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Illegal unregulated and unreported fishing: Methods and increasing trends in Lake Naivasha, Kenya

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Abstract

Illegal, unregulated and unreported (IUU) fishing is a negative social vice that adversely affects global capture fishery production. The inadequate disclosure of IUU methods and trends in fishery waters hampers management actions to curb illegal fishing activities. Seldom have empirical studies been conducted on IUU methods and their trends in Lake Naivasha. Therefore, this study analysed data on the fisheries monitoring, control and surveillance (MCS) during 2012 to 2018 to test for the significance of trends, and compare the enforcement plans to seizures of illegal fishing gear in the lake. The IUU fishing methods included both the types of equipment and the means used to perpetrate illicit capture or acquisition of fish from the lake. The results indicate a 37% reduction of MCS enforcement patrols during 2018 compared to 2012, and a 16% to 100% upsurge in the quantity of seized IUU fishing items. Illegal fishing boats potentially threaten the fishery of Lake Naivasha with an additional fishing effort of 22% above the 176 licensed boats. An average of 10,700 fishing nets seized per year has the potential fishing intensity of 74 gillnets/km^2 against an ideal intensity of 12 gillnets/km^2. The frequencies of MCS patrols in Lake Naivasha exhibit no particular trends and likely ineffective in deterring the upsurge of IUU activities, or the evolution of new illegal fishing methods. An increased seizure of illegal fishing boats, outboard engines and gillnets could imply their rampant use in IUU fishing activities. These findings merit a multi-stakeholder participatory approach to identifying the MCS weaknesses and opportunities for sharing resources to strengthen the fishery management efforts in Lake Naivasha.

KEYWORDS
fishery, IUU fishing, management, monitoring control and surveillance, seizure, trend

1 | INTRODUCTION

Inland fisheries are important in regard to their contribution to creation of employment opportunities for millions of people around the world. As a valuable protein food source, they provide nutritional security and livelihoods for many rural households, especially in low-income economies (Lynch et al., 2015; Welcomme et al., 2010; Youn et al., 2014). Distinct from marine fisheries, inland fisheries are often characterized by small scale and household activities, with a potential for high local participation in fishing and consuming the larger part of fish catches (Welcomme et al., 2010). Inland fisheries are also highly dynamic, with their nature changing with evolution of the local economies (Arlinghaus et al., 2002). These authors observed the importance of inland fishery resources, as food, increases with the underdeveloped local economies, while Suuronen and Bartley (2014) also noted inland fisheries are socio-economically important. Nevertheless, the inland fisheries resources are often undervalued and inadequately addressed in development policies at both national and international levels.

Illegal, unregulated and unreported (IUU) fishing is a social vice that adversely affects the production of many capture fishery resources around the world (Agnew et al., 2009; Glassco, 2017). This vice potentially undermines most of the global effort undertaken by organizations to manage capture fisheries and their associated livelihoods for sustainability. It is reported, for example, that IUU leads to the loss of many billion dollars of annual fisheries benefits, damages the fishery environment through poor methods of fishing and disrupts the annual fish supply for food (Brashares et al., 2004; MRAG, 2005a, b; Pauly et al., 2002). According to FAO (2016), IUU broadly encompasses all forms of unauthorized fishing activities, including 'Fishing and fishing-related activities conducted in contravention of national, regional and international laws; non-reporting, misreporting or underreporting of information on fishing operations and their catches; fishing by "Stateless" vessels; fishing in convention areas of Regional Fisheries Management Organizations (RFMOs) by non-party vessels and fishing activities which are not regulated by States and cannot be easily monitored and accounted for'. In fact, extensive IUU fishing discussions are conducted within the context of fishery losses and environmental degradation in the marine ecosystems (Agnew et al., 2009; FAO, 2001a, b; FAO, 2016). At the same time, however, this subject is also well applicable to inland freshwater systems, wherein small-scale artisanal fisheries are more easily accessible and vulnerable to illegal fishing threats. This social vice typically takes advantage either of corrupt administrations or weak management systems, especially where the capacity and resources to carry out effective monitoring control and surveillance (MCS) are limited (Agnew et al., 2009; FAO, 2016).

Lake Naivasha, a freshwater body and a Ramsar Wetland of International Importance (Ramsar, 2019), is a relevant case study of IUU fishing in a stressed lake. The lake supports an artificial fishery based on introduced fish species populations whose history dates back to 1925 (Muchiri & Hickley, 1991; Njiru et al., 2017). Over time, however, changes in the fish species composition, annual catches and exploitation levels, all being attributed to different management regimes. As an example, drastic changes in fishing efforts culminated in the fishery collapse observed during the mid-1970s and early-2000s. This was primarily due to overfishing, although other factors (e.g., lake water-level fluctuations; habitat degradation) also might have contributed to the situation (Hickley et al., 2002, 2008). Fishing in Lake Naivasha is commonly conducted by licensed fishers using gillnets set out from either wooden or glass-fibre boats propelled manually by oars and sails or outboard engines. The fishermen are required by fishery regulations to use a maximum fleet of 10 multifilament gillnets, each about 100 m long and not <100 mm (4 inches) of the stretched mesh size. The fishers should have fishing licences issued by the Department of Fisheries (FD) and are required to land their catches at designated sites for official recording by the Department staff and the Kenya Marine and Fisheries Research Institute (KMFRI). In addition to the above requirement, all fishermen should practice responsible fishing by avoiding encroachment in the fish breeding areas. The fish spawning areas were participatory identified and demarcated (Yongo et al., 2013) and fishers are voluntarily required to refrain from fishing in such areas. Any infringement of these regulations is deemed illegal and punishable - under existing fishery laws. The typical punishment for such a contravention can include, but not be limited to, suspension or revocation of fishing licences, court fines and/or imprisonment for a term varying from three to six months. The items used for illegal fishing also are seized and retained by fishery department officials as exhibits for criminal prosecutions in court. Kundu et al. (2010) suggested, however, that the fisheries laws were generally too lenient to significantly deter illegal fishing in Lake Naivasha. In fact, violators typically get light sentences and fines or are simply committed to community services.

Illegal fishing embodies the negative social impacts that threaten sustainable fishery resource exploitation in Lake Naivasha (Muchiri & Hickley, 1991; Njiru et al., 2017; Waithaka et al., 2019; Waithaka et al., 2017a; Waithaka, 2017b). These studies emphasize the need for more robust monitoring, control and surveillance activities that should include participatory strict enforcement of gear size regulations, protection of fish breeding areas and accounting for fish caught from the lake. Although there are substantial efforts being made towards achieving these recommendations (Kundu et al., 2010), inadequate disclosure of the methods and trends of illegal fishing can significantly hamper consolidation of the management decisions needed to curb these fishing practices for Lake Naivasha. Furthermore, illegal fishing activities are clandestine, dynamically adaptable and highly mobile, with their impacts on the lake's fishery only roughly estimated, as in the case for many world fisheries (FAO, 2016). Nevertheless, efforts to empirically evaluate the trends of IUU fishing in Lake Naivasha have seldom been undertaken. Thus, the goal of the present study is to analyse the fisheries MCS reports to document the methods and patterns of IUU fishing in the lake.

2 | METHODOLOGY

The study area is located on Kenya's Rift Valley floor (Figure 1), covering a surface area fluctuating between 110 and 160 km^2, depending on the extent of dry and wet periods. An extensive catchment area containing several rural and urban settlements maintains the lake ecosystem. Fisheries statistics are routinely recorded at four landing sites located around the lake, namely Central, Karagita, Kamere and Tarambete landing beaches. The statistics include the total weight of fish caught by all licensed fishing boats and their approximate market value. Government officials should sample all fish species in the fisher's landings for data on the individual body length (total length) and weight. Each fish landing site is handled by two government officials, one from the FD and another from KMFRI. All licensed fishing boats have unique identification marks and land at a

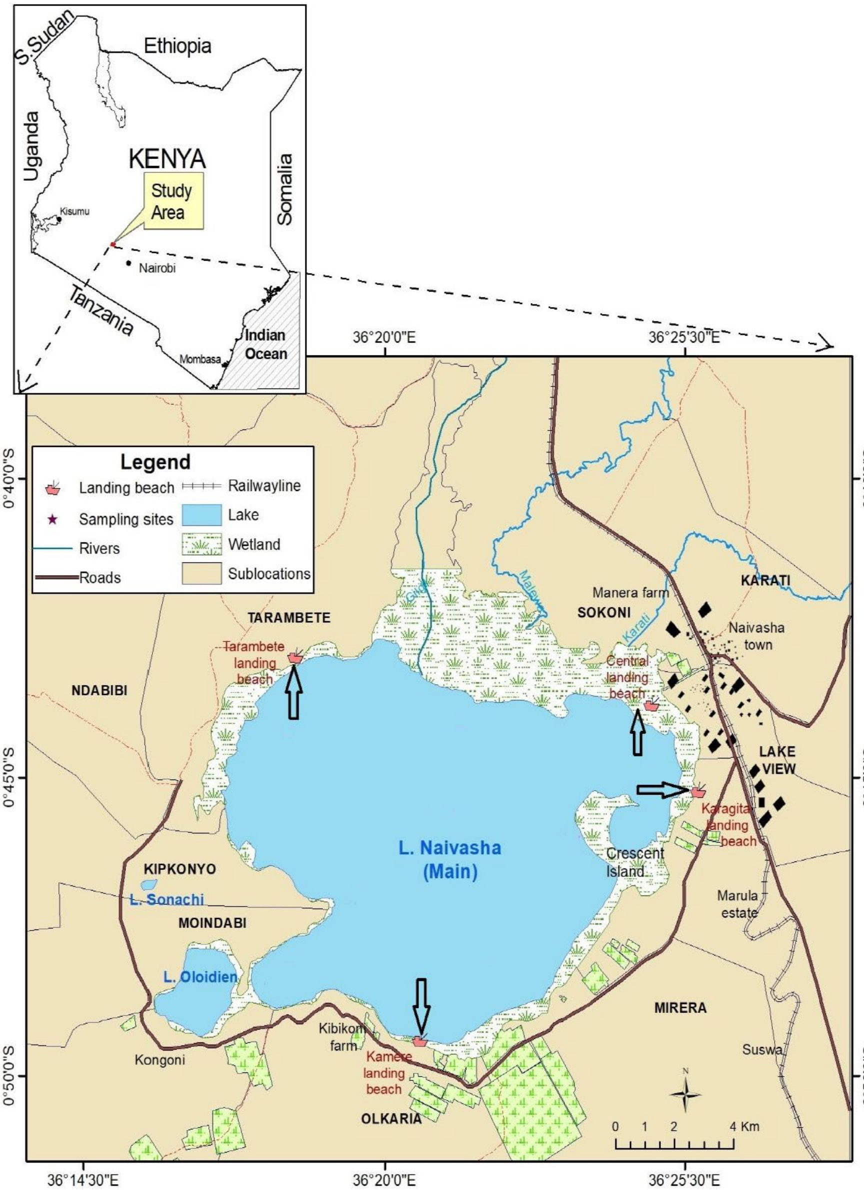

FIGURE 1 Map of Kenya showing location of Lake Naivasha and four official fish landing beaches (indicated by arrows)

specified site. Fish landings run daily from 08.00 to 17.00 hours, and a daily register of the boats per site being maintained.

The FD keeps monitoring, control and surveillance records with monthly and annual reports submitted to the relevant county and national government ministries. The MCS reports include the number of patrol operations conducted and the kinds of illegal activities (i.e., number of people, tools and equipment apprehended). The present study obtained information for the 2012 to 2018 period from the Department of Fisheries for data extraction. Illegal fishing methods included gears and means (including boats, bicycles, motorbikes and vehicles) used by fishers to conduct illegal capture or acquisition of fish from the lake. The present study tallied the numbers of MCS enforcement patrols and illegal fishing items seized from the monthly reports to determine their annual totals and average values from 2012 to 2018. It constructed plots of the data values against respective years, with their trends visualized using the computerized moving average (MA) trendline function. The MA method can eliminate data fluctuations by taking averages of the data point intervals and creating serially arranged average values of different subsets of the full dataset. The MA calculation applied a two-year dataset interval in the case of the present study.

The Mann–Kendall (MK) trend test determined whether the data exhibited a significant monotonic increasing or decreasing trend. This test is a rank-based non-parametric test that did not require a normal or linear distributed dataset (Kendall, 1975; Mann, 1945). The null hypotheses were that there was no significant (increasing or decreasing) trend in the time series over time, with the alternative hypothesis being that the reverse was true. The mathematical equations used in the present study to calculate the MK trend statistic (S), the variance of S (s.e.) and the normalized test statistic Z were adopted from Ahmad et al. (2015), as follows:

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \operatorname{sign}(X_j - X_i), \tag{1}$$

$$\mathrm{sign}\left(X_j - X_i\right) = +1 \mathrm{if} \left(X_j - X_i\right) > 0 \quad (2)$$

$$\mathrm{sign}\left(X_j - X_i\right) = 0 \mathrm{if} \left(X_j - X_i\right) = 0 \quad (3)$$

$$\mathrm{sign}\left(X_j - X_i\right) = -1 \mathrm{if} \left(X_j - X_i\right) < 0 \quad (4)$$

The variance of S (s.e.) was determined as:

$$VarS = \frac{1}{18}\left[n(n-1)(2n+5) - \sum_{p=1}^{q} t_p (t_p - 1)(2t_p + 5)\right] \quad (5)$$

Z was calculated as:

$$Z = \frac{S-1}{\sqrt{var(S)}}; \mathrm{if} S > 0; \mathrm{if} S > 0; Z = 0 \mathrm{if} S = 0; Z = \frac{S+1}{\sqrt{var(S)}} \mathrm{if} S < 0 \quad (6)$$

where X_i and X_j = the observed time series data when arranged in chronological order; n = length of time series dataset; t_p = number of ties for the *p*th value; and *q* = total number of tied values. The value of *Z* (positive or negative) indicated the direction of trends, with positive *Z* values indicating monotonically increasing trends, negative values indicating the opposite and zero values of Z indicating absence of a clear trend. The significance of a trend was $Z_{1\text{-}\alpha/2}$ at a *p*-value of .05 in the normal curve (Z) table. If the calculated Z statistic was greater than $Z_{1\text{-}\alpha/2}$ at a *p*-value of .05, the null hypothesis was rejected. Otherwise, the alternative hypothesis was accepted.

Spearman's Rank correlation test was applied to compare the direction and strength of associations between the MCS enforcement patrols and the quantities of IUU fishing activities seized over the study period. The correlation analyses were performed using the PAST statistics software (Hammer et al., 2001), with a statistical confidence limit of 95%.

3 | RESULTS

3.1 | MCS operations and output

The results indicated a decrease of about 37% in the frequency of MSC enforcement patrols between 2012 and 2018 (Table 1). The highest (205) and lowest (95) numbers of the MCS patrols were in 2012 and 2015, respectively (Figure 2). The average number of the MCS patrols over the period was 131/year. The reported illegal activities include fishing without permits, use of illegal gear, fishing in breeding areas, and trade in illegally caught fish. The main output of the MCS operations was the number of people apprehended and the items seized, with the former surging from 20 to 98 during 2013 and 2014, respectively. The results also highlighted male dominance in illegal fishing practices, with the male and female gender comprising 98% and 2%, respectively, of the 248 illegal fishers arrested during the review period (Table 2). The highest spike of illegal fishers (98) was during 2014. The average number of people apprehended per year for illegal fishing was 35, equivalent to 20% of the annual number (176) of the individually licensed boats operating on Lake Naivasha in 2018. The fluctuating number of MCS patrols and illegal fishers apprehended did not depict any statistically significant trends ($p > .05$) over the study period (Table 3).

3.2 | Trends of IUU fishing methods

Various modes of transportation were used to perpetuate illegal fishing, including the use of boats, with or without mounted outboard engines, bicycles, motorbikes and motor vehicles. Gillnets were the most common type of fishing gear seized during the MCS patrol operations. Boats and outboard engines were the most frequently seized, representing about 73% and 20% of all the seizures recorded between 2012 and 2018, respectively. The number of boats detained over the entire period was 266, with the highest upsurge (80) being observed in 2017 and representing about 30% of the total number of detained boats. The average number of illegal boats seized annually was 38, and their fluctuating numbers indicated an increasing trend of moving averages (Figure 3a), with the trend being statistically significant ($p < .05$).

The number of outboard engines seized during the present study ranged from 0 to 23, with the highest upsurge (23) occurring in both 2017 and 2018, and an average of 11 engines confiscated annually. The fluctuations in numbers of outboard engines exhibited an upward trend of moving averages (Figure 3b), being significant ($p < .05$; Table 3). Use of the engines as a means of boat propulsion in illegal fishing activities in Lake Naivasha exhibited a recent increase from

TABLE 1 A Comparison of the frequencies of MCS enforcement plans and seizure of IUU fishing activities in Lake Naivasha during 2012 and 2018

Variable	2012	2018	Change (-/+)
Number of MCS patrols	205	130	-75
Number of illegal fishers	22	37	+15
Number of illegal boats	2	57	+55
Number of illegal outboard engines	0	23	+23
Number of illegal fishing nets	1031	48492	+47461
Number of motorcycles (number)	0	2	+2
Motor vehicles (number)	1	0	+1
Bicycles (number)	8	3	-5
Fish (kg)	3438	4120	+682

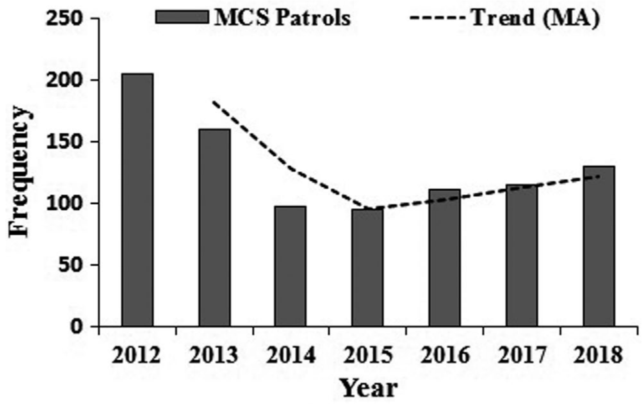

FIGURE 2 Number and moving average (MA) trend of MCS enforcement patrols without a significant ($p > .05$) trend in Lake Naivasha from 2012 to 2018

TABLE 2 Numbers and percentage composition of illegal fishers apprehended in Lake Naivasha during 2012 to 2018

Year	Male	Female
2012	20 (91)	2 (9)
2013	20 (100)	0 (0)
2014	98 (100)	0 (0)
2015	23 (96)	1 (4)
2016	22 (100)	0 (0)
2017	24 (96)	1 (4)
2018	37 (100)	0 (0)
Overall	244 (98)	4 (2)

2014 and was strongly correlated with the increasing number of seized boats (R_s = 0.927; p = .008).

The total number of illegal fishing gillnets seized during the reviewed period was 74,903. They exhibited various mesh sizes and were wrongly deployed either in the shallow areas or fish breeding sites to target undersize fish. The average length and width of a typical gillnet confiscated were about 100 m and 2 m, respectively. The smallest (1,031) and largest (48,482) number of gillnets seized occurred in 2012 and 2018, respectively, representing about 1.4% and 64.7%, respectively, of the total illegal gillnets confiscated during the study period. On average, there was a record seizure of 10,700 illegal nets annually, with the varying numbers during the study period exhibiting a statistically significant increasing trend (Figure 3c; Table 3).

Bicycles, motorcycles and motor vehicles were the mode of on-land transportation for ferrying illegal fishing materials and fish catches. The highest number of bicycles was seized in 2012, although this number decreased over the study period (Figure 4a), with the use of motorcycles and motor vehicles commencing in 2013 and 2015, respectively (Figure 4b,c). The results indicated a minimal interception of both the motorcycle and motor vehicles in IUU activities involving Lake Naivasha. The varying numbers of seized bicycles, motorcycles and vehicles did not exhibit statistically significant trends ($p > .05$; Table 3).

3.3 | Illegal fish catches

The quantity of illegal fish seized during the years 2012 to 2018 was 20,314 kg. The lowest and largest quantities of captured fish were 1,583 and 4,414 kg in 2014 and 2015, respectively (Figure 5). On average, there was an annual seizure of about 2,900 kg of illegally caught fish from Lake Naivasha. The fluctuating quantities of seized illegal catches, however, exhibited no significant trend ($p > .05$; Table 3).

3.4 | Correlations between MCS operations and seized IUU fishing items

The Spearman's Rank correlation test results indicated some association between the frequencies of MSC operations and IUU fishing gears seizures from 2012 to 2018. The associations ranged from very weak to moderate, although not being statistically significant ($p > .05$), as summarized in Table 4. The seizures of bicycles and fish in the IUU activities exhibited positive, but weak, correlations

TABLE 3 Summary of Mann–Kendall Trend test on MSC patrols and seizure of IUU fishing items in Lake Naivasha during 2012 to 2018

Variable	Minimum value	Maximum value	MK test statistic (S)	Variance of S (s.e.)	Normalized test statistic (Z)	Probability (*p*-value)	Trend at 95% level of significance
MCS patrols	95	205	−3	6.658	−0.300	.763	No trend
Fishers	20	98	8	6.658	1.051	.293	No trend
Boats	2	80	17	6.658	2.403	.016	Yes (increase)
Outboard engines	0	23	19	6.583	2.734	.006	Yes (increase)
Fishing nets	1,031	48,492	19	6.658	2.703	.007	Yes (increase)
Motorcycles	0	3	2	6.506	0.154	.878	No trend
Motor vehicles	0	1	0	6.377	0	1	No trend
Bicycles	0	8	−4	6.377	−0.470	.638	No trend
Fish (kg)	1,583	4,414	1	6.658	0	1	No trend

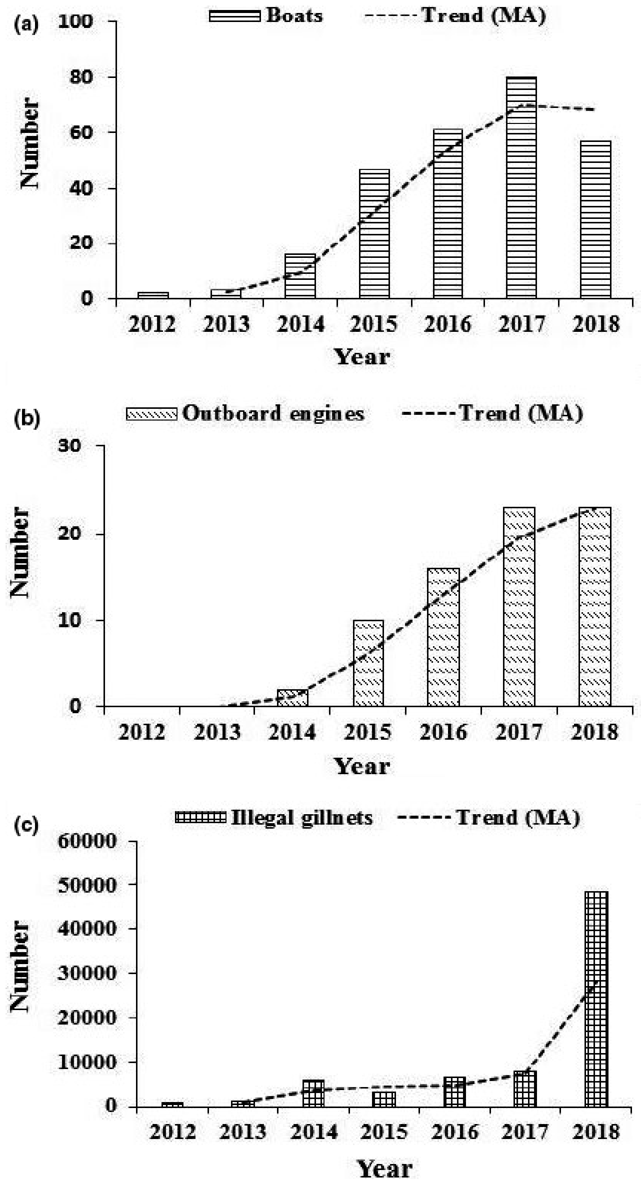

FIGURE 3 Numbers of seized IUU fishing items and moving average (MA) with significant ($p < .05$) trends in Lake Naivasha from 2012 to 2018: (a) fishing boats; b) outboard engines; c) fishing gillnets

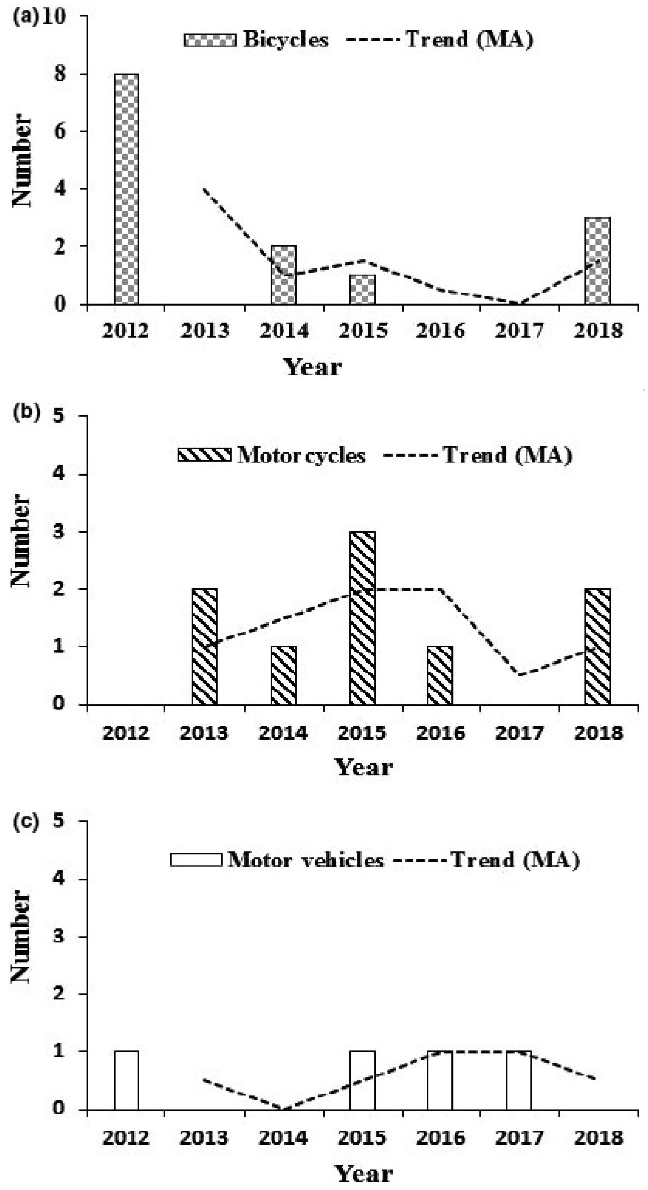

FIGURE 4 Numbers of seized IUU fishing items and moving average (MA) with no significant ($p > .05$) trends in Lake Naivasha from 2012 to 2018: (a) bicycles; b) motorcycles; c) motor vehicles

with the frequency of MCS enforcement plans. The remaining IUU items seized, including the number of illegal fishers apprehended, exhibited a negative and weak-to-moderate correlation with the frequency of MSC operations.

4 | DISCUSSION

The mandate to manage fishery resources in Kenya falls principally under the national Kenya Fisheries Service (KeFS) agency and County Directorates of Fisheries in each of the 47 counties (regional governments). Before 2013, fisheries resource management in the country was done entirely under the centralized national government through the department of fisheries. The county directorates of fisheries are currently responsible for licensing all forms of fishing and trade in fish products, thereby controlling the fishery resource exploitation within their areas of jurisdiction. The departments are expected to work in close collaboration with other relevant stakeholders to foster best practices in the exploitation and management of fishery resources. These changes in administrative arrangements of the fisheries sector have potential impacts on the planning process and the allocation of both the financial and human resources needed to manage fisheries and other aquatic resources in the country for sustainability.

The Lake Naivasha fishery, although artificially enhanced via the introduction and restocking of fish species, has become a hub for various forms of livelihoods that benefit an estimated 4,000 members of the local community. A majority of these comprise male youths that are either directly or indirectly engaged in fishing, while most of the women are engaged in the fish trade. Other studies have demonstrated that most fishers operating in Lake Naivasha have limited formal education, thereby being unable to tap into alternative livelihood opportunities (Waithaka et al., 2019). The same study observed that youths between 20 and 40 years old comprise the dominant class (67%) of the fisher community, while women own only 31% of the total number of fishing boats.

Reports of illegal fishing activities as main challenges to the sustainable management of the fishery in Lake Naivasha are not new (Njiru et al., 2017; Waithaka et al., 2017a; Waithaka et al., 2017b). These activities are both rampant and destructive to the stressed fishery. Nevertheless, it is a difficult task to realistically estimate the forms, levels and trends of IUU fishing activities in the lake because of their discreet and covert nature. The probable IUU fishing drivers could be twofold in nature. The first can be attributed to the rapid human population increase around the lake (Onywere et al., 2012). The second is associated with the increasing demand for fish

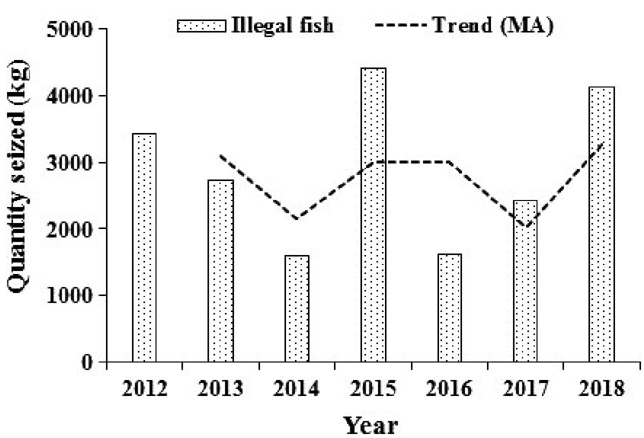

FIGURE 5 Quantities of illegal fish catches seized annually and moving average (MA) with no significant ($p > .05$) trend in Lake Naivasha from 2012 to 2018

in the ready markets of the town of Naivasha, neighbouring towns and the city of Nairobi, which takes the bulk of the catch from Lake Naivasha (Njiru et al., 2017). Limited seasonal employment opportunities within the horticultural farms, hotels and other industries around the lake may also be a causative factor. Thus, illegal fishing provides daily livelihoods for the households of unemployed people, regardless of the damage to the resource.

The fisheries management MCS operations entail a team of staff carrying out surprise field inspections and impoundment of any found illegal fishing items. In a collaborative fishery resource management approach, the team may rely on tips from the fisher community through their beach management units. Although several MCS patrols were enforced to control the exploitation levels of the Lake Naivasha fishery resource, the frequencies have declined by about 37% over time. The observed average number of 131 MCS operations per year implies the fisheries staff conducted about 11 such enforcement patrols in each month. Despite this high number, however, the results demonstrated insignificant correlations with the observed frequencies of IUU items seized, thereby raising questions about the economic sense and effectiveness of the MCS in controlling and mitigating illegal fishing in the lake. This scenario is a consequence of many factors that may include either weak planning or the fisheries staff being compromised while on duty (Kundu et al., 2010). It is worthwhile to note the period from 2013 coincides with changes in the fisheries governance system from a centralized government to a devolved government, a situation that could have weakened both the capacity and legislative framework for effective MCS operations. Thus, a resurgence of high numbers of illegal fishers, boats, nets and outboard engines occurred between 2012 and 2018. This observation agrees with those of FAO (2001a) and Agnew et al. (2009), typifying weak management systems and high resource vulnerability to overexploitation.

As observed in the present study, male dominance in illegal fishing activities agrees with the findings of Waithaka et al. (2019) who reported fishing in Lake Naivasha is a male-dominated industry. The male fishers, the majority being youth, are engaged in the active fishery and transportation using various means. The results of the

TABLE 4 Summary of Spearman's ranked correlation between MCS enforcement patrols and seizure of IUU fishing items in Lake Naivasha during 2012 to 2018

Quantity of IUU fishing gears seizure against MCS enforcement plans	Spearman's ranked correlation coefficient (R_s)	Correlation strength descriptor[a]	Significance of correlation at 95% level
Illegal fishers (number)	$R_s = -0.468$	Moderate	$p = .290$
Boats (number)	$R_s = -0.429$	Moderate	$p = .302$
Outboard engines (number)	$R_s = -0.327$	Weak	$p = .470$
Fishing nets (number)	$R_s = -0.286$	Weak	$p = .795$
Motorcycles (number)	$R_s = -0.385$	Weak	$p = .068$
Motor vehicles (number)	$R_s = -0.144$	Very Weak	$p = .713$
Bicycles (number)	$R_s = 0.259$	Weak	$p = .725$
Fish (kg)	$R_s = 0.143$	Very weak	$p = .857$

[a]Adopted from Dancey and Reidy (2004).

present study indicate that boats, outboard engines and fishing nets were the most frequently used and mostly seized items in the IUU fishing practices over time within the lake. The frequencies of these illegal fishing items confiscated over the period fluctuated with a significantly increasing trend. These findings may serve to indicate a probable change in fishing tactics by illegal fishers to evade arrest. This study also demonstrated high annual average numbers of illegal fishing boats (22%), fishers (7%) and fishing nets (>600%) above the limits of the 176 licensed boats that should be operated by three crew members, and a maximum of 10 nets per fishing trip (Waithaka et al., 2019). Together with the increasing use of outboard engines for boat propulsions, illegal fishing exerts dramatic pressure on the Lake Naivasha fish stocks because of both high fishing effort and capacity. Waithaka et al. (2019) reported daily exploitation of fish stocks in Lake Naivasha, and throughout the year, without any intervals for replenishment of the populations. The inability to obtain fisheries data from illegal fishers poses a challenge to estimating the actual annual fish production or the sustainable exploitation levels of the lake's fishery.

Past studies (Hickley et al., 2002; Muchiri & Hickley, 1991) discussed the need for a continual readjustment of the fisheries management controls (e.g., effort) on an appropriate timescale to sustain the fish production of Lake Naivasha. These studies estimated the maximum sustainable yield (MSY) ranged between 341 and 889 t/yr, with an optimal fishing effort of about 51 boats. Following the recent fish stocks enhancement through the introduction of Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*), a study by Obegi et al. (2020) observed that the current number of 176 licensed fishing boats were already beyond the optimal fishing effort (<125 boats) for a sustainable fishery. Without effective MCS strategies, therefore, the impacts of illegal fishing in the already-stressed fishery of Lake Naivasha are likely more severe than estimated, with additional fishing effort and capacity attributable to the high number of illegal fishing gillnets. Considering an ideal maximum number of ten gillnets per the licensed fishing boat, and an average lake surface area of 145 km^2, the expected fishing intensity of the 176 boats in Lake Naivasha could be about 12 gillnets/km^2. The average number of seized illegal nets observed in the present study was 10,700 per year, which translates to a potential threat of high fishing intensity (>74 gillnets/km^2). The situation would be even worse if such a magnitude of illegal nets was both undersized, and the majority deployed in the critical fish breeding areas.

The present study observed a shift in the mode of transportation from previously used means (e.g., using bicycles) to different new means (e.g., outboard engines (motorized boats); motorbikes; vehicles). This situation may indicate newly evolving methods by which illegal fishers can dodge arrests. Motorized boats, motorcycles and cars are a somewhat faster means of delivering a bulk of illicit catches to clienteles waiting at discrete sites along the shores without being noticed by fisheries management authorities. The increasing use of these items could also be attributed to the fishers' economic gains from illicit fishing activities. There was a high fluctuation of illegal fishing nets and catches, for example, associated with a likely high market demand for fish within and around the town of Naivasha. However, the present study could arguably associate various factors with observed interannual differences in the quantities of illegal nets and fish seized. It depends, for example, on the abundance of fish stocks in the lake. Furthermore, the seizure of gillnets either before or after catching fish in the lake and also failure of enforcement officials to fully disclose the exact quantities of illegal fish seized during the MCS patrol operations.

Correlation analysis tested the direction and strength of MCS enforcement patrols attribution to IUU fishing illegalities in Lake Naivasha, exhibiting weak associations between the frequency of MCS operations and capture of various IUU fishing items. These observations could imply ineffectiveness of the control and surveillance systems utilized for fishery management in Lake Naivasha. Ideally, the confiscation of IUU fishing items and arrest of illegal fishers should indirectly discourage investment in the illegal fishing businesses, provided the penalties associated with the illegalities are strong and enforced. Unfortunately, however, the fines and jail terms resulting from unlawful fishing offences are lenient, thereby not be a sufficient deterrent to combat this problem in Lake Naivasha (Kundu et al., 2010). Other weaknesses of the MCS patrols include leakage of information by licensed fishers to their unlicensed colleagues about planned patrols, compromised actions of fisheries staff in regard to law enforcement, and unethical practices on the part of some long-time serving officers. Surveillance plans are leaked to illegal fishers in exchange for bribes (Kundu et al., 2010). These factors suggest possibilities of misreporting by law enforcement staff and may explain the observed low and inconsistent quantities of seized fish reported during the study period.

Illegal fishing undermines all the principles of fisheries ethics and the FAO code of conduct for responsible fisheries (FAO, 1995). Because of its intricate nature, accounting for the direct and indirect losses caused by these fishery practices is a serious challenge. At the same time, however, negative impacts of such practices include a potential for loss of revenue to the government, reduction of fish stocks, and degradation of fishery grounds through encroachment and destruction of protected fish breeding areas. This situation can indirectly also lead to loss of income and livelihoods for the local community dependent on this resource.

5 | CONCLUSION AND RECOMMENDATIONS

There is no doubt the fishery of Lake Naivasha supports the livelihoods of a large number of local people around the lake and even beyond. However, IUU fishing poses a severe threat to the sustainability of the Lake Naivasha fishery. The frequency of MCS operations conducted to minimize fishing pressure on the fishery resource in Lake Naivasha did not highlight a particular trend, likely being ineffective in deterring the upsurge of IUU activities and the evolution of new methods of illegal fishing. There has been an increased seizure of illegal fishing boats, outboard engines and gillnets over time, implying their rampant use in the IUU fishing activities. The situation calls for a multi-stakeholder participatory approach to identifying the weaknesses and harnessing the necessary sharing of resources for stronger MCS and fishery management efforts in the lake.

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CONFLICT OF INTEREST

None.

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