MANAGEMENT STRATEGIES FOR EXPLOITATION OF UGANDA FISHERIES RESOURCES

by

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Management of Uganda Fishery Resources.

ABSTRACT

Fisheries legislation in Uganda has not been feasibly applicable to all Uganda water bodies and species therein. Failure to make appropriate legislation to regulate fishing gears and methods has led to the decline or near collapse of some fisheries. Most fisheries have been damaged by destructive fishing gears and methods. Selectivity characteristics of several gears and fishing methods were therefore examined for different commercially important fish species in major and minor lakes and recommendations made on suitable types of gears, gear sizes and fishing methods for exploitation of the fisheries resource.

INTRODUCTION

Uganda has an area of 241,038 Km^2 and up to 18% of this is covered by lakes and rivers. The country therefore has the potential of producing large quantities of fish and capable for increased fish production if the resources are properly managed. The main lakes include:- Lake Victoria 68,000 km^2 shared between Uganda (43%), Tanzania (51%) and Kenya (6%); Albert 5,500 km^2 shared between Uganda (54%) and Zaire (46%). Edward 2300 km^2 similarly shared with Zaire (71%) and Uganda (29%). Lake Kyoga 2,700 km^2, L. George 250 km^2, Kazinga Channel, and the River Nile. There are also progressively smaller lakes scattered all over Uganda especially in south western and eastern Uganda numbering up to about 160.

The country's fishery resources have been under several strains which have a great impact on fish stocks and ultimately fish production. These include among others; the introduced Water Hyacinth (*Eichornia crassipes*) and *Lates niloticus*, destruction of wetlands and river margins, water pollution, excessive fishing effort and the use of destructive fishing gears and methods. The paper concentrates only on fishing effort, gears and fishing methods. Collapse and or decline of most fisheries has been caused by non-selective fishing, excessive use of destructive fishing gears and methods, increased effort due to open assess policy to some lake fisheries, poachers and fish introduction (Jackson 1979, Garrod 1961, Cadwalladr 1969, Gwahaba 1973, Ogutu-Ohwayo 1990, Ogutu et al 1995, Sentongo 1992).

Each of the water system in Uganda has its own characteristic major fishery/fisheries. Exploitation is therefore based on multispecies fisheries. Since different species mature at different sizes due to differences in biological processes of growth and natural mortality, different types of fishing gears and methods are needed to effectively exploit the resources. Therefore the present Uganda "**Fish and Crocodile Act**" which is the major tool for management of the country's fisheries may not be applicable to the entire country's water bodies. The Act prohibits use of gill net mesh sizes less than 127 mm (5") stretched mesh and yet there are some species of commercial importance which have to be cropped using mesh sizes below 127 mm.

Different gears in use have been developed over a long period and range from simple traps and perforated basins to highly and sofiscated mechanised trawling. Common to all these gears in use is the fact that they are not highly specific for target species in a multi-species fishery. Certain gears and gear sizes target particular age groups or length classes while others target particular species or all species and age groups. So, most of the fishery resources are exploited indiscriminately due to lack of appropriate fishing technology and education.

The socio-economic implications of fishing communities constantly introducing or adjusting the fishing technology complicates the way fishery management regulations can be enforced.

The recent mushrooming fish processing plants on Lake Victoria with raw materials exclusively derived from artisanal fisherfolk, the high demand for artisanal processed fish by neighbouring countries and local population coupled with production of animal feeds, have led to increase in fishing effort and encouraged the fisherfolk to increase fishing activities and also to exploit the small and immature fish to satisfy the increasing demand. The basis of a thriving fishing industry must aim at a well regulated process of exploitation for increased and sustainable fish production. The purpose of the paper therefore is to recommend the appropriate fishing technology pertaining to particular water body/bodies or species therein. This will enable policy makers design proper regulatory laws acceptable to the fishing communities and adjust or improve on the present fisheries management legislations.

Methodology

The work was started in January 1992 and ended in December 1995. Experimental fishing using various gears and fishing methods was conducted only on Lake Victoria. Selectivity characteristics of gillnets, seine nets, cast nets, traps, hooks and trawl codends were determined. Gillnets ranging from 63.5 mm to 127.0 mm were fished both passively and actively but mesh sizes greater than 127 mm had few samples for meaningful analysis. Lampara nets of 5 mm and 10 mm mesh sizes were used to catch *Rastrineobola argentea* (Mukene). Beach seines of 15 mm, 50.8 mm and 63.5mm mesh sizes of bags were used to catch fish especially *Lates niloticus* (Nile perch). The trawl codends examined were of 25.4 mm, 50mm, 75mm, 101.6 mm, 127mm and 144mm stretched mesh and trawling was conducted on M.V. IBIS and MV MPUTA mainly in Napoleon Gulf and surrounding areas. Gillnets and trawlnets data were used to examine mesh size selectivity of *L.niloticus* and *Oreochromis niloticus* (Nile tilapia) as the two species were the ones mainly caught. Single mesh size cast nets of mesh sizes 76.2 mm, 88.9 mm 101.6 mm, 114.3 mm and 127.0 mm were fished to examine mesh size selectivity on *O.niloticus*. Basket traps of varying internal diameter openings ranging from 15.0 cm to 22.0 cm were used to crop the tilapiines. These were set in papyrus fringes along the shore line. Hooks of No. 12 to No. 4 using live or dead bait were used to catch the *L. niloticus*.

Supplementary information was gathered from raw data obtained previously on Lakes Victoria, Kyoga and Nabugabo. Selectivity characteristics of gears, gear sizes and fishing methods above were carried out on the other water bodies where applicable by examining the fishermen's catches for different gears, gear-sizes and fishing methods. The other water bodies were; Lakes Kyoga, Albert, Edward, George and Kazinga Channel. Representatives of Minor lakes sampled were: Lakes Wamala, Kijanebalola, Kachera, Mburo, Nyabihoko, Kibwera, Rwijongo, Mafuro and Nabugabo.

In all aspects fish species composition in each gear, gear size and fishing method were recorded. Total, fork or standard lengths of fish were measured depending on the type of species encountered. Sex and maturity state were determined and size at first maturity estimated for the major commercial fish species from different water bodies.

Length frequency distributions of major fish species caught in different types of gears, gear sizes and methods of fishing were analyzed and related to known size at first maturity and other ecological and biological aspects of the species.

Results and discussion

Size at first maturity:

In fisheries management, the size limit of fish that should be caught is set at the size at first maturity i.e. the size at which 50% of the fish are mature (Beverton and Holt, 1957). The logic behind is that it allows 50% of the individuals to breed before they are caught. The size at first maturity differs from species to species, in many instances differs from males to females or from fish of the same species in different geographical zones or habitats. Table 1 show the size at first maturity for major commercial fish species in different major and minor water bodies of Uganda.

Lakes Victoria, Kyoga and Nabugabo

The three lakes have similar major commercial fisheries namely *L.niloticus*, *O.niloticus* and *R.argentea* although the *R.argentea* in Lake Nabugabo is presently unexploited. In addition, *Schilbe* on Lake Nabugabo is exploited in rainy seasons only. The size at first maturity for the *O.niloticus* in Lakes Victoria and Kyoga is around 23 - 24 cm total length for males and 25 cm total length for females, at 28 - 29 cm all fish are mature. The sizes at first maturity for *L.niloticus* is around 52 cm TL for males and 85 - 88 cm for females. All males are mature by 63 - 65cm and females around 102 - 110cm. In Lake Nabugabo the situation is closely related to that of Lakes Victoria and Kyoga. The size at first maturity for Mukene is around 41 - 42 mm standard length for both sexes and by 45 mm all fish are mature on Lake Victoria. The situation on Lake Kyoga is slightly different from that on Lake Victoria (Table 1).

The impact of different gears, gear sizes and fishing methods

Impact of trawlnets and beach/boatseines:

Trawling is carried out only on Lake Victoria on experimental basis by the Sino-Uganda Fisheries Venture Company Ltd using pair trawlers in artisanal fishing grounds while beach and boat-seining are rampant on both Lakes Victoria and Kyoga. Seines and trawl-nets are operated as dragged gears. The dragging of these gears on the lake bottom especially near the lake margins where tilapiines breed, disrupts courtship on breeding grounds of fish. These gears are also not selective. They catch smaller fish than would normally be retained due to blocking of the meshes by larger fish.

Dragging of the gears at the lake bottom also destroys benthos organisms' habitats which ultimately affects important food of fishes. Trawling in artisanal zones (less than 20 m deep) also destroys fishermen's nets.

Length frequency distribution of *L.niloticus* caught by different mesh size beach seines on

Lake Victoria is shown in Figure 1. Over 95% of the fish cropped were below the minimum size for capture.

The length frequency distribution of *L.niloticus* and *O.niloticus* caught in trawlnets of different codend mesh sizes are illustrated in Figure 2. Codend mesh sizes less than 127 mm (5") caught large proportions of immature *L.niloticus* and *O.niloticus*. If trawling was to be permitted on Lake Victoria the minimum codend mesh size should be 127 mm and operated away from artisanal zones. However, the catch rates beyond 40 m depth are uneconomical (Okaronon 1995).

<u>The Impact of the gill nets</u>

Gill nets are the most popular fishing gears used in exploiting *L.niloticus*, *O.niloticus* and in addition *Schilbe* on Lake Nabugabo. Both passive and active fishing methods are in use. The length frequency distributions of *O.niloticus* and *L.nilotucus* caught in gill nets of 63.5 mm (2.5") to 152.0 (6") fished passively are illustrated in Figure 3 and Figure 4 for Lake Victoria. Similar trends were observed for Lakes Kyoga and Nabugabo. The size distribution in each mesh size followed a normal distribution. This had been observed earlier (Ogutu et al 1995). Gill nets of less than 114.3 (4.5") mm catch large numbers of immature *O.niloticus*. Therefore the minimum gill net mesh size limit in respect to *O.niloticus* should in theory be 114.3mm. The minimum mesh size suggested for *O.niloticus* would however, crop a lot of immature *L.niloticus* (see Figure 4).

It is also known that the fishing pressure especially on *O.niloticus* on the three lakes is very high while fecundity of the species is very low. It is therefore fair to set the gill net mesh size limit for *O.niloticus* at 100% maturity to conserve enough spawners in the population. In these lakes 100% maturity in *O.niloticus* is around 28 - 29 cm TL which would require a minimum gill net mesh size of 127 mm (5") (Figure 3). Therefore, the minimum mesh size limit in respect to *O.niloticus* should be set at 127 mm.

The minimum size suggested above for *O.niloticus* would crop a lot of immature *L.niloticus* (Figure 4). However, biological and ecological considerations justify setting the minimum mesh at 127 mm. *L.niloticus* is a predator which at the size above 50 cm TL feeds on other commercially important species such as Mukene, its own juvenile and *O.niloticus* (Ogutu-Ohwayo 1985). Increase of fishing pressure on *L.niloticus* of this size range which feeds on other commercially important fish species would be beneficial to the fishery. Furthermore, *L.niloticus* has a high reproductive potential. Females produce millions of eggs at each breeding (Ogutu-Ohwayo 1988). The species up to 50 cm TL feeds predominantly on invertebrates, especially, the prawns and dragonfly nymphs. This is a beneficial role because the invertebrates are converted into consumable commodity fish.

Cropping *L.niloticus* using 127 mm mesh size gill nets would therefore reduce predation pressure on other important fishes with little decrease in *L.niloticus* yield. The size range of 50 cm for *L.niloticus* (Figure 4) coincides with the mesh size limit suggested for *O.niloticus*. Therefore the minimum size of *L.niloticus* permitted to be landed should be 50 cm TL.

Active fishing (tycoon)

The fishing method targets mainly the tilapiines in shallow waters close to the lakes' margins. These areas are breeding and nursery grounds especially for the tilapiines. The fish caught are of smaller sizes for the same mesh size fished passively although the fish caught in 114.3 mm mesh size gill nets and above have a high proportion of mature fish close to that in passive gill net fishing but the fish sizes are a little bit smaller. The length frequency distributions of *O.niloticus* from various gill net mesh sizes fished actively on Lake Victoria and Lake Kyoga are shown in Figure 5 and Figure 6 respectively. Active fishing is very common for several Socio-economics reasons. (Kamanyi, 1996)

However, this method of fishing increases the fishing pressure as gillnets are fished several times to increase catch per unit of effort, interferes with nursery and breeding grounds of fish, the method scares the tilapiines and leads to ejecting of the brood in mouth brooder fish. Therefore active fishing should be abolished.

The Impact of Lampara and Scoop nets

R. argentea (mukene) is predominantly fished on Lake Victoria, the fishery has recently been exploited on Lake Kyoga and it is un-exploited on Lake Nabugabo. Mukene on Lake Victoria was initially exploited using a 10 mm mesh size seine net. A 5 mm mesh seine operated either as a Lampara net or scoop net offshore was introduced around 1989. This mesh size and fishing methods are currently in wide use on Lakes Victoria and Kyoga.

While the 10 mm Lampara or scoop nets cropped mostly mature individuals, the 5 mm net captured a large proportion of immature Mukene especially during April - May and September when new cohorts are recruited into the fishery (Wandera, 1992). Length frequency distribution of *R. argentea* retained by the 10 mm mesh and 5 mm mesh Lampara net are shown in Figure 7. The 10 mm mesh captured about 85% of mature Mukene and the 5 mm mesh 52%. During the period of recruitment, in the 5 mm mesh size net, the percentage of the mature fish dropped considerably.

The Lampara net operated offshore captures mainly Mukene with negligible quantities of Juvenile *L.niloticus* and *O.niloticus*. In the 5 mm Lampara net operated inshore about 5% was made up of juvenile *L.niloticus* and *O.niloticus* as a by catch. Fishing for Mukene should therefore be done using Lampara or scoop nets operated offshore. The minimum mesh size limit for Mukene nets should have been 10mm but since virtually all fishermen have already shifted to 5 mm nets the minimum mesh size for Mukene should not be allowed to drop below 5 mm pending further investigations. Prohibiting use of 5 mm mesh without providing a suitable substitute may have socio-economic consequences in the fishing communities.

The Impact of Hooks

Hooks are mainly targeted at *L.niloticus* and *Protopterus* spp. The gear is not very popular but the fish caught by hooks has better market especially among industrial fish processors, as the catch is always fresh. Live bait however, is normally needed to catch the *L.niloticus*. The percentage maturity of *L.niloticus* from different hook sizes is shown in Table 2. Though not much data on hook selectivity characteristics was available, the hooks impact on the fishery is negligible although live bait is collected using mosquito seines, and small mesh size gillnets which are destructive to the fish stocks.

Impact of castnets

The mixed and single mesh size castnets are popular on these lakes and mesh sizes range from mainly 76.2 mm (3") to 127 mm (5"). The castnets target the tilapiines by entanglement and are mainly operated in shallow inshore waters. Cast nets of less than 101.6 mm (4") caught high proportions of immature fish (Figure 8). Operation of castnets in shallow inshore waters interferes with breeding and nursery grounds of fish. Use of cast nets therefore is detrimental to the fisheries.

Impact of basket and fixed fencing traps

The traps are used in vegetation areas along the lake margins and target tilapias. These are also areas inhabited by juveniles of most fish species. Besides interfering with breeding and nursery grounds of fish, traps take large tolls of juvenile tilapias (Figure 9).

Lake Albert

Lake Albert so far is the only lake in Uganda with multispecies fishery. It has a good number of endemic species being exploited by various gears, gear sizes and fishing methods. The commercial fish species vary from the small *Alestes nurse* (Mungala) to the huge *L.niloticus* and this range of fish sizes pauses problems in resource exploitation as it complicates the task of selecting the gear and optimum gear size to exploit the multi-species fisheries. However, there is need to have guidelines to enable maximum utilization of the resource at a sustainable level.

Decline of some of the major fisheries on the lake are due to indiscriminate use of certain gears especially the beach seine. The major commercial fisheries of the Lake include *Hydrocynus* spp (Ngasia) *Lates* spp (Mputa), *Alestes* spp (Ngara), *O.niloticus* (Ngege), *Bagrus* spp (Semutundu/Lanya) and *Barbus* spp (Kisinja). The major gears are gillnets of various mesh sizes, beach seines, hooks, castnets, traps and of recent, perforated basins.

The size at first maturity has been determined for some of the major commercial fish species as follows:- *Hydrocynus forskalii* 18.5 cm fork length, *L.niloticus* 50cm TL for males and 85 cm TL for females, *Alestes baramose* 24 cm FL, *O.niloticus* 25 cm TL and *Bagrus bayad* 41 cm FL. (Table 1).

Impact of beach seines

Due to the configuration of Lake Albert, boat seining is not popular instead fishermen do beach seining and crop almost all types of species and sizes of fish in the area of operation.

The gear is further more encouraged by the ready market for processed juvenile fish. Besides, beach seines as already mentioned for Lakes Victoria and Kyoga are operated as dragged gear at the lake bottom near the shoreline. This destroys the breeding and nursery grounds of fish. To achieve increased and sustainable fish production, use of seines should be prohibited to allow successful recruitment.

Impact of the gillnets

Gillnets are the main fishing gears on the lake and generally fished passively as the lake is very deep with steep escarpments. Mesh sizes of 63.5 mm (2.5") to 88.9mm (3.5") target *Hydrocynus* and *Alestes* spp. However, mesh sizes of 63.5 mm and below crop a high proportion of *A. baramose* (Figure 10). Therefore, since the two species are fished together, to protect *A. baramose*, the mesh size limit should not be below 76.2 mm and strictly in the areas where the two species are very dominant. The large gillnet mesh sizes of 101.6 mm (4") and above target *L.niloticus, O.niloticus, Bagrus* spp, *Auchenoglanis*, *Clarias* and *Protopterus* spp. However, use of 114.3 mm (4.5") mesh sizes and below crops a high proportion of immature *O.niloticus* (Figure 11), *L.niloticus*, *Barbus* spp and other large size species in the lake. As reasoned before for Lakes Victoria, Kyoga and Nabugabo, the minimum gillnet mesh size should not be below 127 mm (5") fished passively when targeting the large size fish species.

Impact of Hooks

Hooks target large size fish species that include *L.niloticus*, *Bagrus, Protopterus*, *Clarias*, *Auchenoglanis* (Bubu) spp. Like in Lakes Victoria, Kyoga and Nabugabo, the impact of present size of hooks in use on the lake is negligible.

Impact of Castnets

Castnets consisted of a mixture of mesh sizes ranging from 76.2 mm (3") to 152.4 mm (6") and target the tilapias in shallow inshore waters. Their use should be prohibited for reasons given earlier.

Lakes Edward, George and Kazinga Channel

Unlike the lakes discussed earlier, there is no *L.niloticus* in the two lakes and the channel. The water system in the 1970s used to be among the most productive water bodies in the country. The *O.niloticus* then contributed about 80% of the commercial catches. The fisheries supported a fish processing plant which collapsed due to among other factors commercial fish stock decline as a result of high fishing pressure and the use of destructive fishing gears and methods. Lake George is a controlled lake. Only specific number of canoes are licensed but poaching by the unlicensed canoes has resulted into increased fishing effort. Similar trends are happening on Lake Edward and Kazinga Channel. The gillnets and hooks are the major gears in use. Seines are operated on Lake Edward by Zaire fishermen. Traps are used to a less extent. Gillnets target the Tilapias, *Bagrus docmac* (Semutundu), *Protopterus aethiopicus* Mamba/Lungfish) and *Clarias gariepinnus* (Male/Mudfish) but hooks target exclusively *P. aethiopicus, C.gariepinnus* and to some extent *B. docmac.*

Impact of gillnets

Gillnets are either fished passively or actively. Gillnets of 114.3 mm (4.5") catch mature *O.niloticus* for both fishing methods (Figure 12). Active fishing should be prohibited for reasons given before. This same mesh size crops a large proportion of mature *P. aethiopicus* (Figure 13),and *B. docmac* (Figure 14) . The 114.3 mm mesh size therefore is ideal for cropping *O.niloticus, P. aethiopicus, and B. docmac.* To protect these three species of commercial importance therefore, it would be beneficial to exploit the resource using a minimum gillnet mesh size of 114.3mm (4.5") fished passively.

Impact of Hooks

The impact of hooks on the fishery is minimal though live and young cichlids are mostly preferred as bait and are caught using mainly mosquito seines or small mesh size gillnets. Figure 15 shows size distribution of *P. aethiopicus* caught by hook number 8 commonly used in hook fishing. An increase in Longline fishing would reduce pressure on the *O.niloticus*. Hooks of number 9 and bigger are highly recommended.

Impact of seines and traps

Although seining and use of traps are not common they should be discouraged for reasons outlined earlier.

MINOR LAKES

The fisheries of small lakes are important as they produce fish for local populations around them especially those far away from the major lakes. They also act as reservoirs for some of the fish species that may be subject to extinction in the major water bodies e.g. Haplochromines, *Schilbe*, and *Oreochromis esculentus* of Lake Victoria. Although the annual fish production is not well documented, they have a potential to produce large quantities of fish if properly managed. The determined size at first maturity of the major fish species are shown in Table 1.

LAKE WAMALA

Of the minor lakes studied, Lake Wamala pauses the biggest problem for management. The lake produced an estimated annual catch of 6000 mt in 1975 and 75% was *O.niloticus*. By 1986 the catches dropped to 500 mt. The gillnet mesh sizes in use during 1975 were of 101.6 mm to 127 mm but at present they use 63.5 mm mesh to target the *O.niloticus* and using active fishing. The species in the lake is stunted. The size at first maturity for *O.niloticus*was about 20 - 21 cm TL in 1975 and presently it is around 14 cm (Table 1). The *O.niloticus* caught presently in the 63.5 mm mesh size gill nets are mostly mature (Figure 16)

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Table 1: Size at first maturity for major fish species in different water bodies in Uganda.

WATER BODY	SPECIES	SIZE AT FIRST MATURITY	SIZE ALL MATURE
Victoria	L.niloticus	52cm TL♂; 88cm TL♀	63cm TL♂; 102cm TL♀
	O.niloticus	24 cm TL	29cm TL
	R.argentea	41mm SL	45mm SL
Kyoga	O.niloticus	23cm TL	28-29cm TL
	L.niloticus	52cm TL♂; 85cm TL♀	65cm TL♂; 110cm TL♀
	R.argentea	35cm SL	40mm SL
Albert	Hydrocynus forskalii (ngasia)	18 - 19cm FL	28cm FL
	L.niloticus	50cm TL♂; 85cm TL♀	65cm TL♂; 110cmTL♀
	Alestes baramose (ngara)	24cm FL	28-29cm FL
	Bagrus bayad	41cm FL	43-45cm FL
	O.niloticus	25-26cm TL	28cm TL
Edward, George & Kazinga Channel	Bagrus docmac (Semutundu)	35-39cm FL	50-54cm FL
	O.niloticus	20cm TL	24cm TL
	Protopterus aethiopicus (Mamba)	55-59cm TL	75-79cm TL
L. Wamala	O.niloticus	13cm TL♀ 16cm TL♂	18-21cmTL

Kacheera	Oreochromis esculentus (Tilapia) O.niloticus Haplochromines (Nkejje)		From 3" mesh size gillnets - 95% were mature. 82% were mature from 3" mesh size gillnets. 66% were mature from 1.2" mesh size gillnets.
Kijanebalora	Haplochromines Protopterus spp		88% from 1.2" mesh size gillnets were mature 90% from hook No. 9 were mature
Mburo	Oreochromis esculentus O.niloticus Protopterus spp Haplochromines		Oreochromis esculentus and O.niloticus from 3" mesh size were all mature. Protopterus spp from hook size 8 and 9 were mature. 90% of the haplochromines from 1.2" gill net mesh sizes were mature.
Nyabihoko	O.niloticus Clarias - mudfish	94% from 3.5" gillnet were mature All mature from 3.5" gillnet.	22cm TL 36cm TL
Rwijongo	O.niloticus	14.5cm TL	17cm TL
Nabugabo	L.niloticus	52cm TL♂	70cm TL♂

Table 2. Lates niloticus catch characteristics for different hook sizes on Lakes Victoria and Kyoga

LATES NILOTICUS (LAKES VICTORIA AND KYOGA)

Hook size	% Mature fish	
	Males	Females
4	92	91
5	94	75
6	71	86
7	-	-
8	75	50
9	75	0*

*** No specimen obtained**

LAKE KYOGA	O.niloticus	Gillnets - active, passive	Passive 5" >	O.niloticus, L.niloticus
	L.niloticus	Seine nets - boatseines	x	All
	R.argentea	Mukene nets: - lampara - scoop - seine - lift	5mm > offshore	R.argentea (Mukene)
		Hooks	Not smaller than size 9	L.niloticus
		Traps - fixed fencing, - basket	x	Tilapiines
		Castnets	x	Tilapiines

LAKE ALBERT	Hydrocynus spp. (Ngasia) L.niloticus Alestes spp (Ngara) O.niloticus Bagrus	Gillnets - passive - active	Passive 5" > x	L.niloticus, O.niloticus Bagrus spp
			Passive 3"	Hydrocynus & Alestes spp
		Beach seine	x	All
		Hooks	Not smaller than size 9	Nile perch, Bagrus, Protopterus, Auchenoglanis spp
		Castnets	x	Tilapiines
		Basket traps	x	Tilapiines, young Protopterus & Clarias
		Perforated basins	Recommended under controlled fishing effort.	Alestes nurse

s : /e	Passive 1.2" >	Haplochromines
	Passive 5" >	O.niloticus, Protopterus, Clarias
:ke	x	Haplochromines
	Not smaller than size 9	Protopterus, Clarias
I :	Passive 3" >	O. esculentus, O.niloticus
	Passive 1.5" >	Haplochromines
	Not smaller than size 9	Protopterus, Clarias
M	Passive 3" > Passive 1.2" >	O. esculentus Haplochromines
	Not smaller than size 9	Protopterus, Clarias

Captions to the Figures

Figure 1. Length frequency distribution of Lates niloticus caught by different beach-seine mesh size bags on Lake Victoria (sexes combined).

Figure 2. Length frequency distribution of Lates niloticus and Oreochromis niloticus caught by various trawl codend mesh sizes on Lake Victoria (sexes combined).

Figure 3. Length frequency distribution of Oreochromis niloticus (Nile tilapia) caught by different gill net mesh sizes fished passively on Lake Victoria (sexes combined).

Figure 4. Length frequency distribution of Lates niloticus (Nile perch) caught by different gillnet mesh sizes fished passively on Lake Victoria (sexes combined).

Figure 5. Length frequency distribution of Oreochromis niloticus (Nile tilapia) caught in different gillnet mesh sizes fished actively (sexes combined) - Lake Victoria.

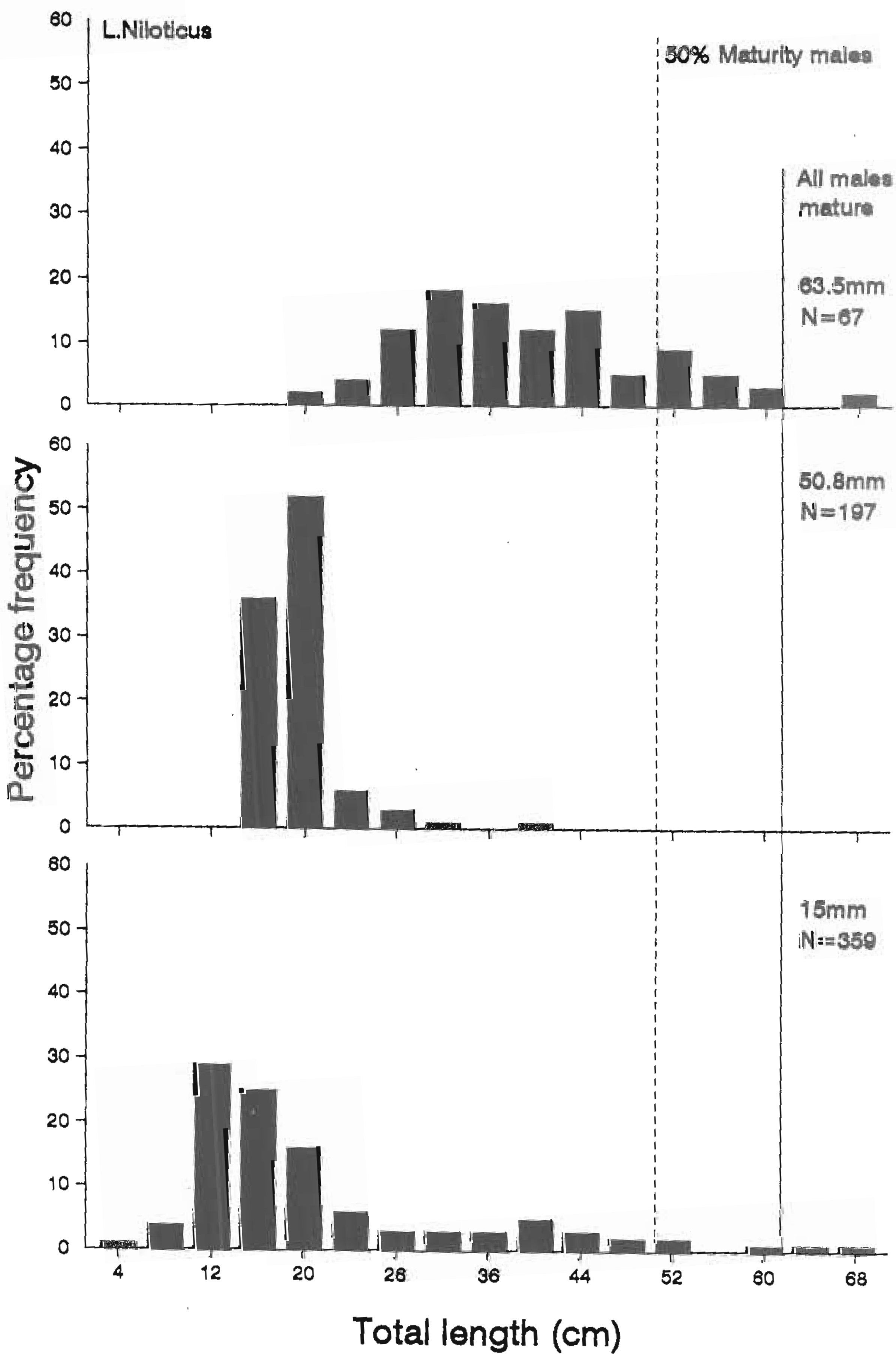
Figure 6. Length frequency distribution of Oreochromis niloticus (Nile tilapia) caught in different gillnet mesh sizes fished actively (sexes combined) - Lake Kyoga.

Figure 7. Length frequency distribution of Rastrineobola argentea retained by the 10mm and 5mm Lampara net operated inshore on Lake Victoria - sexes combined.

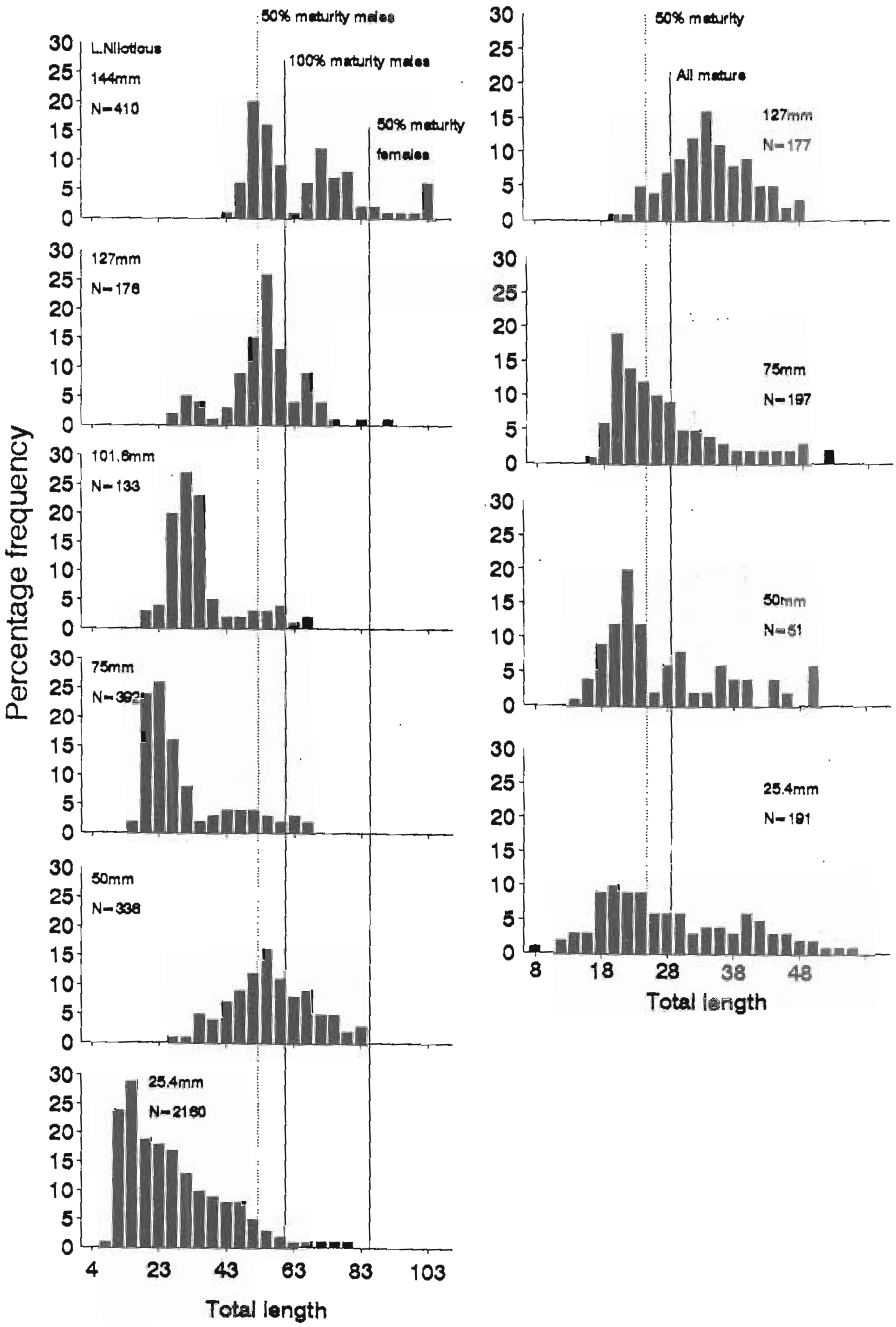
Figure 8. Length frequency distribution of Oreochromis niloticus caught in various single mesh castnet mesh sizes on lake Victoria (sexes combined).

Figure 9. Length frequency distribution of Oreochromis niloticus caught by basket traps of different internal diameters (ID) openings on Lake Victoria- sexes combined.

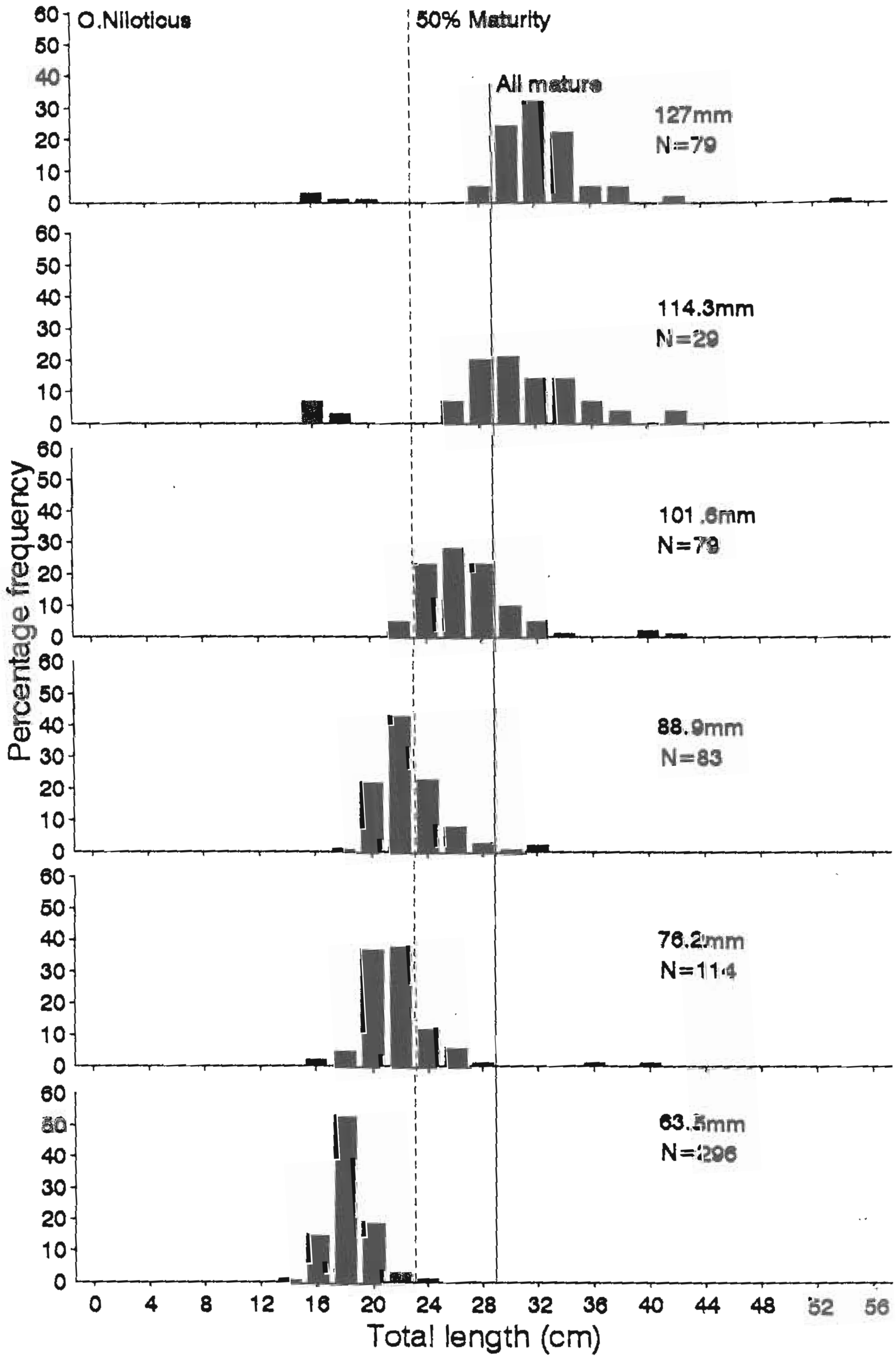
Figure 10. Length frequency distribution of Hydrocynus forskalii from 50.8mm and 38.1mm mesh size gillnets and of Alestes baramose from 50.8 mm mesh fished passively on Lake Albert (sexes combined).



L.Niloticus
50% Maturity males
All males mature
63.5mm
N=67
50.8mm
N=197
15mm
N=359
Percentage frequency
Total length (cm)
4
12
20
28
36
44
52
60
68
0
10
20
30
40
50
60



50% maturity males
100% maturity males
50% maturity females
L.Niloticus
144mm
N=410
127mm
N=176
101.6mm
N=133
75mm
N=392
50mm
N=336
25.4mm
N=2160
Percentage frequency
Total length
50% maturity
All mature
127mm
N=177
75mm
N=197
50mm
N=61
25.4mm
N=191
Total length


O.Niloticus
50% Maturity
All mature
127mm
N=79
114.3mm
N=29
101.6mm
N=79
88.9mm
N=83
76.2mm
N=114
63.5mm
N=296
Percentage frequency
Total length (cm)

fishing using 30.5 mm mesh size nets therefore is recommended for fishing the haplochromines. The 76.2 mm (3") mesh size gillnets caught 95% of mature *O. esculentus*, 82% *O.niloticus* and 100% *O. leucostictus* on L. Kachera, and on Lake Mburo all were mature (Figure 17). Use of mesh sizes lower than this would be destructive to the fishery.

Impact of Hooks

The target species (*Protopterus* and *Clarias*) are seasonal and those landed are big and mature. Hooks of size no. 9 and larger should be encouraged and the haplochromine bait is readily available.

Impact of Traps

Basket traps on Lake Mburo target young *Clarias* spp. As argued before, fish trapping should be discouraged.

LAKE NYABIHOKO

Of the lakes so far mentioned, the lake has not had any research attention. It is about 2.5 m deep, has 30 active fishing canoes, an average of 4 gillnets per canoe, one landing and is located in Ntungamo district. The mirror carp and *O.niloticus* were introduced in the lake in 1950 but the carp failed to survive. The fishery is therefore presently dominated by the *O.niloticus* and *Clarias* spp and exploitation is by use of 88.9 mm (3.5") gillnet mesh size nets. Basket traps are used in rainy seasons to harvest *Clarias spp*. Other fish species which are un- exploited include *Barbus*, Haplochromines and *Mastacembelus*.

Impact of gillnets

The 88.9mm mesh size gillnets harvest mature fish (Figure 18). The *O.niloticus* and *Clarias* spp caught were 94% and 100% mature respectively with an average weight of 0.2 kg (mean TL 21.5 cm) and 0.6 kg (mean 43.3 cm TL) respectively. Like on Lakes Kijanebalola, Kachera and Mburo, the fisheries of all these lakes are promising if properly managed especially regarding the fishing effort and restricting reduction of gillnet mesh sizes. Though the fish cropped were of small size, they were in high demand and supplied some of the needed protein in the area.

LAKES RWIJONGO, MAFURO AND KIBWERA

Lakes Rwijongo and Mafuro are crater lakes found in Bunyaruguru -Bushenyi District and the fisheries are mainly for subsistence though on Rwijongo fish of small size are on great demand. On L. Mafuro rafts made of banana stems are in operation. L. Kibwera is yet another crater lake within the game reserve adjacent to Queen Elizabeth National Park (Rwenzori Park) and is presently run by the Zwilling Safaris.

The major fisheries are *O.niloticus* on Rwijongo, *O.niloticus.*, *O.leucostictus* and Haplochromines on L. Mafuro and *O.niloticus* and *Clarias* on Lake Kibwera.

Impact of gillnets, hooks and basket traps

Gillnets of 63.5 (2.5") to 76.2mm (3") are fished passively using 10 nets on average per canoe on L. Rwijongo. The length frequency distribution of *O.niloticus* caught from the 50.8 mm (2") and 63.5 mm (2.5") mesh size gillnets are shown in Figure 19. 77% of the fish from the (63.5 mm) mesh size nets were mature, mean weight 80g and mean total length 15.5 cm with a sex ratio of 1.7:1 males: females.

On L. Mafuro the *O.niloticus*, *O. leucostictus* and haplochromines are generally not fished, if attempts are made, gillnets of 63.5 mm and 76.2mm are used. Otherwise the few fishermen on the lake fish for *Clarias carsoni*. Simple angling using small hooks size 12 catch the small *O.niloticus*. The mirror carp introduced in early 1970s never survived. There are annual fish kills due to high temperatures in the lake. The production from the lake is negligible even for subsistence and to try and manage such a lake is not worth much.

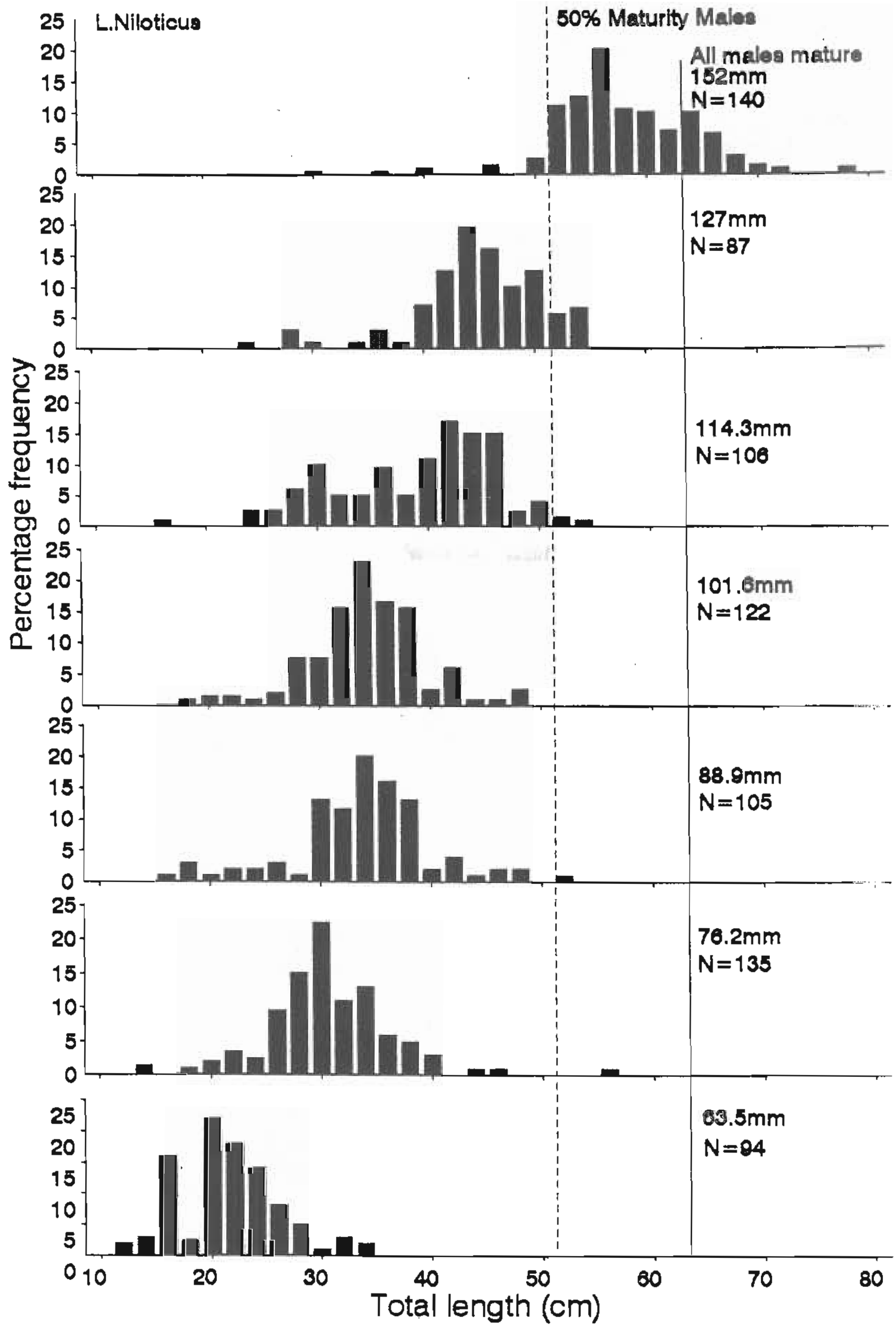
Lake Kibwera in theory is not exploited. There is one canoe for recreation. The fishing is carried out using 114.3 mm gillnet mesh size for catching *O.niloticus* and Angling using hooks of size 9 targeting *Clarias* spp. From the opinion leaders answers, *O.niloticus* of 0.6 kg average weight and *Clarias* of 3 kgs are caught. However, though privately owned, there may be other illegal fishing activities for commercial venture. Close watch therefore would be important as this could be a lake of future important fishery.

Recommendations

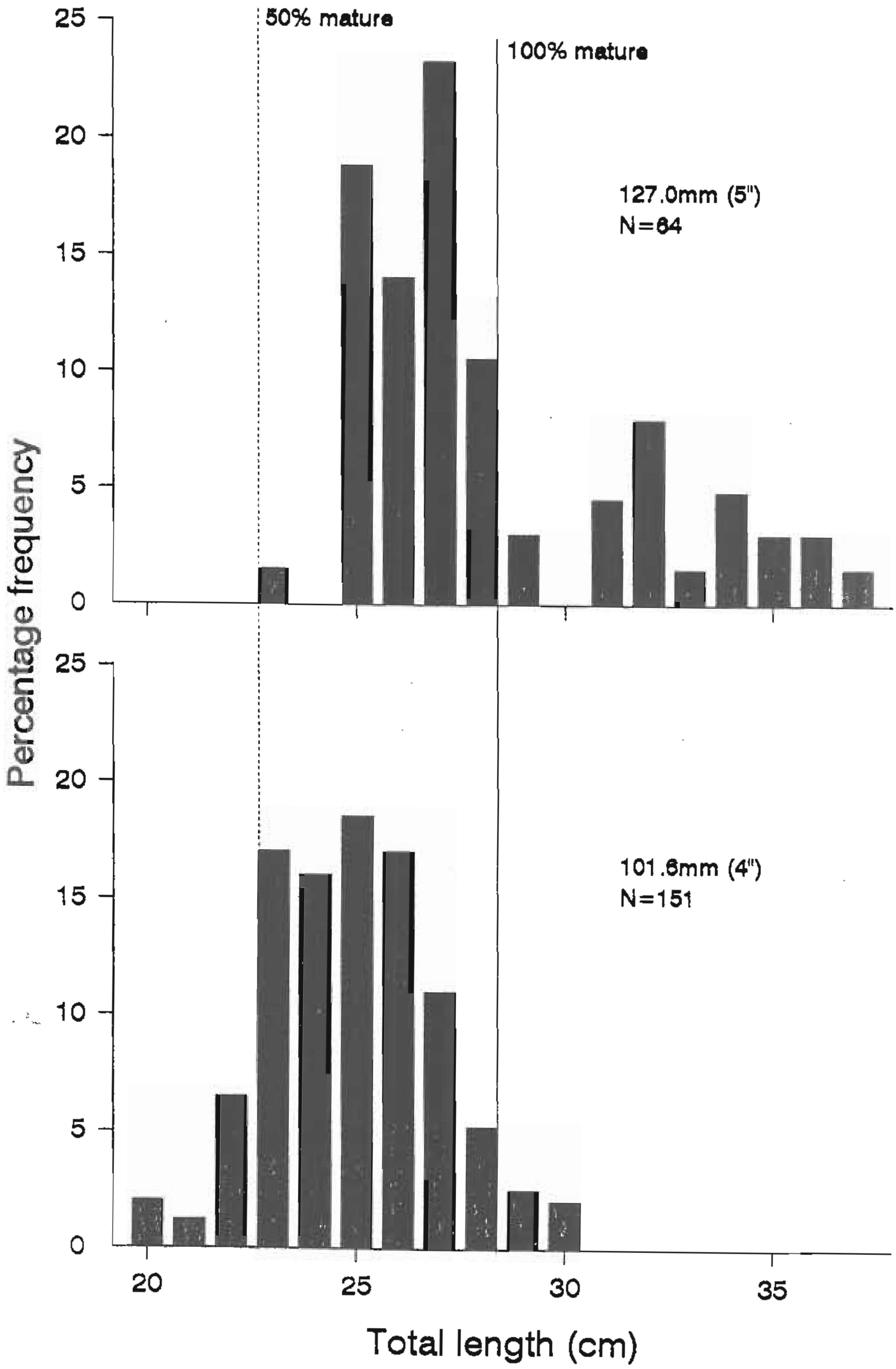
On the basis of the observations made, some of the present regulatory laws are not feasibly applicable to some of the water bodies or major species therein. The fishing effort is on the increase on every water body and there is need to acertain the approximate number of fishing canoes and gears in use. The present fishing legislation therefore should be re-examined to fit particular water bodies, fish and crocodile act need to be reviewed. The legislation of shared lakes e.g. Victoria, Albert and Edward should be harmonized. From the Socio-economics studies of fishing communities and opinion leaders it is evident that acceptability of fishing regulations needs involvement of the local communities if an effective mechanism of managing any fishery is to be attained.

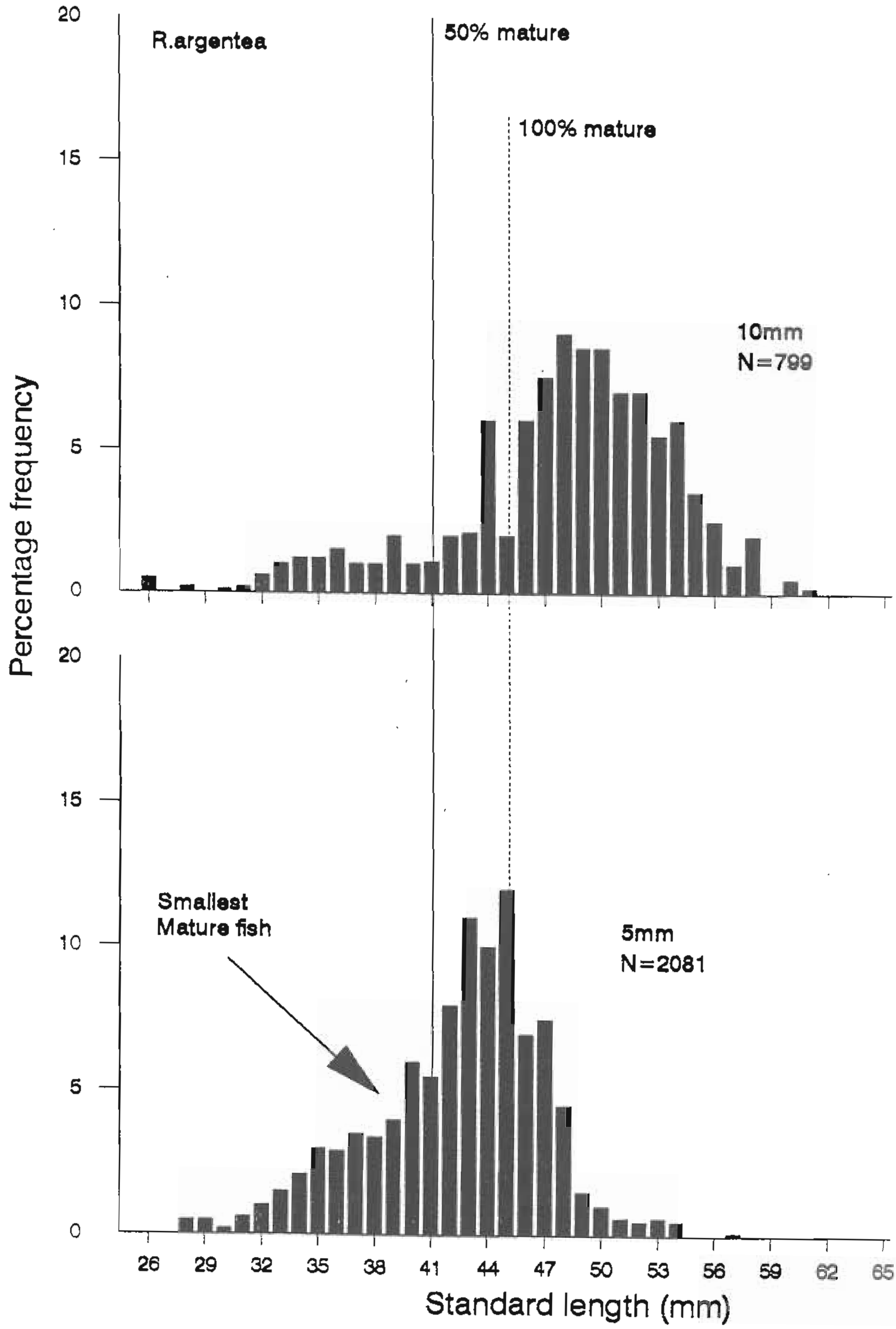
Community based management should therefore be encouraged by making fishermen aware of the costs and benefits of using certain types of fishing gears and methods. Involving the fishermen in the formulation and management strategies of the fisheries therefore, is beneficial. Legislation should be flexible and allow for change when there are changes in the fisheries or when there is a new fishery coming up. Table 3 summarises the recommendations for appropriate fishing technologies for increased and sustainable fish production in Uganda.

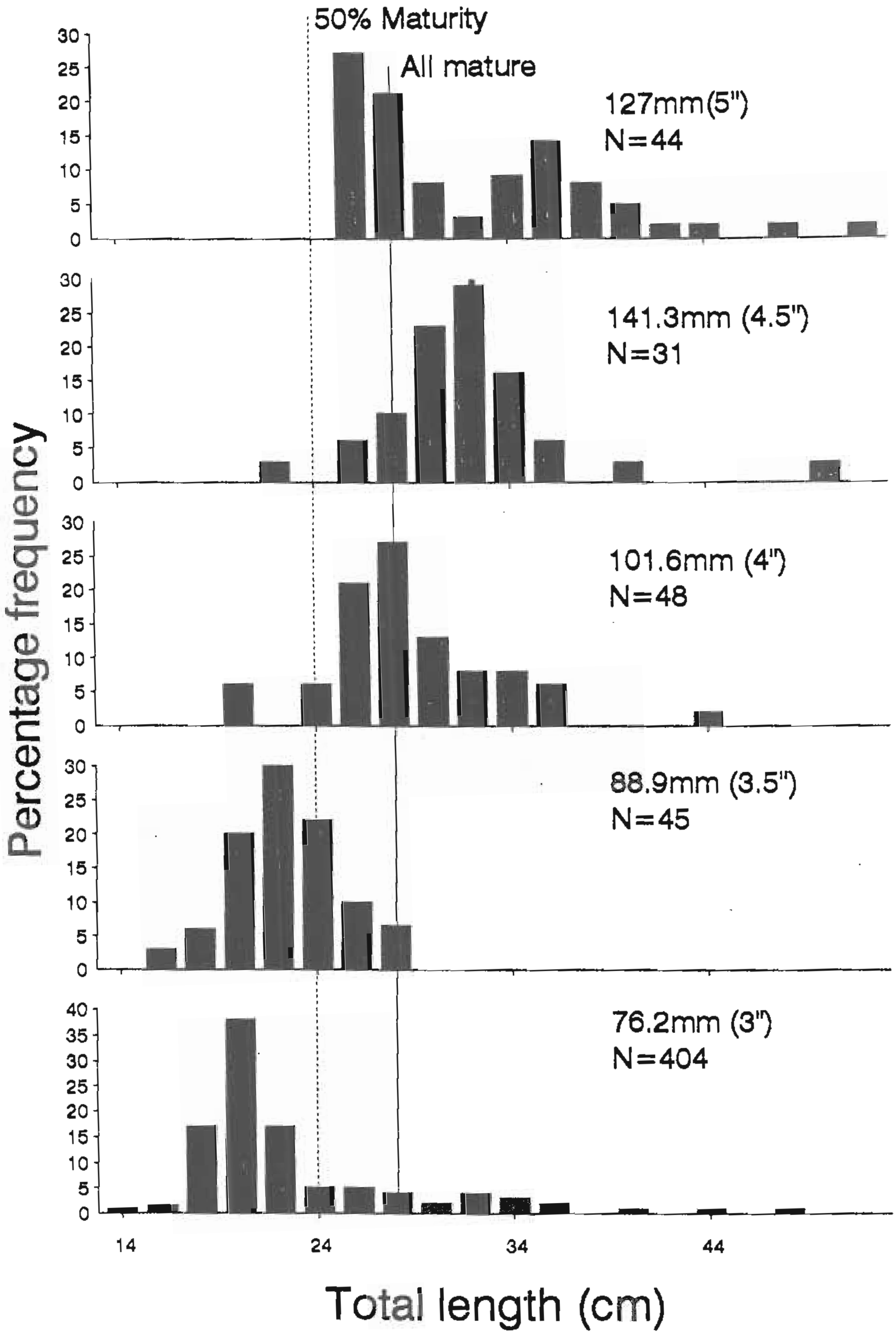
However, there is need to extend more of these studies to the remaining minor lakes and rivers and constantly monitor the changes in the fisheries due to increase in fishing effort and changes in fishing technologies. Constant pilot surveys would be important.



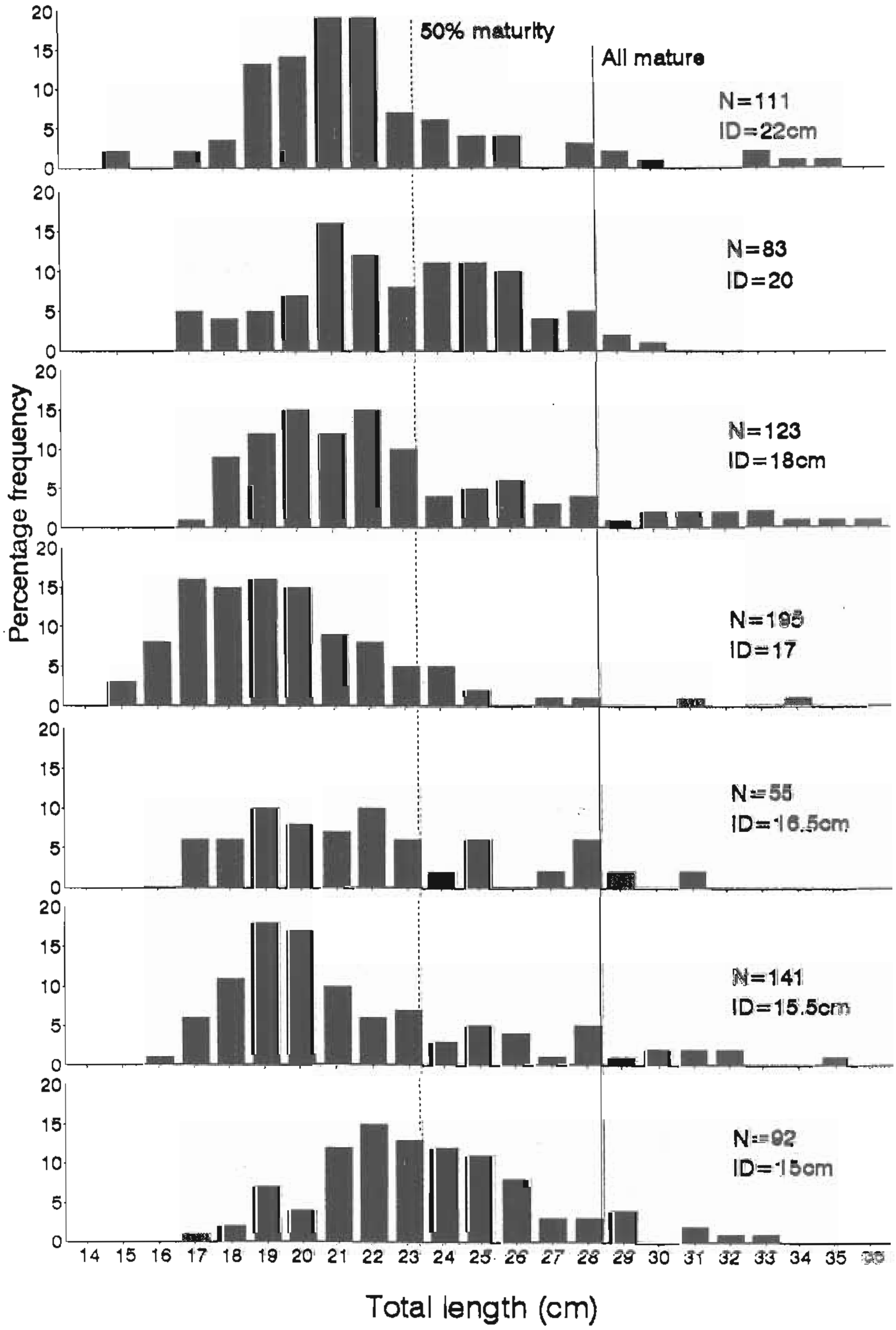
L.Niloticus
50% Maturity Males
All males mature
152mm
N=140
127mm
N=87
114.3mm
N=106
101.6mm
N=122
88.9mm
N=105
76.2mm
N=135
63.5mm
N=94
Percentage frequency
Total length (cm)

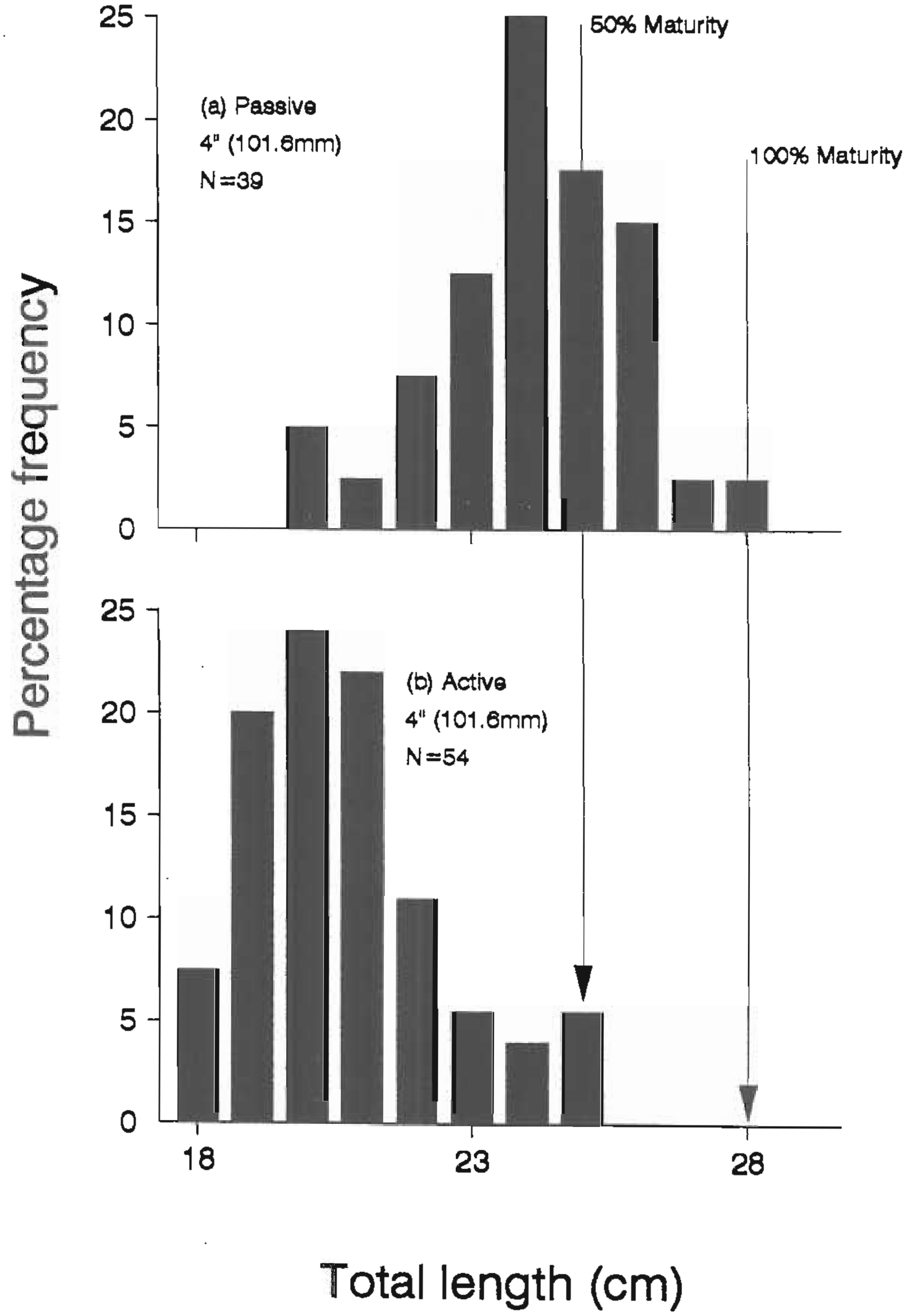

50% mature
100% mature
127.0mm (5")
N=64
101.6mm (4")
N=151
Percentage frequency
Total length (cm)
0
5
10
15
20
25
20
25
30
35


R.argentea
50% mature
100% mature
10mm
N=799
Smallest
Mature fish
5mm
N=2081
Percentage frequency
20
15
10
5
0
26
29
32
35
38
41
44
47
50
53
56
59
62
65
Standard length (mm)

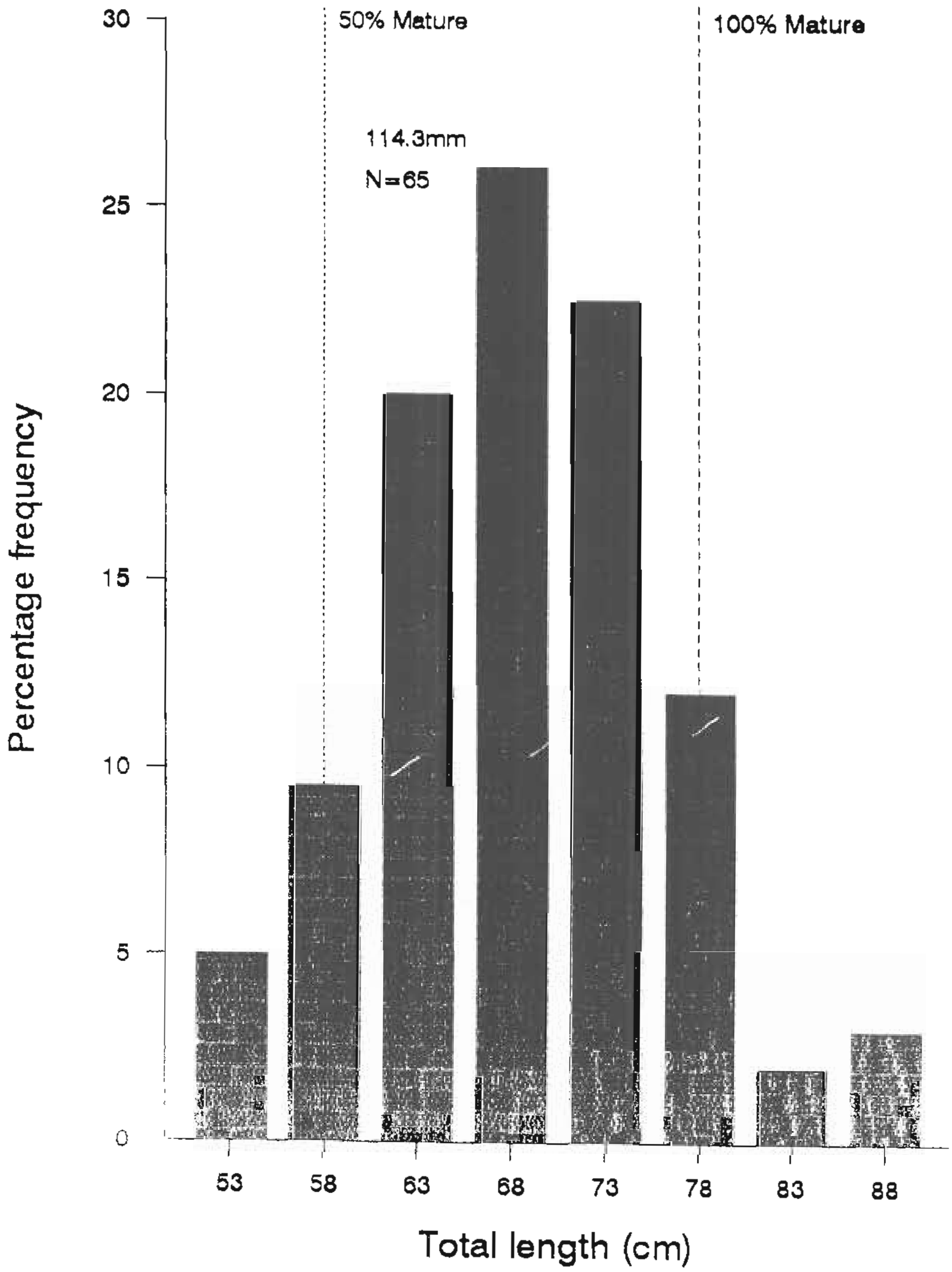


50% Maturity
All mature
127mm(5")
N=44
141.3mm (4.5")
N=31
101.6mm (4")
N=48
88.9mm (3.5")
N=45
76.2mm (3")
N=404
Percentage frequency
Total length (cm)
14
24
34
44

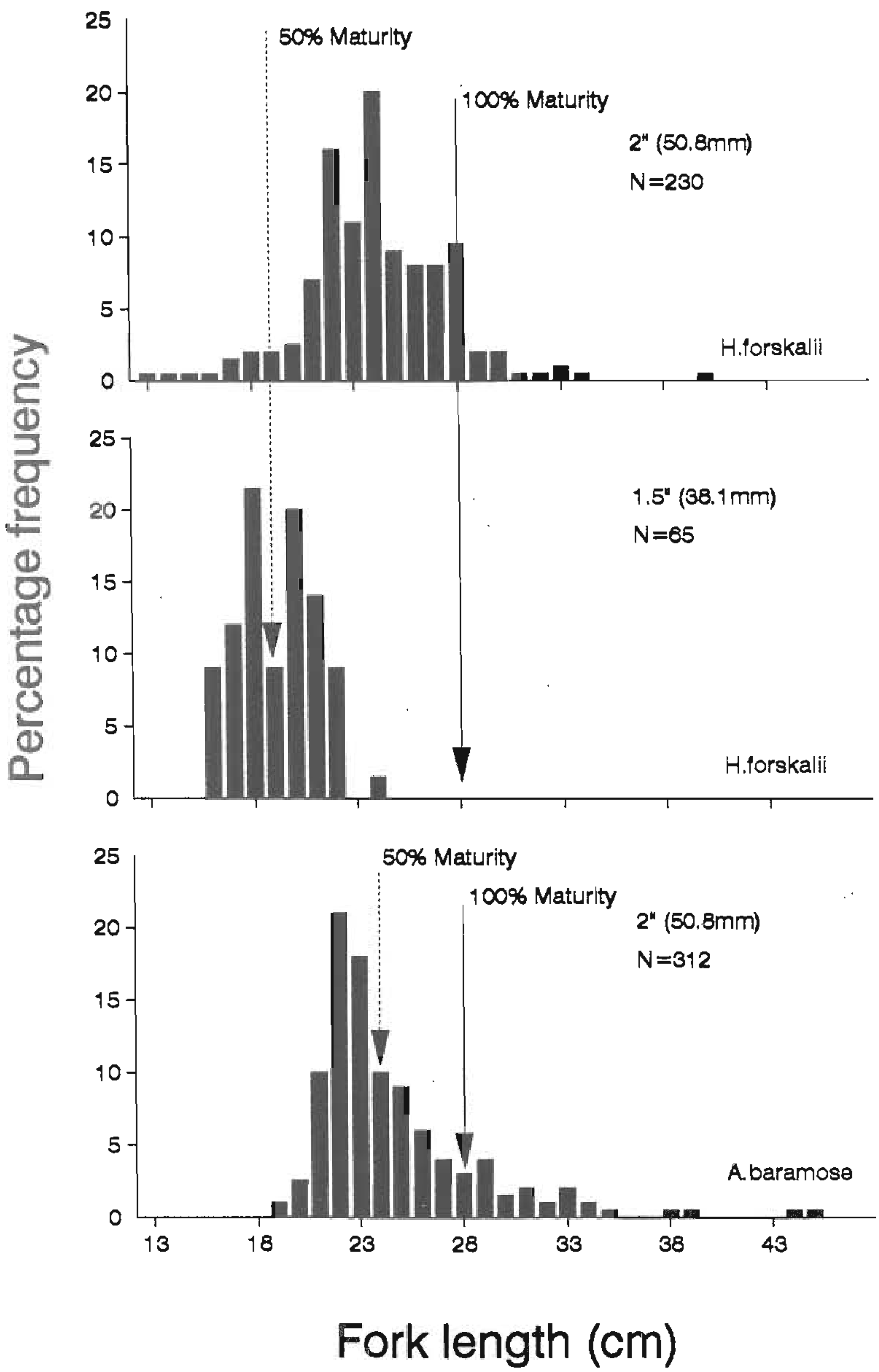

50% maturity
All mature
N=111
ID=22cm
N=83
ID=20
N=123
ID=18cm
N=195
ID=17
N=55
ID=16.5cm
N=141
ID=15.5cm
N=92
ID=15cm
Percentage frequency
Total length (cm)



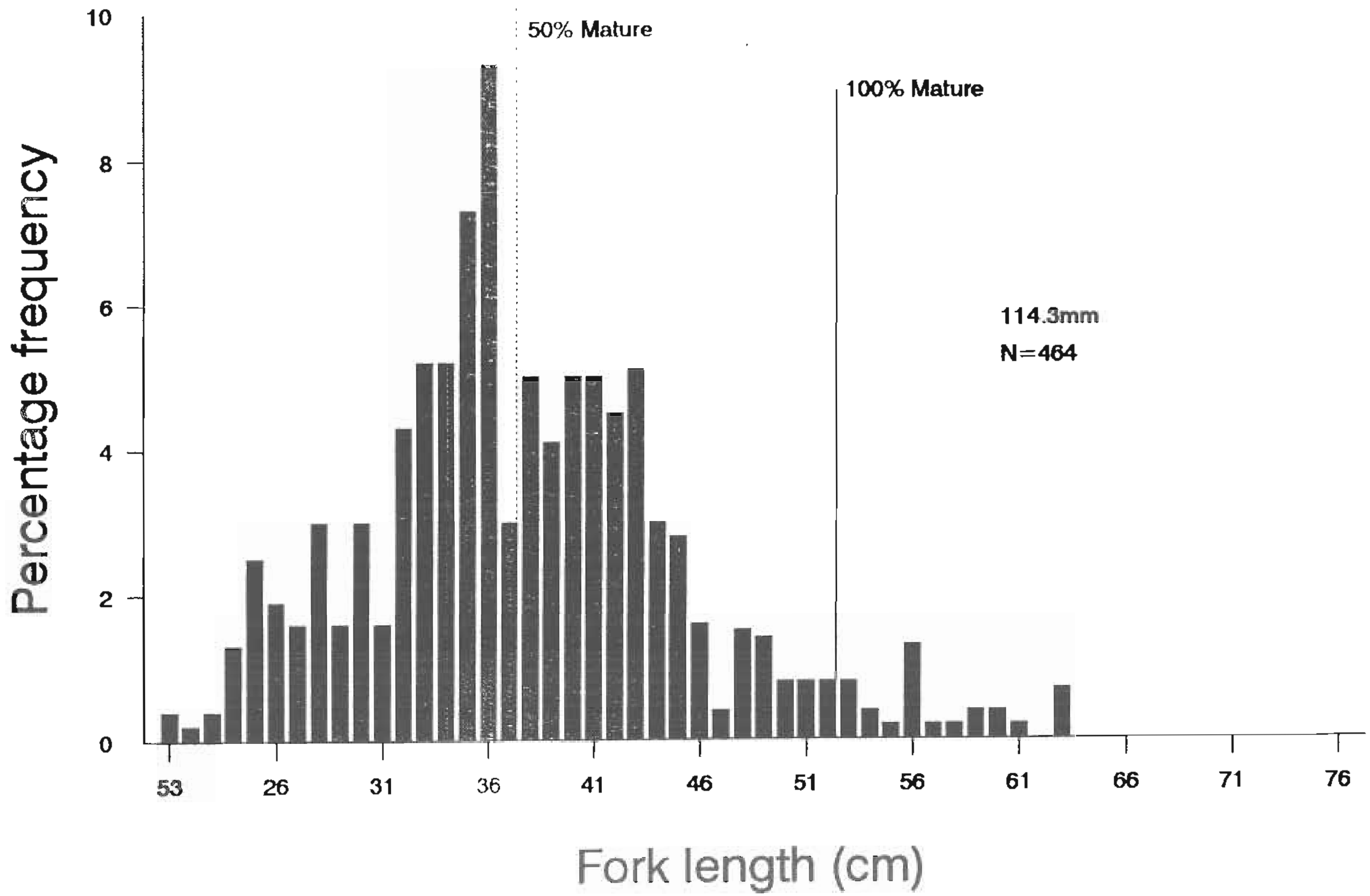
Percentage frequency
25
20
15
10
5
0
(a) Passive
4" (101.6mm)
N=39
50% Maturity
100% Maturity
(b) Active
4" (101.6mm)
N=54
18
23
28
Total length (cm)



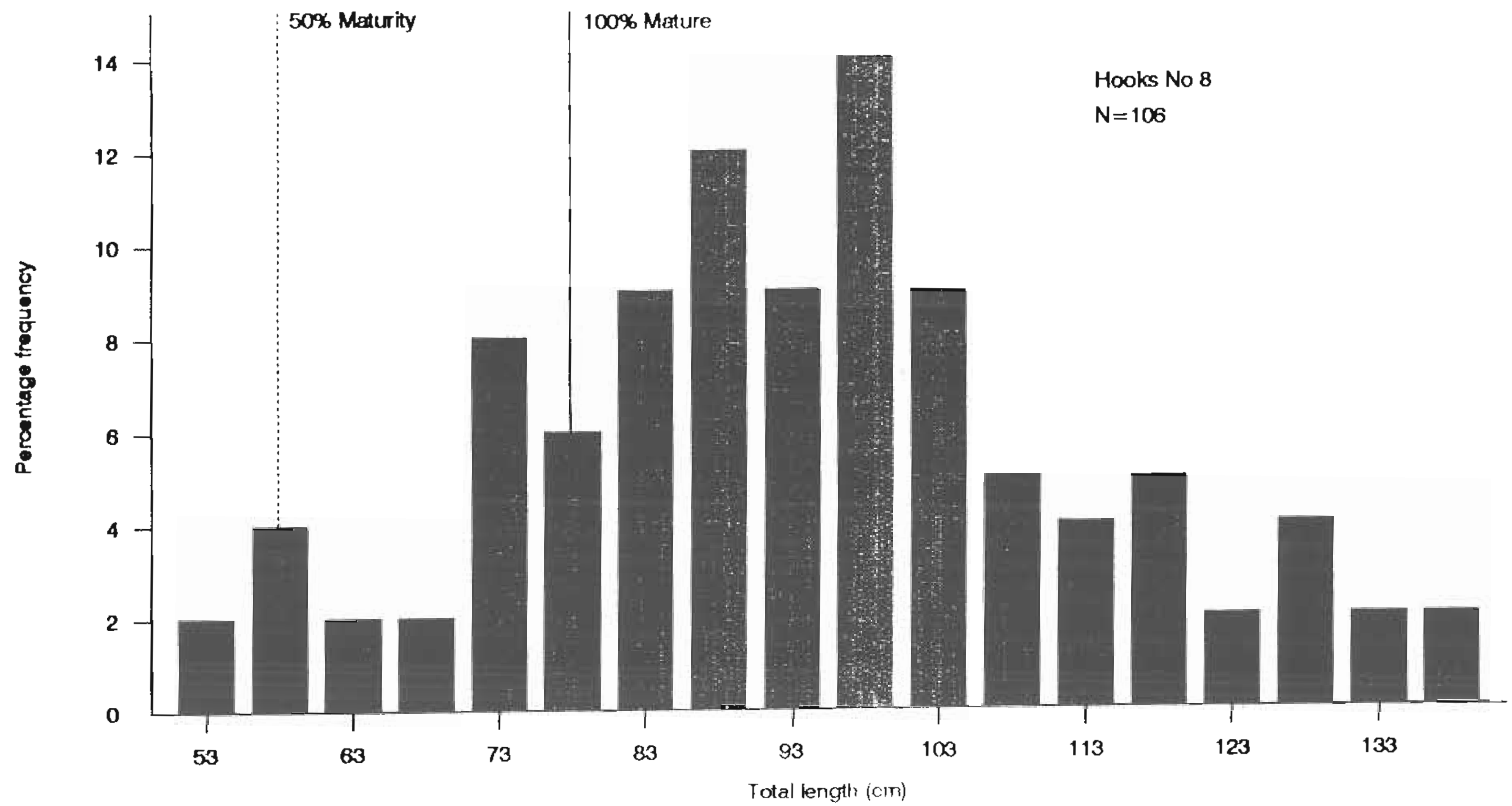
50% Mature
100% Mature
114.3mm
N=65
Percentage frequency
30
25
20
15
10
5
0
53
58
63
68
73
78
83
88
Total length (cm)



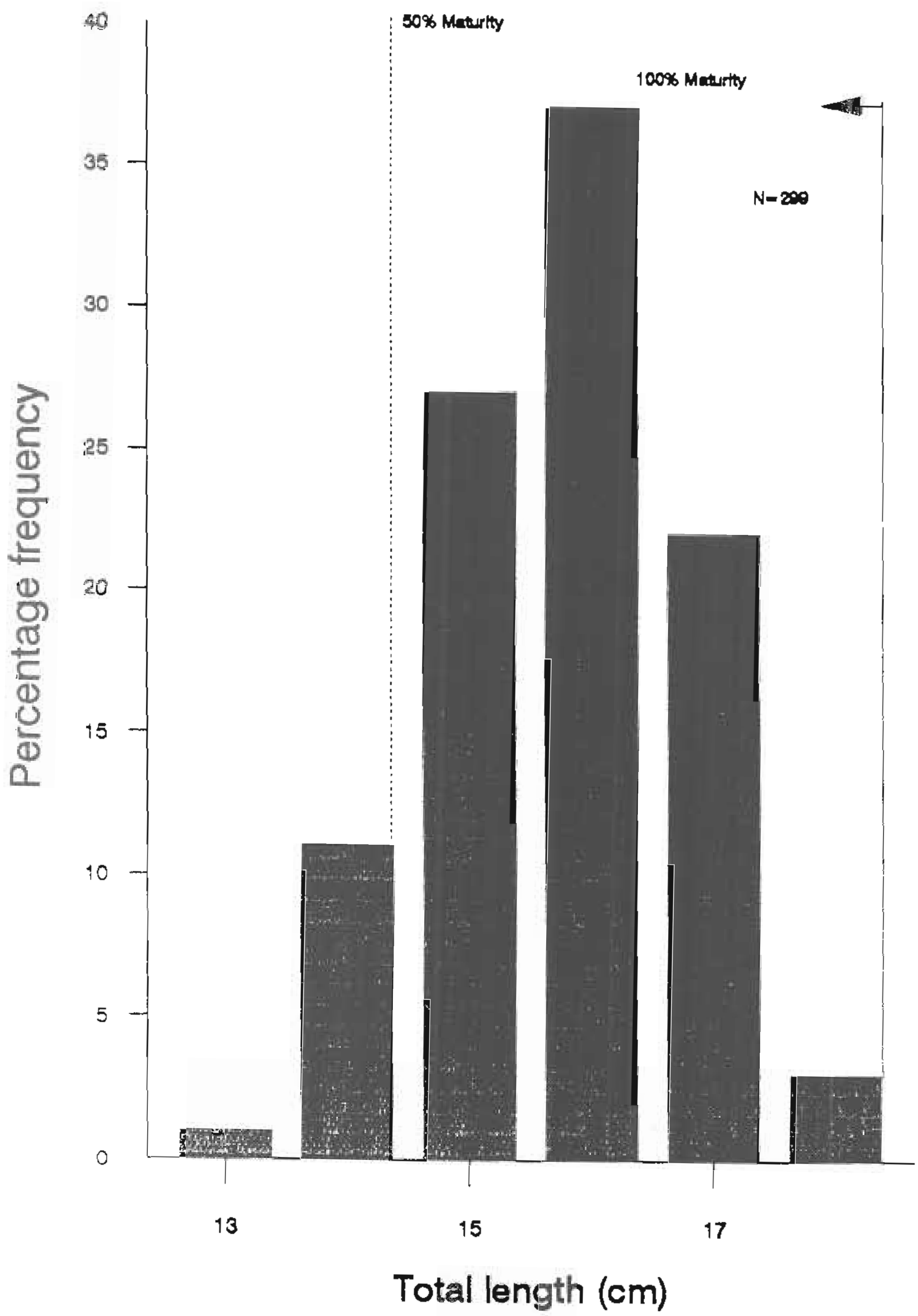
Percentage frequency
50% Maturity
100% Maturity
2" (50.8mm)
N=230
H.forskalii
1.5" (38.1mm)
N=65
H.forskalii
50% Maturity
100% Maturity
2" (50.8mm)
N=312
A.baramose
13
18
23
28
33
38
43
Fork length (cm)



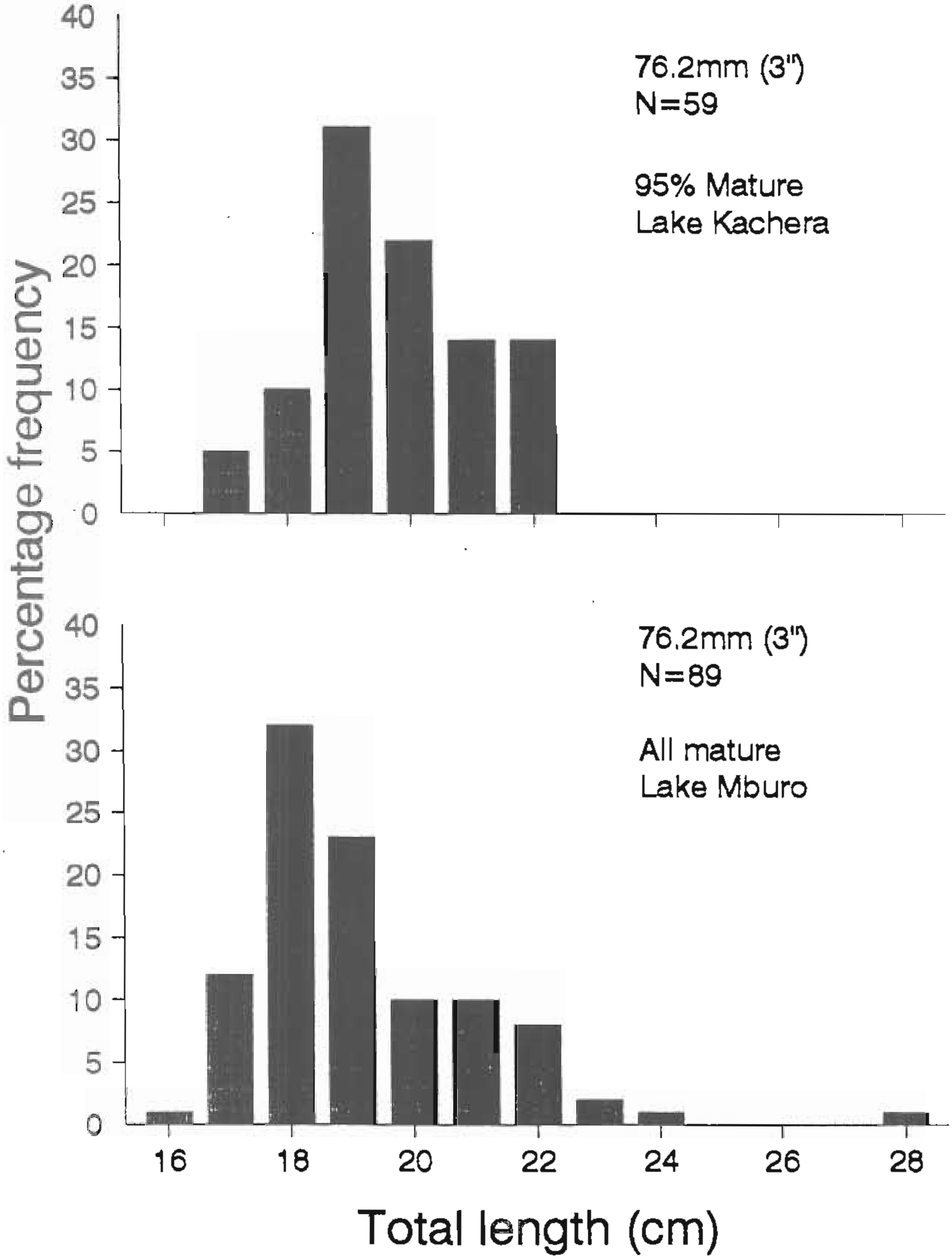
10
8
6
4
2
0
Percentage frequency
50% Mature
100% Mature
114.3mm
N=464
53
26
31
36
41
46
51
56
61
66
71
76
Fork length (cm)



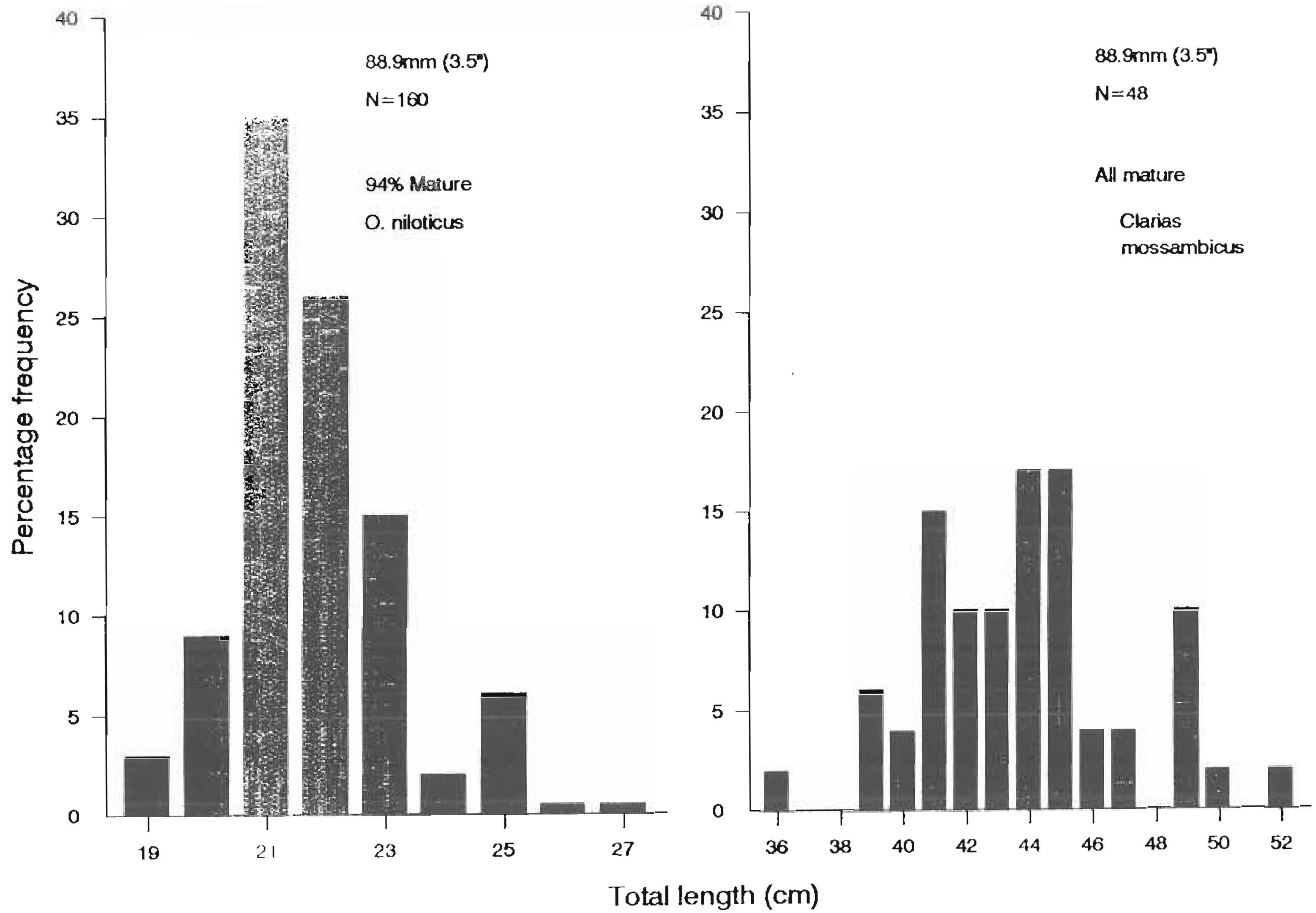
50% Maturity
100% Mature
Hooks No 8
N=106
Percentage frequency
0
2
4
6
8
10
12
14
53
63
73
83
93
103
113
123
133
Total length (cm)



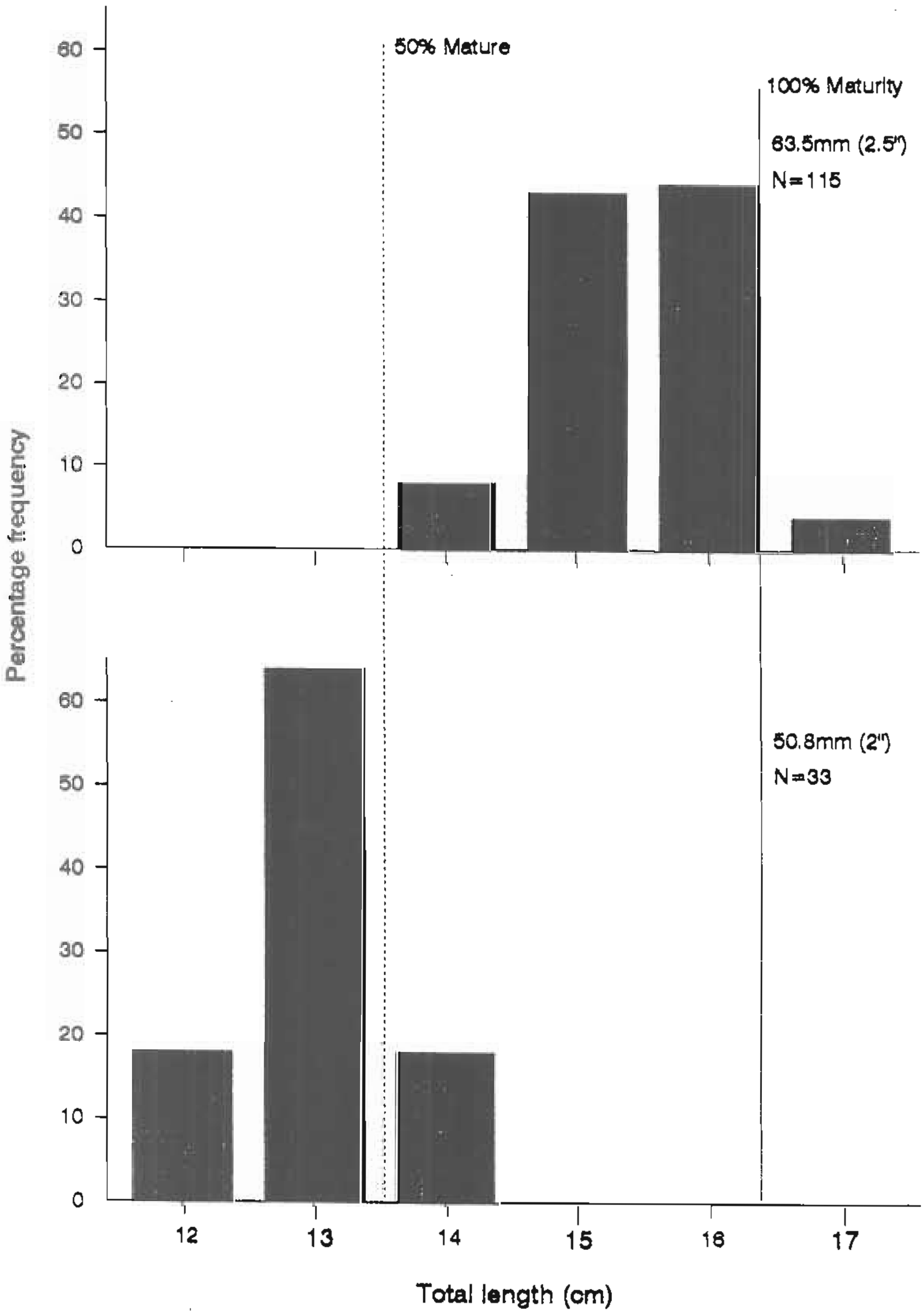
50% Maturity
100% Maturity
N= 299
Percentage frequency
0
5
10
15
20
25
30
35
40
13
15
17
Total length (cm)



Percentage frequency
40
35
30
25
20
15
10
5
0
76.2mm (3")
N=59
95% Mature
Lake Kachera
76.2mm (3")
N=89
All mature
Lake Mburo
16
18
20
22
24
26
28
Total length (cm)



40
35
30
25
20
15
10
5
0
Percentage frequency
88.9mm (3.5")
N=160
94% Mature
O. niloticus
19
21
23
25
27
88.9mm (3.5")
N=48
All mature
Clarias mossambicus
36
38
40
42
44
46
48
50
52
Total length (cm)


50% Mature
100% Maturity
63.5mm (2.5")
N=115
50.8mm (2")
N=33
Percentage frequency
0
10
20
30
40
50
60
12
13
14
15
16
17
Total length (cm)