.

Although adoption of the lake fisheries co-management program was viewed as a good option for regulating the exploitation of the fishery (van der Knaap *et al.* 2002), catch and effort continue to expand on Lake Victoria (Kolding *et al.* 2008), leading to concerns about the ability of the co-management program to manage this valuable fishery in a sustainable manner. Despite the many functions of BMUs (LVFO 2005), their main function was to enhance the level of compliance of fisheries rules and regulations, thereby fostering responsible fishing practices for the lake (LVFO 2007). Cinner *et al.* (2009) provides a comprehensive review of the roles of

BMUs as stipulated in the Beach Management Regulations, including boundaries/membership of BMUs, rule-making, enforcement and monitoring, and partnership roles of nested institutions. Inefficiencies have emerged, however, that negatively affect BMU abilities to perform their designated roles of sustainable fisheries management (Abila *et al.* 2006; Ogwang *et al.* 2009).

A major concern is that BMUs have not influenced fishers' attitudes about unsustainable fishing tendencies (Nunan 2007; LVFO 2008b; Eggert & Lokina 2008). Although BMUs were initiated about a decade ago, there is still insufficient information on their performance levels, the challenges they face, and their role in fostering responsible fisheries and community development. These knowledge gaps may lead to unjustified conclusions concerning the impacts of co-management for Lake Victoria. Accordingly, this study investigated the challenges facing fisheries co-management structures and processes on Lake Victoria, and how they impact the Nile perch fisheries.

Theoretical framework

Lake Victoria is categorized as a common pool resource (CPR) (Ogello *et al.* 2013). Broadly defined, CPRs are resources to which more than one individual has access, but where each person's consumption reduces the availability of the resource to others (Dietz *et al.* 2003). In this regard, fishers are free to exploit fisheries resources, subject to regulations such as gear restrictions, fishing area closure and seasonal restrictions (Eggert & Ellergård 2003). However, it is important to note that whereas fishers have 'user' rights, they do not have absolute 'ownership' rights. This is one key limitation in management, as any one or a group of fishers cannot exclude others from enjoying the same resource.

Over the past two decades, scholarship on resource use and management has emphasized the key role of institutions, communities and socio-economic factors (Agrawal & Chhatre 2006). Successful fisheries co-management requires an appropriate institutional and organizational framework for CPR governance (Baland & Platteau 1996). Institutions constitute the central element in co-management analysis. In this research framework, an institution is defined as: '*the rules of the game in a society; or the humanly devised constraints that shape human interactions, and are affected by social, cultural, economic and political factors*' (North 1990). An Institutional Analysis Framework (IAF) was used to identify and examine key factors affecting the BMU institution and outcomes of co-management in the Lake Victoria fishery (Fig. 1). This empirical research framework allowed for data to be collected and analysed in a standardized format, and generalizations made about fisheries co-management arrangements for use within the country and beyond (Pomeroy *et al.* 2001). IAF helps us better understand that institutions are affected by multidimensional and complex relationships of causal influences arising from biophysical, economic, demographic, institutional, infrastructural and socio-political contexts that surround, or are a part of, such institutions (ICLARM & IFM 1998; Agrawal 2001). Existing studies have recognized each of these causal classes as being instrumental in influencing resource governance outcomes (Alvarez & Naughton-Treves 2003; Agrawal & Chhatre 2006; Ostrom *et al.* 2009).

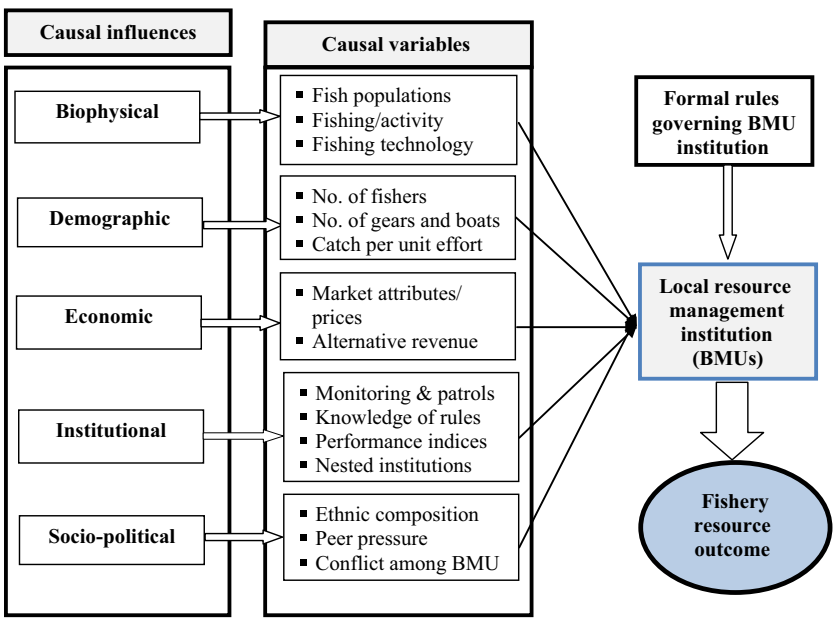

Fig. 1. Institutional Analysis Framework (IAF; modified from ICLARM & IFM 1998).

Biophysical characteristics of a resource often influence harvest behaviour (ICLARM & IFM 1998). As an example, perceived low fish populations in Lake Victoria can lead to further overexploitation of the fishery by those using smaller nets to catch fewer fish. The harvesting activity of an individual fisher subtracts from the quantity of fish available for other fishers to catch (Oakerson 1992). Indeed, a number of scholars have explicitly identified high levels of variation in biophysical factors, and therefore resource flows, as the source of pressures for self-organization and local cooperation (Ostrom 1990; Wade 1994; Baland & Platteau 1996; Agrawal 2001) Institutional arrangements, however, have an indirect effect on outcomes as they lead to changes in human behaviour and choice, which can affect interactions and outcomes (Oakerson 1992). Institutional variables include those related to representation and inclusion of users; monitoring, control and surveillance; enforcement of rules; and relationship with external authorities. Agrawal and Gibson (1999) argue that institutional arrangements, structured by the contextual variables, affect the actions of the resource users by shaping the incentives and disincentives they face to coordinate and cooperate in resource governance, management and use.

Economic variables include market attributes that influence the incentives for resource use activities, effort levels and motivations for compliance with fishing rules (ICLARM & IFM 1998). Some of these market variables include stability of supply and demand in terms of price and quantity, market availability and location, market structure, credit/market relationships, and changes in market and market operation. Demographic factors are represented by the number of fishers per unit area, number of boats and gears operational in the lake, or similar variables. Socio-political variables facilitate collective action through cultural and economic homogeneity in terms of kinship, ethnicity, religion, interests, beliefs, customs, and livelihood strategies (Onyango & Jentoft 2008). As an example, if the fishers are highly dependent upon the fishery, and if the availability of the resource is uncertain or limited, fishers are more likely to facilitate collective action to deal with the problem (ICLARM & IFM 1998).

METHODOLOGICAL APPROACH

Study area, research design and sample size

This study was conducted between July and October 2009 at formal Beach Management Units located at fish landing beaches on the Kenyan shoreline of Lake Victoria (Fig. 2). A two-stage stratified random sampling approach was used to select the BMUs surveyed and the study participants. As a first step, as Nile perch was the motivation for establishment of the Lake Victoria co-management program, the criterion for BMU inclusion in this study meant identifying landing beaches with Nile perch fishing as the main fish species. Thus, a total of 36 BMUs were selected on the basis of this criterion, using data from Kenya's 2008 Frame Survey (LVFO 2008c). Second, participants were selected on the basis of their role at the BMU. Two BMU committee leaders and two boat owners were selected at each BMU, to gain an understanding of fishery management-related activities and the variables

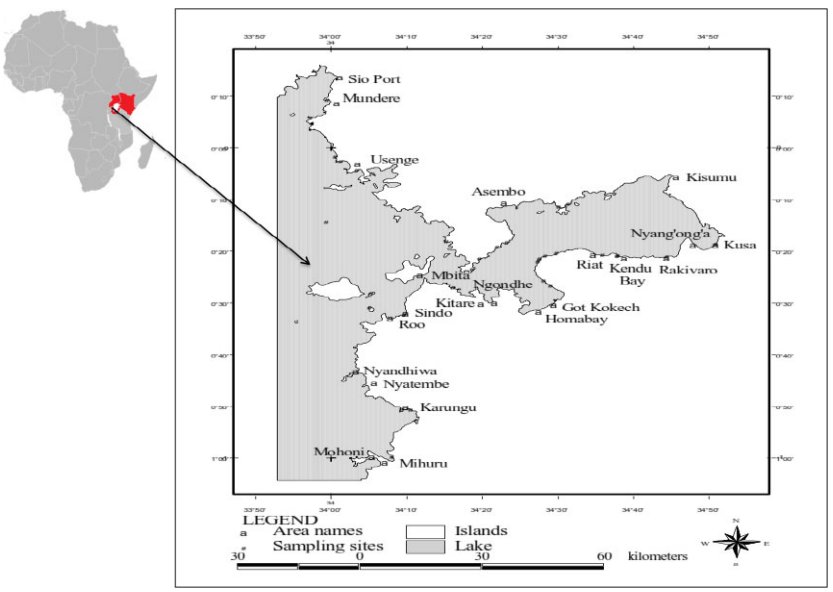

Fig. 2. Map of Lake Victoria, showing locations of landing beaches and Beach Management Units visited in Kenya.

that might affect these activities. BMU committee leaders were chosen because they are responsible for day-to-day operations of the BMU. Boat owners were chosen because they are the main decision makers when it comes to fishing-related decisions. Boat owners are those that invest in fishing enterprises, check on catches, oversee the sale of fish and payment of crew, and consider input needs such as the costs of nets and boat repairs. Boat owners are generally wealthier, more powerful and have influence on decisions over the boat crews (Nunan 2007). Thus, four respondents were selected at each BMU, comprising a total of 141 respondents. It is noted that only one BMU committee leader was interviewed for one study site, due to conflict in the BMU leadership, owing to corruption and mismanagement.

Data collection and analysis

To determine the appropriateness of the structured questionnaires used in this study, a pilot study was used to adjust the questionnaires before conducting the actual survey. The questionnaires were pretested at three BMUs, using 12 respondents (six boat owners and six BMU leaders). Primary data were collected at landing beaches, using structured questionnaires. The survey comprised of two different categories of interviews: (i) a questionnaire targeting boat owners; and (ii) a BMU executive committee leaders questionnaire targeting BMU committee leaders, specifically the chairman and secretary. Other members of the committee were used in cases when the chairman or secretary was absent. Secondary data from reviewing government documents and other archival materials, and published studies and consultant reports on the Nile perch fisheries, provided additional details. Data provided by recent lakewide Frame Surveys conducted since 2000 (LVFO 2010; LVFO 2012) were used to assess the level of effort in fish production sector, as well as to generate socio-economic and ecological information. Primary data were entered and analysed, using Statistical Package for Social Sciences (IBM-SPSS Inc. version 20.0 IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: USA). Both descriptive and inferential analyses, such as percentage distribution techniques, cross-tabulations and chi-square (χ^2) goodness of fit, were used to analyse the data.

RESULTS

Perceptions on the biophysical factors of the Nile perch fishery

Among the interviewed boat owners, 93% stated there was a serious decline in Nile perch catches, 4% reported that catches remain unchanged, and 3% felt that catches have increased compared to the past 5 years. Similarly, 98% of BMU committee leaders reported that Nile perch catches had declined considerably. A significant majority ($\chi^2 = 62.9739$; d.f. = 2; $P = 0.001$) of boat owners acknowledged the lake fishery is threatened with complete collapse, due to a drastic decline in the Nile perch stocks. According to 49% of the respondents, the major cause of the Nile perch decline is the use of illegal and destructive fishing practices, including fishing in breeding grounds, using illegal beach seines, and small mesh-sized 'monofilament' nets; and overfishing, the latter being expressed as 'too many fishers' in the lake (Table 1). Other cited reasons included a massive increase in fishing effort occasioned by too many boats and gears (26%), pollution and eutrophication brought by agricultural nutrients, water hyacinth re-emergence and industrial effluence; and blockage of the Mbita Causeway (19%), among other factors (19%). In addition, BMU leaders and boat owners reported they have experienced changes in average catches of Nile perch captured per boat. Fifty seven per cent of boat owners indicated their average daily catch was below 10 kg boat^{-1}, compared to 2 years ago, while 24% stated their daily catch ranged

Table 1. Fisher's perceptions on changes in Nile perch catches and causes for the changes

	Perceived causes of changes in Nile perch stocks (%)				
Perceived change in Nile perch catch	Overfishing	Pollution and eutrophication	Increasing fishing effort (boats and gears)	Illegal fishing	Others
Become worse (catch is declining)	49*	19	26	49*	19
Improved from the past	1	0	0	3	1
Remained the same (No change)	0	0	1	0	0

Proportions: Each fisher was given an opportunity to identify up to three causes. (Significant difference*) ($\chi^2 = 15.4604$; d.f. = 2; $P = 0.0004$)

between 11 and 30 kg boat^{-1}. Nearly 12% reported they capture over 30 kg boat^{-1} daily, compared to only 7% who caught more than 60 kg boat^{-1} daily.

Demographic factors causing changes in Lake Victoria fishery

A majority of respondents in this study reported their belief that there is an increased number of fishermen on the lake, with 62% of boat owners, and 63% of BMU leaders stating there are more fishers, compared to 2 years ago. Furthermore, respondents were asked whether they were worried that the increasing number of fishermen would result in a decline in their individual catches. Those who were worried about having enough fish in the future, compared to those who do not worry about this issue, were almost evenly distributed; a further 51% of boat owners do not worry and 49% do worry. Of the 70 boat owners interviewed, 38% were not worried, and will not buy any additional gear, 18% are worried, but will not buy more gear, and 11% are not worried but will buy more gear. Sixty-four percent (n = 49) of boat owners had increased the number of gear, while only 16% had increased the number of boats owned. The major reason for not investing in the purchase of more boats was identified as declining fish catches (84%), resulting in a reduced rate of capital investment into the fishery. Despite the increase in the number of gear, 60% of the respondents reported they had caught less fish. These findings are consistent with actual results for the whole lake for all the biennial Frame Surveys conducted from 2000 to 2012 (LVFO 2013). Lakewide fishing efforts increased between 2010 and 2012, measured in terms of fishing crafts and fishing gear, apart from traps and baskets, (fishing crafts 7.7%; gillnets 19.1%; small seines 11.6%; scoop nets 61.2%; longline hooks 15.6%; beach seines 16.9%; cast nets 21.9%; and monofilament gillnets 113.8% (Table 2)).

Economic factors regarding the fishery

About 82% of boat owners target Nile perch because of its high net income, driven by rising prices in export markets. Other stated reasons include a lack of skill for catching other fish other species (6%), with another 6% alluding to the difficult working conditions in fishing for *R. argentea,* which is traditionally done at night (Table 3). Regarding the presence of illegal-sized Nile perch at landing beaches, 64% of boat owners disclosed that they 'freely' sold undersize fish to local traders within their beach, while 40% of BMU officials admitted they allowed sales of illegal-sized fish and/or sanctioned rampant undersize fish trade practices. In most beaches visited, sun-drying and deep-frying of juvenile fish were observed before the fish were transported to local (<5 km) and distant markets in the Democratic Republic of Congo.

Over 70% of respondents stated they are involved in other income-generating activities, due to declining eco-

Table 2. Indicators of fishing effort in the Lake Victoria fishery

Indicator	2000	2002	2004	2006	2008	2010	2012	% change 2010–2012
Landing sites	1492	1452	1433	1431	1327	1443	1481	**2.6**
No. of fishers	129 305	175 890	153 066	196 426	199 242	194 172	205 249	**5.7**
No. of boats	42 519	52 476	51 592	68 836	67 513	64 595	69 549	**7.7**
Outboard motors	4108	6552	9609	12 765	13 721	16 188	20 217	**24.9**
Sails	6304	9620	8672	10 310	9811	8424	7871	**−6.6**
Paddles	32 032	35 720	33 405	45 753	43 553	39 771	41 392	**4.1**
*Gillnets <5"**	113 117	178 205	142 618	215 049	207 954	159 013	200 689	**26.2**
Gillnets >5"	537 475	724 879	1 090 434	1 007 258	805 678	708 292	832 295	**17.5**
Hand lines	53 205	58 123	40 953	71 636	65 717	48 681	49 679	**2.1**
Longlines hooks	3 496 247	8 098 023	6 096 338	9 044 550	11 267 606	11 472 068	13 257 248	**15.6**
Dagaa: small seines	3588	7796	8601	9632	10 276	13 514	15 064	**11.5**
*Beach seines**	7613	3491	3355	3653	4187	3743	4375	**16.9**
*Cast nets**	5887	1095	803	775	1174	1282	1551	**21.0**
*Monofilament nets**	0	0	5944	2293	20 194	16 488	35 253	**113.8**

* and italics denote illegal type of gear (Source: Frame survey LVFO, 2010; LVFO 2012). Bold letters show percentage change in fishing effort for different indicators between 2010 and 2012 Frame Surveys.

Table 3. Main reasons for fishing Nile perch species in Lake Victoria during study period

Main reasons for fishing Nile perch	% Frequency of respondents (n = 70)
High income returns due to rising export prices	*82*
Lack skills for fishing other species	*6*
No other alternatives	*6*
Others factors such as low market value of other fish species and poor working conditions	*6*

nomic returns from the fishery. Forty-two percent of BMU committee leaders stated they are engaged in farming; 30% are engaged in postharvest fisheries-related activities such as fish processing and trading, boat building, net repairing, and boat transport; 14% are engaged horticultural crop farming; 6% in livestock rearing; and 8% in other livelihood-generating activities such as sand mining, agroforestry, fish farming, cafes, bars and beachside hotels. Thirty-six percent (n = 18) of boat owners stated they were involved in farming; 28% in postharvest fisheries-related activities; 20% in horticulture; 5% in livestock rearing; and 11% in other activities such as bicycle and motorcycle taxis and boat transport, casual labourers, poultry rearing, and small-scale business.

Socio-cultural and political factors affecting BMU operations

The fishing community of Lake Victoria comprises people of diverse ethnic, gender and socio-cultural backgrounds, all of whom derive their livelihoods from fishing or fish trading. The major ethnic groups encountered during the survey were from the Luo tribe (93%), followed by the Luhya (4%) and Suba (2%) tribes. Other tribal groups included immigrant fishers of Somali origin, Kikuyus, Kisii and Kalenjins who were attracted to the lake for commercial gain. The fishery also supports formal and informal groups at the community level. Sixty percent (n = 42) of BMU committee leaders stated they are members of formal and informal groups such as fishery co-operatives, self-help groups, trader groups and welfare and credit associations.

This study sought to identify the presence and level of conflict within, and between, neighbouring BMUs. Survey findings indicated that 59% of BMU leaders and 39% of boat owners acknowledged they had experienced various kinds of conflicts within their BMUs, mainly attributed to theft or destruction of fishing gear; competition for fishing resources or landing space; differences between 'traditional' fishing boundaries and newly demarcated boundaries and areas; access to fish landings due to water hyacinth; and, use of 'destructive' fishing techniques in breeding areas. Furthermore, 51% of BMU leaders and 31% of boat owners acknowledged they experienced both internal and external conflicts between their BMUs and neighbouring BMUs. Most respondents (over 50%) indicated the level of conflict is limited, while 38% of boat owners and 28% of BMU committee leaders stated that significant tensions can erupt into violence, and 22% of BMU committee leaders and only a few of the boat owners (8%) responded there have been violent disputes. Of all the study respondents, 89% indicated their BMU was successful in resolving disputes.

Institutional factors affecting BMU performance

Beach Management Units are at the frontline of enforcing fishing rules and regulations, as conducted through regular monitoring and patrol exercises. Eighty-seven percent of BMU committee leaders and 77% of boat owners reported that BMUs conduct regular patrol and monitoring exercises. Collectively, over 50% of the respondents stated that patrols are done frequently. When asked whether other authorized entities conduct patrols, 60% of BMU leaders and 54% of boat owners reported government agencies conduct patrols independent of BMUs. Many respondents also indicated, however, that BMUs do not have provisions for regular surveillance or patrols to ensure compliance. Based on results from BMU committee leaders, the BMUs are limited in their capacity to conduct patrol operations, including lack of equipment (51%) such as boats and engines, high fuel costs (22%), lack of funds to pay patrol teams (12%), lack of security during patrols (10%), and other factors such as bribing of fisheries officials, and high cost of hiring security officials (5%). About 51% of BMUs use boats with motorized engines to conduct patrols, 33% use hand paddle-propelled boats, 12% use wind-propelled boats, and 4% apply land-based observations to monitor fishing irregularities.

Regarding fishers knowledge of fishing rules and regulations, almost all the BMU committee leaders and boat owners admitted they are aware of current national laws and BMU regulations regarding Nile perch fishing. In particular, a majority of BMU committee leaders (90%) and boat owners (91%) were aware of the minimum mesh size (5"), while 88% and 89% of respondents, respectively, correctly identified the minimum legal size (50 cm total

length) of fish to be landed (Fig. 3). Furthermore, 57% of the BMU committee leaders and 50% of boat owners stated they were aware of regulations that prevent fish landings from other BMUs without a 'letter of introduction'.

In terms of enforcing fishing regulations, 88% of BMU committee leaders and 85% of boat owners acknowledged that BMU committees take legal action by arresting or fining offenders, confiscating illegal gears when someone is caught using them, or stopping use of destructive fishing methods. Furthermore, over 50% of BMU committee leaders regarded the punishment of offenders to be 'fair,' while 45% of boat owners thought the punishment was 'too severe,' especially cancellation of licences, permits or certificate of registration; confiscation of gears by police, and burning of illegal nets, among others. About 26% of boat owners stated the rules are 'too lenient', meaning they would not report habitual offenders if they encountered them breaking the law.

This study analysed key indicators of BMU institutional performance, based on indices produced by Abila *et al.* (2006), as shown in Figure 4. Overall, only two activities exhibited significant indices of good performance according to BMU committee leaders, namely resolving disputes (91%) and receiving visitors (99%). Activities that the BMUs performed averagely were the provision of services by the BMUs (75%), arresting of offenders (64%) and enforcement of fishing rules (61%). The activity with the worst performances, according to the BMU leaders, was confiscation of illegal gears (53%). These results indicate that BMUs are involved in activities with a high potential for social sustainability. However, they have poorly undertaken their core functions related to enforcement and compliance with fishing rules. These results agree with findings of Abila *et al.* (2006) who found the activities most frequently carried out by BMUs are resolving disputes, receiving visitors, and arresting offenders. Abila *et al.* (2006) reported that no BMU activity received an overall good performance index mainly because they lacked legal power for prosecuting offenders and confiscating illegal gears.

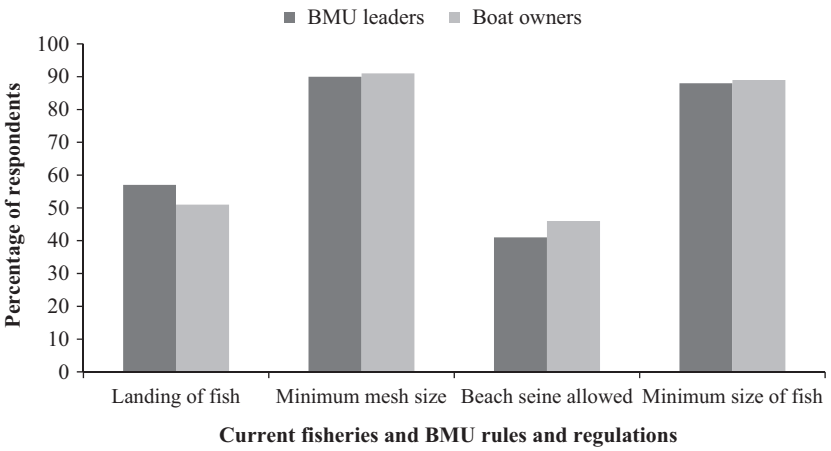

Fig. 3. Fisher's knowledge of fisheries regulations in Lake Victoria, Kenya.

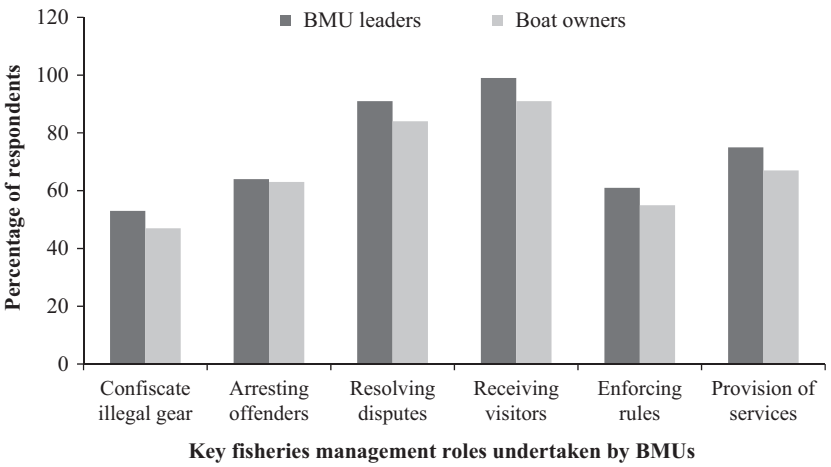

Fig. 4. Indicators of Beach Management Unit performance in key fisheries management roles.

Considering the financial sustainability and viability of BMUs, most BMU leaders (96%) stated the main source of income for BMUs are taxes charged on beach area access, fish sales, boat and gear licensing, while 43% stated they obtain their incomes from fines imposed on illegal fishing tendencies. Very few BMUs (4%) obtain any significant income from other sources. Forty-six percent (n = 33) of BMU committee leaders reported collecting income in the range of Kshs 4000–20 000 per month, 36% collect less than Kshs 4000 per month, while 6% do not get any income. BMU committee leaders reported that 13% of BMUs earn more than Kshs 20 000.

Furthermore, the roles of partnership or nested institutions such as the Fisheries Department (FD), Kenya Marine and Fisheries Research Institute (KMFRI) and Lake Victoria Fisheries Organization (LVFO) also were investigated in regard to BMU empowerment. These institutions are regarded as the main actors operating at different stages and scales in the fisheries sector, including their involvement in development and functions; visiting BMUs to monitor performance; and in representation of fishers interest in fisheries management plans. Almost all respondents (99%) were aware of FD activities, as it is vested with the overall responsibility for monitoring and supervising BMU activities, and also is involved in all stages of BMU development process. Similarly, a large percentage of BMU officials (86%) are well-informed about the activities of KMFRI through repeated support, mentorship and guidance of their BMU activities. Although a majority of the respondents (99%) know what the LVFO is, their functions are not well recognized as only a few BMU committee leaders reported they have met the staff of the organization.

DISCUSSION

Biophysical factors of the fishery

A declining trend in the catches of Nile perch has been recorded for Lake Victoria over the last two decades. In the present study, fishers reported that fish catches have declined rapidly in recent years, and have remained low despite the development of co-management initiatives. Similarly, almost all the fishers reported a decrease in individual fish catches over the last 5 years since the creation of BMUs. Likewise, other biological indicators such as fish size at maturity, growth, longevity and maximum size of fish populations also are under stress, suggesting heavy overexploitation (Ogari & Asila 1992; Matsuishi *et al.* 2006). Peak production was realized in Kenya in 1991, when Nile perch contributed 57% of the total landings (Othina & Tweddle 1999). Kenya invested more heavily in the Nile perch fishery, being the first to venture into fish processing factories in East Africa (SEDAWOG 2000), therefore also first experiencing the decline in Nile perch catches (Othina & Tweddle 1999). Annual catches in Kenya declined from a peak of 122 780 t in 1991, to about half (61 416 t) in 1998 (Othina & Tweddle 1999). The contribution of Nile perch towards fish catches in all three Lake Victoria's riparian countries rose to 58% in 1996, but dropped to 39.2% in total fish production in 2007 (LVFO, 2008). The catch per unit effort decreased from 180 kg boat day^{-1} in 1989, to 80 kg boat day^{-1} in 1999 (Othina & Tweddle 1999), leading to severe food and income insecurity, a situation currently persisting in the Lake Victoria region. While fishers generally catch fewer fish for daily household consumption, there is little certainty for the future, as fishers may catch no fish on some days (Geheb *et al.* 2007).

Although the future of the Lake Victoria fishery is difficult to predict, if current fishing levels continue, future fish stocks may consist of smaller fish with lower commercial value. According to Kolding *et al.* (2008), changes in the size and distribution of the Nile perch in Lake Victoria may reflect the interaction of both fishing pressure and eutrophication. Kolding *et al.* (2008) argue that eutrophication is primarily responsible for the current observed downward trends in Nile perch stocks. Thus, management should be more concerned with controlling eutrophication than focusing on illegal fishing practices which have no significant effect on fish stocks. Although eutrophication has been shown to have significant effects on fish stocks (Hecky 2003), the negative influences of fishing pressure and illegal fishing on the Nile perch populations have demonstrated that fishery management must specifically address each of these factors (Matsuishi *et al.* 2006; Mkumbo *et al.* 2007; Goudswaard *et al.* 2008). Acknowledging that multiple factors often influence aquatic ecosystems, and in the light of research that demonstrates both eutrophication and fishing pressure can have detrimental effects on the Lake Victoria Nile perch fishery, efforts should be made to address both eutrophication and overfishing as causative factors for the declining fishery.

Demographic factors affecting the fishery

The Lake Victoria fishery has been influenced by an increased number of fishers, boats and gear operational in the lake. These features have been, and still remain, the dominant features in managing the fish stocks (Matsuishi *et al.* 2006; Ogello *et al.* 2013). Most fishers join the fisheries either using their own boats, or by renting boats from other fishers. Study results indicate a

large percentage of boats owned by fishermen are targeting Nile perch. The fishers targeting Nile perch use three main fishing gears, namely hooks and longline, gillnets operated either passively or as drift gillnets, and beach seines. The increase in gears such as beach seines and small hooks targeting young fish, or the more efficient gear such as monofilament nets, and the inexpensive, but efficient, gear such as hand line hooks and cast nets, all being illegal, is probably a response of fishers to declining catches and limited financial returns in the fisheries. This situation clearly may lead to further depletion of the fisheries if not controlled (LVFO 2008c). Gill nets of <127 mm (<5") are readily available in beach side shops and in some fishing villages that were visited during the present study.

The number of nets a fisherman can use has increased over the past few years because of two main factors. The first is that depth consideration has changed the concept of a 'single net' to 'double netting.' In the deeper or open waters, the mounting of small seines can go up to 8 pieces, that is, a maximum depth of 27 m. The second is that, in shallow waters such as in the gulf, the nets remain single, but are extended horizontally to cover wider areas. In certain areas such as around Kendu Bay, however, it can be mounted twice; that is, hanging at nine metres depth (Abila *et al.* 2009). It is important to note that shallow areas act as important feeding areas and breeding grounds for many species, especially Nile tilapia. Overfishing in these areas, therefore, threatens the ecological integrity of the lake ecosystem. Indeed, the Nyanza Gulf is the most intensively fished part of the lake, experiencing more than 10 fishers per km^2, compared to about 2 per km^2 for the rest of the lake (LVFO 2008c). This suggests an unsustainable tendency for the Nile perch fishery, as fish are being caught before they can contribute to the regeneration of the stocks. Overall, Lake Victoria fisheries, similar to other regulated access fisheries, exhibit significant signs of overexploitation, overcapitalization and low profitability (Bokea & Ikiara 2000). The declining fish stocks threaten the survival of nearly half a million communities in Kenya dependent on the fisheries.

Economic factors of the fishery

The Nile perch fishery has been the hub of development for the Lake Victoria fishery in Kenya, contributing significantly to the national economy (Yongo *et al.* 2009). Most fishermen target Nile perch, and make the largest incomes of approximately Kshs. 170 kg^{-1}, compared to Kshs 150 kg^{-1} earned by tilapia fishermen. The exploitation of Nile perch in Lake Victoria is strongly export-oriented, achieved through the international trade of fish and fish products by the processing factories (Schuurhuizen *et al.* 2006; Johnson 2010). Fishermen sell their catch to a variety of buyers, including agents of fish companies, traders and other intermediaries or brokers (Yongo *et al.* 2009). As a result, there has been intense competition for Nile perch and its by-products between the local, regional, export and fishmeal markets (Johnson 2010). The global demand for Nile perch has reshaped the pressure on fish stocks in ways that overwhelm the ability of locally evolved BMUs to regulate their use. Fishers are organized around BMU networks that are not strong enough to negotiate on prices, for example, leaving them at the mercy of fish agents and processors. This is in contrast to fish processors that regularly meet to champion better marketing and trade terms for participants in the industry.

An emerging challenge affecting BMU performance has been an increase in export markets that prefer smaller fillets from immature fish of 0.5–1 kg live body weight (LVFO 2001; Geheb *et al.* 2007). This could increase the incentive for fishers to utilize smaller nets to capture undersized fish at the expense of larger ones capable of spawning to supply those markets. The neighbouring regional and local markets also encourage the exploitation of undersized Nile perch, which continue to be caught with both legal and illegal gear (Geheb *et al.* 2007; LVFO 2013). It is possible that the regional market for small fish, rather than the formal export market, is now driving illegalities in the Nile perch fishery, thereby endangering the stock (LVFO 2008a). Such regional markets and their suppliers are directly contributing towards the destruction, through overfishing, of the same fishery that is benefitting them, thereby negating the gains made by community participation in resource management.

Socio-cultural factors hinder the fishery

The fishing community of Lake Victoria comprises people of diverse ethnic, gender and socio-cultural backgrounds sharing the common interest of deriving their livelihood from fishing or fish trading. The fishery in Kenya is dominated by the Luo, Luhya and Abasuba ethnic groups (LVFO 2006). Despite the different origins of these groups, all display similar social structures and long historical relationships with the fishery. During the early stages of BMU formation, Abila *et al.* (2000) suggested that traditions and cultural practices of these indigenous people may have been used effectively to co-manage the fisheries. The proliferation of immigrant fishermen from other ethnic groups, such as Somalis, Kikuyus, Kisiis and Kalenjins, presents new challenges in the management of

Lake Victoria that may compromise sustainable fisheries management. Geheb and Crean (2003) argue that the new groups of people have different socio-economic considerations and background. Thus, relations between newcomers and established community members are often weak or impaired. Moreover, immigrant fishers likely have less 'ownership' and knowledge of the fishery, therefore also having less incentive and will to limit their fishing effort to protect future stocks (Geheb & Crean 2003). In fact, it is in their interest to maximize catches in the short term through intensive fishing (Viner *et al.* 2006).

Most fishermen acknowledged that a number of formal and informal organizations exist at the fishing community level. In Kenya, the lake supports over 50 000 fishers, 300 000 artisanal fish processors and traders, seven fish processing plants and many primary cooperative type fisheries organizations. The latter include more than 300 BMUs, 30 small fishermen cooperative societies, and over 350 women fish traders associations (Abila 2009; LVFO 2012). These fisher organizations are important for enhancing collective responsibility in managing the fisheries resources as they may be used to mobilize fishers and resources for fisheries management (Abila 2002). However, formal and informal groups formed within the BMU are always responsible for ensuring adherence to the fishing rules (Owino 2002). In the present study, the perceived compliance by one's peers is an important determinant in the decision to comply with, or alternatively to violate, the regulations. If the local BMU members go to the same church, shop in the same markets, and their children go in the same schools, a fisher may feel less inclined to use illegal gear if he knows that it will hurt his friends (Onyango & Jentoft 2008). In fact, some fishers reported that any community member known to use illegal gear is shunned by other villagers.

Institutional factors affecting BMUs

The major reason for establishing BMUs was to improve community participation in surveillance and management, and to stop detrimental fishing practices such as using illegal gear or destructive methods (LVFO 2007). The present study found that BMUs have inadequate resources for intensive monitoring, control and surveillance (MCS) operations and that most BMUs are not yet able to successfully control illegal fishing in their areas. In spite of the efforts of many BMU committees to improve compliance to fishing rules, most BMUs have been unable or unwilling to undertake regular MCS activities because of a lack of patrol equipment such as boats and engines, high fuel costs, inadequate funds to pay patrol teams; lack of proper security during patrols; and corruption or bribing of fisheries officials which undermine the legitimacy of the BMU committee leaders authority (Lawrence 2013); and the high cost of hiring additional security officials. While fishermen interviewed in the present study seem to have good knowledge of current fishing regulations concerning the minimum mesh sizes of nets and the slot size of fish to be landed, a majority of fishers do not adhere to or comply with these regulations. The present study findings suggest knowledge of the rules has little impact on fisher's behaviours. Thus, there is a high degree of regulatory disobedience regarding the lake. Thus, these data suggest more resources are required for MCS operations if successful co-management is to take place through the BMU organizations. Monitoring, control and surveillance must be strengthened to enforce the implemented rules, and measures from higher political entities must be implemented to address the corruption of fisheries officials.

The overall impression of monitoring and enforcement in Lake Victoria fisheries is that it suffers from a combination of problems. First, convictions of offenders result in very low fines. Second, illegal gear and immature fish are often kept and traded by fishers, despite being outlawed. Third, those with the capacity to control such unsustainable practices are discouraged and unmotivated, resulting in their culpability in these activities (Geheb 1997; Lawrence & Watkins 2011; Lawrence 2013). A simple deterrence model by Eggert and Lokina (2008) predicted that most fishers would violate the regulations when the risk of detection was low, fines were modest, and the profits from violation were substantial. Inability to enforce rules also is attributable to corruption and clanism and/or family/kinship relations (LVFO 2008b). Thus, BMU performance is likely to be limited among fishing communities, as they are culpable to these factors.

For the Lake Victoria fishery, there are small groups of persistent violators, as indicated by previous studies on fishery compliance (Eggert & Ellergård 2003; Eggert & Lokina 2008). Fishers have a tendency to use illegal mesh size, and to issue bribes when caught by enforcement agents, in order to evade compliance with the regulations. These persistent violators benefit from using illegal small mesh-sized nets over larger, legal-sized nets. Smaller nets will catch illegal-sized fish, and with weak MCS on Lake Victoria, offenders view continued illegal fishing to be more beneficial (profit or benefit of illegal fishing and being caught exceeds the

cost for doing it) than following the rules. A Lake Victoria study of Tanzanian fishers compliance produced similar results, whereby fishers seemed to have found that violation of fishing regulations was the most beneficial strategy, irrespective of deterrence measures put in place to prevent such practices (Eggert & Lokina 2008).

Many BMUs still perform poorly in the area of financial management. Sustainable financing of BMUs is essential for the sustainability of the organizations and their effective operation (Scullion 2008). The present study indicates the revenue-raising capability of BMUs has been modest, likely attributable to limited income-generating powers, reduced direct support from donors and other financial institutions to fishers, a weak tax base, and the dependency on diminishing fish catch volumes. BMU committee leaders also lack skills and legal powers to operate savings and credit services and to collect revenue. The funding problems of Kenya's BMUs are indicative of most donor-supported fisheries co-management engagements in Africa, which are typically managed under conditions tailored to meet donor expectations, with the community being relegated to being recipients of donor instructions (Hara & Nielsen 2002). Nunan (2007) noted that dependence of co-management on donor-support threatens the sustainability of the systems and structures created as part of Lake Victoria co-management.

The success and operation of the BMUs depend on the nested institutions supporting it (Cinner *et al.* 2009). The Ministry of Fisheries Development, research institutions, LVFO, courts and non-governmental organizations (NGOs) have defined roles at different stages of the co-management programme that encompass initial steps, enforcement, monitoring and making new rules. Repeated exposure to sensitization by District Fisheries Officers (DFOs) and Kenyan Marine Fisheries Research Institute (KMFRI) researchers concerning fisheries management and bad fishing methods did yield positive results, namely a high rate of knowledge of legal fishing practices at the BMUs. These results concur with the findings of Geheb *et al.* (2002), who showed that the beach committee's continuous association with the KMFRI research team at Obenge Beach resulted in the beach administration developing systems to patrol around their set nets in order to prevent theft, and to ban the sale of undersized fish from their landing site. Despite the fact that DFOs are supposed to transfer knowledge to their field staff and BMU officials, little training has been effectively conducted because of financial constraints and lack of administrative oversight. This dilemma was captured well by one respondent who said that: '*We protect the fisheries better than the government can. We have to, because Government employees don't really have any interest in fisheries. It is a job for them. For us, it is life*' (personal communication, Tom Guda, Kenya BMU Network Chairman).

CONCLUSION

This study's findings highlight several challenges facing implementation of fishery co-management for Lake Victoria. First, the creation of BMUs has not systematically ensured the success of co-management of Lake Victoria fisheries. BMUs are involved in activities that have high potential for social sustainability, but have been either unable or unwilling to undertake their core functions related to enforcement and compliance with fishing rules. Second, BMUs have inadequate resources for intensive MCS operations, being often unable to control illegal fishing in their areas of jurisdiction. Third, although fishers are well aware of the fishing rules and regulations, violation rates are high, likely due to weak MCS activities by the BMUs. The decision of fishers to not comply with regulations demonstrates the benefits of illegally fishing outweigh the costs, that the risk of detection is low, that fines are very cheap, and the profits from participation in illegal activities are substantial.

Although co-management is used as a mechanism to devolve power to resource users, the reality is that balance of power and authority often favours the state, as opposed to BMUs. BMUs can currently create rules and by-laws, but their scope is limited to designating closed fishing seasons, creating gear restrictions or restricting the number of fishing vessels at their landing site, and creating no-take areas. The rules created by BMUs, however, depend on the ability to enforce them. In view of the weakness of MCS operations, however, BMUs must rely on external entities, such as the Fisheries Department or police, for enforcement. This dependence demonstrates the proper authority has not yet been delegated, and that BMU committees have less legitimacy in conducting their operations. The findings of the present study demonstrate the degree of power devolved is a key factor associated with the failure(s) of co-management arrangements, leading to inadequate community participation, inadequate sustainable funding streams, and the inability to conduct MCS successfully. As a result, BMUs are struggling to fulfil their designated roles in fisheries management and community development.

Recommendations

The following recommendations arise from the present study:

1 Improved Governance Measures: The government and BMU networks must conduct regular, efficient MCS operations. All MCS activities should be carried out in partnership between the designated, formal government entities, and with each BMU committee leadership, in order to ensure legitimacy is preserved at the community level. Priority should be given to enforcing existing legislation on gear restrictions, including the ban on beach seining and use of small mesh-sized nets (<5"). Increased collaborative MCS activities should lead to increased compliance with fishery regulations;

2 Sustainable Funding Mechanisms: A major challenge facing BMUs is reliance on donor funding for their operations. Becoming legitimate and sustainable fishery management organizations requires that BMUs become financially independent. Reducing the need for donor funding might be accomplished through partnerships with established financial institutions that provide education and training in financial management. BMU financial independence, however, relies on numerous variables, including the BMU committee's ability to collect taxes and fines with little or no interruption from higher levels of authority. It is urged, therefore, that attention be focused on BMUs financial independence through proper trainings and oversight. Facilitating such independence might be best conducted through programmes by the LVFO and KMFRI;

3 Continuous Collaboration: The Lake Victoria co-management programme relies on the need for continuous collaboration between BMUs and other fishery-oriented organizations, including the LVFO, fisheries research institutes (e.g. KMFRI), the Ministry and the departments of fisheries, and other organizations. Continuous collaboration facilitates the flow of consistently changing information, including changes to the biophysical (catches and perceived fish populations), institutional (regulations changes), economic (value of fish), socio-political (community response and awareness to regulations or enforcement), demographic (number of fishers, boats), and infrastructural (access to markets) characteristics of Lake Victoria. Information flowing between those engaged in the fishery is necessary for successful Lake Victoria co-management activities. Information and communications must be facilitated through appropriate mechanisms, and should include meetings, public awareness campaigns and educational programmes.

4 Further Research on Fishing Communities: Lake Victoria is an important resource for millions of people. Understanding how successful management can be accomplished will take time and much more data. Accordingly, continued and enhanced studies of this resource, and the communities charged with managing it, is urged. The present study, for example, was limited in scope and would have benefited from the input of other fishery stakeholders such as boat crews, traders, artisanal processors, factory agents and other members who engage in fisheries and interact with BMUs.

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