The Status, Drivers, and Impacts of Poaching in Lake Chilwa Biosphere Reserve

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ABSTRACT: An assessment of the status, drivers, and impacts of poaching was conducted in the Lake Chilwa Biosphere Reserve (LCBR) in Malawi. One hundred households from which primary data was collected were sampled using systematic random sampling. Secondary data was collected from fisheries and agriculture departments, and the biosphere reserve manager. The results of the study indicate that poaching in the LCBR exists, and its level of frequency is high, as indicated by 61.3 percent of respondents, and the annual licensing of <5 percent of tools. The main drivers of poaching are poverty, food

insecurity, population growth, low level of education, and unemployment. Poaching is causing a decline in fish catches, reduction in composition of both birds and fish species, and size of fish caught. There is also a reduction of income in the area, as well as an increase in malnutrition, due to lack of cheap protein sources. The Malawi government should put up policy framework that will create a good environment for small businesses to thrive, improve the livelihood of communities, and eliminate the exploitation of resources from the biosphere reserve. Deliberate policies must be enacted to provide sustainable alternative protein sources.

Keywords: Poaching, Fish, Birds, Impacts, Drivers, Lake Chilwa

Introduction

Poaching is a term that carries a variety of definitions, dependent on the context and individual. In common terms, for convenience and consistency, Carter et al. (2017) adopted the definition of poaching as the illegal killing or taking of wildlife. In this context, it refers to hunting without license or permit in protected areas (National parks, game reserves), using illegal equipment or tools, and any other hunting practices that are against legal provision of any institution or country. Poaching is a problem where wildlife meat is valued as a source of both income and protein (Wilfred and Maccoll, 2015). Wildlife meat is any non-domesticated terrestrial mammals, birds, reptiles, and amphibians harvested for consumption (Nasi et al*.,* 2008). Brashares et al. (2004) reported that the intensity of hunting in Africa is usually inversely related to time spent on agricultural activities. The presence and importance of factors behind wildlife exploitation differ from place to place, and the strategies employed to address problems related to poaching cannot be universal.

Human pressure on wildlife in protected areas is increasing. This is partially due to wildlife being driven off from their habitats as land is converted for settlements and agricultural use. Illegal wildlife use is usually related to the distance between human settlements and protected areas. For example, in the Serengeti of Tanzania, both wildlife meat poaching and consumption rates are quite high among the villages near protected areas (Hofer et al., 1996).

Biosphere reserves are established in hopes of preserving both cultural and natural heritage, in accordance with sustainable development (Sonali, 2017). These reserves include unique areas of the world's biomes, whose selection has been greatly facilitated by a thorough knowledge of the important biotic communities. According to Ratika (2013), biosphere reserves conserve genetic resources, species, ecosystems, and landscapes, without uprooting inhabitants. Biosphere reserves are models for co-existence between nature and human, and provide significant information for scientific studies and research.

Lake Chilwa Biosphere Reserve in Malawi has a variety of birds, fish, and small animal species, that are used for food by a large proportion of the local community (Bhima, 2006). In the area, poaching is considered a key component of the socio-economic framework of people's livelihood. Population increase, poverty, and food insecurity are some of the factors that can influence poaching levels.

Hunting of birds and fishing in the Lake Chilwa wetland of Malawi has taken place for many years, ultimately developing into a significant socio-economic activity. The practice supports a variety of groups of people, both nutritionally and economically. In recent years, the pressure on the wildlife has been increasing due to higher populations, and illegal and unsustainable hunting practices. This has become a threat to the sustainability of

fish, birds, and other wildlife species in this unique ecosystem. Though poaching is a common practice in the Lake Chilwa wetland, there has been no research on status of poaching within the biosphere, and its drivers and impacts caused are not known. Such information is crucial for decision making, considering the LCBR has no legal protection status, despite being a wetland of national importance.

This study sought to assess the status of poaching, driver forces, and its impact on birds and fisheries within the Lake Chilwa Biosphere Reserve. It is through the understanding of the status, drivers, and impacts that we generate information, and can incorporate these findings into existing and new legislations to help eradicate the vice in the management of resources by the relevant authorities.

Methodology

Lake Chilwa Biosphere Reserve and its wetland ecosystem lies in three districts: Machinga, Zomba, and Phalombe. It also lies between the two countries of Malawi and Mozambique.

Lake Chilwa Biosphere Reserve is located in the Southern region of the Republic of Malawi, on the country's eastern border with Mozambique, between latitude 15°00'S and 15°30'S, and longitudes 35°30′E and 35°55′E (EAD, 2001). The biosphere reserve comprises of the lake, typha swamps, marshes, and seasonally inundated grassland floodplain, in which the transition, buffer, and core zones are located. The hydrology of the wetland is an important control on the ecology of the biosphere reserve, determining not only the water chemistry and physical properties, but also the composition of the vegetation and soil characteristics (Howard and Walker, 1974). The area has a tropical climate, that is relatively dry and strongly seasonal (British Geological Survey, 2004).

The Lake Chilwa Biosphere Reserve has a high population, with a density of 164/ km^2 and 1 700 452 in the entire Lake Chilwa basin (EAD, 2001). In 2008, the estimated number of households in the area was 347 300 (NSO, 2008). In an economy dominated by agriculture, individual maize production is one of the key occupations in the area, while tobacco is cultivated as the leading cash crop. Small and medium-scale businesses dominate the area's non agro-based economy, with general retail accounting for the gross of sales (Ludaka, 1991).

Lake Chilwa continues to be the main source of fish in the area, with an annual catch of more than 5 000 tons (Njaya, 2001). Lake Chilwa Biosphere Reserve also hosts a variety of bird species, including some that are migratory (Bhima, 2006). It is estimated that 164 bird species are associated with the area, of which 41 are Palearctic and 14 intra-African.

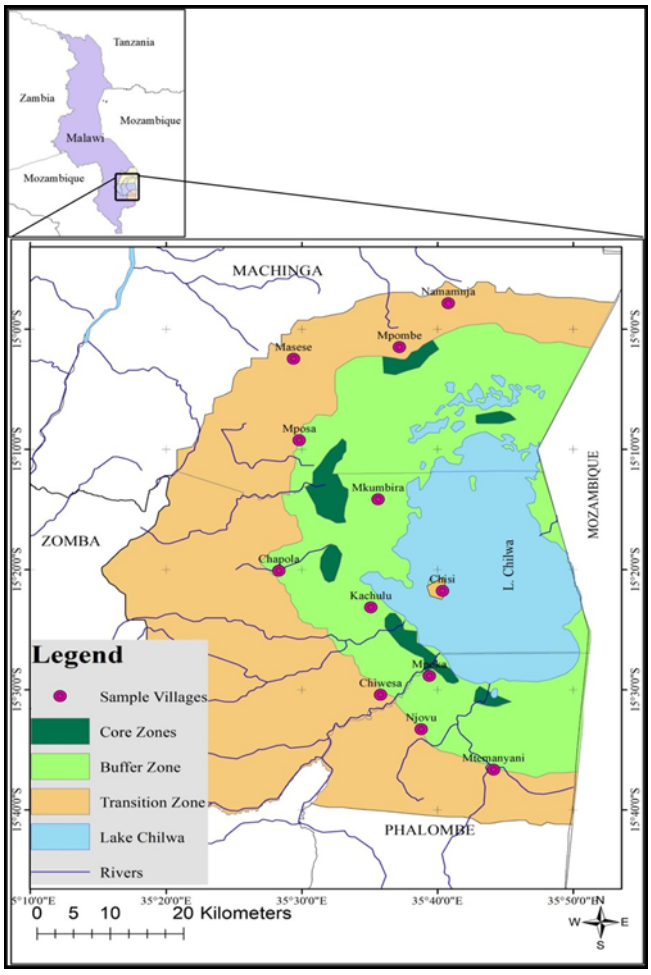

Figure No. 1: Map of the study area.

This study employed a social survey research design, in which semi-structured questionnaires were used to interview sampled households in communities around Lake Chilwa, and key informants in different government sectors. The target population for the study was the community members living within the transition zone of the LCBR. The targeted

community comprised of 347 300 households.

The formula below, by Nassiuma (2000), was used to determine the appropriate number of households that were sampled from the Lake Chilwa Biosphere Reserve.

$$n = \frac{NC^2}{C^2+(N-1)e^2} \quad \text{(Nassiuma, 2000)}$$

In the formula above; n represents sample size; N represents the population size of 347 300 households; C represent coefficient of variation, ≤ 30 percent; and *e* represents margin of error, which is fixed between 2-5 percent. The sample was calculated at 30 percent coefficient of variation, and 3 percent margin of error.

$$n = \frac{347300 \times 30^2}{30^2 + (347300 - 1)3^2} = 99.97 \approx 100$$

Table No. 1. Number of households sampled

District	Target Households	Sampled Households
Machinga	113 683	34
Zomba	158 563	45
Phalombe	75 054	21
Total	347 300	100

Primary data was collected through administration of questionnaires and focused group discussions. Secondary data was collected from documented information in government departments and institutions, and included fisheries and agriculture, and the Biosphere Reserve Manager.

Results and Discussion

The status of poaching

The survey results indicate that poaching occurs in the LCBR, as reported by respondents. The existence of poaching in the LCBR was supported by 88 percent of those surveyed. Respondents who acknowledged the existence of poaching, classified its prevalence as follows (Figure No. 2): 61.3 percent high, 30.7 percent medium, 5.7 percent very high, and only 2.3 percent indicated low levels of poaching. The respondents also indicated that poaching occurs at higher levels on fish, rather than birds.

There are three key reasons for the popularity of poaching in the area. Firstly, it is due to easy access to the buffer and core zones of the LCBR. Secondly, the increase in number of people in the area, resulting in corresponding increase in number of people fishing and hunting. This could also result from fishing being one of the community's major sources of subsistence, second only to farming.

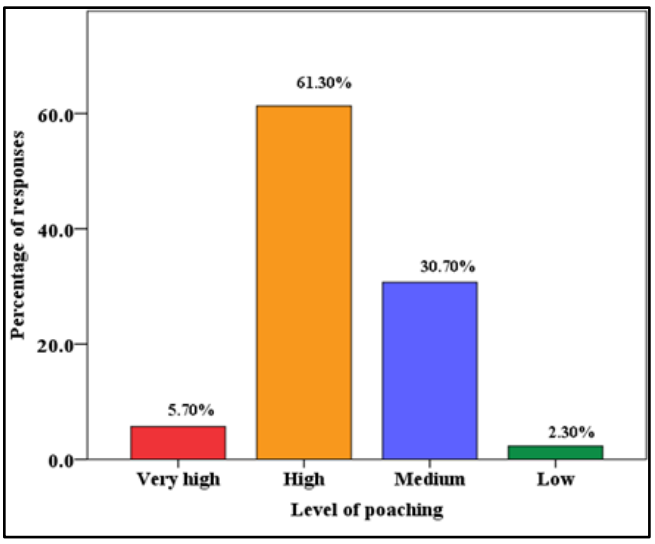

Figure No. 2: Level of poaching in LCBR

Fish is the main source of protein, as it is relatively cheap to obtain in comparison to other livestock, such as goats, poultry, and cattle. Bird hunting is mostly intensified when fish catches no longer meet demand but is otherwise only practiced by a few people in the community. An assessment on the status of biodiversity and threats in Malawi by Millington and Kaferawanthu (2005), revealed that hunting of wildfowl in LCBR has been practiced for some time, but its exploitation increased in 1996, following the drying up of the lake and the collapse of the fishery in 1995.

Poaching levels were also indicated by the trends in licensing of fishing tools. An assessment on the number of fishing tools licensed on annual basis between 2014 and 2017, as shown in Table No. 2 and Figure No. 3, indicate that less than 5 percent of the total recorded fishing tools are licensed annually. This implies high levels of poaching, as it is in contravention of the fisheries regulations.

Table No. 2: Percentage of licensed fishing tools from 2014 to 2017

Year	2014	2015	2016	2017
Estimated tools	74078	82393	37950	-
Licensed tools	48	192	742	23
Percentage licensed	0.06	0.23	1.95	-

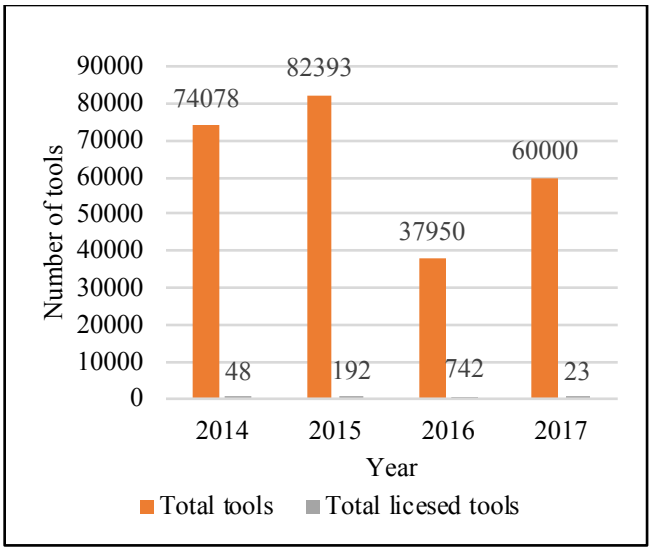

Figure No. 3: Total number fishing tool and total licensed tools

Other indicators of poaching

In the LCBR there was an overall increase in trend of the number of people engaged in fishing between 2008 and 2016 ($r^2 = 0.0711$; $y = 4357+140t$) (Figure No. 4). The reduction in numbers of fishermen between 2011 & 2012 coincides with the period in which Lake Chilwa dried up and the fishery collapsed. The general increase in the trend indicates the possibility of an increase in poaching on fisheries resources.

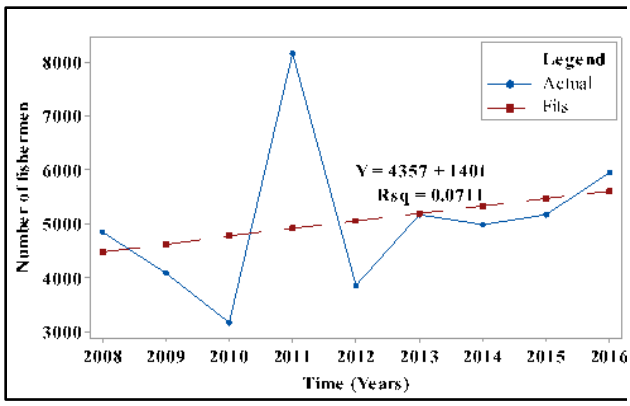

Figure No. 4: Numbers of fishermen from 2008 to 2016

A variety of tools are used for fishing in the LCBR, including gillnets, fish traps, seine nets and lines, and hooks. Many of these tools are modified in violation of the government's prescribed regulations (e.g. mesh size and net material). There has been a general increase in the number of different fishing tools over the years (Figure No. 5), which are rarely licensed, as per the government requirements (Table No. 2). This increase has been brought on by a growth in the number of local fishermen. This further indicates that most of the people involved in fishing activities do so illegally, as they do not have the permit to do so.

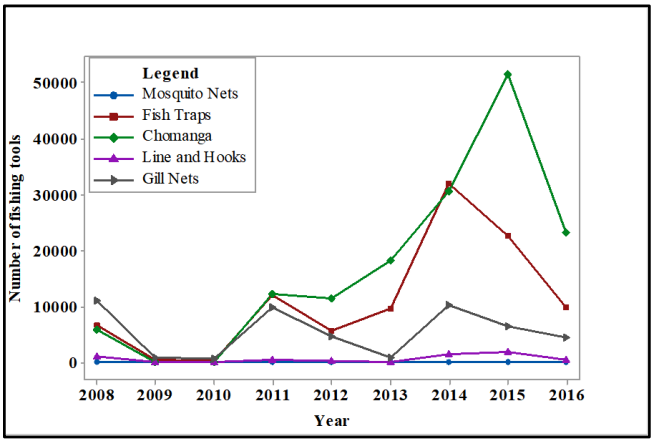

Figure No. 5: Trends of fishing tools in Lake Chilwa from 2008 to 2016

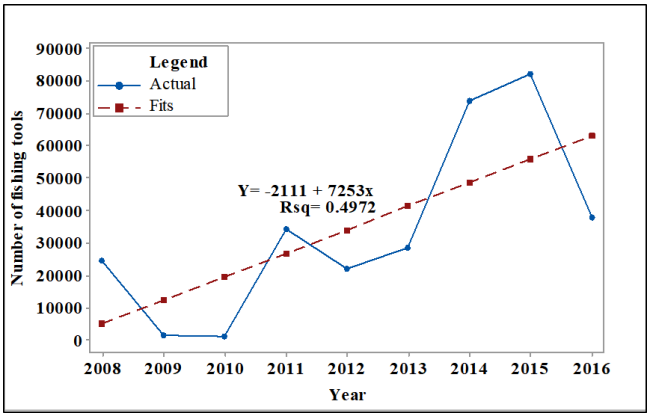

Figure No. 6: Trend of annual total number of fishing tools in the LCBR from 2008 to 2016

The trend of the total number of all fishing tools has been significantly rising (r^2 = 0.4972; y = -2111+7253x, $p < 0.05$) (figure 6). In addition, some fishermen clear vegetation in the lake, such as the *Typha dominguensis* (*mjedza*) and *Aeschynomene pfundii*, to make it easier to catch higher quantities of fish. Such practices result in the destruction of habitats for both fish and bird species. The vegetation provides a natural sanctuary—a secure breeding and hiding spot for fish—and also serves as sites for bird nests. The removal of such vegetation is an illegal practice, as per fisheries regulations.

Drivers of poaching

The driving forces of poaching in the LCBR are the need of food and income, and, to a smaller extent, employment and the protection of crops. Poaching as a means of food and income account for 48 percent and 48 percent, respectively. Employment and the protection of crop fields only accounts for a combined total of 4 percent. Community members are mostly engaged in poaching for sustenance, in both nutritional and economical senses of the word. However, it was indicated that poverty, lack of enough food, population growth, inadequate enforcement resources, low education levels, and unemployment drive poaching to higher levels (Figure No. 7).

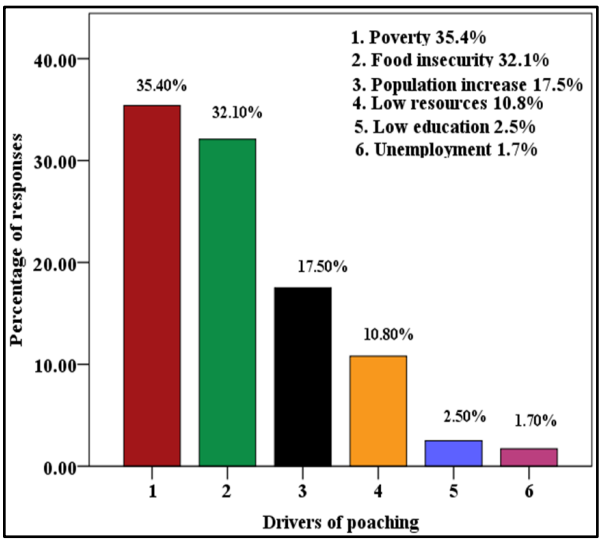

Figure No. 7: Drivers of poaching in the LCBR

Table No. 3: Level of income and involvement in fishing and bird hunting in the LCBR

Daily Income	Fishing and Bird Hunting		Overall (%)	□²
	Not involved (%)	Directly involved (%)		
Below $1.90 /day	66.7	67.3	67	0.005
Above $1.90 /day	33.3	32.7	33	
Total	100	100	100	

The results show that 67.3 percent of those directly involved in fishing and bird hunting were poor, as opposed to the 32.7 percent who were not poor (Table No. 3). Though the findings show that poverty drives illegal fishing and bird hunting, the results indicate that there is no association between income level and involvement in the activity (X^2 (1) >= 0.005, p = 0.946). This is because those with high income have the capacity to procure efficient fishing and hunting tools, as opposed to the poor who must resort to more traditional fishing and hunting methods.

Malawi is one of the poorest countries in the world, with 50.7 percent of the population living below the poverty line (IMF, 2017), receiving approximately $1.90 per day. The population of the Lake Chilwa wetland is no different, and people depend on fishing to earn an income. The report by CITES Secretariat et al., 2013, discloses that sites with communities experiencing higher levels of poverty, will also have higher levels of poaching. However, in their review, Duffy and St. Johns (2013) found that, though poverty may motivate people to poach, members of poor

communities would not engage in the poaching of commercially valuable species, unless there was demand from wealthier communities. Individuals in the LCBR mostly practice subsistence type of poaching. The primary purpose for this kind of poaching, is food, and, in the process, supports local trade, as not all can be fishermen.

Table No. 4: Level of education and involvement in fishing and bird hunting in the LCBR

Education Level	Fishing and Bird Hunting		Overall (%)	χ^2
	Not involved (%)	Directly involved (%)		
Primary	41.02	65.6	56	6.099*
Secondary	53.85	32.8	41	
Tertiary	5.13	1.6	3	
Total	100	100	100	

The results (Table No. 4), show that 56 percent of the respondents only attained primary education, thus indicating that most individuals in the biosphere reserve are not highly educated, and lack the credentials required for employed in the formal sector. The results also show that 65.6 percent and 32.8 percent of those directly involved in fishing and bird hunting attained primary and secondary education, respectively, and only 1.6 percent attained tertiary level. There is a significant association between level of education and direct involvement in fishing and bird hunting in LCBR (X^2 (2) = 6.099, $p < 0.05$). In Malawi, unemployment rates are very high. Many people remain idle due to a lack of skills and experience required in the labor force. It is also a fact that many uneducated people are involved in illegal hunting, simply because

they don't understand the importance and benefits of wildlife resources.

Table No. 5: Food security status and involvement in fishing and bird hunting

Food security status	Fishing and Bird Hunting		Overall (%)	□²
	Not involved (%)	Directly involved (%)		
Food Insecure HH	46.2	70.5	61	5.923*
Food Secure HH	53.8	29.5	39	
Total	100	100	100	

The results (Table No. 5) show that 70.5 percent of those involved in fishing and bird hunting are food insecure, whereas 29.5 percent are food secure. Food security level in the LCBR significantly influences the involvement of individuals in fishing and bird hunting activities (X^2 (1) = 5.923, $p < 0.05$). In addition, food insecurity has been indicated as one of the key drivers of poaching (figure 7). According to World Summit on Food Security 1996, food security exists when all people, at all times, have physical, social, and economical access to sufficient, safe, and nutritious food, adequately meeting their dietary needs and food preferences. In recent years, adverse effects of climate change, e.g. drought, have led to loss of yields, thereby forcing people to seek alternative sources of food. Natural resources, such as fish and birds, are prone to exploitation when they are open access. Such is the case in the LCBR. These findings coincide with the findings of Kafumbata et al. (2014). In their report, they noted that African inland lakes, such as Lake Chilwa, contribute significantly to food security and livelihoods through direct exploita-

tion of fisheries resources. However, they stated that the ecosystem services provided are under significant stress, mainly owing to the high demands of an increasing population, negative anthropogenic impacts on lake catchments, and high levels of poverty, resulting in unsustainable use.

With the increase in population, farmable land is becoming smaller, resulting in low food production. GOM and World Bank (2006) found that the average landholding size per household in Malawi is 1.2 hectares, while the average land per capita is 0.33 hectares, leading to low agriculture production whilst the population grows. The report by CITES Secretariat et al. (2013), supports the reports that poaching levels decrease as food security increases.

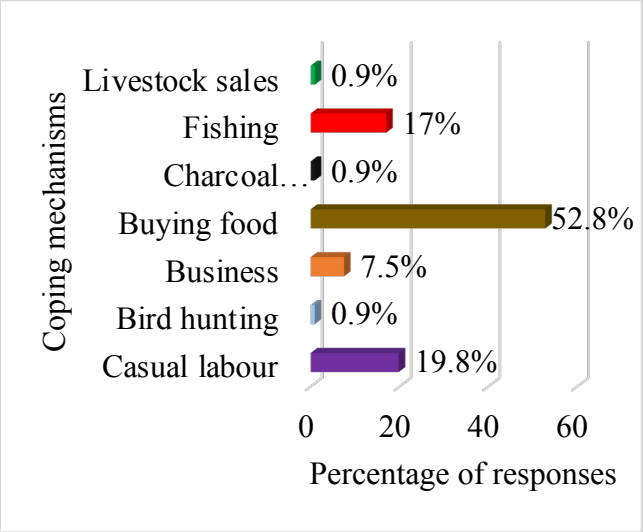

Figure No. 8: Coping mechanisms during food shortage

Fishing is one of the major coping mechanisms used by people in times of food shortage (Figure No. 8). This indicates that some people are driven into fishing activities due to a lack of food. It has also been shown that the fishing and hunting of birds are often ways for individuals to support their families.

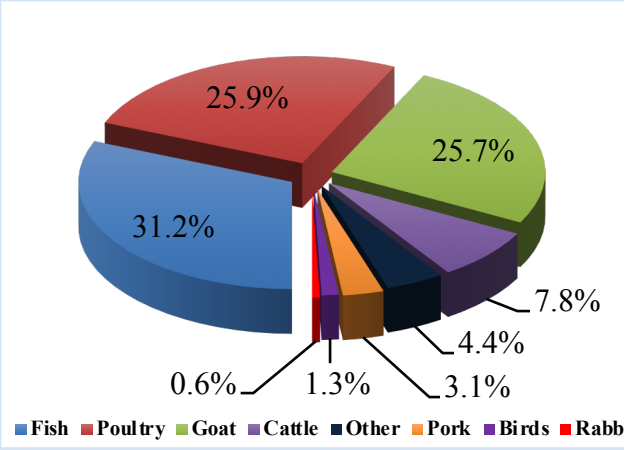

Figure No. 9: Identified protein Sources for communities

Fish is also one of the major animal proteins to the people in the LCBR, as indicated by 31.2 percent of respondents (Figure No. 9). This is because it is readily available and cheaper than other animal protein sources. Lake Chilwa is an open access resource and easily accessible by everyone, making illegal fishing and bird hunting an easy option for people during times of food shortage. Many people depend on natural resources for food during difficult times. In their study, Chiotha et al. (2017) reported that bird hunting intensifies from November to February in the LCBR, a period when most households experience seasonal food shortages. These indicators show the link between food security status and an increase in poaching levels in the LCBR. According to Fa (2000), intensive farming of livestock and other forms of domestic protein is the only way to provide a sustainable source of food. However, Brown and Williams (2003) argue that the capital for livestock rearing is too restrictive for smallholder farmers. Therefore, this condition makes it difficult for most individuals to stop relying on natural resources for food and other amenities, because most of them are openly accessible, and simple, inexpensive tools are used to kill them. This results in a high return for little investment.

The impacts of poaching

Poaching has been causing devastating impacts to both the biosphere resources (fish and birds) and people's livelihood in the Lake Chilwa Biosphere Reserve. In Figure No. 10, 28 percent of the respondents indicated that

there was reduction in fish catches, followed by 27 percent reduction in sources of cheap protein, and 21, 11, 5, 4, 3, and 1 percent indicating reduction in income for the people and species, variability of bird species, reduction size of fish caught over time, increased malnutrition, and non-existence of some fish species respectively.

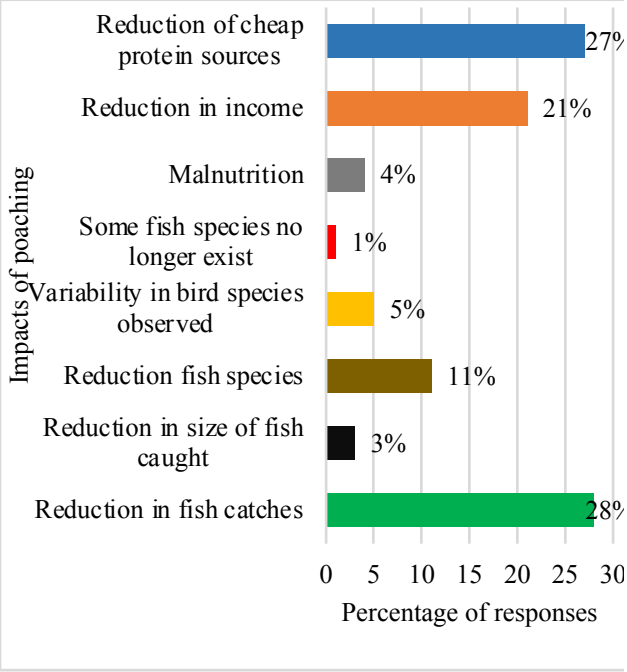

Figure No. 10: Results on observed impacts of poaching

The impact of poaching in the biosphere reserve on species is manifested through a reduction in fish catches. It is reported that in the past, the lake had a variety of fish species. In recent year, however, only a few species are found, and the fish population is currently dominated by catfish (*Clarias gariepinus*), tilapia (*Oreochromis shiranus chilwae)*, and barbus species (*Barbus paludinosus*). This shift indicates that the number of fish species has significantly diminished; a stark contrast to years before. Figure No. 11 shows the decline in species diversity between 2008 and 2017 The trend shows an actual reduction in catches of most of the species. The trend in Figure No. 12 shows that there has been a steady reduction of catches of all fish species over the course of ten years ($r^2 = 0.1576$, $y = -485t + 9173$).

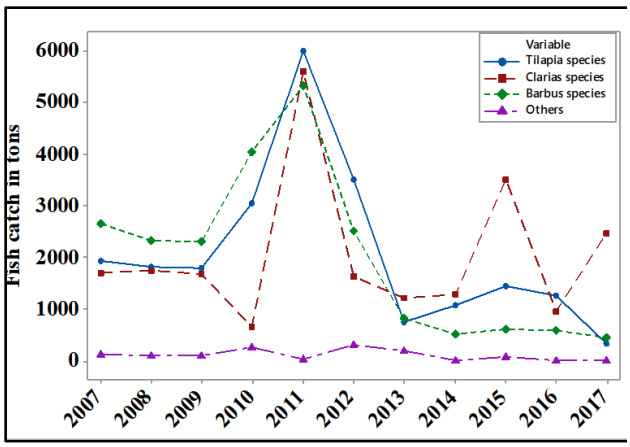

Figure No. 11: Trend of fish catches in the LCBR from 2007 to 2017

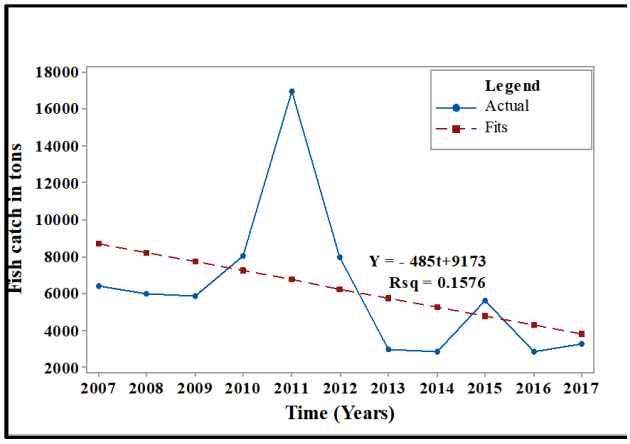

Figure No. 12: Trend of total annual fish caught between 2007 and 2017

In Figure No. 13, the total number of birds killed/trapped over the years shows a general increase between 2009 and 2012, and a decline between 2012 and 2013, indicating the trend is somehow dynamic. The trend's line shows a gentle increase in number of birds killed, though not significant (r^2=0.0088, y = 321+10.3).

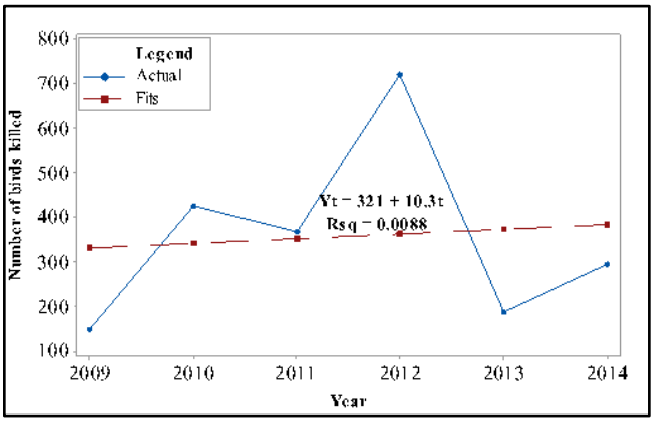

Figure No. 13: Trend of birds trapped between 2009 and 2014

The slight increase in number of birds trapped is attributed to high levels of poaching, confirming that people continue to exploit birds, thus threatening them with extinction. Birds are poached for both consumption and income. The collapse of the fishery due to overfishing and frequent lake recessions has resulted in the need for an alternative source of livelihood: the hunting of many bird species. The major bird species most targeted include Fulvous whistling ducks (*Dendrocygna bicol-*

or), white-faced whistling ducks (*Dendrocygna viduata)*, Lesser Moorhen (*Gallinula angulata),* Lesser Gallinula (*Gallinula alleni*), Crested francolin (*Dendroperdix sephaena*), Lesser masked weaver (*Ploceus intermedius*), and Spur-winged goose (*Plectropterus gambensis)*. However, there is paucity of data indicating the number of birds killed per species, as well as the amount of birds that have been caught in the past, due to a lack of documentation.

In this study, poaching has been implicated as the main cause of reduction in quantities and size of fish caught, reduction in variety of fish species caught, seasonal variability in bird species observed and trapped, and inexistence of some species. The respondents also indicated that these changes could not be entirely attributed to poaching alone, but also the effects of climate change, poor farming practices, and destruction of habitats. Climate change in the area has been evidenced by fluctuating water levels in the lake. This affects availability of water in the lake, thereby impacting breeding and habitat of fish and bird species. Climate change is also affecting crop production in the area, leading to poor harvests for the community, and ultimately driving people to rely on the natural resources within the biosphere reserve, for both food and income. It has been reported that some people depend solely on the resources of the LCBR for livelihood.

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