# Relative abundance and distribution of fish in Kenyan waters of Lake Victoria

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**Abstract:** Bottom trawl surveys were conducted in Kenyan waters of Lake Victoria during the period September 1997 and March 1999. The means of fish biomass for the two most important species; Lates niloticus (L.) and Oreochromis niloticus (L.) were estimated at 61.5 kg $ha^{-1}$ and 4.5 kg $ha^{-1}$ respectively. There were few L. niloticus greater than 80 cm TL and O. niloticus greater than 50 cm TL, though these species attain maximum sizes of 205 cm and 65 cm respectively. Oreochromis niloticus was mostly found shallower than 5 m though some specimens were encountered deeper than 10 m, suggesting that the species has extended its ecological range. Very low catches were obtained from areas under water hyacinth cover. Water in such areas was turbid with oxygen levels below the critical 3.0 mg $L^{-1}$.

## Introduction

The fisheries of Lake Victoria have undergone dramatic changes since the mid 1950s including: the introduction of alien species, increased fishing pressure with the introduction of more efficient fishing gear and motorized fishing craft, and changes in the trophic status of the lake (Ochumba, Gophen & Pollinger 1994; Crul 1995). The introduced Nile perch, *Lates niloticus* (L.), preyed on the once abundant haplochromines, reducing their percentage contribution to the catch to less than 1% by weight. This has had an impact on the trophic status of the lake as well as on the population dynamics of other fish species. The indigenous species disappeared as a combination of the effects of predation by the Nile perch and overfishing (CIFA 1982; Witte & van Densen 1995).

More recently the spread of water hyacinth, *Eichhornia crassipes* (Mart.) Solms, has affected the distribution of fish in the lake, particularly the Nyanza Gulf. The weed has also hampered fishing activities in Kenyan waters. Industrial, urban and agricultural developments in the lake basin have also indirectly contributed to the change in species and catch composition due to increased nutrient inputs from them with resultant eutrophication (Ochumba 1990; Ochumba *et al.* 1994).

Unfortunately, few studies have been carried out on the Lake Victoria fisheries on a lakewide basis. Indeed, since the last lakewide survey (Bergstrand & Cordone 1971), only a few localized studies have been undertaken (Wanjala & Marten 1974; Muller & Benda 1981; Okemwa 1981; Asila & Ogari 1988; Asila 1994; Dache 1994). The general opinion was of a decline in the stocks of indigenous fish species and an increasing trend of the catches of *L. niloticus*. However, the catches of this species have been unstable since 1990 after peaking in 1989.

Consequently, to avoid a potential collapse in the fishery, there is need to thoroughly assess the status of the stocks in a manner that can be used by management. The main objectives of the present study are to estimate magnitudes of fish stocks and their distribution in the lake. This is part of a lake-wide survey of fisheries resources under the auspices of the European Union Lake Victoria Fisheries Research Project, in collaboration with the three East African fisheries research institutes.

## Lake Victoria fisheries

The fishery in the Kenyan waters of Lake Victoria is mainly artisanal and has until recently been concentrated in inshore waters <25 m deep. A few fishermen with mechanized fishing craft venture into distant open water, which is relatively less fished. This is because the greater part of the Kenyan waters constituting the Nyanza Gulf and the North coast is surrounded by a heavily populated catchment. Practically all parts of these two sections are heavily fished due to their accessibility (Wanjala & Marten 1974; Dache 1994).

The fisheries are mainly gillnet based, exploiting the Nile perch, *Lates niloticus* and the Nile tilapia, *Oreochromis niloticus* (L.). There is also a prominent fishery based on light attraction exploiting the dagaa, *Rastrineobola argentea* (Pellegrin) using mosquito seines. Other methods of fishing include long-lining, hook and lining and the banned beach seining and trawling. Catches are dominated by *L. niloticus* followed by *R. argentea* and by *O. niloticus* which constitute over 96 % of the landings.

## Methods

Monthly sampling was based on 2.5 x 2.5 nautical mile squares of the Kenyan waters of Lake Victoria, using the latitude and longitude readings on the chart to define the sampling grid (Fig. 1). Thirty-minute trawl hauls were made in alternate grid squares. A codend bag of mesh size 5 mm was used in some hauls to obtain samples of R. argentea.

The sample sites were defined using GPS. In the period 1997-1999, it was not always possible to sample at exactly the same position in each survey due to water hyacinth mats. Efforts were made to sample as close as possible to the blocked site in areas free of hyacinth.

Demersal fish biomass was estimated using the swept area method (Witte & van Densen 1995; Sparre 1998). Two different trawl nets were used, one with a headrope of 14.4 m and the second new one with a headrope of 24.5 m. Depending on the size of the catch and the time available for sorting, either the whole catch was sorted into species and every fish measured (TL, cm below) and weighed (g) or a sub-sampling procedure was used. In the latter case, all *L. niloticus* above 35 cm TL were sorted from the catch. The smaller fish were thoroughly mixed on deck and a subsample of three shovelfuls (about 200 fish) was taken. The subsample and the larger fish were individually measured and weighed. The rest of the catch was weighed to provide a raising factor for the subsample. The other species in the catch were also measured and weighed.

Catch curve analysis was carried out on length frequency distributions of *Lates niloticus,* using growth parameters from Asila and Ogari (1988), to estimate total mortality (*Z*).

**Results**

*Species composition and abundance*

During the current surveys, 14 fish species groups were recorded (Table 1). These included species complexes such as the haplochromine cichlids. As in other regions, *Lates niloticus* dominated the catches (77% by weight), although the contribution was considerably lower than in Tanzania and Uganda (Okaronon, Muhoozi & Bassa 1999; Mkumbo 1999) where approximately 95% of the fish were Nile perch. The difference was primarily because of a higher contribution by *O. niloticus* (16%). Haplochromines were also reasonably well represented (4%) and are possibly showing signs of recovery. Similarly, a number of minor species are showing signs of recovery. Species which were commonly caught included: *Protopterus aethiopicus* Heckel, *Clarias gariepinus* (Burchell), *Synodontis* spp. and *Schilbe intermedius* Rüppell (Table 1). In the past it was rare to obtain catches of more than 10 kg ha$^{-1}$ of *P. aethiopicus* and *C. gariepinus.* This species now occur more frequently and in some cases catches equivalent to more than 20 kg ha$^{-1}$ were obtained (Table 1).

The mean biomass of the two important species, *L. niloticus* and *O. niloticus*, was estimated at 66 kg ha$^{-1}$. Fish abundance varied considerably between surveys at the same station (Tables 2 & 3), e.g. off Dunga, an area which normally yielded low catches, the equivalent of 430 kg ha$^{-1}$ was caught in November 1998, but only 33.6 kg were caught in the following month.

Areas with consistently high catches extended from west of Maboko Island to Mbita Channel in the depth range 5-22 m. This area is outside major urban and riverine influence and is where most of the fishing effort by artisanal fishermen is currently concentrated.

Very low catches were obtained from areas that had recently been covered by water hyacinth. Water at such sites was turbid with low oxygen levels, e.g. off Oluch River mouth in Homa Bay, oxygen concentrations ranged from 1.1 mg L$^{-1}$ at the bottom to 3.9 mg L$^{-1}$ near the surface. Only 1.8 kg ha$^{-1}$ was caught, consisting mainly of juveniles of a wide range of species, including *L. niloticus*, and *O. niloticus.* Juveniles of *P. aethiopicus,* still with intact yolk sacs, were also caught. The area also had a high diversity of indigenous fish species, *Brycinus sadleri* (Boulenger), *Haplochromis* spp., *Synodontis* spp., *R. argentea* and tilapia.

Abundance of *L. niloticus* was highest at sites more than 10 m deep (Table 2). *Oreochromis niloticus* (Table 3) is showing evidence of recovery with occupancy in a wider depth range. Formerly, it was distributed only in areas less than 10 m deep and trawl catches equivalent to more than 5 kg $ha^{-1}$ were rare. The species is now distributed in water of up to 20 m deep, and catches in excess of 30 kg $ha^{-1}$ are common (Table 3).

The standing crops of both *L. niloticus* and *O. niloticus* tend to increase with depth (Fig. 1; Table 1). This is partially due to increased efficiency of the trawl in deeper water, but there is possibly a greater stock biomass in waters which are less accessible to artisanal fishermen.

*Population characteristics of* **Lates niloticus** *and* **Oreochromis niloticus**

Length frequency analysis was carried out on more than 61 000 *L. niloticus* and 1200 *O. niloticus* caught during the trawl survey programme. There were few *L. niloticus* greater than 80 cm and *O. niloticus* greater than 50 cm (Figs 3 and 5) though these species previously attain maximum sizes of 205 cm and 65 cm respectively (Asila & Ogari 1988; Getabu 1992).

There was little evidence of modal progression of cohorts in the Nile perch population (Fig. 3), and the picture was clouded by the introduction of the new trawl net in November 1998, which is more efficient at catching smaller individuals. This was evident from the marked shift towards smaller size classes at this time (Fig. 3). Irrespective, all samples were dominated by the very small size groups with few fish attaining 50 cm TL. Once a full year's data with the new net are available more in-depth analysis will be performed.

Marked differences in the Nile perch population structure were found between zones (Fig. 4), although no obvious explanation for this was evident. This will be examined further when a complete data set is available for each zone.

The total mortality of *L. niloticus* was calculated using growth parameters estimated by Asila and Ogari (1988) as $Z = 3.72$ for the period Nov 1998 to June 1999. This is higher than the estimate for the period between 1978 and 1984, which was $Z = 1.3\text{-}2.2$ (Asila & Ogari 1988).

Although the data are weak, some evidence of cohort development is evident from the length frequency distribution of *O. niloticus* (Fig. 5). A new cohort of fish appears to have recruited to the fishery around April 1998. It will be necessary to correlate this finding with information being collated on the reproductive strategies of the species (Ojouk 1999) to identify if this is a single annual event.

## Discussion

The estimated biomass of 66 kg $ha^{-1}$ for the two important species is low compared to the estimate of 104 kg $ha^{-1}$ for Kenya waters of Lake Victoria by Kudhongania and Cordone (1974), when the fishery was dominated by *Haplochromis* spp.

The low catch of fish in shallow inshore areas and bays is probably due to high fishing pressure as these areas are easily accessible. Most fishermen do not have motorized canoes so do not have access to fish distant waters. Hence the areas in the open gulf and immediate outside have relatively higher catches

The scarcity of larger sized fish in the present survey when compared to the earlier surveys (Asila & Ogari 1987) may reflect the heavy fishing pressure (Othina & Tweddle 1999), leading to higher fishing mortality. This was supported by the very high estimates of total mortality, considerably greater than in the past, which can largely be attributed to fishing. This aspect will be investigated further during this project.

The shift in depths at which *O. niloticus* was caught suggests that the species has extended its ecological range. Declining stocks of the predatory *L. niloticus*, and an increase of detritus at the lake bottom due to debris depositing from hyacinth mats, may partially explain the increased depth range.

Initially the distribution of indigenous species and tilapia was confined to waters of less than 5 m and in swamps and in the riverine habitat. As the water hyacinth spread, these species appears to have followed. These include *C. gariepinus, P. aethiopicus, Synodontis* spp, tilapia and *S. intermedius*. The water hyacinth mats introduce a lot of organic matter at the bottom and organic matter caught in the trawlnets contains a wide variety of small invertebrates, including gastropod molluscs, oligochaetes, Odonata and Trichoptera larvae. This constitutes a rich source of food for the species which have expanded their ecological range. The spread of the traditional fishes could also have been enhanced by the declining stocks of *L. niloticus.*

Areas around the water hyacinth have been observed to have low dissolved oxygen concentrations (Kenyanya 1999). *Lates niloticus* avoids areas with low dissolved oxygen concentrations. The fish species associated with the water hyacinth have higher tolerance to low oxygen concentrations. Hence the hyacinth is acting as an hypoxic refugium for these species from which they evade predation. Good examples of such fish include *P. aethiopicus* and *C. gariepinus,*

This report presents preliminary analysis of the trawl survey programme in Kenyan waters of Lake Victoria. Once a full year's data based on the new trawl gear have been gathered these will be more fully analysed to elucidate the population dynamics of the major fish species in the lake.

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**Table 1.** Mean catch rates (kg $ha^{-1}$) from trawl surveys in the Kenyan waters of Lake Victoria (March - June 1999)

| Species | Depth (m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0-4 | 5-9 | 10-14 | 15-19 | >20 | Total | Percentage composition |
| *Lates niloticus* (L.) | 51.3 | 55.5 | 97.0 | 44.7 | 82.0 | 70.5 | 77.51 |
| *Oreochromis niloticus* (L.) | 16.4 | 16.4 | 19.6 | 5.4 | 31.5 | 19.3 | 15.85 |
| *Bagrus docmak* (Forsskål) | | 0.1 | 0.4 | | | 0.2 | T |
| *Brycinus sadleri* (Boulenger) | | 0.5 | 0.1 | | | 0.3 | T |
| *Barbus profundus* Greenwood | | | | 4.2 | 1.4 | 2.3 | 0.02 |
| *Clarias gariepinus* (Burchell) | 6.8 | 7.6 | 4.2 | 5.6 | | 7.1 | 0.71 |
| Haplochromines | 1.9 | 1.8 | | 4.9 | 21.8 | 4.3 | 4.71 |
| *Labeo victorianus* Boulenger | | 0.4 | | | | 0.4 | T |
| *Aethiomastacembelus frenatus* (Boulenger) | 0.0 | | | | | 0.2 | T |
| *Protopterus aethiopicus* Heckel | 18.2 | 13.3 | 3.0 | | | 12.4 | 0.71 |
| *Rastrineobola argentea* (Pellegrin) | 0.6 | 12.1 | 2.7 | 1.3 | | 5.5 | 0.30 |
| *Schilbe intermedius* Rüppell | 4.7 | 0.2 | 0.7 | | 0.1 | 0.9 | 0.03 |
| *Synodontis victoriae* Boulenger | 0.2 | 2.7 | 0.1 | 4.1 | 0.8 | 1.9 | 0.14 |
| *Tilapia zillii* (Gervais) | | | | | | 0.9 | T |

**Table 2.** Mean catch rates (kg ha$^{-1}$) of *Lates niloticus* in the Kenyan waters of Lake Victoria

| Location | Depth m | Catch (kg ha$^{-1}$) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sept. 1997 | Oct. 1997 | Nov. 1997 | Dec. 1997 | Jun. 1998 | July 1998 | Oct. 1998 | Nov. 1998 | Dec. 1999 | Feb. 1999 | Mar. 1999 | Apr. 1999 | May 1999 | June 1999 | Mean |
| Kisumu Bay | 2.8 | 81.29 | 2.01 | | | | 55.67 | 102.07 | 3.51 | 45.26 | | | | | | 48.30 |
| Paga | 2.9 | 68.48 | 17.63 | | | 64.03 | 28.04 | | | | | 0.0 | 13.6 | 14.1 | 30.0 | 29.48 |
| Awach Paga | 3.5 | 15.47 | 31.75 | | | 42.27 | 23.09 | | | | | | | | | 28.15 |
| Sondu Miriu | 3 | 23.71 | 24.13 | | 2.01 | 20.62 | 10.31 | 10.31 | | | | 0.0 | 7.0 | 12.8 | 0.0 | 11.09 |
| Awach-Maboko | 5 | 74.92 | 29.59 | | | 50.42 | 53.61 | 25.88 | | 117.28 | | 84.0 | 0.0 | 0.0 | 50.3 | 48.60 |
| Ndere | 5.1 | 45.08 | 45.98 | 104.23 | | 58.46 | 55.67 | 113.41 | | 68.56 | | 7.0 | 21.8 | 0.0 | 75.8 | 54.18 |
| Asembo-Bay | 3.3 | 13.92 | 6.44 | 42.68 | | 29.28 | 597.98 | 50.73 | 75.78 | 30.93 | | 26.0 | 65.3 | 0.0 | 104.8 | 86.98 |
| Bala-Lawi | 10.2 | 143.34 | 82.07 | 79.18 | 77.33 | 162.38 | 269.50 | 25.21 | 225.79 | 230.94 | | 0.0 | 0.0 | 77.5 | 106.9 | 113.86 |
| Miti-Mbili | 4.2 | 181.20 | 24.95 | 102.53 | | 88.67 | 216.51 | 40.21 | 25.78 | 120.52 | | 99.2 | 108.9 | 61.3 | 112.8 | 98.54 |
| Gudwa | 12.9 | 300.61 | 71.09 | 292.90 | 213.73 | 70.11 | | 139.24 | 58.41 | | | 174.4 | 131.5 | 41.6 | 61.6 | 141.38 |
| Launda-Gembe | 7.2 | 24.23 | | 109.99 | | 11.34 | | 16.70 | 8.87 | 23.20 | 31.45 | 60.2 | 40.5 | 0.0 | 24.3 | 31.89 |
| Mirunda-Bay | 7 | 228.37 | | 92.76 | | 108.26 | 30.93 | 14.02 | 12.89 | 86.60 | 20.62 | 28.3 | 79.3 | 0.0 | 43.9 | 62.15 |
| Madundu | 21 | 91.30 | | | 124.44 | 210.12 | 252.60 | 62.53 | 22.89 | 234.04 | 5.36 | 108.6 | 63.4 | 0.0 | 40.2 | 101.28 |
| Kopiata | 11.2 | 80.93 | 169.86 | 25.21 | 52.27 | 144.34 | | 108.98 | 79.90 | | 24.33 | 161.0 | 69.6 | 0.0 | 24.8 | 78.44 |
| Achieng-Oneko | 4.1 | 40.72 | 169.60 | 169.86 | 128.05 | 100.01 | | 2.68 | 73.72 | | | 119.3 | 0.0 | 0.0 | 48.5 | 77.49 |
| Rusinga Channel | 10 | 67.98 | | 165.48 | | 105.16 | 96.30 | 183.52 | 14.43 | 105.68 | 55.67 | 239.2 | 44.0 | 30.8 | 86.5 | 99.56 |
| Luanda Naya | 11.3 | 107.08 | | | | | | | | | 0.26 | | | | | 53.67 |
| Kuja | 8.4 | 7.38 | | 4.23 | | 142.28 | 107.64 | 149.70 | | | | 0.0 | 35.8 | 0.0 | 74.6 | 57.96 |
| Karunga Bay | 7.6 | 41.96 | | | | 86.60 | 23.92 | 19.38 | 184.03 | | | 0.0 | 24.7 | 0.0 | 77.4 | 50.89 |
| Muhuru Bay | 25 | 206.06 | | | | 342.40 | 38.35 | 33.61 | 10.21 | | | 0.0 | 141.3 | 0.0 | 80.1 | 94.67 |
| Mageta | 17.8 | 44.72 | | | | | | | | | | | | | | 44.72 |
| Mageta Usenge | 13.2 | 111.86 | | | | 291.57 | | | | | | | | | | 201.72 |
| Yala | 3.4 | 32.48 | | | | 147.23 | | 93.82 | 94.85 | | | 1.8 | 12.2 | 0.0 | 220.1 | 75.31 |
| Sio River | 4.5 | 2.32 | | | | 64.54 | | 13.82 | 38.66 | | | 56.5 | 111.2 | 0.0 | 2.1 | 36.14 |
| Sisenye | 3.4 | | | | | 297.44 | | 166.61 | 65.98 | | 24.74 | 8.2 | 6.0 | 0.0 | 0.2 | 71.14 |
| Gingra Rock | 10 | | 15.67 | 54.02 | 125.16 | 101.66 | | 122.61 | 110.83 | 206.20 | | 101.9 | 110.0 | 0.0 | 49.3 | 90.66 |
| Kowuor | 3 | | | | 41.45 | 441.27 | 9.69 | 60.62 | 32.99 | 15.67 | 15.47 | 45.9 | 0.0 | 0.0 | 35.8 | 63.53 |
| Awach River | 3.9 | | | 9.70 | 54.44 | | | 11.34 | | 30.93 | 13.45 | 2.4 | 26.5 | 0.0 | 10.2 | 17.66 |
| Sukru Island | 4.9 | | | 15.47 | 39.69 | | | | | | 97.43 | | | | | 50.86 |
| Kendu Bay | 3.2 | | | 9.28 | | | | | | | | | | | | 9.28 |
| Mabako | 8 | | | 111.24 | | 34.23 | | 18.04 | 25.57 | 86.60 | | 0.0 | 51.1 | 21.5 | 42.1 | 43.38 |

**Table 2 continued.** Mean catch rates (kg ha$^{-1}$) of *Lates niloticus* in the Kenyan waters of Lake Victoria

| Location | Depth m | Catch (kg ha$^{-1}$) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sept. 1997 | Oct. 1997 | Nov. 1997 | Dec. 1997 | Jun. 1998 | July 1998 | Oct. 1998 | Nov. 1998 | Dec. 1999 | Feb. 1999 | Mar. 1999 | Apr. 1999 | May 1999 | June 1999 | Mean |
| Rusinga S | 21.2 | | | 6.39 | | | | | | | | 0.0 | 0.0 | 58.7 | 0.0 | 13.02 |
| Soklo Island | 5.4 | | | | | 61.86 | 40.83 | 41.96 | 18.97 | 34.80 | | 22.8 | 0.0 | 0.0 | 44.0 | 29.47 |
| Naya | 7 | | | | | 19.59 | 107.64 | 2.45 | 33.51 | 22.17 | | 312.9 | 30.6 | 0.0 | 200.2 | 81.00 |
| Kisian | 3.7 | | | | | | | 30.31 | 3.71 | 76.29 | 37.12 | | | | | 36.86 |
| Off Dunga | 4.2 | | | | | | 25.98 | 87.27 | 443.33 | 34.70 | | 42.4 | 14.1 | 28.6 | 14.0 | 86.29 |
| Soda Paga | 4.2 | | | | | | | 26.81 | | | | | | | | 26.81 |
| Miti Mbili Ndere | 6.6 | | | | | 196.92 | 161.66 | 65.67 | | 24.23 | | 46.2 | 85.9 | 50.9 | 51.7 | 85.40 |
| Gudwa K'Owuor | 11.8 | | | | | 98.67 | | 117.43 | 562.93 | | | 151.0 | 66.1 | 80.2 | 120.9 | 171.01 |
| Oluch River | 6.5 | | | | | 72.69 | 185.37 | 62.38 | | | 54.64 | | | | | 93.77 |

**Table 3.** Mean catch rates (kg ha$^{-1}$) of *Oreochromis niloticus* in the Kenyan waters of Lake Victoria

| Location | Depth m | Catch (kg ha$^{-1}$) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sept. 1997 | Oct. 1997 | Nov. 1997 | Dec. 1997 | Jun. 1998 | July 1998 | Oct. 1998 | Nov. 1998 | Dec. 1999 | Feb. 1999 | Mar. 1999 | Apr. 1999 | May 1999 | June 1999 | Mean |
| Kisumu Bay | 2.8 | 7.76 | 2.68 | | | | | | 8.66 | 1.55 | | | | | | 5.16 |
| Paga | 2.9 | 4.86 | 2.47 | | | 32.48 | | | | | | 0 | 1.2 | 10.6 | 6 | 8.23 |
| Awach Paga | 3.5 | 4.87 | 1.49 | | | | 0.25 | | | | | | | | | 2.20 |
| Sondu Miriu | 3 | 5.52 | 2.37 | | | | | 49.18 | | | | 0 | 7 | 0 | 0 | 9.15 |
| Awach-Maboko | 5 | 2.42 | 1.86 | | | | 6.19 | 2.47 | | 61.86 | | 66.4 | 0 | 0 | 12.2 | 17.04 |
| Ndere | 5.1 | 5.36 | 0.31 | | | 4.02 | | | | 15.47 | | 68.2 | 33.05 | 0 | 13.3 | 17.46 |
| Asembo-Bay | 3.3 | 1.70 | 2.84 | 7.63 | | 0.10 | | 1.52 | 4.12 | 30.31 | | 70.5 | 29.3 | 0 | 13.2 | 14.66 |
| Bala-Lawi | 10.2 | 2.01 | 2.06 | | | | | 2.21 | 2.47 | 5.93 | | 0 | 0 | 4.2 | 11.6 | 3.39 |
| Miti-Mbili | 4.2 | 0.15 | | 0.10 | | 3.20 | | 0.56 | 0.41 | 29.90 | | 0 | 8.55 | 8 | 15.5 | 6.64 |
| Gudwa | 12.9 | | | | | 2.58 | | | 5.05 | | 114.96 | 35 | 0 | 0 | 0 | 22.51 |
| Launda-Gembe | 7.2 | 10.36 | | | | 2.68 | | 2.69 | 3.09 | 10.31 | 348.48 | 24.4 | 2.8 | 0 | 1.5 | 40.63 |
| Mirunda-Bay | 7 | 6.84 | | | | 4.12 | 7.42 | 2.29 | 16.50 | 8.82 | 87.02 | 11 | 17.1 | 0 | 8.4 | 15.41 |
| Madundu | 21 | | | | | | | | | 18.56 | 294.35 | 30.75 | 5.6 | 0 | 3.2 | 58.74 |
| Kopiata | 11.2 | 1.65 | | | 3.38 | | | | | | 101.04 | 26 | 0 | 0 | 25.8 | 22.55 |
| Achieng-Oneko | 4.1 | 4.12 | | | 2.52 | 21.86 | | | | | 28.87 | | | | | 14.34 |
| Rusinga Channel | 10 | 1.43 | | | | 1.86 | 5.98 | | 0.67 | | 212.39 | 9.3 | 0 | 0 | 0.5 | 25.79 |
| Luanda Naya | 11.3 | 2.40 | | 8.35 | | | | | | | | | | | | 5.38 |
| Kuja | 8.4 | | | | | | | | | | | | | | | |
| Karunga Bay | 7.6 | | | | | 1.91 | | | | | | 0 | 0 | 0 | 0.5 | 0.48 |
| Muhuru Bay | 25 | | | | | | | | 6.80 | | | | | | | 6.80 |
| Mageta | 17.8 | | | | | | | | | | | | | | | |
| Mageta Usenge | 13.2 | | | | | | | | | | | | | | | |
| Yala | 3.4 | 2.04 | | | | 9.90 | | | 0.88 | | 187.13 | 10.9 | 3.5 | 0 | 3.75 | 27.26 |
| Sio River | 4.5 | 27.32 | | | | 1.86 | | | 26.03 | 32.17 | 34.02 | 5 | 0.07 | 0 | 5.3 | 14.64 |
| Sisenye | 3.4 | | | | | 7.73 | | | 1.13 | | 15.98 | 5.6 | 1 | 0 | 0.55 | 4.57 |
| Gingra Rock | 10 | | | | | 23.71 | | | 3.35 | 4.74 | 149.50 | 0 | 5.5 | 0 | 0 | 23.35 |
| Kowuor | 3 | | | | 1.91 | 19.59 | 3.92 | | | 3.66 | 60.31 | 54.2 | 0 | 0 | 4.6 | 16.47 |
| Awach River | 3.9 | | | 1.87 | 0.36 | | | | | 20.83 | 85.57 | 35.2 | 19 | 0 | 11 | 21.73 |
| Sukru Island | 4.9 | | | 3.45 | 10.72 | | | | | | | | | | | 7.09 |
| Kendu Bay | 3.2 | | | 1.55 | | | | | | | | | | | | 1.55 |
| Mabako | 8 | | | 10.10 | | | | 2.27 | 3.71 | 12.89 | | 0 | 38.3 | 3.2 | 3.5 | 9.25 |

**Table 3 continued.** Mean catch rates (kg ha$^{-1}$) of *Oreochromis niloticus* in the Kenyan waters of Lake Victoria

| Location | Depth m | Catch (kg ha$^{-1}$) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sept. 1997 | Oct. 1997 | Nov. 1997 | Dec. 1997 | Jun. 1998 | July 1998 | Oct. 1998 | Nov. 1998 | Dec. 1999 | Feb. 1999 | Mar. 1999 | Apr. 1999 | May 1999 | June 1999 | Mean |
| Rusinga S | 21.2 | | | | | | | | | | | 0 | 0 | 15.8 | 0 | 3.95 |
| Soklo Island | 5.4 | | | | | 7.84 | | | 28.87 | 1.09 | | 34 | 0 | 0 | 18 | 12.83 |
| Naya | 7 | | | | | 3.30 | | 24.13 | 8.25 | 24.23 | 337.14 | 44 | 7.05 | 0 | 13.3 | 51.27 |
| Kisian | 3.7 | | | | | | | 2.78 | | 47.43 | | | | | | 25.10 |
| Off Dunga | 4.2 | | | | | | | | 16.81 | 19.73 | | 27.6 | 21 | 20.9 | 23 | 21.51 |
| Soda Paga | 4.2 | | | | | | | 5.31 | | | | | | | | 5.31 |
| Miti Mbili Ndere | 6.6 | | | | | | | 2.96 | | 10.00 | | 29.2 | 11.6 | 5 | 1.25 | 10.00 |
| Gudwa K`Owuor | 11.8 | | | | | | | | | | 270.12 | 14 | 10.9 | 23.65 | 22.5 | 68.23 |
| Oluch River | 6.5 | | | | | 9.28 | 3.09 | 10.21 | 173.21 | | | 0 | 0 | 0 | 2 | 24.72 |

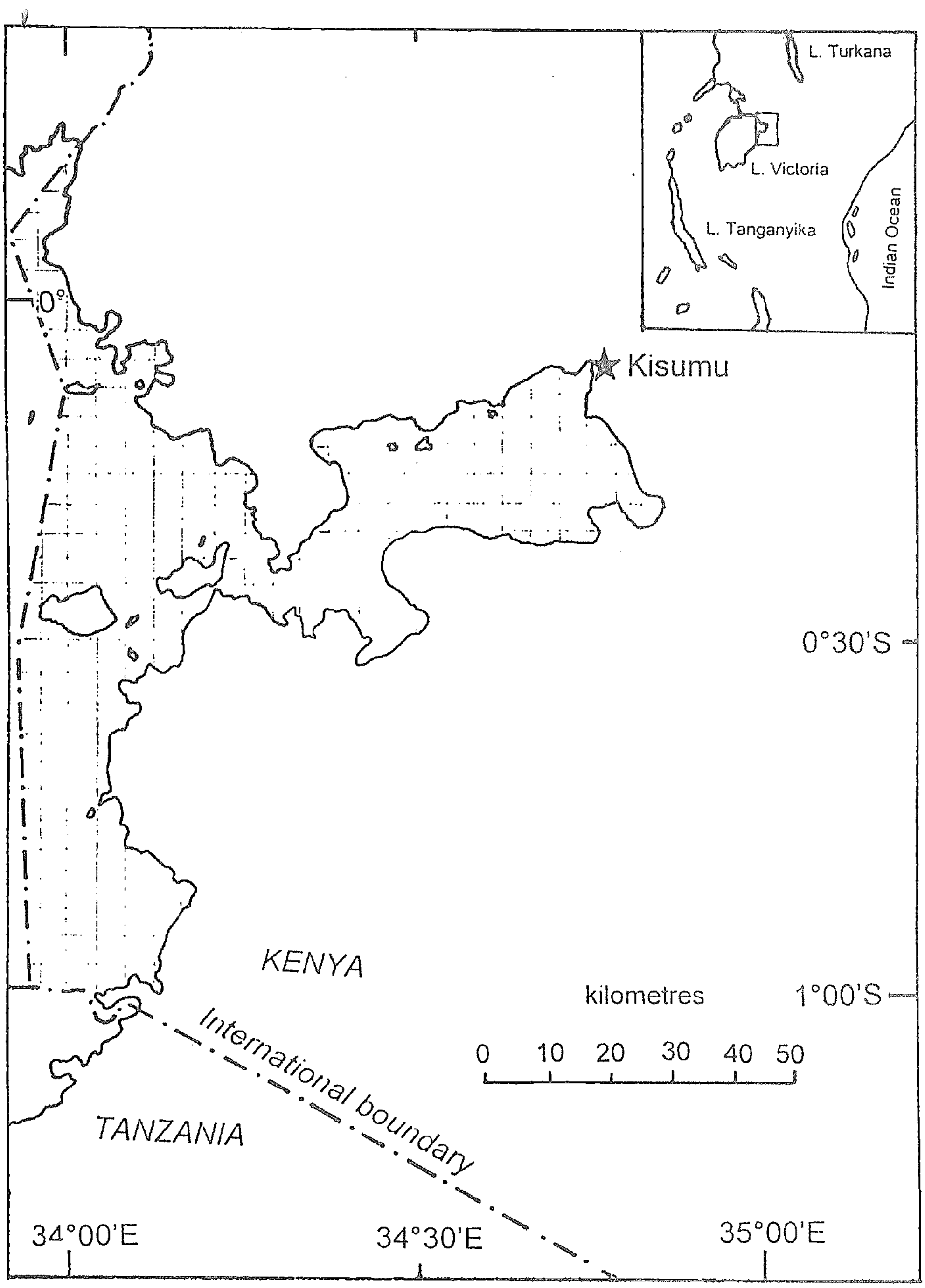


**Fig. 1.** Map of the Kenyan waters of Lake Victoria, showing the sampling grid used in the trawl survey.

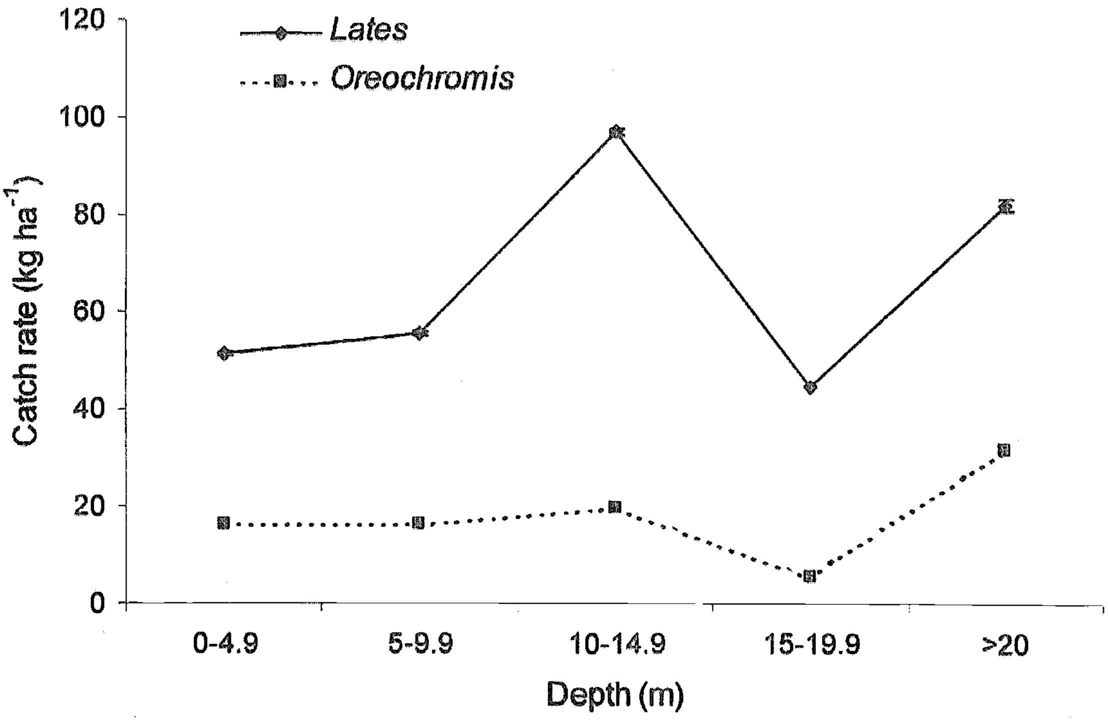


Fig. 2. Variation in catch rates (kg $ha^{-1}$) of *Lates niloticus* and *Oreochromis niloticus* with depth in Kenyan waters of Lake Victoria

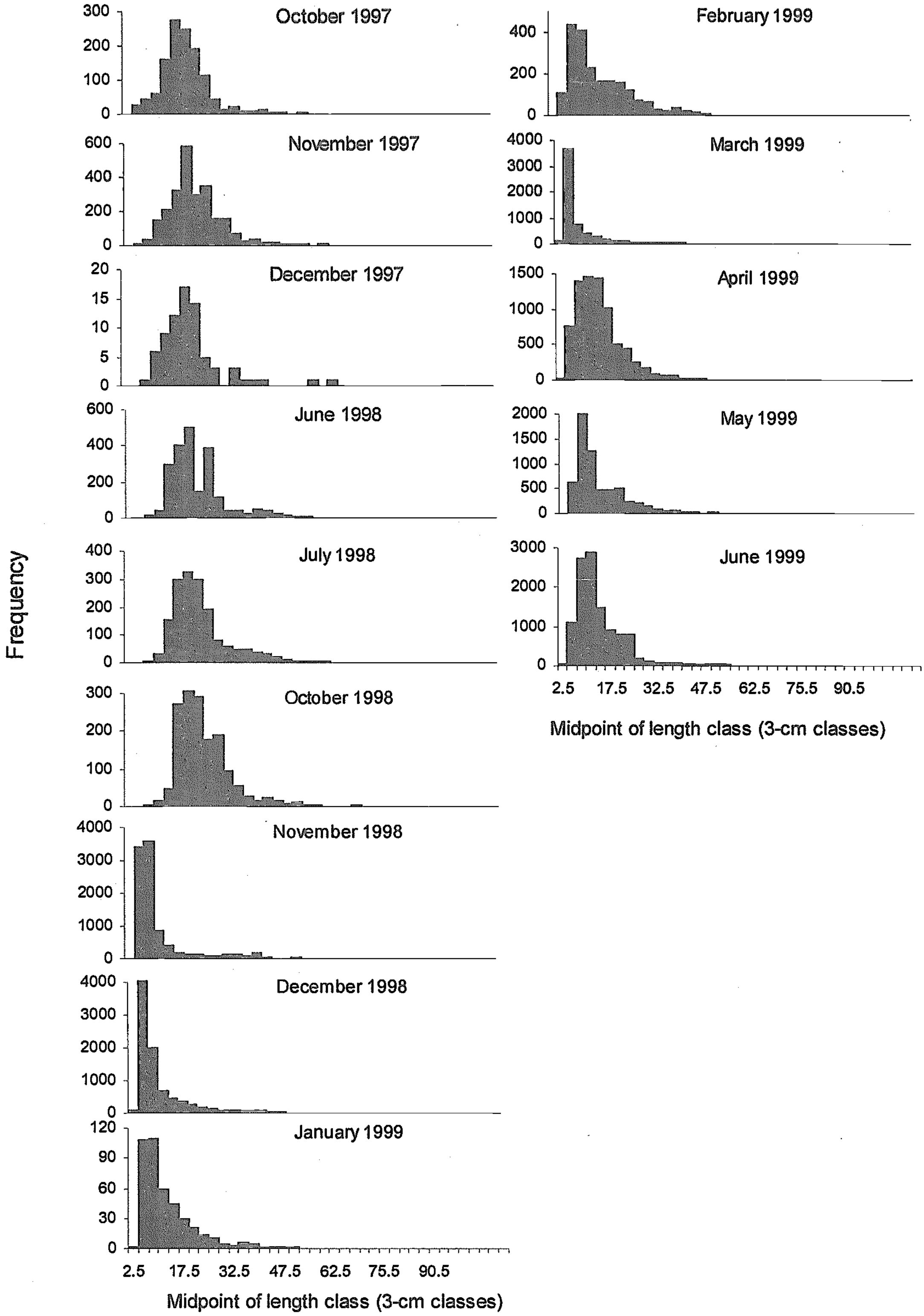


Fig. 3. Length frequency histograms of *Lates niloticus* caught by trawling in the Kenyan waters of Lake Victoria between October 1997 and June 1999.

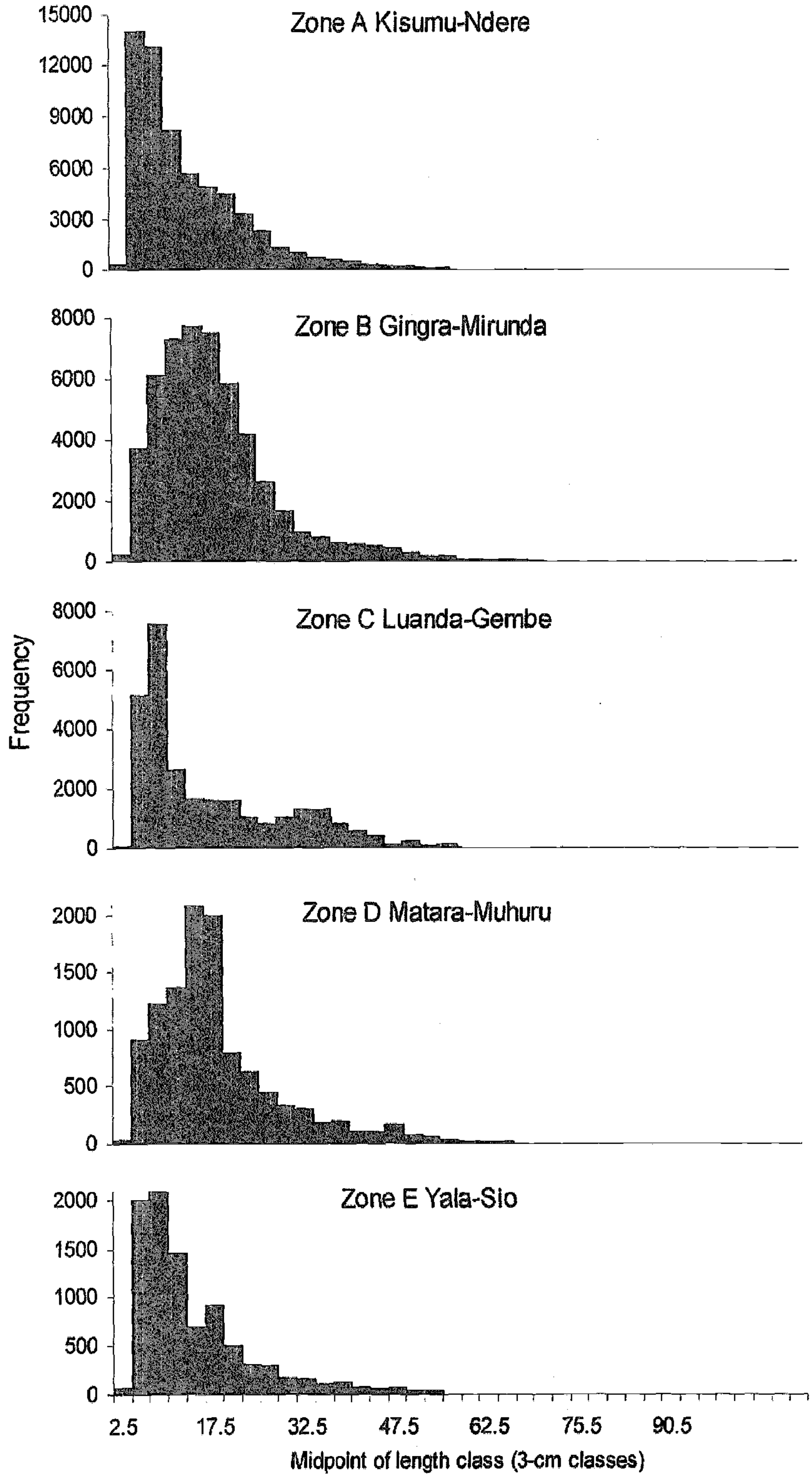


Fig. 4 Length frequency distributions for *Lates niloticus* from bottom trawling in five zones of Lake Victoria, Kenya, October 1997 to June 1999.

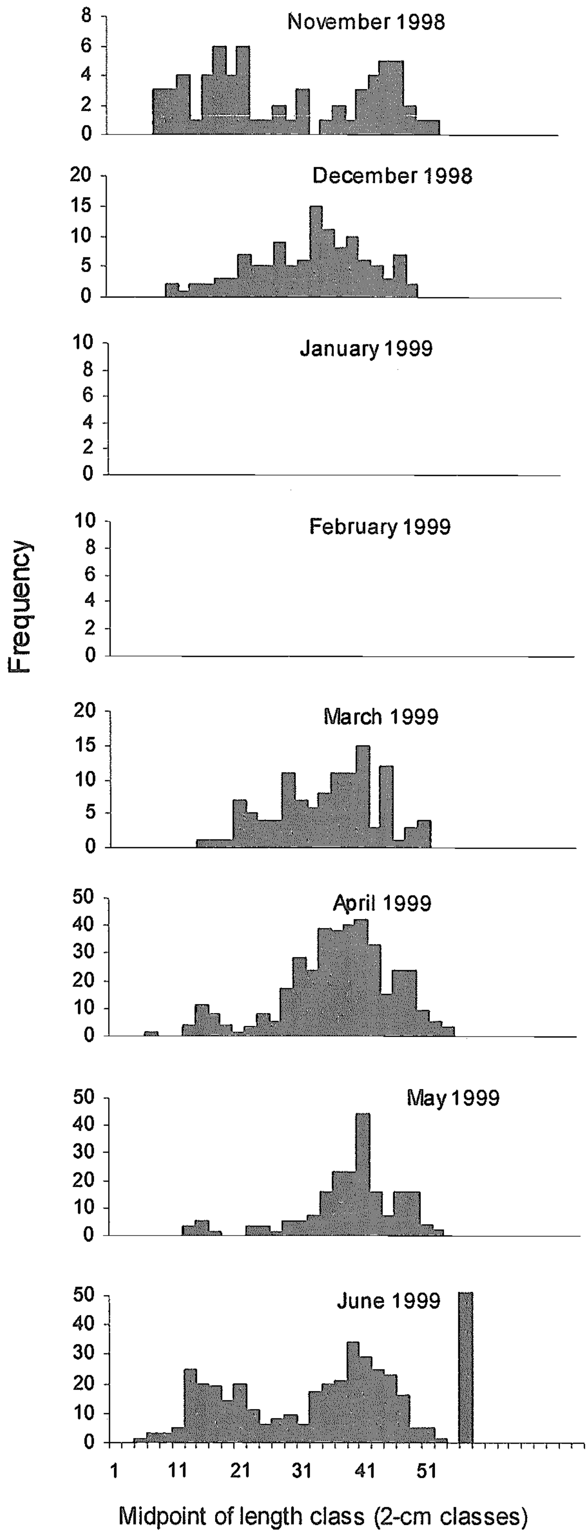


Fig. 5. Length frequency histograms of *Oreochromis niloticus* caught by trawling in the Kenyan waters of Lake Victoria between November 1998 and June 1999.