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Control of fishing effort, gears and methods in management of fisheries in lake Victoria and Kyoga

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Abstract

Natives around the lakes historically dominated fishing on Lakes Victoria and Kyoga and the fishing gears consisted of locally made basket traps, hooks and seine nets made of papyrus. In view of changes in the fisheries of the two lakes, Frame surveys were conducted on lakes Victoria and Kyoga between 1990 to 2000. Selectivity characteristics of the fishing gears targeting the three major commercial fish species, the Nile perch, Nile tilapia and Mukene on the lakes were studied. Size at first maturity was determined for the three species in both lakes. Historical estimated annual fish catches, effort and catch per unit of effort (CPUE) data were analyzed for Lake Victoria Uganda (CPUE for entire lake) for period 1968 to 1998. Fish catches on Lake Victoria increased from 34,000 metric tones (t) in 1972 to 132,400 t in 1989 alongside an increase in fishing boats from 3000 to 8,000. However, a further increase in boats to 15,418 in 2000 resulted in the decline of the catches from 35 tonnes per boat per year to about 10 t. There was also increased use of longline, handline, beach seines, cast nets, traps, active fishing and mukene nets in different boat categories. Similar trends were observed on Lake Kyoga, where the CPUE had reduced to 14.6 t per boat per year in 1991. Using values of size at first maturity, it was observed that trawl codends (in L. Victoria), passive gill nets and cast nets mesh sizes below 127mm cropped mostly immature Nile perch and Nile tilapia; boat/ beach seines also harvested mainly immature fish, but mukene nets of 5mm and above harvested mainly mature *Mukene*. Hooks of size 9 and bigger cropped over 75% mature Nile perch. Basket traps harvested immature Nile tilapia. In view of these trends, it is recommended that fishing effort be reduced to 8000 on Lake Victoria and to below 6500 boats on Lake Kyoga. Destructive fishing gears and practices should be prohibited. Passive fishing using a minimum mesh size of 127mm, drift netting only on Lake Victoria using a minimum gill net mesh size of 152.4 mm, hook fishing with minimum hook of size 9 and *mukene* nets not below 5mm mesh size operated offshore should be encouraged on both lakes. If trawling and cast nets are to be used (L. Victoria) they should be operated in waters deeper than 20m but the catches are very low and it is difficult to enforce the regulation. Trawling is already prohibited on Lake Victoria.

Introduction

The initial artisanal commercial fisheries of lakes Victoria and Kyoga were dominated by the original native tilapiines namely *Oreochromis variabilis* and *Oreochromis esculentus* in addition, *Protopterus aethiopicus* and *Labeo victorianus* were being harvested on lakes Kyoga and effluent rivers of Lake Victoria respectively (Graham, 1929; Worthington, 1929, adwallardr, 1965.1969). These were being exploited n simple crafts using locally constructed gears. The ies at first were mainly at subsistence level. The 1 (5") mesh size of gill nets were used to harvest the tilapiines and hooks were used to harvest *P. aethiopicus*. By 1937 to 1950s the tilapiines and *P. aethiopicus* were the most important commercial species and contributed over 95% of the total fish catches on Lake Kyoga.

During the 1950s, the proportion of the native tilapiines in the commercial fishery started to decrease due to increase in fishing effort and use of small mesh size gill nets. By this time, the catch rates had fallen to an extent that use of 127 mm size of gill nets was not profitable so the fishers shifted to smaller mesh size nets. The habit of shifting to yet smaller meshes continued whenever the catches in larger meshes decreased. Eventually, the tilapia based native fishery on the two lakes collapsed mainly due to uncontrolled fishing effort and use of small mesh sized gill nets (Jackson, 1971; Fryer & Iles, 1972; Ogutu-Ohwayo, 1990). As the commercially important native tilapiines continued to decline, the exotic fish species (*Oreochromis niloticus* – Nile tilapia and *Lates niloticus* (Nile perch) were introduced in the two lakes in early 1950s and early 1960s respectively.

Following species introductions, lakes Kyoga and Kwania together were the most productive lakes in Uganda from the early 1970s producing about 90,000 t to late 1970s producing about 167,000 t (Ogutu-Ohwayo, 1990) but by 1989 the catches had declined to about 55,000 t. A similar trend occurred on Lake Victoria where the Nile perch had become established in the 1980s. Production from Lake Victoria in the early 1970s was about 38,000 mt and by late 1970s was 16,000 mt and increased to about 132,000 t by 1989 and declined to 100,000 t by 1999. Though the introduction of the exotics had contributed to the increase in yield, the decline of some of the other species like the haplochromines through predation by the Nile perch or competition for food like the Nile tilapia with the native tilapiines was noticed. The open access policy to the fisheries, the unregulated fishing gears, gear sizes and fishing practices leading to indiscriminate exploitation of the resource have contributed to the decline of the fish yield in the two lakes.

The fishing effort, gears and fishing practices were examined in order to recommend a strategy for increased and sustainable exploitation of the declining fish production from lakes Victoria and Kyoga for the purpose of increasing incomes of the people in the industry, reduce poverty and increase foreign earnings to the nation.

Methodology

Available historical data of fishing effort and fish catch statistics were analysed for lakes Victoria and Kyoga. Details of total fishing effort and gear composition were compared for Frame surveys conducted on Uganda sector of Lake Victoria during 1990 and 2000 and Lake Kyoga for 1991 and 1997. A field fish catch and fishing effort study was conducted on 25 selected fish landing sites on lake Victoria – Uganda. The landing sites were selected to represent the major commercial fisheries (*L. niloticus* – Nile perch, *O. niloticus* – Nile tilapia and *R.argentea* – Mukene). Sampling was done for a known number of different boat types, categories, gears, gear sizes and fishing practices. The number, weight and total or standard length of individual fish speciemens were taken. Where the catches were very high, sub-samples were used and extrapolation done for the entire catch on a boat. Size at first maturity for the three major fish species above was determined according to (Beverton and Holt, 1957) using specimens from experimental catches on Lake Victoria and commercial catches on Lake Kyoga. Selectivity characteristics of trawl codends, seine nets (beach), lampara nets, traps, hooks, gill nets (active and passive) for the three major commercial fish species were determined using experimental data collected from different, gears, gear sizes during 1995 in Napoleon Gulf of lake Victoria and commercial catches on different fish landings on lake Kyoga.

Frequency distributions of the speciemens from various gears, gear sizes and fishing methods were analysed and related to size at first maturity and other ecological and biological aspects of the species.

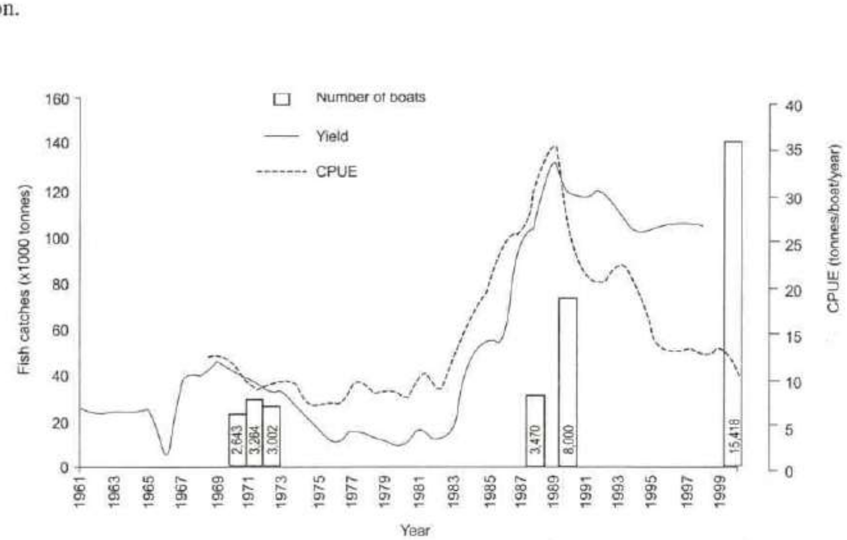


Fig 1. Estimated total number of fishing boats (the number of boats are inside the bars) and estimated total fish catches in the Uganda sector of Lake Victoria (source UFRD records); estimated catch per unit of effort (CPUE) for the whole lake 1968-2000 (source Asila., 2001).

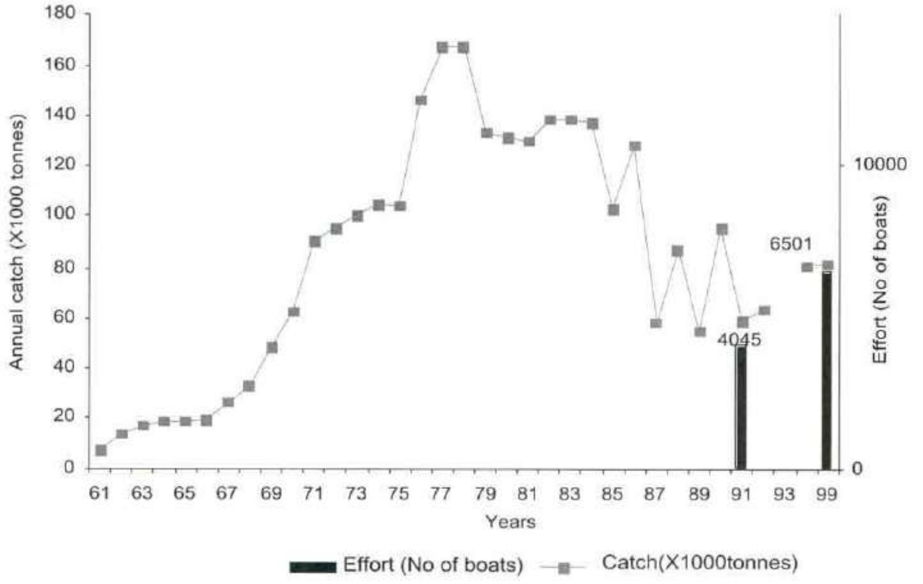


Fig.2. Estimated annual fish production in lakes Kyoga, Kwania and Bisina

Results

Effort and fish catches

The production and catch per unit of effort in Lake Victoria increased with increase in fishing effort (crafts) up to a maximum of 132,000 t corresponding to 8000 boats on Lake Victoria. Further increase in boats to 15,418 in 2000, the CPUE and estimated annual catches declined (Fig. 1). Similarly, though long-term fishing effort data on Lake Kyoga were not available, it is likely that maximum sustainable yield was during 1979 (Fig. 2) after which the catches started to decrease. Assuming the catch of 1994 of 80,200 t (FRD unpublished report) was more or less close to catch of 1997, and 1999 catch was estimated at 81,116t, increase in boats to 6501 (1997) from 4045 in 1991 slightly increased the catches due to the new mukene fishery which started in 1994.

Boat types and fishing gears

The details of types of boats, gears and gear sizes that were operating on the two lakes are shown in Tables 1 and 2. There was increased use of small mesh size nets (<127 mm) 10.9% of nets in 2000 from 5.3% in 1990 in Lake Victoria (U). In Lake Victoria the mean number of gill nets per boat between 1990 and 2000 frame urveys are shown (Fig. 3). During commercial catch lysis (2000), flat-bottomed parachutes were mainly in active fishing (82%), paddled Sesse boats in passive fishing (75%) and motorized/sailed Sesse in drift netting 95%. The major mesh sizes of nets used in parachutes were 127 mm and 101.6 mm targeting the Nile tilapia while paddled Sesse used mainly 152.4 mm, 127 mm and 101.6 mm mesh sizes targeting Nile perch. In motorized/sailed Sesse, drift nets were used in (95% of the boats and the mesh size of nets were mainly 152.4 mm and 177.8 mm targeting the Nile perch. The mean catch rates were highest (55 kg/boat/day) compared with 22 and 18 kg/boat/day in paddled Sesse and parachute boats respectively (Fig. 4), increased use of 88.9 mm and 101.6 mm mesh size of nets between 1990 and 2000 frame surveys was biased to parachute and dugout boats (Fig. 5).

In these boats, the nets of 88.9 mm increased from 1% in 1990 while the 101.6 mm nets increased from 4% in 1990 to 20% in 2000. Other increases were noted between 1990 and 2000 in 101.6 mm and 114.3 mm mesh size nets in paddled Sesse boats.

Impact of fishing gears, gear sizes and methods of fishing.

Gill nets, beach/boat seines, (and trawlnets in L. Victoria) caught mainly *L. niloticus* and *O. niloticus* while drift nets targeted Nile perch. Cast nets and basket traps targeted the tilapiines mainly Nile tilapia. Hooks caught Nile perch and lampara nets caught R. argentea (Mukene).

Table 1. Lake Victoria Frame Survey effort information for 1990 and 2000

Parameters measured	1990	2000
Total number of fish landings	**715**	**603**
Total number of fishing boats (excluding transport boats)	**8000**	**15,418**
Dugout	**2030**	**269**
Flat bottomed parachute	**5332**	
Sesse paddled	**5122**	**7551**
Sesse sail		**241**
Sesse motorized	**848**	**2002**
Others		**23**
Percentage of boats using:		
Gill nets	**82.3**	**61.5**
Beach seines	**4.8**	**4.6**
Longlines	**4.6**	**5.0**
Hook and line	**0.6**	**5.0**
Mosquito seines/lampara	**3.7**	**13.4**
Scoop nets	**2.2**	**0.7**
Traps	**1.2**	**3.4**
Cast nets	**0.7**	**6.4**
Percentage composition of gill net mesh size in use:		
<63.5mm (2.5")	**<0.01**	**0.02**
63.5mm (2.5")	**0.02**	**0.06**
76.2mm (3.0")	0.07	0.48
88.9mm (3.5")	0.10	1.66
101.6mm (4.0")	0.72	4.31
114.3mm (4.5")	4.38	4.36
127.0mm (5.0")	6.96	15.66
139.7mm (5.5")	0.23	5.58
152.4mm (6.0")	20.91	36.39
165.1 mm (6.5")	**0.10**	**3.18**
177.8 mm (7.0")	**33.0**	**21.10**
190.5mm (7.5")	**0.02**	**0.56**
203.2mm (8.0")	**31.28**	**3.28**
228.6mm (9.0")	**0.30**	**0.69**
254.0mm (10.0")	**1.86**	**2.21**
>254.0mm (10.0")	**0.05**	**0.26**

Table 2. Lake Kyoga Frame Survey effort information for 1991 and 1997

Parameters measured	1991	1997
Total number of fish landings on the lake		**266**
Total number of boats including transport		**7175**
Total fishing boats	**4045**	**6501**
Percentage boats (Dugout)	**7.5**	**3.0**
Flat bottomed	**24.9**	**52.8**
Sesse planked	**67.6**	**44.2**
Percentage of boats using:		
Gill nets	**79.7**	**65.8**
Beach seines	**12.0**	**22.7**
Hook	**5.0**	**4.6**
Mosquito seines/lampara	**0.0**	**2.7**
Basket traps	**3.2**	**4.1**
Percentage gill netting boats using mesh size of:		
50.8mm (2")		**0.9**
63.5mm (2.5")		**2.4**
76.2mm (3.0")		5.3
88.9mm (3.5")		3.7
101.6mm (4.0")		37.4
114.3mm (4.5")		28.8
127.0mm (5.0") and above		21.5
% seining boats using mesh size of bag of:		
(1.5")		***10.6***
50.8mm (2.0")		***62.0***
63.5mm (2.5")		***9.3***
76.2mm (3.0")		13.0
101.6mm (4.0")		5.1

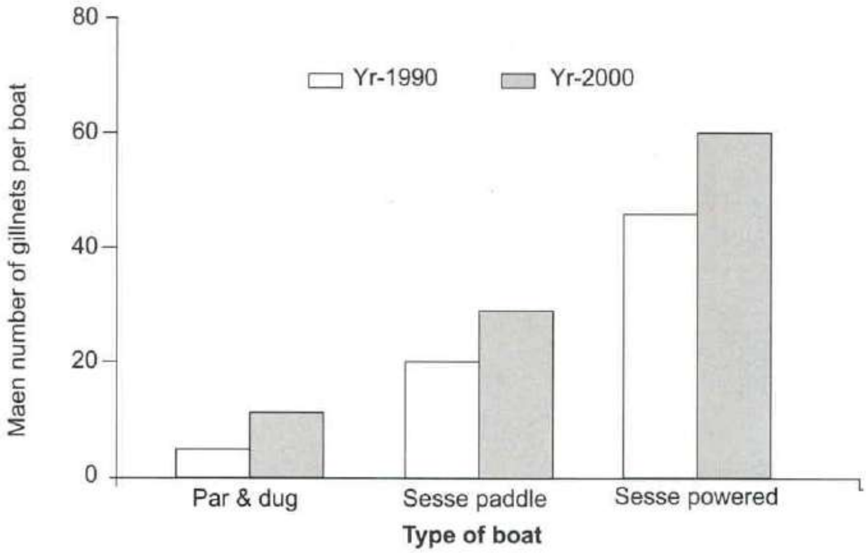
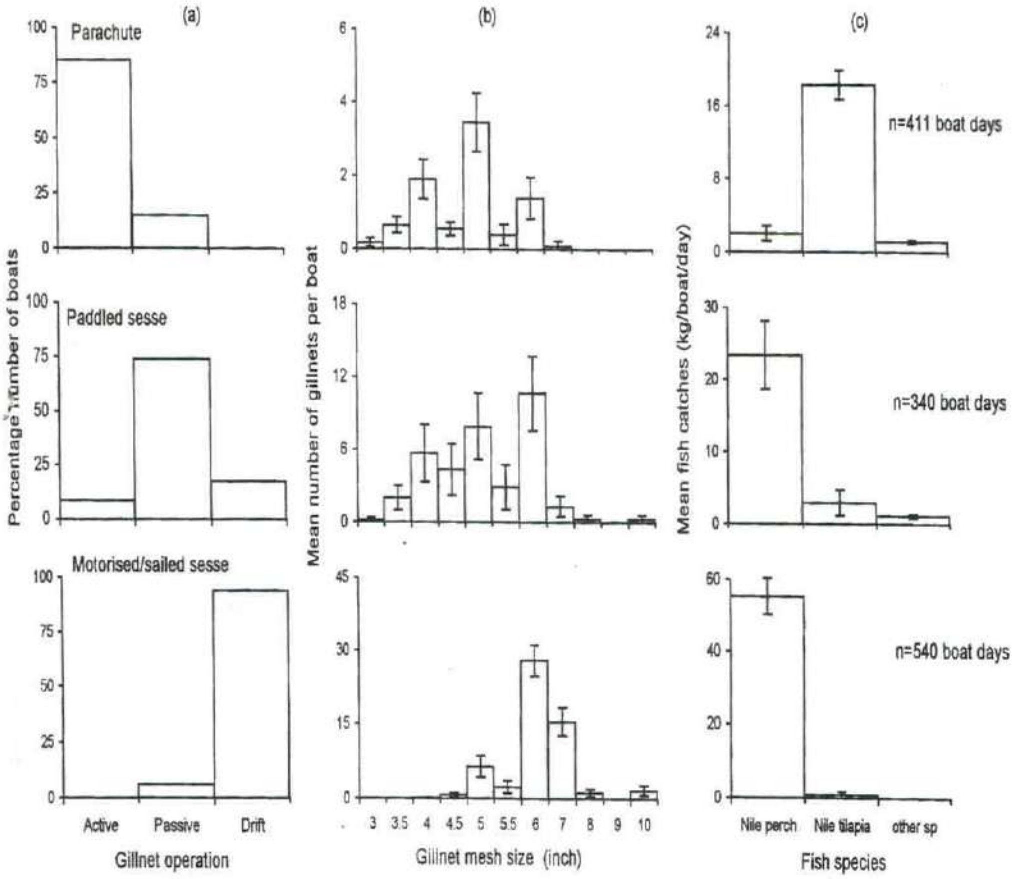


Fig.3. Mean number of gillnets per boat for three main categories of boats in 1990 and 2000



. 4. (a) Percentage number of boats in which gill nets are operated actively, passively or as drift (b) Mean number of gill nets per boat and (c) fish catch rates in flat bottom (parachute) boats, lled sesse boats and motorized/sailed boats in the Uganda part of Lake Victoria (Error bars = 95%

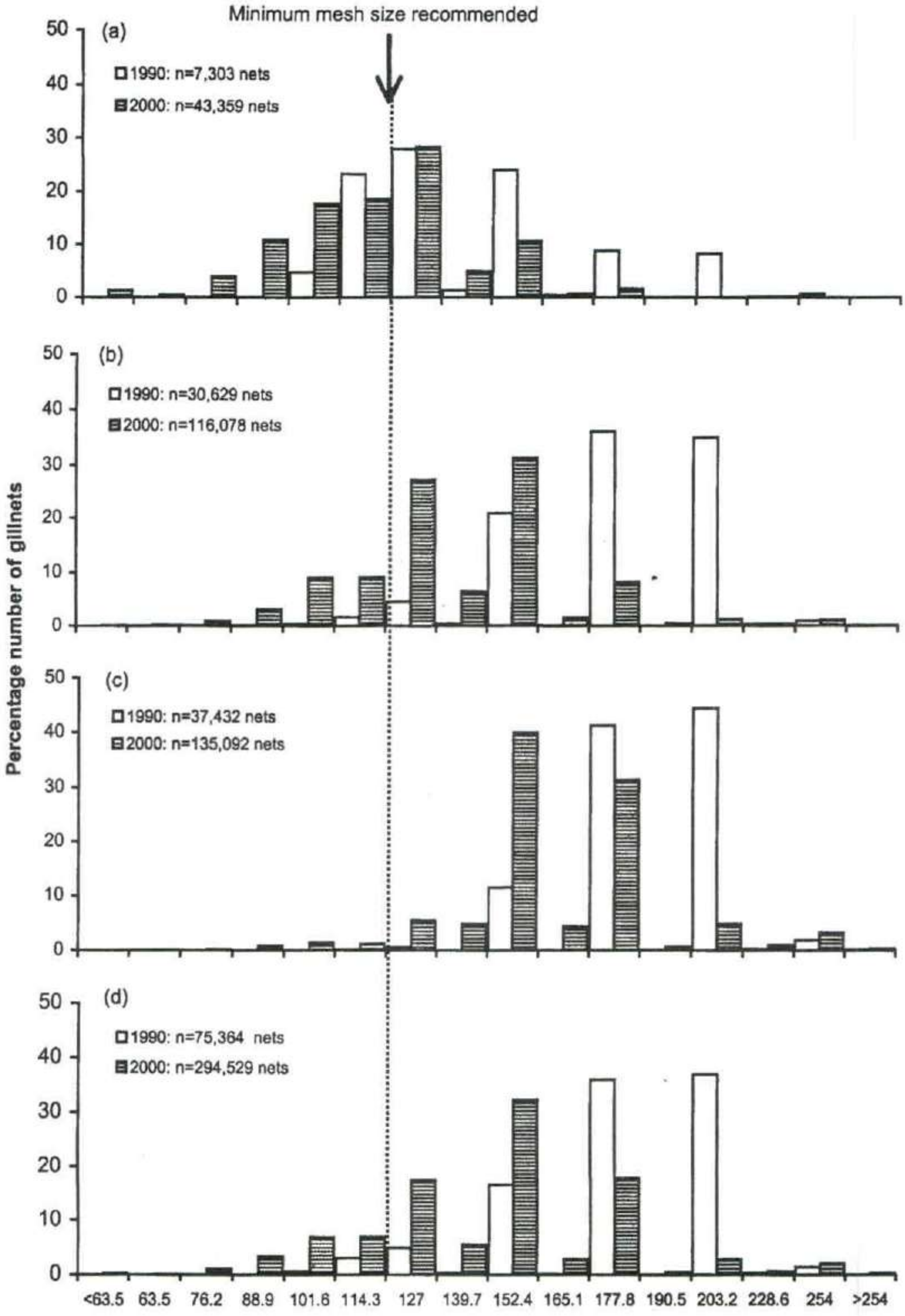


Fig. 5. Mesh size composition of gill nets used in the Uganda sector of L. Victoria by (a) parachute and dugout boats (b) paddled sesse boats (c) motorized and sailed boats and (d) overall, in 1990 and 2000.

Selectivity characteristics of gears and gear sizes

Beach seines

All mesh sizes of bags in experimental trials caught over 95% immature Nile perch on Lake Victoria. A similar situation would apply to Lake Kyoga.

Trawl codends:

Trawling could only be carried out in deep waters in Lake Victoria but not on shallow (average depth 3m) Lake Kyoga. The Nile perch caught by codends of less than 127mm mesh size were over 95% immature (less than 50 cm TL in males) while the Nile tilapia in the 127mm and above were mature though juveniles were caught in the smaller condends.

Gill nets

Gill nets are fished passively and actively on both lakes. In passive gill netting the nets target both the Nile perch and Nile tilapia while in active fishing (tycoon) the nets target Nile tilapia and in drift nets (Lake Victoria) Nile perch is the target species in open waters.

The Nile tilapia caught in mesh sizes of 114.3mm and above were over 80% above size at first maturity (24 cm TL) but in active fishing, the 101.6mm and below were over 65% immature fish while the Nile perch (males) caught in the mesh of 152mm were over 95% above size at first maturity and in the minimum of 127mm were about 15% above size at first maturity. This minimum mesh however, would crop immature females Nile perch whose size at first maturity is about 88cm TL on Lake Victoria and about 85cm TL on Lake Kyoga

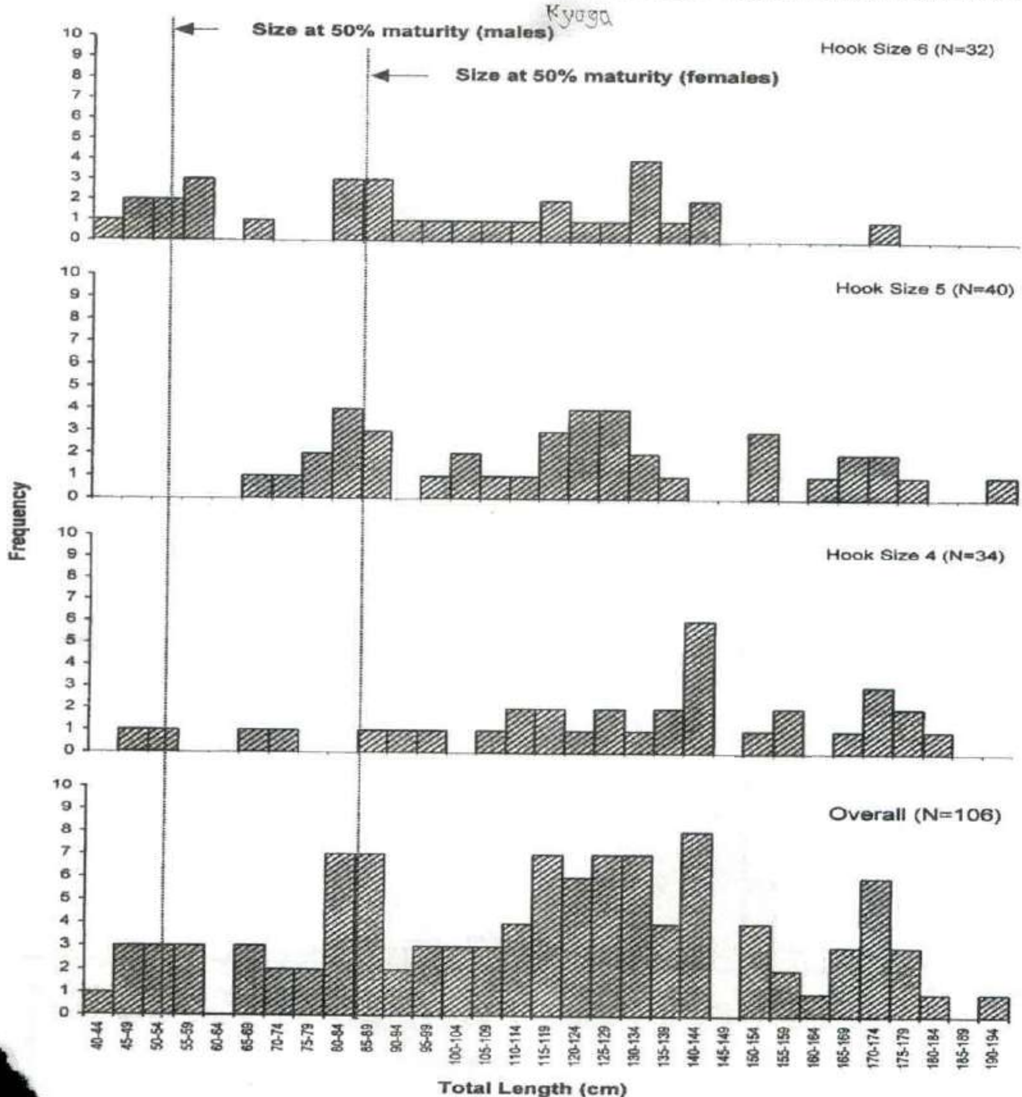


Fig. 6. Length frequency distribution of *Lates niloticus* from hook fishery on Lake Kyoga

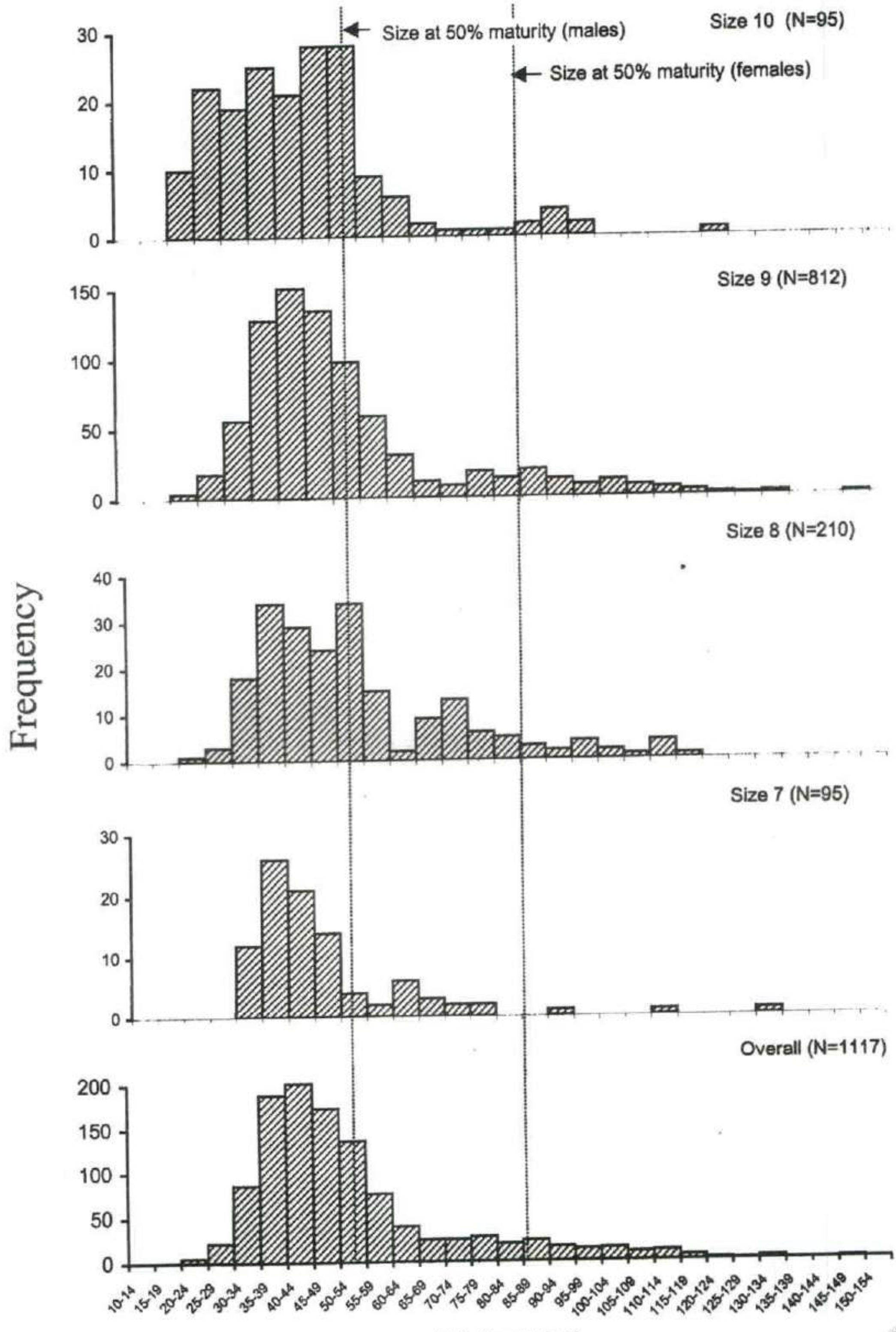


Fig. 7. Length frequency distribution of *Lates niloticus* from hook fishery on lake Victoria (Uganda)

Hooks

The selectivity characteristics of hooks is not very clear, but large size hooks (Fig. 6) on Lake Kyoga caught mainly mature Nile perch but on Lake Victoria (Fig. 7) the majority were immature.

Cast nets and basket traps

These gears target the Nile tilapia. The fish caught in experimental single mesh size cast nets of less than 101.6mm were over 65% below size at first maturity and in various internal diameters of basket traps were over 70% below size at first maturity. The Nile tilapia in the 101.6mm mesh cast nets and above were mature.

A summary of the size characteristics of the commercial catches from the major fishing gears (beach seines, active gill nets, passive gill nets, drift nets, traps, hooks) targeting the Nile tilapia and Nile perch in commercial fishery on Lake Victoria are shown in Figs. 8 and 9 respectively. The most destructive gears in commercial fishery were as noted in experimental surveys. These were beach seines, traps, active fishing and passive gill nets where small mesh size of nets below 127mm were in use. Drift nets harvested over 50% mature male Nile perch.

Lampara nets

The nets target *R. argentea* (commercial) in shallow waters or bays during dark nights. The 10mm mesh caught mainly mature fish while the 5mm mesh caught about 40% below size at first maturity in Napoleon Gulf of Lake Victoria (Fig. 10). In commercial catches on Lake Victoria, about 50% of the fish were below size at first maturity (Fig. 11). On Lake Kyoga at Bukungu fish landing site during 2000, over 98% of mukene caught using 3mm mesh lampara nets were mature (35mm SL) Fig. 12.

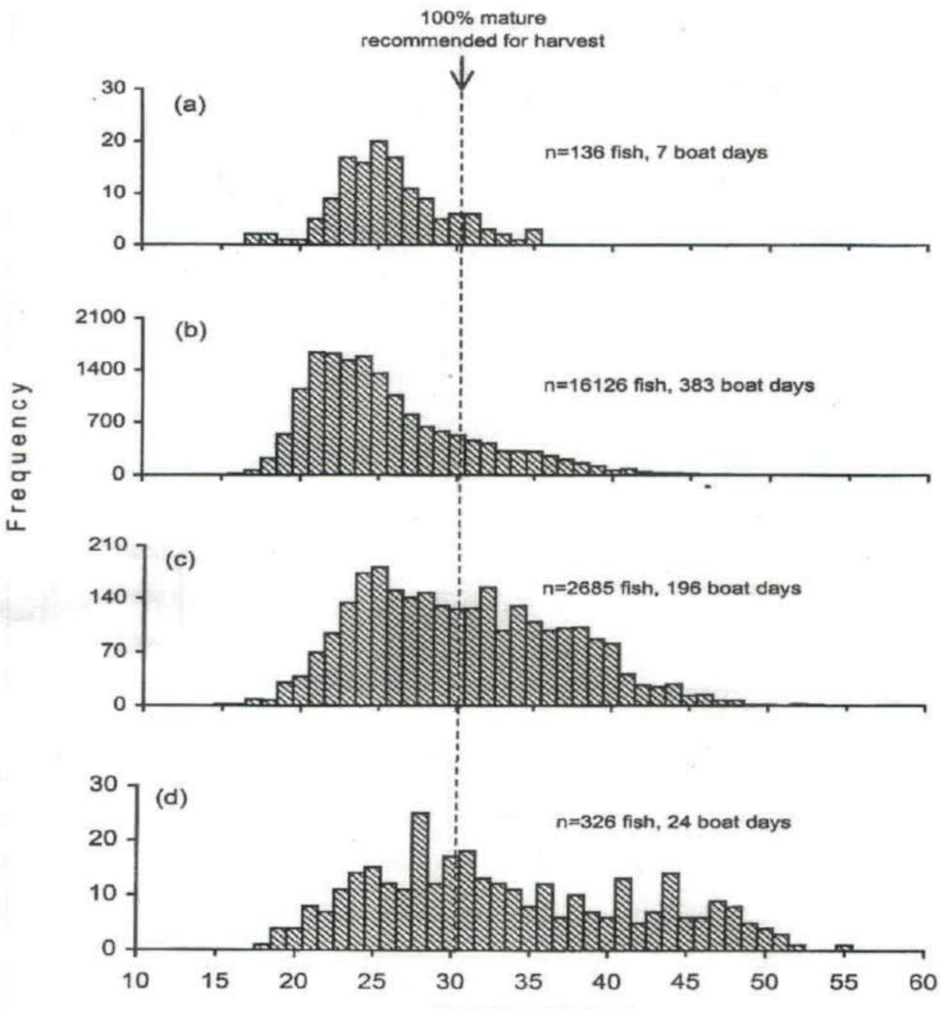


Fig. 8. Length frequency of Nile tilapia caught in the four major fishing gears / methods that target Nile tilapia in L. Victoria; (a) basket traps (b) active gill nets (c) passive gill nets and (d) cast nets

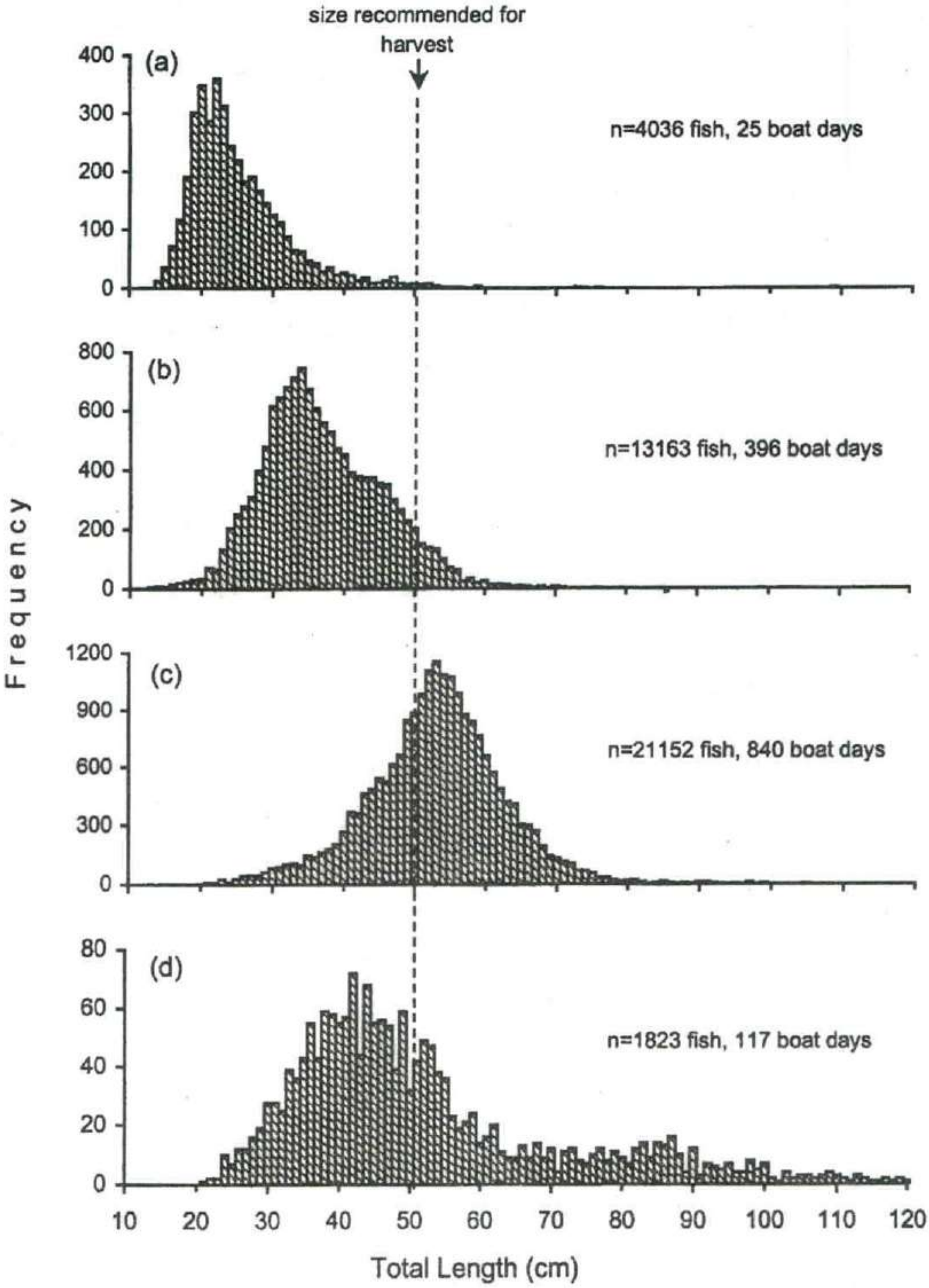


Fig. 9. Length frequency of Nile perch caught in the four major fishing gears / methods that target Nile perch in L. Victoria; (a) Beach seines (b) Stationery/passive gill nets (c) drift gillnets and (d) hooks on longlines or handlines.

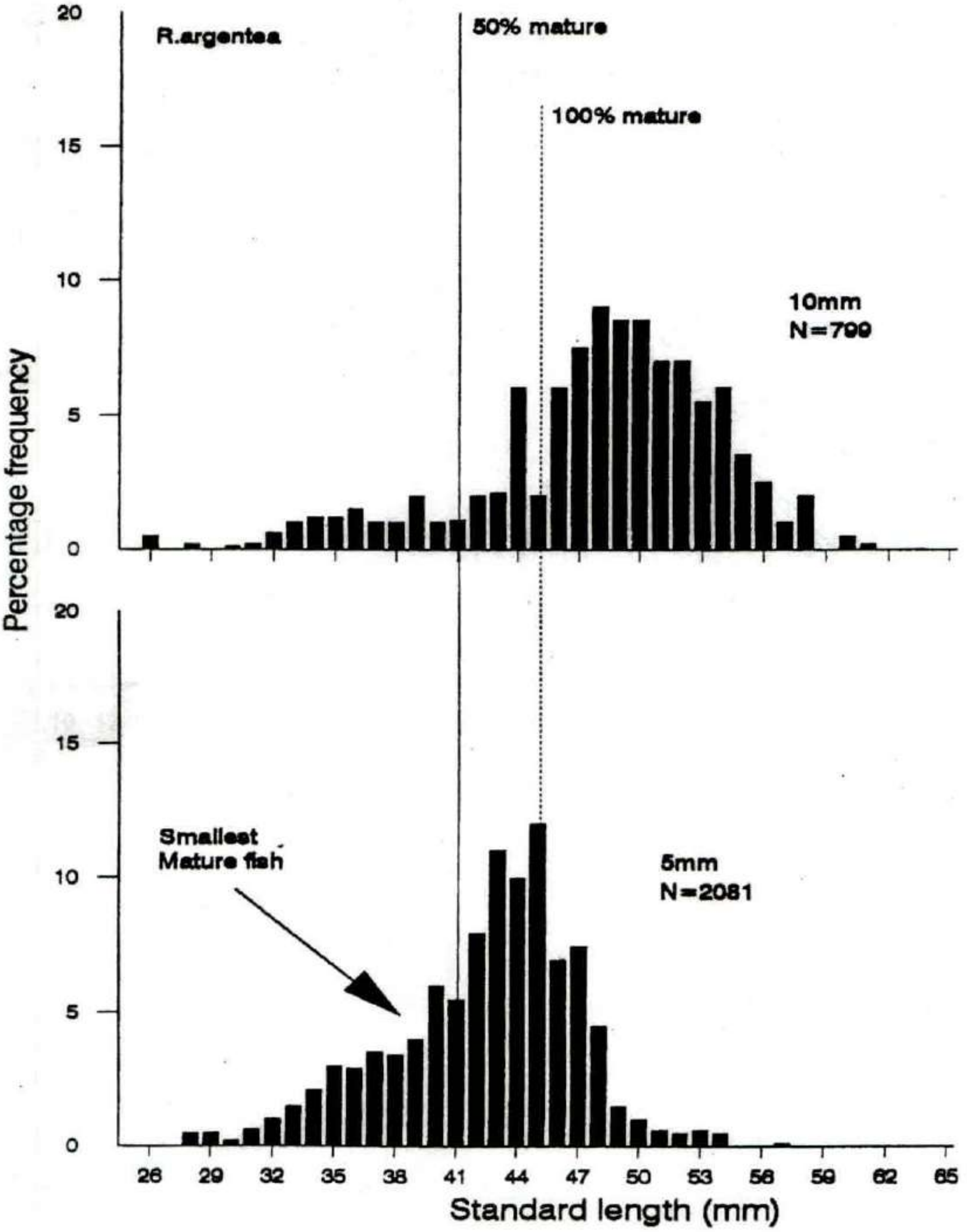


Fig. 10. Length frequency distribution of *Rastrineobola argentea* retained by the 10mm and 5mm Lampara net operated inshore on Lake Victoria.

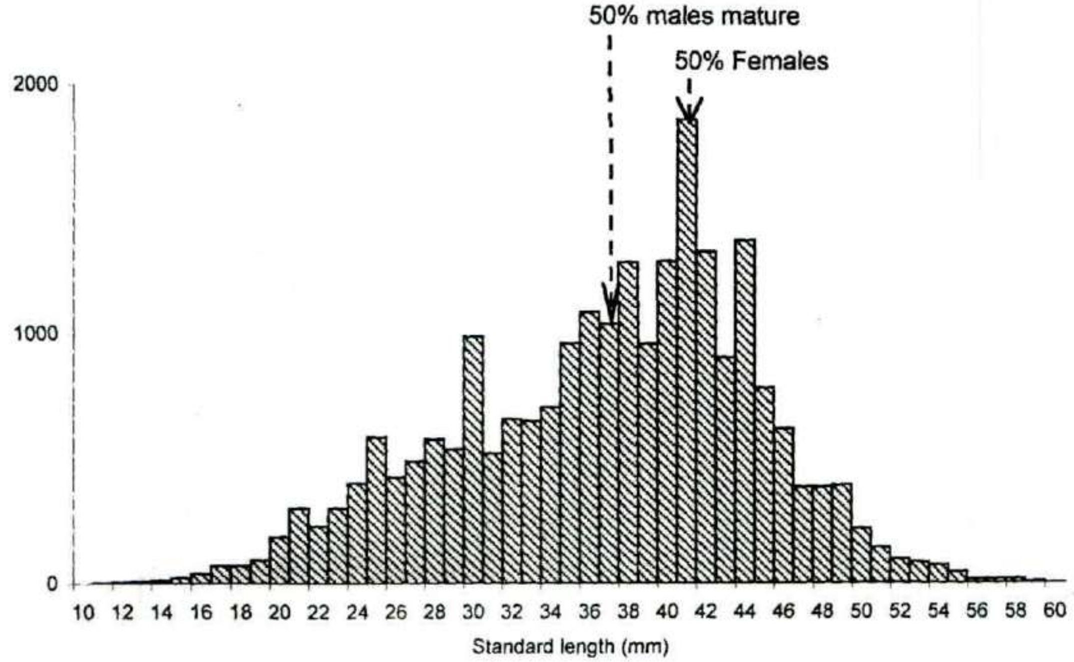


Fig. 11. Length frequency distribution of *Rastrineobola argentea* from commercial catches in the Uganda sector of Lake Victoria (2000).

Discussion

The commercial fisheries of lakes Victoria and Kyoga are similar, composed of the Nile perch, Nile tilapia and mukene as the dominant commercial fish species. The mukene fishery on Lake Kyoga however, is recent (from 1994) and matures at a smaller size (35mm SL) compared with Lake Victoria (45mm SL) and is exploited using 3mm mesh lampara nets while 5mm nets are being used on Lake Victoria. The mukene fishery on Lake Kyoga started probably to increase the catches that had declined to 63,000 t in 1992. Exploitation of the species led to increase in catches to 80,200 t by 1994. Juvenile mukene was landed on Lake Victoria especially when the fishing activity was carried out in inshore sheltered bays and during periods when the new corhots were joining the fishery (April to May, September and October) (Ogutu-Ohwayo *et al* 1998). Trawl and beach/boat seines during operation disrupt courtship of fish in breeding grounds, destroy benthic organisms' habitats which in turn affects important food of fish. Boat/beach seines are not selective and take large tolls of juvenile fish. Trawling also destroys fishers' nets in artisanal fishing areas.

Small mesh size gill nets and active fishing harvest large proportion of immature fish. The 127mm mesh harvest mature Nile tilapia but at the same time crops a high proportion of immature Nile perch which co-exists with the Nile tilapia. To protect enough spawners in the Nile tilapia populations therefore, it is logical to set the gill net mesh size of nets at 100% maturity (28 – 29cm TL) which would require a minimum of 127mm mesh size of nets to protect the spawners.

At the same time, the fishing pressure on Nile tilapia is high while fecundity is low for example 2000 – 4000 eggs for fish from Lake Victoria (Balirwa, 1998). However, this 127 mm cropped a lot of immature Nile perch. Considering that Nile perch above 50cm TL feeds on other commercially important species (Nile tilapia, Mukene, and its own young) (Ogutu-Ohwayo, 1985), fishing out the predatory size of Nile perch would be beneficial to the prey. In addition, the Nile perch produces millions of eggs at each breeding (Ogutu-Ohwayo, 1988) and fish size below 50cm TL feeds on invertebrates which are converted into consumable commodity fish. Therefore, harvesting Nile perch using 127mm mesh size of nets reduces predation pressure on other important fish with little decrease in Nile perch

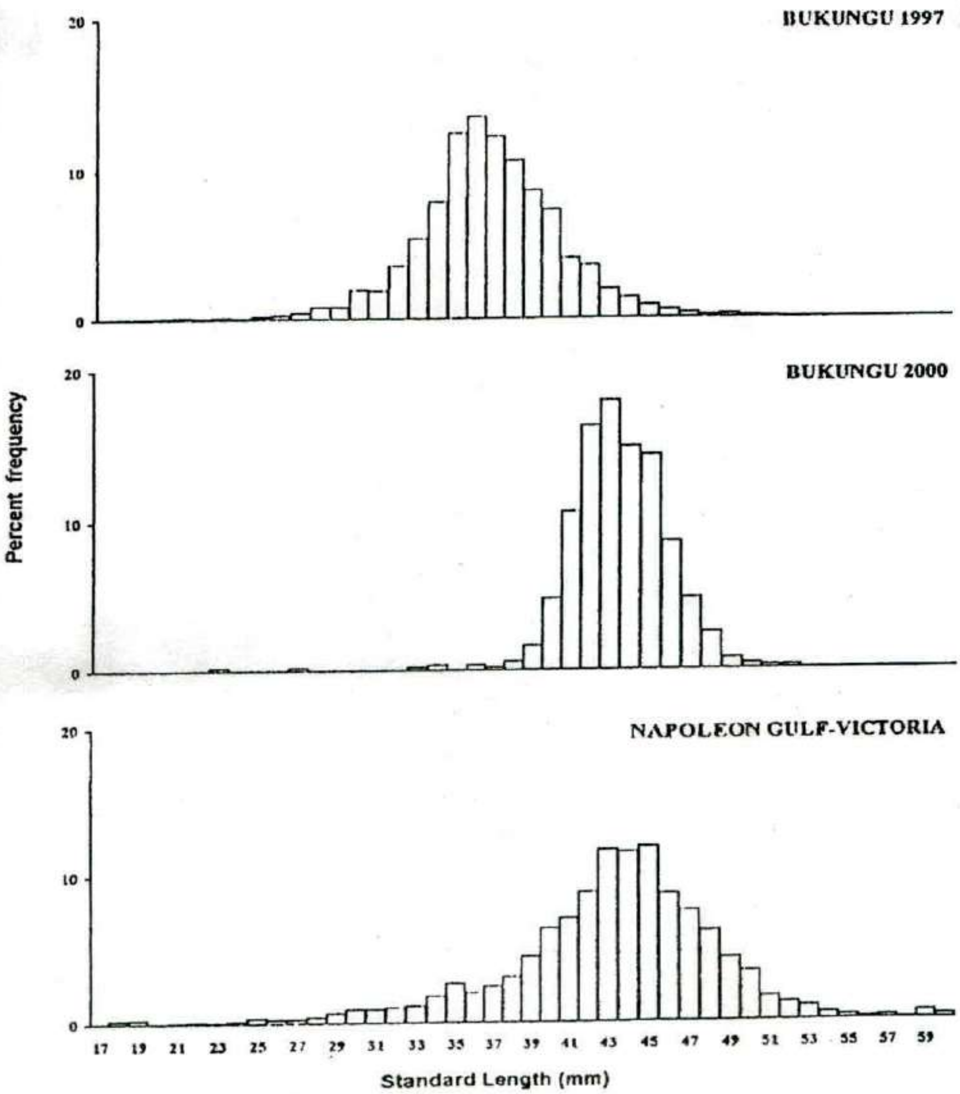


Fig. 12. Length frequency distribution of *R. argentea* in Lake Kyoga (Bukungu) 1997 and July 2000 and Napoleon Gulf of Lake Victoria.

yield. The 50cm TL of Nile perch to be harvested coincides with the mesh size limit (127mm) suggested for Nile tilapia. Cast nets, basket traps and active (tycoon) fishing is done in shallow waters which are breeding and nursery grounds of most fish such as Nile tilapia. Active fishing (gill nets, cast nets) in these areas disrupts courtship in fish, catches breeding individuals and will also force the mouth brooder fish to spit the young thus reducing recruitment. Similarly, basket traps disrupt breeding and nursery grounds of fish and take large tolls of juvenile fish. Drift netting is recent and is operated in open waters targeting the Nile perch on Lake Victoria. This is a popular fishing method providing fresh fish which is on high demand among the industrial fish processors. However, the fishing method needs further investigation. Selectivity in hook fishing was not clear. It is likely that some other factors like nature of bait or fishing grounds affect the size of fish caught.

Conclusion

Unregulated destructive fishing gears, gear sizes, fishing practices and open access policy to the fisheries leading to increased fishing effort (crafts and gear numbers) are, among other factors leading to decline in fish yield. Proper fishery management put in place will ensure increased and sustainable fish production for poverty reduction in present and future generations of fishers and fishery related communities in Uganda.

Recommendations

- Open access to the fishery for both fishing crafts and gears should be reviewed to limit entry. Boats on Lake Victoria (U) should be reduced to e.g. 8000 and to a figure less than 6000 boats on Lake Kyoga.
- The minimum gill net mesh size regulation (127mm) should be enforced and the nets fished passively or as drift nets offshore (20m deep).
- Minimum size of *Oreochromis niloticus and Lates* niloticus should be 28cm TL and 50cm TL respectively on both lakes.
- Mesh size of mukene nets should not be allowed to drop below 5mm and fishing should be offshore and not in bays. The prohibited fishing grounds should be mapped.
- Active gill net fishing (tycoon), traps, beach/boat seines should be abolished. Trawling is already prohibited on Lake Victoria. If cast netting was to be carried out, it should be in open waters (>20m deep). However, catches are very low and it is difficult to enforce. It should therefore be prohibited.
- Drift net fishing though active in nature, should be investigated further but should presently be encouraged

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