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Does seasonal closure have effect on fishery?: the case of common carp, C*yprinus carpio* L in Lake Naivasha, Kenya

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ABSTRACT

Studies were done on catch trends and population parameter of common carp, *Cyprinus carpio* in Lake Naivasha between 2002 and 2006 following a year closure in 2001 after decline in catch of *Tilapia zillii* and *Micropterus salmoides*. The fishing ban has continued between June and September every year. Total catch and samples for length frequency analysis were obtained from commercial catch caught using gillnets. Population parameters were estimated using FAO-ICLARM stock assessment tool (FISAT). After reopening of the fishery in 2002, common carp contributed to the total catch was < 1%, rising to 90% in 2005 and declined to 74% in 2006. Before every annual fishing closure, the catches of common carp show a decline. After lifting of the fishing ban, the catches show a pronounced increased. The decline in catches before closure of the fishery may be due increased fishing pressure targeting the species. Asymptotic length () increased from 61 cm TL in 2002 to 97 cm TL in 2005, declining to 74 cm TL in 2006. Exploitation rate has been on the increase – 65% to 75% in 2002 and 2006 respectively. Continual dominance of common carp is also attributed to flexibility in its diet, reproductive potential and use of gillnets of ≥ 4 inches (127 mm) which capture only the bigger sized carp. If further recovery and sustainability of the fishery has to be attained, poaching, water abstraction which are major threat to the fishery have to be tacked. Management strategy will require a concerted effort of all the stakeholders.

Key words; Water levels, illegal gears, co-management, overexploitation

INTRODUCTION

Lake Naivasha is a freshwater lake, approximately 160 km^2, situated in the eastern rift valley of Kenya. It is shallow, bordered by papyrus, *Cyperus papyrus* L., and the aquatic macrophytes are in a state of flux (Adams et al., 2002). Lake Naivasha fisheries consist of introduction species with variable catch composition determined mainly by fishing intensity, water levels and changing in aquatic macrophyte densities. The mean annual commercial species composition of the fin-fish landed for the period 1987 to 2000 was dominated by *Oreochromis leucostictus* (Trewavas) 71.1%, *Micropterus salmoides* (Lacépède) 19.5 % and *Tilapia zillii* (Gervais) 8.8% (Hickley *et al.,* 2004). Between 2002 to 2006 there is a shift in composition with dominance of *Cyprinus carpio* (L) 51.0%, while contribution of others were; *O. leucostictus* 21.9%, *M. salmoides* 13.2% and *T. zillii* 7.9%. The other important fishery in the lake is the introduced Louisiana crayfish, *Procambarus clarkii* (Girard) which is consumed locally and some is exported. Other fish species found in the lake are *Barbus amphigramma* Blgr, and *Poecilia reticulate* Peters.

Closure of the fishery has continued for four months every year since 2003 between June and September. The aim of this study was elucidate trends in common fin fish catches following fishing closure in 2001 and subsequent seasonal closures. Changes in the population characteristics of common carp between 2002 to 2005 were also examined.

MATERIALS AND METHODS

A detailed description of Lake Naivasha is given by Muchiri et al (1994). Lake Naivasha has gillnet fishery and all catches in the lake are landed at designated landing sites. Daily catches in all landing sites between 2002 to 2006 were separated into species and weighed in five days a week, from Monday to Friday, and later raised to monthly and annual catches. Length frequency data for *C. carpio* from commercial catches was collected from February 2002 through December 2006. The total length (TL) of fish was measured to the nearest cm using a measuring board. Data analysis was based on the Electronic Length Frequency Analysis (ELEFAN) computer programs incorporated in FAO-ICLRAM Stock Assessment Tool (FISAT) (Pauly et al. 1984). The estimate of the growth parameters were based on the von Bertalanffy growth formula (VBGF) expressed by the form:

$L_t = L_\infty (1\text{-}exp (-K*(t- t_o))),$

where, L_t is the predicted length at age t, L_∞ is the asymptotic length, K is a growth constant, t_o is the age the fish would have been at zero length. The growth performance index (ø') was computed according to Pauly & Munro (1984):

$\varphi' = log_{10} K + 2 \log_{10} L_\infty$

The length at which 50% of the individuals were fully mature (Lm_{50}) was estimated by fitting frequency of mature individuals by length, using least square method to a logistic curve using a solver function in Microsoft Excel spread sheet. Guts content of *C. carpio* obtained in 2006 were analyzed using a modified point method according to Hyslop (1980). Each stomach was awarded an index of fullness from 0 to 20; empty stomach scored 0; a quarter full 5; half full 10; three quarter full 15 and full 20. Food items were categorized and assigned points proportional to their estimated contribution. The importance of each food category was expressed as a percentage by dividing the total points awarded to all food types into number of points awarded to the food type in question.

RESULTS

Catches

The total catch trend in Lake Naivasha revealed a dominance of *O. leucosticus* from 1992 to 2003 and *C. carpio* between 2004 to 2006 (Fig 1). After the opening of the fishery in 2002, *C. carpio* contribution to the total catches was still insignificant. Catches increased from 5 900 kg (15%) in 2003, to 5 100 kg (84%) in 2004, was 92 000 kg (90%) and 133 000 kg (74%) in 2005 and 2006 respectively. Comparison of catches since 2003 showed a pronouced trend of decrease before closure and an increase after lifting of the fishing ban (Figure 2).

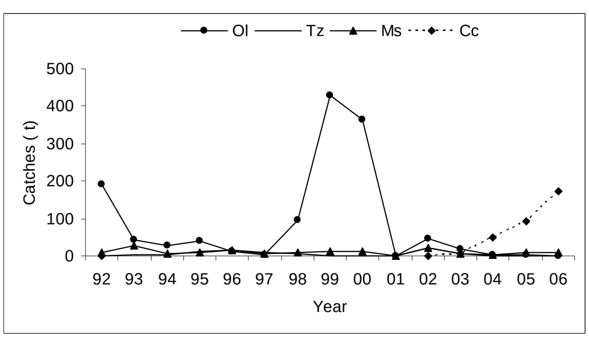

Figure 1. Trends in catches of major commercial species in Lake Naivasha Ol= *Oreochromis leucostictus,* Tz= *Tilapia zillii,* Ms= *Micropterus salmoides,* Cc = *Cyprinus carpio.*

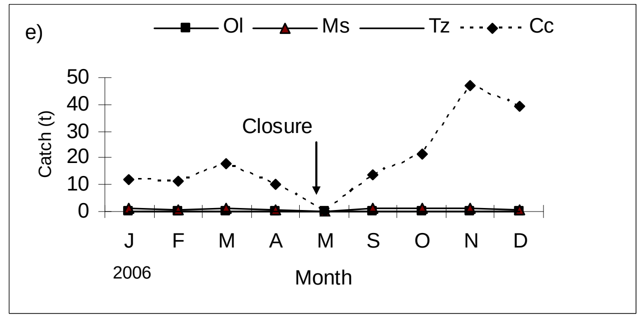

Figure 2. Catches of major species in Lake Naivasha between from 2002 to 2006. Vertical arrow indicate closure to fishing. Tz= *Tilapia zillii,* Ms= *Micropterus salmoides,* Cc= *Cyprinus carpio.*

Population parameters and diet

The asymptotic length (L_∞) increased from 60.8 to 97 cm TL between 2002 to 2005 and a declined to 95 cm TL in 2006 (Table 1). Fishing mortality (F) increased from 0.81 to 0.95 yr^{-1}, while exploitation rate (E) increased from 0.65 to 0.75 between 2002 and 2006. Growth curvature (K) seems to have stabilized at 0.14-0.15 yr^{-1} after a declining from 0.20 to 0.70 between 2002 and 2003 (Table 1). Diet analysis found that *C. carpio* has a diversified diet ingesting a variety of food items (Figure 3). The major food items included plant material (40%), plant seeds (17%), detritus (12%) and fish remains (11%).

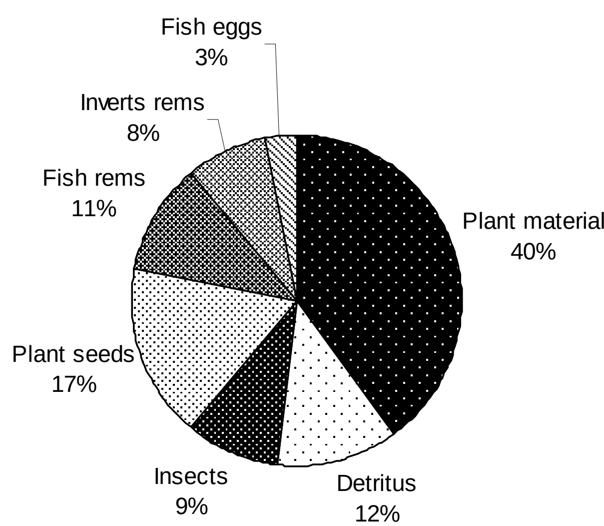

Figure 3. Food ingested by *C. carpio* in Lake Naivasha. Fish rms = Fish remains.

DISCUSSION

Closure of Lake Naivasha fishery gives common carp a reprieve and allows increase in catches (Figure 2). However, the increase in catch is short-lived probably because there is increasing fishing after opening the fishing. Though studies done before the 2001 closure recommended reduction in fishing boats from 100 to 45 boats each with 10 nets of 4 inches and above (Ojuok & Mugo, 2002), this recommendation is not easily implemented. Due to high rate of unemployment in the region, use of more 10 nets per boat, poaching and use of illegal gears have continued (Ojuok et al. 2007). Increased exploitation could be contributing to high exploitation rate (Table 1).

The domination of *C. carpio* in catches could be attributed to ban of gillnets less 4 inches (102 mm). Though the smaller sized tilapiines and *M. salmoides* could be present in the lake in sizeable quantities, the dismal contribution to the commercial catches may be attributed to ban on the use of gillnets < 4 inches. The recommended gillnets of ≥ 4 inches are unable to catch large quantities of the smaller sized tilapiines and *M. salmoides.*

Table 1. Major population parameters for *C. carpio* from Lake Naivasha, Kenya

Population			period		
Parameters	2002	2003	2004	2005	2006
L_∞ (cm, TL)	60.8	67.0	82.6	97.0	95.0
K yr^{-1}	0.20	0.17	0.15	0.14	0.14
F yr^{-1}	0.81	0.70	0.87	0.91	0.95
E	0.65	0.64	0.71	0.74	0.75
φ'	2.87	2.88	3.01	3.12	3.10

The potential success of *C. carpio* in Lake Naivasha could also be attributed to favourable conditions in the lake. Population parameters obtained in the study indicate a species growing to big sizes at a slow growth rate. The population parameters obtained in the study were within the range of the species its native regions of Europe For example, *C. carpio* attains L_∞ of 60.7, 63, 74.8, 82 cm TL, *K* of 0.16, 0.20, 0.16 0.12 yr^{-1} in France, Spain, Kazakhstan and Croatia respectively (www. Fishbase. Org. (2006). The species is hardy, tolerant of degraded aquatic environment and thrives well in turbid waters (Scott & Crossman 1973).

CONCLUSION

Seasonal closure of Lake Naivasha fishery seems to favour common carp more than the other introduced species of tilapiines and blackbass. The increase could probably due the bigger mesh sizes (≥ 4 inches) recommended in the lake and favourable condition in the lake (Ojuok and Mugo 2002, Ojuok et al 2007). *However, this increase in catches might not be sustained for long*. The increased dominance of *C. carpio* has changed the fishing done in the lake. Number of fishers boats have been reduced, while smaller mesh sized nets have been ban. The preclusion of fishers who targeted the smaller tilapines and blackbass in the lake with gillnets < 4 inches would probably led to increase poaching subsequently threatening the whole fishery (Ojuok et al. 2007). Increase in capacity has a correlation with catches obtained in the lake (Fig 4). An increase in boat and fishers goods to reduced catches. Reduce water levels affect breeding and nursery grounds subsequently impinging negatively on recruitment of the lake fishes (Adams et al. 2002; Hickley & Harper 2002). Reduced water have continued due to degradation (deforestation) and changes in climatic conditions in the catchment area. Continued unregulated abstraction of water by surrounding horticultural farms and Ol karia geothermal station, not only reduces the amount of the water in the lake, but also siphon larvae and juvenile fish threatening fish recruitment. There is therefore a need to regulate the amount of water taken out of the lake and use of sieves would reduce uptake of young fish (Ojuok et al 2007).

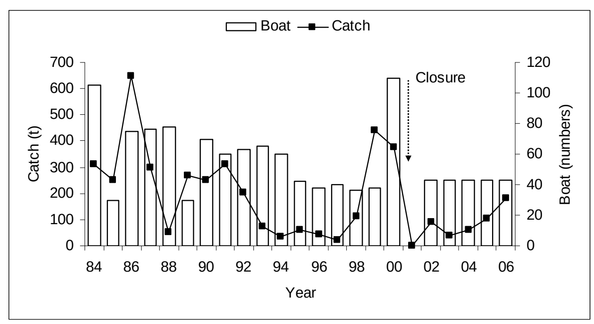

Figure 4. Trends in catch and boat in Lake Naivasha.

For sustainability of the fisheries there is need to involve all the stakeholders in the management of the lake, because top down management coordinated by the central government has not worked in Kenya (Njiru et al. 2007). Community involvement in management of Lake Victoria through Beach Management Units drastically reduced illegal fishing methods and gears (Njiru et al. 2007). In Lake Naivasha, the stakeholders are being involved through the Fisheries Department, Kenya Marine and Fisheries Research Institute, the Lake Victoria Riparian Owners Organisation among other organisations.

Length frequency indicates a population structure dominated by juvenile fish (<36 cm TL, 53%), though with substantial number of mature individuals indicating good recruitment (Ojuok et al 2007). Spawning is unlikely to be limited because normal temperature of Lake Naivasha is 21-24°C, above the required 18°C (Cowx 2001), and *C. carpio* is not selective in its choice of substratum for attachment of eggs (Petr 2000).

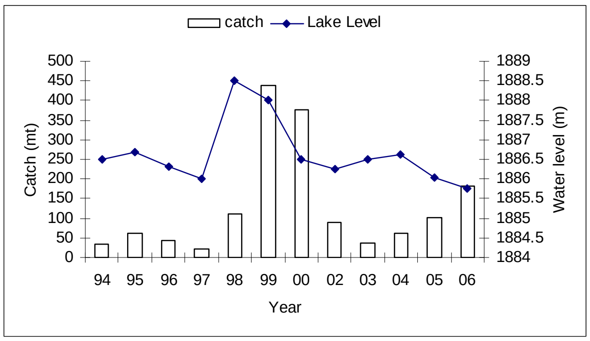

Figure 5. Effects of water levels to catches in Lake Naivasha.

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