Chapter 2

The Lake Victoria fish stocks and fisheries

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In this chapter a review is given of the recent changes in the fish communities of Lake Victoria. The abundance and spatial distribution of the currently most important commercial fish species Nile perch (*Lates*), dagaa (*Rastrineobola argentea*) and Nile tilapia (*Oreochromis niloticus*) is described and information is presented about the different types of fishery associated with them. Finally a description of types of landing sites in the Tanzanian part of Lake Victoria is given.

2.1 Recent developments in the fish community

In the first half of this century Lake Victoria had a very diverse fish fauna comprising 28 genera (Greenwood 1974) and *ca.* 350 species. The majority (300+) of these species were haplochromine cichlids (Greenwood 1974, 1981; van Oijen *et al.* 1981; Witte & van Oijen 1990; Witte *et al.* 1992b). Two tilapiine cichlids were present, which were the main target species for the gill net fishery (Graham 1929). In addition to cichlids, 38 fish species belonging to other families were present in the lake (Graham 1929; Greenwood 1974). According to a lake-wide trawl survey at the end of the 1960s, haplochromine species comprised some 80% of the demersal fish biomass of Lake Victoria (Kudhongania & Cordone 1974). However, due to their small size and bony texture they were among the last to be exploited by the fishery (Scully 1975).

In the 1950s the tilapiine cichlids and *Labeo victorianus* decreased to low population levels following intensive gill net fishery (Cadwalladr 1965b; Fryer & Iles 1972; Fryer 1973), and in order to boost tilapiine production, *Tilapia melanopleura*, *Tilapia zillii*, *Oreochromis leucostictus* and *Oreochromis niloticus* were introduced to the lake (Welcomme 1968, 1988). Nile perch *(Lates niloticus)** was also introduced, from Lakes Albert and Turkana, during the late 1950s and early 1960s (Hamblyn 1961; Arunga 1981; Welcomme 1988), but was caught only in small quantities over the following twenty years.

However, at the beginning of the 1980s an explosive increase of the *Lates* stock was reported in several areas of the lake *(Figure 2.1)* in conjunction with a simultaneous decline of most other fish stocks (Arunga 1981; Okemwa 1981; Hughes 1983, 1986; Barel *et al.* 1985; Okaronon *et al.* 1985; Goudswaard & Witte 1985; Goudswaard 1988; Goudswaard & Ligtvoet 1988; Ogutu-Ohwayo 1990a,b,c; Witte *et al.* 1992a,b). In *Table 2.1*, a comparison is made of the relative abundances of the major species, using data obtained by bottom trawling in the Mwanza Gulf (Tanzania) in 1969/1970, 1985 and in 1989. The figures clearly show that, except for *Lates*, all the other bottom dwelling species have fallen to very low levels of abundance, especially the haplochromines. The once dominant haplochromines are shown to have virtually disappeared from the trawlable littoral (less than 6 m deep), sub-littoral (6-20 m deep) and offshore (over 20 m deep) waters. In a detailed account, Witte *et al.* (1992b) show that about 120 haplochromine species were once captured regularly on a transect across the Mwanza Gulf. Since 1987, only some 35% have been recorded, and these just occasionally. The surviving species are mainly found in very shallow bays and along rocky shores.

Recent data from trawl surveys in Kenyan and Ugandan waters suggest corresponding trends with those seen in Tanzanian waters (Fisheries Department, Kenya 1988; Acere 1988; Ogutu-Ohwayo 1990a,b).

With the appearance of *Lates*, the level of predation in the lake increased markedly. Originally the level of predation was set by the bottom dwelling 'lurking' catfishes *Clarias* and *Bagrus* (Fryer 1965) and the pelagic *Schilbe*, which fed mainly on haplochromines, *Rastrineobola* and insects. From the onset, *Lates* preyed upon haplochromines predominantly, but most small fish species have been recorded in its diet (Gee 1964, 1969; Hamblyn 1966; Okedi 1971a; Ogari 1985; Ogari & Dadzie 1988; Hughes 1986; Ogutu-Ohwayo 1990c; Mkumbo & Ligtvoet 1992). The processes responsible for the reduction of most species are probably

* The identification of *Lates niloticus* in Lake Victoria has still to be confirmed (see Appendices I and II).

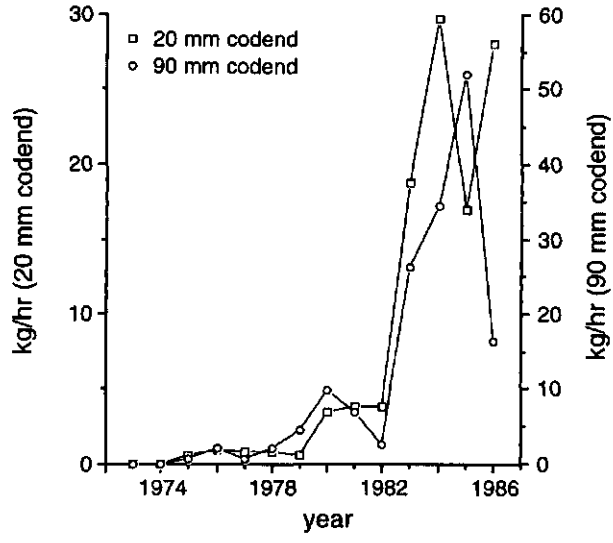

Figure 2.1 Increase of *Lates* in trawl catches in the Mwanza Gulf of Lake Victoria. (After Witte *et al.* 1992b).

Table 2.1 Comparison of trawl catches in the Mwanza Gulf in 1969/1970 (R.V. Ibis; Kudhongania & Cordone 1974) and 1985 and 1989 (R.V. Kiboko). R.V. Ibis used codends of 19, 38, 51, 64 and 83 mm, R.V. Kiboko used a codend of 19 mm. Goudswaard (1988) suggested that the difference in efficiency between the research vessels amounted to 30% (R.V. Ibis having the higher efficiency). Catches of the pelagic *Rastrineobola* were not recorded in both cases. Other species not included in the Table contributed less than 1% to the total catch weight.

	1969/1970		1985		1989	
	Catch weight		Catch weight		Catch weight	
	kg/hr	percentage	kg/hr	percentage	kg/hr	percentage
Bagrus docmak	13.1	2	3.7	1	0.2	0
Clarias gariepinus	40.6	5	1.8	1	0.9	1
Protopterus aethiopicus	25.2	3	16.8	5	1.5	2
Lates niloticus	—	—	75.3	24	94.6	97
Oreochromis niloticus	24.3	3	0.1	0	0.8	1
Oreochromis esculentus	114.4	15	0	0	0	0
Oreochromis variabilis	1.5	0	0	0	0	0
Haplochromines	548.1	71	219.1	69	0	0
Total	767.2	99	316.7	100	98.1	101

predation by *Lates* (in the case of haplochromines and other small fishes) and/or competition with *Lates* (in the case of *Clarias* and *Bagrus*). Locally, however, intensive fishing may also have contributed to the decline of certain species. Documented examples of the impact of the fisheries include, for example, the decline of the *Labeo* stock (Cadwalladr 1965b, 1969), the decline of the endemic tilapiine stocks (Fryer & Iles 1972; Fryer 1973) and changes in species composition and catch sizes of haplochromine cichlids (Kukowski 1978; Marten 1979; Witte & Goudswaard 1985; Goudswaard 1988). The endemic tilapiine species are also likely to have been affected by competition from the introduced tilapiine species (Welcomme 1968, 1984; Lowe-McConnell 1987) and possibly hybridization (Ogutu-Ohwayo 1990a).

There are strong indications that, together with the growing *Lates* population, three other populations have expanded. They are those of *Oreochromis niloticus*, *Rastrineobola* (see Sections 2.4 and 2.5), and the small benthic shrimp, *Caridina nilotica*. In the sub-littoral waters of the Mwanza Gulf at least, the stock size of *Caridina* has increased substantially (Goldschmidt *et al.* 1993; Witte *et al.* 1992a). Moreover, the quantities of shrimp in trawl catches have risen significantly in offshore waters.

2.2 Trophic inter-relationships

The pre-*Lates* food web (*Figure 2.2 A;* Ligtvoet & Witte 1991) was dominated by the haplochromines, encompassing many trophic specializations (Greenwood 1974; van Oijen *et al.* 1981; Witte 1981; Witte & Van Oijen 1990). In terms of biomass, the major trophic groups in the sub-littoral zones were the detritivores/phytoplanktivores and the zooplanktivores which constituted more than 40% and 16% of the total demersal fish mass respectively (Witte & van Oijen, 1990). Starting from phytoplankton and bottom deposits (detritus), the major pathways of energy through the system were:

1. Via haplochromines to the piscivorous catfishes and haplochromines.
2. Via zooplankton and insect larvae to zooplanktivorous haplochromines and *Rastrineobola* to piscivores.
3. Via insect larvae to various fish taxa (haplochromines, *Brycinus, Barbus*, Mormyridae, *Synodontis*) to piscivores.
4. Via molluscs to various fish taxa (haplochromines, *Barbus altianalis*, *Protopterus aethiopicus*) to piscivores.
5. A direct culmination in several tilapiine cichlid species.

In the present food web (*Figure 2.2 B*; Ligtvoet & Witte 1991) *Lates* is the top predator, feeding mainly on the prawn *Caridina* (primary consumer) and on *Rastrineobola* and juvenile *Lates* (both secondary consumers). The main pathways of energy are:

1. Via *Caridina* to *Lates*.
2. Via *Caridina* and juvenile *Lates* to *Lates*.
3. Via insect larvae and juvenile *Lates* to *Lates*.
4. Via zooplankton to *Rastrineobola* and juvenile *Lates* to *Lates*.
5. A direct culmination in the tilapiine cichlid *Oreochromis niloticus*.

By contrast with the pre-*Lates* situation, the bulk of the biomass within the fish community has shifted from primary consumers (detritivorous/phytoplanktivorous haplochromines) to the top predator *(Lates)* which now operates mostly as a secondary and tertiary consumer. Another noteworthy feature of the present system is the extensive cannibalism within the *Lates* population (Ligtvoet & Mkumbo 1990), in which very young stages are involved. Individuals of 6-10 cm total length feed abundantly on individuals of 2-3 cm total length.

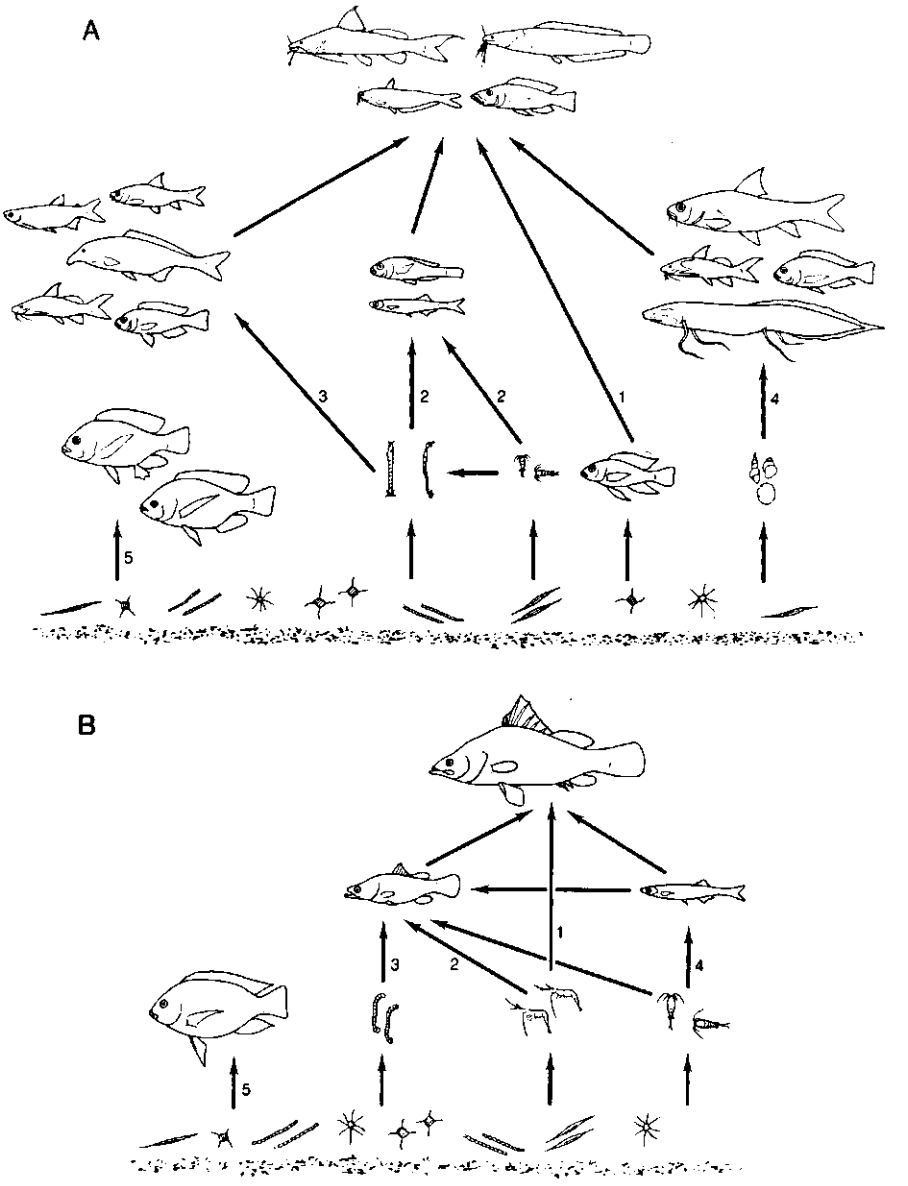

Figure 2.2 Food web in the sub-littoral zone of Lake Victoria. A: before the expansion of the *Lates* stock; B: after the expansion of the *Lates* stock. Only the key taxa are incorporated in the diagrams. Numbers refer to the energy pathways described in the text. (After Ligtvoet & Witte 1991).

The food webs, as presented, show that there have been four cases of stock replacement (*sensu* Daan 1980):

- The prawn *Caridina* replacing the detritivorous/phytoplanktivorous haplochromines (Goldschmidt *et al.* 1993).
- *Rastrineobola* replacing the zooplanktivorous haplochromines (Wanink 1991).
- The tilapiine *Oreochromis niloticus* replacing the endemic tilapiines *Oreochromis esculentus* and *Oreochromis variabilis.*
- *Lates* replacing the original piscivores.

A discussion on the possible mechanisms underlying these replacements is given in Ogutu-Ohwayo (1990a), Ligtvoet & Witte (1991), Wanink (1991) and Goldschmidt *et al.* (1993).

2.3 Stock of *Lates*

Abundance

Since 1986 *Lates* was found to be the dominant demersal stock in various areas (Kagera, the Mwanza Gulf, the Speke Gulf, north of Ukerewe) of the Tanzanian part of Lake Victoria when trawling with the R.V. Kiboko. In 1987 *Lates* comprised 95-100%, on average, of the total trawl catch by weight (Ligtvoet & Mkumbo 1990; P.C. Goudswaard pers. obs.). Without a correction for catchability, Ligtvoet & Mkumbo (1990) calculated a standing stock of 46.6 kg/ha, by the swept area method. This is a conservative estimate for the following reasons.

- The trawl net covers only the lowest 1.5 m of the water column, while *Lates* is common up to at least eight metres above the bottom.
- Comparison of the trawl catches with catches from other fisheries (long lines, pair trawls and beach seines) indicate that, with R.V. Kiboko, the proportion of larger *Lates* is underestimated (see Section 4.6).

Taking account of these facts, it seems realistic to fix the sampled proportion, as has often been done in other studies (Gulland 1983), to 50% of the actual stock. This means that the standing stock would have been about 100 kg/ha in 1987. Since trawling was normally restricted to waters up to 40 m deep, the above estimate of stock density may be considered representative for waters over that depth range in the Tanzanian part of Lake Victoria only.

Spatial distribution

Lates has a lake-wide distribution, occurring in virtually every habitat. In 1988, in the Ugandan area, specimens of a wide range of size classes were found even in swamps, when water reached a high level after heavy rainfall (D.L. Ocenodongo pers. comm.). Research on Kenyan rivers entering Lake Victoria, revealed specimens of *Lates* of various sizes (largest 15 kg) 9 km up-stream from the lake (P.B.O. Ochumba pers. comm.). In the lake, *Lates* has been found at depths of 60 m, in the deepest waters in which trawling surveys have been carried out (Goudswaard 1988). The highest catch rates in Tanzanian waters in 1985 were obtained from depths of 16-35 m (*Figure 2.3*; Goudswaard 1988; Goudswaard & Ligtvoet 1988). Generally *Lates* is a bottom dwelling species, but recent observations in the Mwanza area indicate that in deeper waters (20-40 m) it also stays and forages pelagically in water layers 10-20 m below the surface. This phenomenon is probably related to the fact that *Lates*

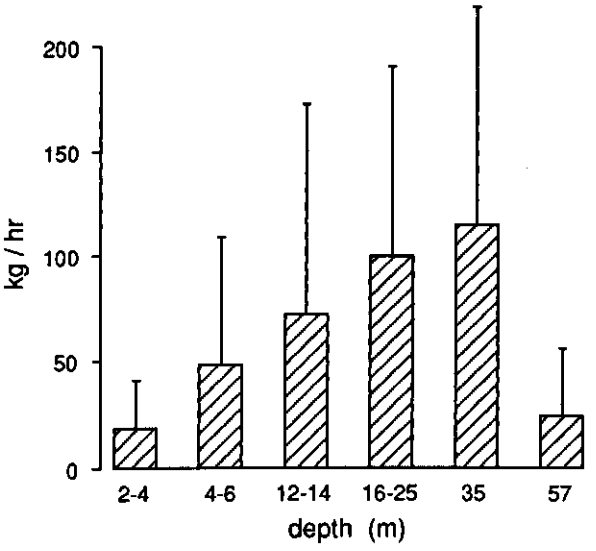

Figure 2.3 Mean catch rates (and one standard deviation) of *Lates* in trawl shots made between October 1984 and November 1985 at various depths in the Mwanza area. (After Goudswaard & Ligtvoet 1988).

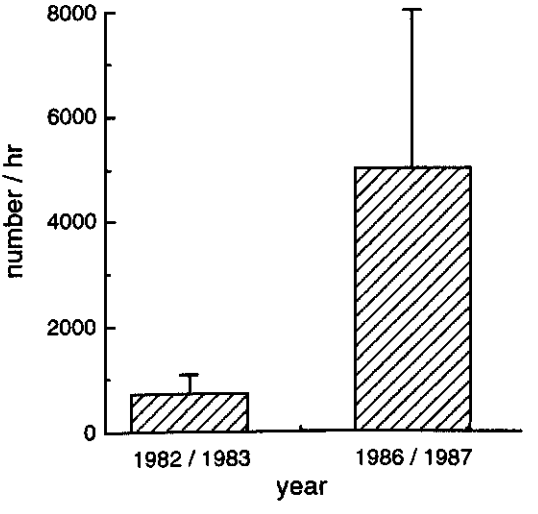

Figure 2.4 Mean catch rates (and one standard deviation) of *Rastrineobola* from surface trawl catches at a sampling station in the Mwanza Gulf. (After Witte *et al.* 1992a).

has a relatively high demand for oxygen (Fish 1956). Due to stratification, especially in the rainy season when winds are less strong, oxygen concentrations are low (often less than 2 ppm) in the basal part of the water column (Talling 1966; Ochumba 1987; van Oijen *et al.* 1981; Ochumba & Kibaara 1989; Wanink *et al.* 1988). In these periods the species apparently moves to higher water layers. Movement to higher water layers may be also related to the presence there of the pelagic fish *Rastrineobola* (which is a source of food for *Lates*) and also to the light conditions prevailing at night, *i.e.* the phase of the moon.

Little specific information is available for the distribution of juvenile *Lates* in Lake Victoria. In Lakes Chad, Turkana and Albert, *Lates* fry are mainly found in shallow, sheltered bays, and young fish up to lengths of 20-30 cm live inshore, in the vicinity of submerged vegetation (Hamblyn 1962; Gee 1966; Hopson 1972). In Lake Victoria juvenile *Lates* (<10 cm) have been caught in waters up to 60 m deep. However, highest densities are found in the shallow littoral zones (E.F.B. Katunzi *et al.* in MS). There are indications of diurnal vertical migrations of juvenile *Lates* (<10 cm). During the day they are concentrated near the bottom, but at night they migrate to mid-water levels (Wanink 1988, 1992).

2.4 Stock of *Rastrineobola*

Abundance

Referring to Okedi (1982), Ssentongo & Welcomme (1985) estimated a standing stock of *Rastrineobola* of 187 400 tons for the entire lake, but because of the profound changes which have occurred in the lake and its fishery this figure is of little relevance to the present situation. A four-fold increase in biomass was detected between 1982 and 1987, in the sub-littoral waters of the Mwanza Gulf (Wanink 1988, 1991). This was the gross result of an increase in abundance (*Figure 2.4*), and a decrease in the mean length, of this species. It is not known if this development has been paralleled over the whole lake, but an increase in the artisanal *Rastrineobola* fishery also indicates an expanded *Rastrineobola* stock (Bwathondi 1990; Ogutu-Ohwayo 1990a). There is no current estimate of the absolute biomass of *Rastrineobola* in the Mwanza Gulf.

Spatial distribution

According to Wanink (1988, 1992), adults of *Rastrineobola* show a diurnal vertical migration. During the day they move as far down as oxygen concentrations allow. During the night the adults migrate to the surface layers. Most *Rastrineobola* which are parasitized by a cestode (probably *Ligula intestinalis*) are surface dwelling throughout day and night. The depth distribution of adult *Rastrineobola* is presented in *Figure 2.5*. There is little information on the diurnal vertical migration pattern of the juveniles, although they seem to follow an opposite pattern to the adults. This was concluded from the fact that juveniles disappear from surface trawl catches at night (Wanink 1988, 1992).

There are indications that the mean size of the *Rastrineobola* population increases with water depth. The modal length of *Rastrineobola* increased from 4-4.5 cm SL at a station of 2 m depth in the southern part of the Mwanza Gulf to 4.5-5 cm SL at a station of 30 m depth near the entrance of the Mwanza Gulf (Wanink 1988; Wanink *et al.* 1993).

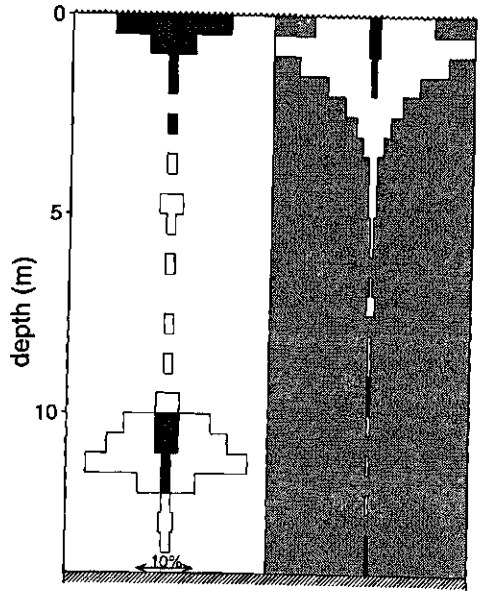

Figure 2.5 Depth distribution of adult *Rastrineobola* during day time (left panel; n = 95) and at night (right panel; n = 664). Sampling was conducted in the Mwanza Gulf. Black bars represent cestode infected fish. (After Wanink 1992).

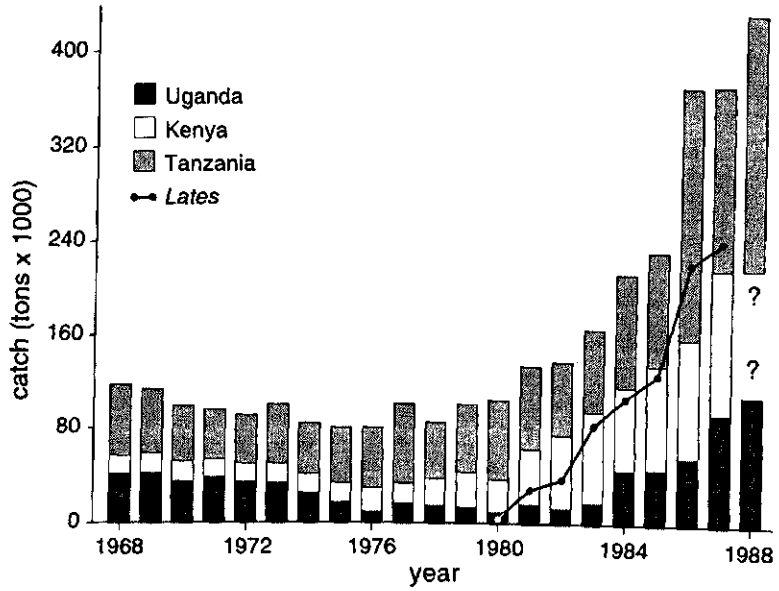

Figure 2.6 Total yield of Lake Victoria as reported from Kenya, Uganda and Tanzania over the period 1968-1988. The increase after 1980 was mainly caused by the increase of the annual catch of *Lates* (linegraph) in the three countries. (Sources: CIFA 1982, 1988, 1990, 1992).

2.5 Stocks of other commercial species

Besides *Lates* and *Rastrineobola*, only the tilapiine *Oreochromis niloticus* is important to the fisheries at present. Other taxa, such as catfish (*Bagrus docmak, Clarias gariepinus, Schilbe intermedius, Synodontis afrofischeri, Synodontis victoriae)*, lungfish (*Protopterus aethiopicus)*, cyprinids (*Barbus altianalis, Labeo victorianus)*, characids (*Brycinus jacksonii, Brycinus sadleri)*, mormyrids (*Mormyrus kannume)* and haplochromine cichlids are targeted by very few fishermen, or comprise an occasional by-catch. The stocks of these species are probably too low to support a fishery (see *Table 2.1*).

Oreochromis niloticus, which was introduced into Lake Victoria in the 1950s (Welcomme 1968, 1988), proves to be the only tilapiine which thrives in the presence of *Lates* and forms the base for a recovering fishery. *Oreochromis niloticus* originates from Lake Albert (Uganda) where it co-exists with *Lates*. Co-existence of this tilapiine and *Lates* is also reported from Lake Kyoga (Uganda), where both species have also been introduced (Ogutu-Ohwayo 1985, 1990a,b). The distribution of *Oreochromis niloticus* is mainly restricted to areas with depths of less than 10 m (Kudhongania & Cordone 1974). No data are available concerning the current stock size of this species.

For a summary of biological information of the fish stocks that play(ed) a role in the Lake Victoria fisheries, see Appendix II.

2.6 Recent developments in the fisheries

Catches

The changes in the fish community, brought about by the introduction of *Lates*, resulted in structural changes in the existing fishery. Originally, the diverse fish fauna supported a mainly artisanal multi-species fishery. Besides the tilapiines *Oreochromis esculentus* and *Oreochromis variabilis*, which formed the base of the most important commercial fishery (Graham 1929; Fryer & Iles 1972; Lowe-McConnell 1956a, 1987; Marten 1979), not less than 11 genera supported, continuously or intermittently, a significant fishery. The most important fisheries were those targeting lungfish *Protopterus aethiopicus*, the catfish *Bagrus docmak* and *Clarias gariepinus*, and the cyprinid *Labeo victorianus*. A wide variety of gear was employed: fish-traps, angling rods, long lines, gill nets and beach seines. In *Table 2.2* the characteristics of this diverse fishery are summarized for types of gear and fishing grounds. For a description of the major developments in the fisheries of the lake since 1900 see Ogutu-Ohwayo (1990a).

In the early 1980s, the *Lates* catch increased exponentially. In Kenya, artisanal catches of *Lates*, during 1979-1982, rose from virtually zero to more than 20 000 tons per year, then comprising almost 60% of the total yield (Okemwa 1984; Ssentongo & Welcomme 1985; CIFA 1988; Ogari & Asila 1990; Ogutu-Ohwayo 1990a). In Uganda, the contribution of *Lates* to artisanal catches showed a similar increase between 1979 and 1983 (Okaronon *et al.* 1985; Orach-Meza 1992). In Tanzanian waters, significant catches of *Lates* were recorded from 1982 onwards, and within five years this species comprised 60% of the total yield (Ligtvoet *et al.* 1988; Bwathondi 1990; Ogutu-Ohwayo 1990a).

In addition to the increasing *Lates* catches from all three countries, there are also reports of increasing catches of *Oreochromis* and *Rastrineobola*. Essentially these are now the only three species of commercial importance in Lake Victoria.

Table 2.2 Characteristics of the Lake Victoria fisheries before the expansion of *Lates* stock. The main target species are given for each type of fishing ground, and gears used. Most of the gears captured a variety of species. The importance of the species is designated by a figure: 1 = target species, 2 = important by-catch, 3 = regular by-catch, + = occasional by-catch. Gill net mesh sizes are given in cm.

	Rastrineobola argentea	Haplochromines	*Brycinus* spp.	*Labeo victorianus*	*Schilbe intermedius*	*Synodontis afrofischeri*	*Synodontis victoriae*	*Mormyrus kannume*	*Oreochromis variabilis*	*Oreochromis esculentus*	*Oreochromis niloticus*	*Protopterus aethiopicus*	*Barbus* spp.	*Clarias gariepinus*	*Bagrus docmak*
Littoral															
Traps*				1	1										
Angling**									1						
Long lines										+		1		2	2
Beach seines		1							1	1		3		3	3
Mosquito seines and light	1	3													
Gill nets (stretched mesh)															
2.5-4.5		1	1	3	3	+	3					+			
5.0-6.4				1	1	+	3		+	+		+			
7.5-12.8									1	1		3	+	+	+
14.1-15.4	Not used														
Bottom trawl		1		+	+	+,	+	+	3	2	2	2	+	2	2
Sub-littoral															
Traps	Not used														
Angling	Not used														
Long lines												3		1	1
Beach seines	Not used														
Mosquito seines and light	1	3													
Gill nets (stretched mesh)															
2.5-4.5		1			3		3								
5.0-6.4					1										
7.5-12.8							1			1			+	2	2
14.1-15.4													+	2	1
Bottom trawl		1			+		+	+		+	+	3	+	2	2
Off-shore															
Traps	Not used														
Angling	Not used														
Long lines														3	1
Beach seines	Not used														
Mosquito seines and light	Not used														
Gill nets (stretched mesh)															
2.5-4.5	Not used														
5.0-6.4	Not used														
7.5-12.8							1	1					+	2	1
14.1-15.4													+	2	1
Bottom trawl	Not used														

* Mostly used near river mouths
** Mostly on rocky shores and from small canoes

Although the accuracy of the absolute figures produced by the statistical services in the three riparian states may in part be disputed (Bernacsek 1986; CIFA 1988), it is clear that the total yield from Lake Victoria has increased considerably between 1968 and 1988 *(Figure 2.6)*. Before the appearance of *Lates*, the total fish yield from Lake Victoria seemed fairly constant, of the order of 100 000 tons per year, while, at the end of the 1980s it was four times as great.

Netting materials

For a long time a serious shortage of netting materials existed in Tanzania, due to lack of foreign currency. This shortage became especially clear when the new *Lates* fishery started to develop and demanded larger mesh sizes and thicker twines than were commonly used before. Fishermen proved to be creative and overcame this problem by using various alternative twines (*e.g.* twine from waste materials of car tyre production). That the lack of materials hampered the development of the fisheries was internationally acknowledged by the Dutch Minister of Development Cooperation who granted an import subsidy of one million US dollars to the Tanzanian net manufacturing industry, and by NORAD who provided cheap gill nets for the *Lates* fishermen.

Table 2.3 Survey of the available gill net webbing at the Mwanza Fishnet Manufactureres Ltd in May 1990.

Stretched mesh size (mm)	(inch)	Ply	Net length (m)	Net height (meshes)	Price (Tsh)
Factory manufactured					
25-44	1-1.75	210/2	45	26	565.00
>50	>2	210/2	45	26	515.00
		210/2	90	26	1030.00
		210/3	45	26	795.00
		210/3	90	26	1590.00
		210/4	45	26	995.00
		210/4	90	26	1990.00
		210/6	45	26	1585.00
		210/6	90	26	3170.00
		210/9	45	26	2160.00
		210/9	90	26	4320.00
		210/12	45	26	2880.00
		210/12	90	26	5760.00
		210/15	45	26	3025.00
		210/15	90	26	6050.00
		210/18	45	26	3890.00
		210/18	90	26	7780.00
Exchange rate: 1 US$ = 194 Tsh					

Table 2.4 Survey of the available beach seine webbing at the Mwanza Fishnet Manufacturers Ltd in May 1990.

	Stretched mesh size		Ply	Net length	Net height	Price
	(mm)	(inch)		(m)	(meshes)	(Tsh)
Wing webbing	28	1.125	210/4	135	130	21 600.00
			210/6	135	130	25 920.00
			210/9	135	130	36 000.00
	>50	>2	210/6	165	130	25 920.00
			210/9	165	130	31 680.00
Codend webbing	19	0.75	210/6	54	400	25 920.00
			210/9	54	400	34 560.00
			210/12	54	400	50 400.00
			210/15	54	400	57 600.00
			210/18	54	400	69 120.00
Exchange rate 1 US$ = 194 Tsh						

Table 2.5 Survey of the available net webbing for the *Rastrineobola* fishery in Mwanza in May 1990. Materials originate from the Mwanza Fishnet Manufacturers Ltd, unless indicated otherwise.

Stretched mesh size		Ply	Net length	Net height	Price
(mm)	(inch)		(m)	(meshes)	(Tsh)
6.35	0.25	210/6	54	300	28 000.00*
		210/6	54	600	56 000.00*
		210/7	54	300	32 000.00*
		210/7	54	600	64 000.00*
12	0.48	210/6	54	300	27 360.00
		210/6	54	600	54 720.00
14	0.56	210/4	54	300	8 640.00
		210/4	54	600	17 280.00
Exchange rate: 1 US$ = 194 Tsh					
* Imported from Hong Kong					

Table 2.6 Survey of the available materials used in the manufacturing of nets in Mwanza in May 1990. Materials originate from the Mwanza Fishnet Manufacturers Ltd, unless indicated otherwise.

Item	Specifications	Price
Mending and mounting twines	50/100/200 g spools; ply 201/2 - 60	2 500.00
Polyethylene twines	ply 36 ply 45	1 500.00*
Floats	PVC	45.00*
Exchange rate: 1 US$ = 194 Tsh * Imported from Hong Kong		

Table 2.7 Summary of the characteristics of the three main artisanal *Lates* fisheries. (Mesh size = stretched mesh).

	Gill net fishery	Beach seine fishery	Long line fishery
Size of	mesh 7- 8" (17.8-20.3 cm)	wing mesh 4-6" (10.2-15.2 cm) codend mesh 1" (2.5 cm)	hook 7, 8
Netting material	genuine; tyre twine; split nylon; polyethylene	genuine	
Net length	50-70 m	1000-2000 m	
Number of nets/hooks	30-40	1	800-1000
Number of fishermen per unit	3-5	20-40	2-4
Size range of *Lates*	60-75 cm	30-150 cm	20-150 cm
Modal length of *Lates*	65 cm	50 cm	60 cm
Landed catch (kg)	20-200	800-2000	20-120

Figure 2.7 So called 'General Tyre' twine (dark) and twine made of polyethylene bags (white) for making *Lates* gill nets.

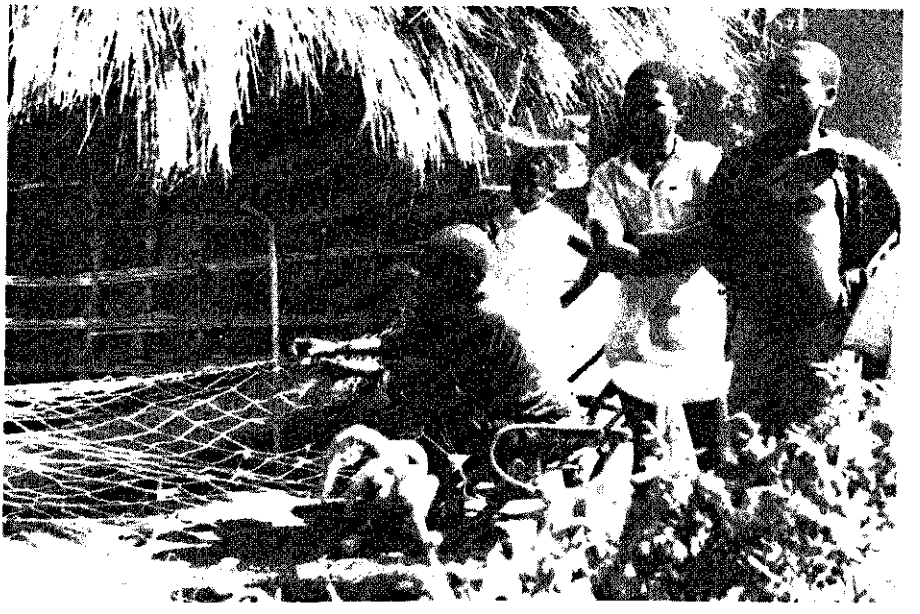

Figure 2.8 Fishermen making a gill net.

By 1990 the situation had improved and Mwanza Fishnet Manufacturers Ltd was able to provide a wide variety of netting materials, supplemented by imports coming mainly from Korea and Hong Kong. *Tables 2.3, 2.4, 2.5* and *2.6* give an overview of the types of webbings and netting materials available in Mwanza in May 1990.

2.7 The *Lates* fishery

General

Men began to fish for *Lates* as early as 1980 in Tanzania, but there was no great increase in this activity until 1984 (Ligtvoet *et al.* 1988) when most fishermen abandoned the traditional fisheries and switched to *Lates*. In the Mwanza Gulf many fishermen used to fish for tilapiines, haplochromines, *Protopterus* and the catfish *Clarias*, while at certain landing sites in the Speke Gulf they used to target *Schilbe*, *Bagrus* and *Clarias* in the main. At present, gill nets, long lines and beach seines are the main gear used in artisanal *Lates* fisheries. Apart from this, a few trawlers are targeting *Lates* in Tanzanian waters.

The switch to *Lates* made it necessary to adapt the gear currently in use. In the gill net fishery, which is by far the most important fishery, the most significant changes occurred: larger mesh sizes and thicker twines came into use. The beach seine fishery, as it was, with relatively small beach seines (100-400 m seines) aiming for tilapiines and haplochromines, gradually deteriorated. At first *Lates* was fished with these small seines, but this proved unprofitable because the nets could be used only in very shallow and inshore waters. A new development in the beach seine fishery is the use of very large beach seines along the shores of the open lake (*e.g.* the Speke Gulf). The long line fishery remained largely unaltered, but where lungfish and catfish were formerly caught, nowadays *Lates* is the chief catch.

Fishing for *Lates* is primarily conducted in the late afternoon and at night, although there are slight differences between the gill net, beach seine and long line fisheries. The time of landing varies considerably, but in general, fishermen aim to land the fish in the early morning. At that time the highest prices are fetched because the fish is in the best condition and the major part of the day is left for processing. Fish landed in the afternoon are more difficult to sell since adequate storage facilities (cold room, ice) are not available.

A discussion of the characteristics of the gear used in the gill net, long line and beach seine fishery for *Lates* is given below, with additional information on the operation, time of landing, and catch of these respective fisheries. *Table 2.7* summarises information on the fisheries and characteristics of the gear used, and compares it with that of the former fisheries.

Gill nets

Due to a general shortage in factory-made netting materials, a wide range of locally available materials was used for making gill nets in Tanzania. As well as nets of the original, and most suitable, nylon netting twine, nets were constructed of nylon thread recovered both from material used by the motor car tyre factory *(Figure 2.7)*, and from split nylon cords. In the early development of the *Lates* fishery, fibres obtained from unravelling polyethylene bags were used *(Figure 2.7)*, but these proved to be too weak and are not seen any more.

The most widely used factory-made multifilament twines, have a ply range of 210/9-210/18. The substitute materials are difficult to classify in terms of ply, but both the tyre and split nylon types are coarse and resemble twine with a ply of 210/15-210/24.

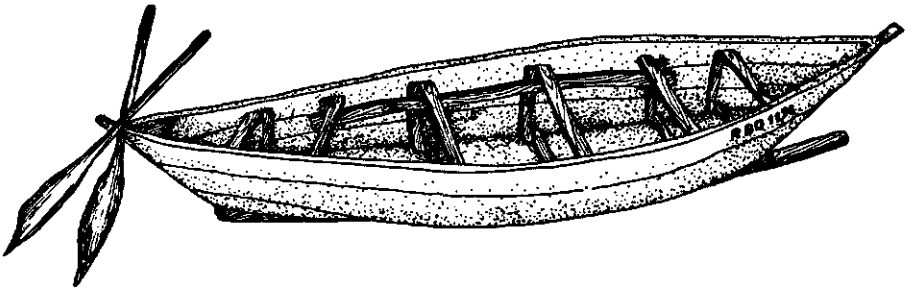

Figure 2.9 Canoe used in Lake Victoria in the artisanal fishery. The figure shows a relatively small canoe.

Figure 2.10 *Lates* fishermen, using gill nets, landing at Igombe.

The majority of the gill nets are home and hand-made *(Figure 2.8)*. The size of the nets made therefore varies considerably. The length of gill nets may range from 20-100 m, but according to the information given by fishermen, nets of 55-75 m (30-40 stretched arms) are the most common. The height of the nets ranges from 1.5-3.5 m, with an average of 2.0-2.5 m equalling 19-25 meshes. The netting is generally mounted with a hanging ratio of 0.5-0.6.

An average gill net fishing unit consists of a canoe *(Figure 2.9)* with a four (minimum 3, maximum 6) person crew and a fleet of 30-40 (minimum 10, maximum 90) nets.

In the inshore *Lates* fishery, the gill nets are generally set late in the afternoon, from 16.00-18.00 h., and lifted at dawn (06.00-07.00 h.) the following morning. Due to the large distances they have to travel and the size of their net fleets, fishermen operating on the offshore fishing grounds often leave their nets in the water permanently and collect their catches during the mornings. A part of the net fleet is regularly brought ashore for maintenance and repair.

The net fleet is anchored and nets are set either at the bottom, or higher up in the water-column. In the open lake, fishermen fish at depths of 10-40 m above the bottom. The depth distribution of *Lates* depends on the prevailing oxygen concentrations in the water column and on the phase of the moon (light conditions at night) (see Section 2.3).

Lates from the inshore fishing grounds is usually landed in the early morning, from 06.00-10.00 h. (*e.g.* at Busisi, Chole and Mkuyuni). Canoes in these areas are moved exclusively by paddling, and travelling time depends mainly on the distance between the fishing grounds and the landing sites. However, *Lates* from the offshore fishing grounds is usually landed by canoes powered by sails or, to a lesser extent, by ones with outboard engines. Times of landing are mostly between 11.00 h. and 14.00 h. Travelling time to and from the fishing grounds varies from one to three hours. However, the strength and direction of the prevailing wind greatly influences the travelling time and thus the times of landings *(e.g.* at Busulwa and Igombe; *Figure 2.10)*.

The gill net fishery for *Lates* is very size selective. The size range of fish caught is similar for all fishing grounds, both shallow and inshore grounds as well as deep water offshore grounds. Most specialized *Lates* fishermen used meshes of 7 and 8" in 1987 and 1988 *(Figure 2.11)*. In 1988 the number of 9" mesh nets was greatly reduced, and this is reflected in the size structure of the catch *(Figure 2.12)*.

By contrast with size distribution, the catch weight landed per canoe depends on the fishing ground. The mean catch per canoe (CpUE) from shallow waters varies from 20-80 kg, but from the deeper offshore grounds, landings of 40-800 kg have been recorded, with 80-160 kg the normal range *(Figure 2.13)*.

Beach seines

The beach seines used are of the type with a bag or codend mounted between two identical wings. In the *Lates* beach seine fishery operating with large seines, larger meshed material is now used in the wings than was used in the seines once used for tilapiines and haplochromines. The largest beach seines now have 6" mesh netting in the wings, tapering to 4" or even 3", with a codend mesh size of 1". The lengths of the two beach seines seen in operation were 1000 and 1200 m respectively (according to the owner), with pulling ropes of about 800-1000 m.

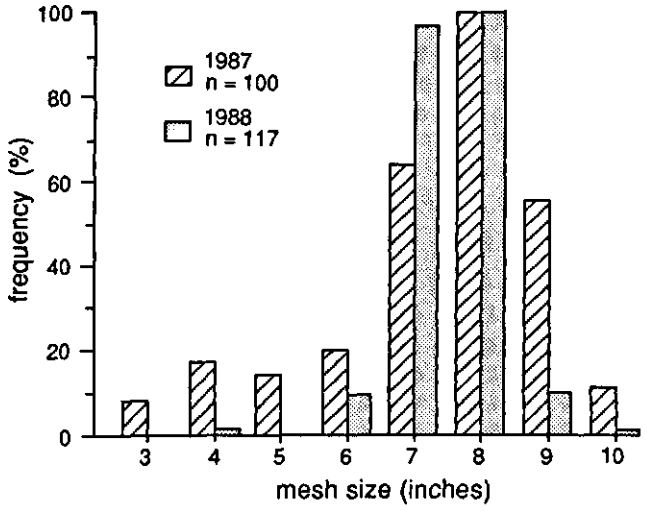

Figure 2.11 Percentage of fishermen using gill nets with stretched mesh sizes from 3-10 inches (7.6-25.4 cm) in the *Lates* fishery in 1987 and 1988. (After Ligtvoet & Mkumbo 1991).

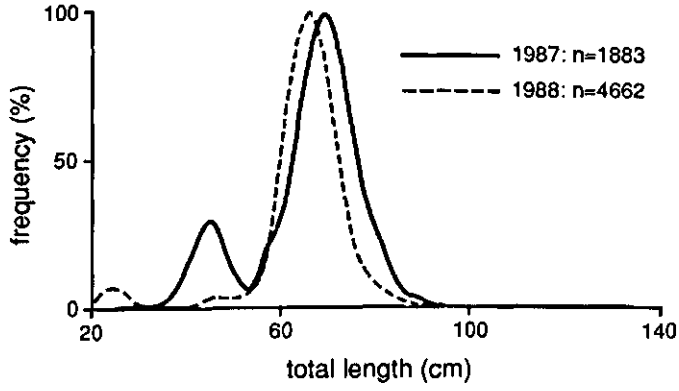

Figure 2.12 Smoothed length-frequency distributions of *Lates* from the gill net fishery at Igombe in 1987 and 1988. (After Ligtvoet & Mkumbo 1991).

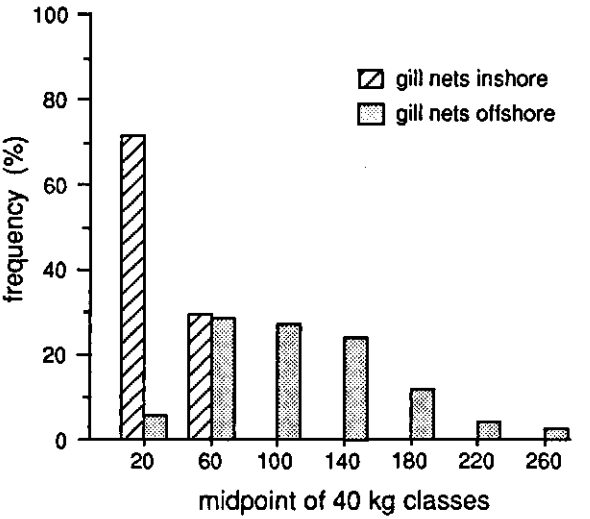

Figure 2.13 Percentage frequency of catches (40 kg categories) per canoe in the *Lates* gill net fishery of inshore waters and the *Lates* gill net fishery of offshore waters. Data for 1987 and 1988 are amalgamated. (After Ligtvoet & Mkumbo 1991).

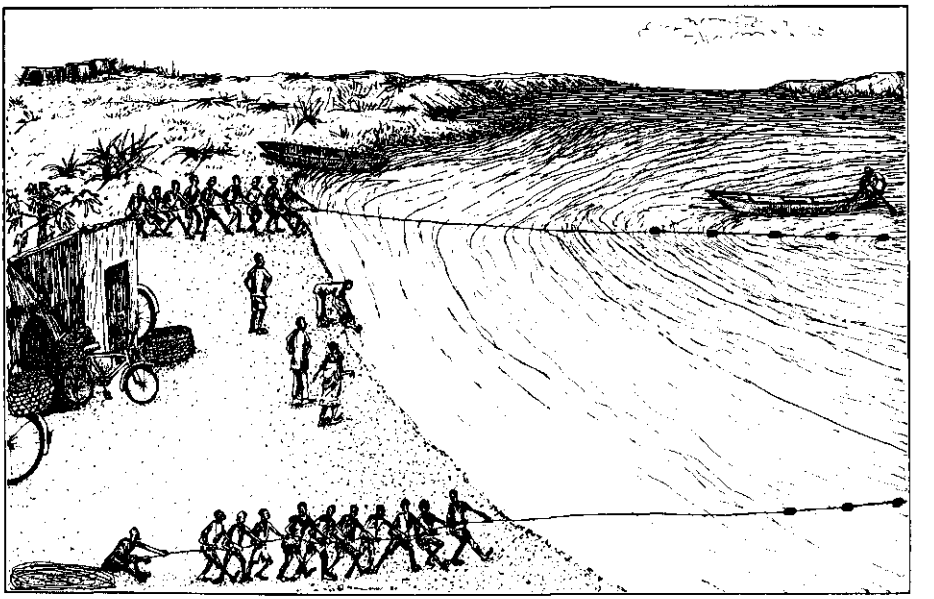

Figure 2.14 Operation of a large *Lates* beach seine by artisanal fishermen.

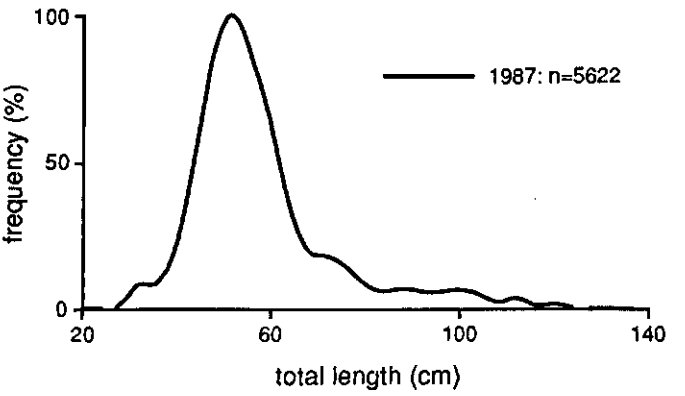

Figure 2.15 Smoothed length-frequency distribution of *Lates* from the beach seine fishery at Semba. (1987) (After Ligtvoet & Mkumbo 1991).

Figure 2.16 Preparation of a long line.

Unlike the situation in the gill net fishery, only factory-made nylon netting material is used to make seines. In 1990, Prado (a gear technologist from FAO) conducted a survey of the different gears used in the Lake Victoria fishery and reported that the webbing of the *Lates* beach seines ranged from R 200 tex-R 3000 tex (Prado *et al.* 1991). This is roughly equivalent to plies of 210/9-210/129 (1 tex = 9 denier, ply 210/9 = 210×9 denier).

The large beach seine unit consists of two wooden canoes, the beach seine, the owner, a number of fishermen permanently employed by him, and a varying number of people to assist in pulling the net. The time needed to complete one haul is 8-10 hours. Usually the seine is set at night around 02.00 h., but depending on the weather (wind) the starting time may be delayed until 08.00 h. To begin the hauling operation, two teams, each of some 12 men, stationed several hundred metres apart, pull in the wings of the seine. As the seine is slowly hauled in, two canoes patrol the outer edges to collect large, floating, dying *Lates*. When the wing ends come close to the shore, the two teams draw together, gradually closing the net circle *(Figure 2.14)*, until they are only a few metres apart. In the last stages the number of helpers increases so that about 40 men are finally involved in landing the seine. Landing time is normally from 06.00-10.00 h., but may be delayed until as late as 14.00 h. After landing, the fish are sold on the spot or transported to nearby landing sites.

Beach seines are not very size selective. Large beach seines capture *Lates* from 25 to over 150 cm TL, with the bulk of the catch at 40-70 cm TL *(Figure 2.15)*. The length-frequency distribution probably reflects the actual population structure of *Lates* in the fishing grounds quite accurately.

The quantity of *Lates* landed per haul varies on average from 800-2000 kg.

Long lines

Hooks of size index 7 and 8 are most commonly used. The number of hooks per canoe varies between 250 and 1250. The majority of canoes were found to operate with 1000 hooks. Individual hooks are tied to ropes of about 1 m length, which in turn are tied to a main line at intervals of about 1.5 m. The rope usually consists of rather thick (ply 210/48) factory-made nylon twine.

Live prey fish are preferred as bait by the fishermen. In the shallower waters the most popular prey fish are rock-dwelling haplochromines, which are obtained by angling on rocky shores. They are normally kept alive (for 2-3 days) in the small waterlayer in the boat, which, due to leaking is more or less continuously refreshed. In deeper waters where there are no rocky shores nearby, fresh *Rastrineobola argentea* (locally known as dagaa) is used, but this species cannot be kept alive *(Figures 2.16* and *2.17)*. In addition to these, pieces of fish (mostly *Lates*) or cut bivalves have been recorded as bait.

An average long line fishing unit consists of a canoe with a crew of 2-4 persons, operating *ca.* 1000 hooks.

Long line fishery targeting *Lates* is largely restricted to shallow inshore waters. The lines are mostly set in the early afternoon and collected the next day at dawn. Landing time is from 06.00-10.00 h.

Long lines catch *Lates* over a wide length range, from 20 up to almost 150 cm TL, with the peak at 50-55 cm *(Figure 2.18)*.

The landed catch per canoe varies widely due to the fact that the presence of one or two large individuals in the catch greatly increases the catch weight. The landed catch per canoe was found to vary from zero up to 180 kg, with an average around 80 kg.

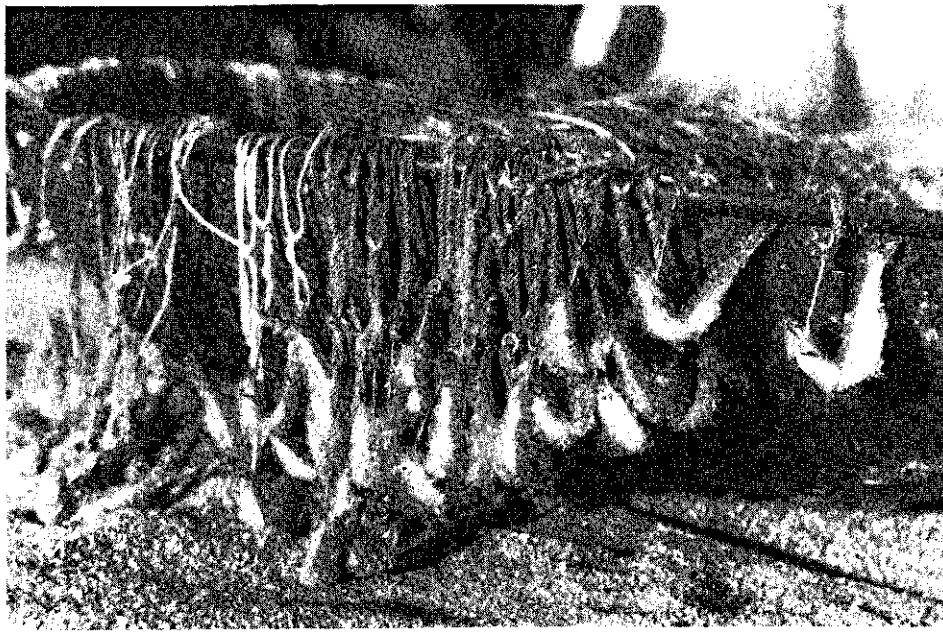

Figure 2.17 Close-up of a long line, baited with dead *Rastrineobola*.

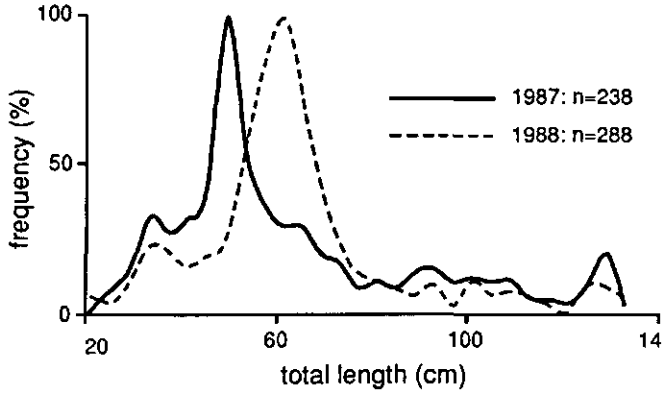

Figure 2.18 Smoothed length-frequency distribution of the catch of the *Lates* long line fishery at Busisi in 1987 and 1988. (After Ligtvoet & Mkumbo 1991).

Figure 2.19 Fisherman selling a *Lates* catch. The catch is grouped in size categories.

Figure 2.20 *Lates* processor at work. The scales of *Lates* are removed and the processor is busy cutting the fish.

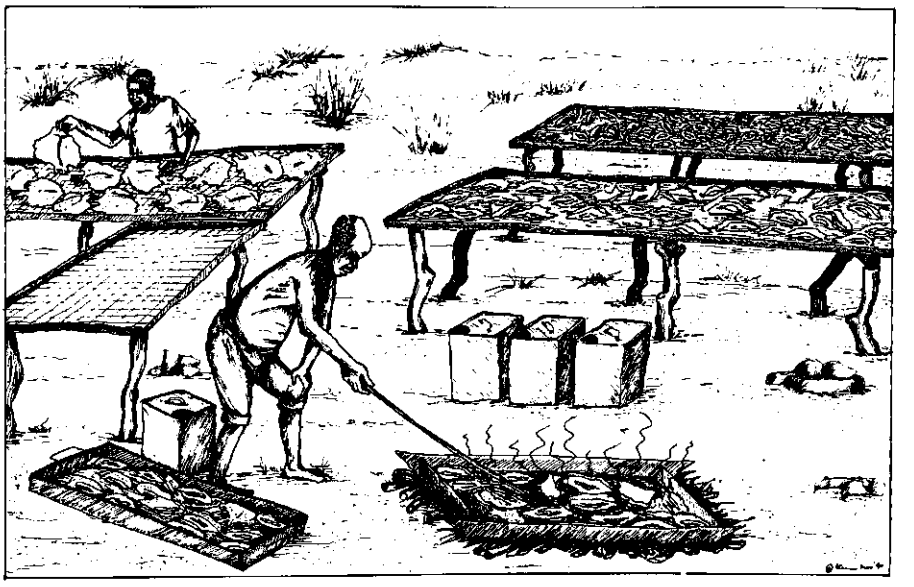

Figure 2.21 Processing of *Lates*. The man in the foreground is frying pieces of *Lates*; the man in the background is turning *Lates* which are drying in the sun.

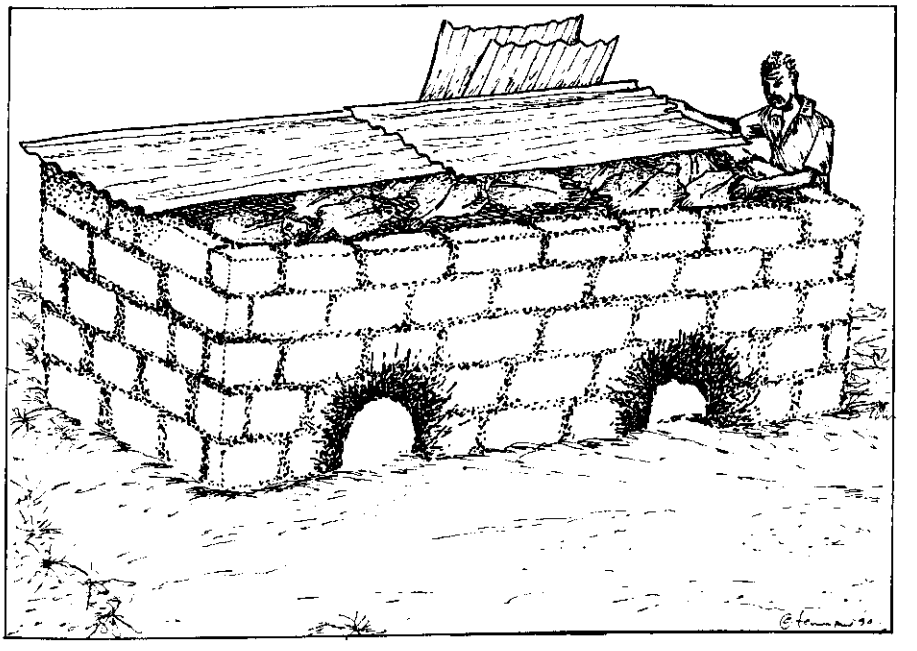

Figure 2.22 Traditional smoking kiln.

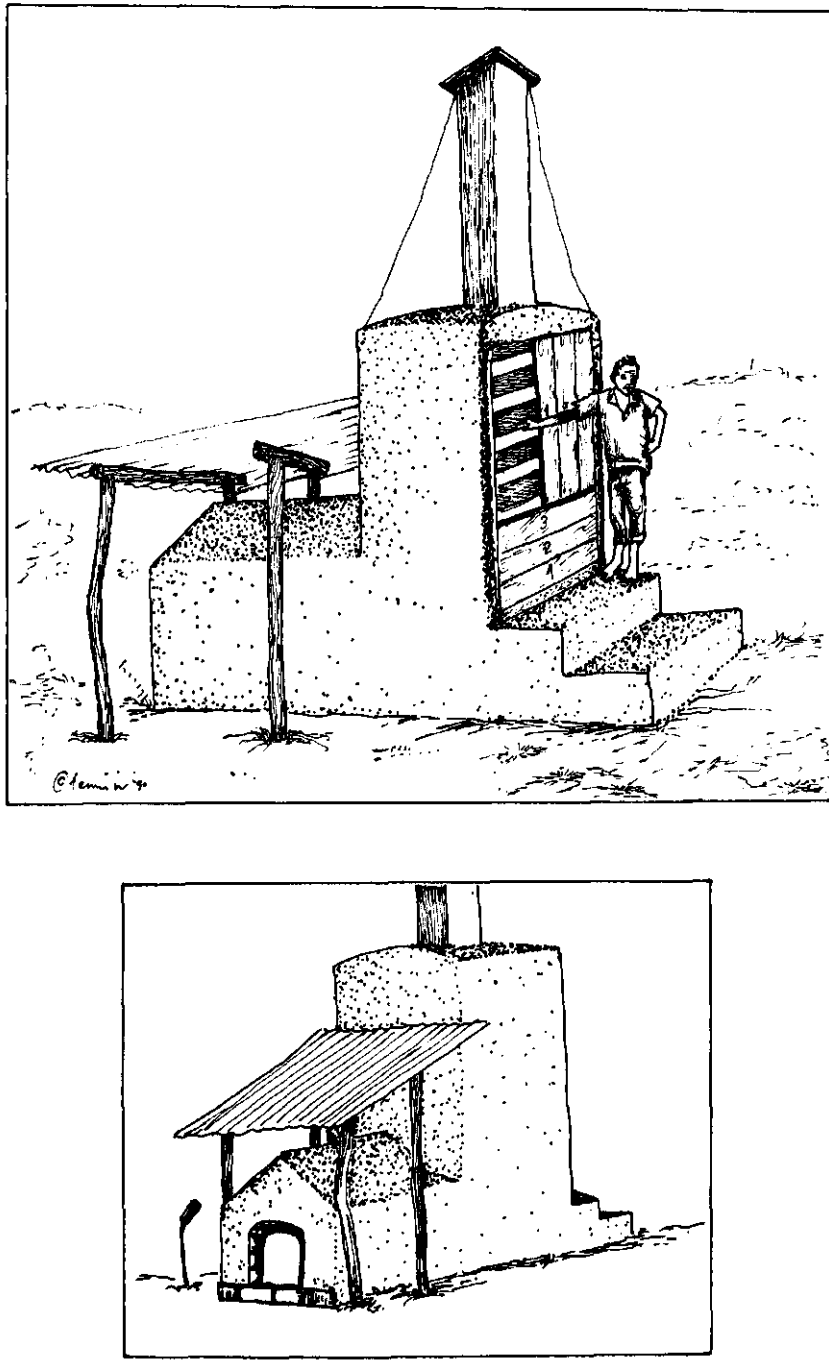

Figure 2.23 Improved smoking kiln.

Figure 2.24 Smoked *Lates* ready for transport at the Mwanza harbour.

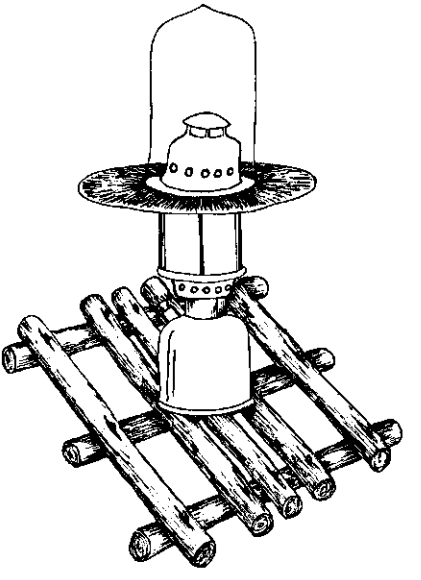

Figure 2.25 Kerosene pressure lamp used in the *Rastrineobola* fishery. This lamp is placed on a small raft.

Processing *Lates*

Most *Lates* is sold off-vessel to small scale traders (often women) and to processors. In some cases the catch of large beach seines is transported by the owner of the gear to the markets of nearby urban areas. This is done with a small truck or Land Rover. For the purpose of selling the fish to small scale traders or processors the catch is often grouped into size categories *(Figure 2.19)*.

Lates processing is carried out in 4 ways:

- Salting and drying.
- Frying.
- Smoking.
- Filleting.

For all these processing methods the fish are cut open *(Figure 2.20)* and the intestines are sorted, since the fat, ripe female gonads and swim bladders have commercial value.

For drying, *Lates* are split along the body axis and are first salted. For frying, *Lates* is generally cut into pieces perpendicular to the body axis and is usually fried in its own fat *(Figure 2.21)*.

Smoking normally takes place in kilns of the traditional type *(Figure 2.22)*, although an improved kiln *(Figure 2.23)* has recently been introduced in the Mwanza area by the Overseas Development Agency (ODA) (Rogers & Tariq 1989). A considerable volume of smoked *Lates* is transported through Mwanza harbour *(Figure 2.24)*.

Since 1992 several fish filleting factories are operational in Mwanza. Fillets on ice are transported to Dar es Salaam for export and local use. Carcasses are smoked in Mwanza.

2.8 The *Rastrineobola* fishery

General

The light fishery for *Rastrineobola* was developed in the mid-1960s (Okedi 1981), and now forms the second most important fishery after that for *Lates*. Four types of *Rastrineobola* fishery are currently being operated in the Tanzanian part of Lake Victoria:

- A beach seine fishery.
- A scoop net fishery.
- A lift net fishery.
- A boat operated, encircling net fishery.

Since the encircling net was only introduced in Mwanza district as recently as February 1990 little is yet known of its catch characteristics.

All these types of fishery are based on the attraction of *Rastrineobola* by an artificial light source. The lamps ('karabai') used in Lake Victoria are all kerosene pressure lamps *(Figure 2.25)*. The brands in use are: Anchor, Mwenge, Butterfly and Petromax (J. Prado pers. comm.). Fishermen claim that they can increase the light production of the lamp by widening the hole where the kerosene flows out. The fuel consumption of a normal kerosene pressure lamp is about 0.2 litres/h. The unit of effort 'lamp burning hours' can be used for all types of *Rastrineobola* fishery (Mous *et al.* 1991). The webbing used in all four types of *Rastrineobola* fishery in

Figure 2.26 Fishermen spreading *Rastrineobola* on the beach for drying.

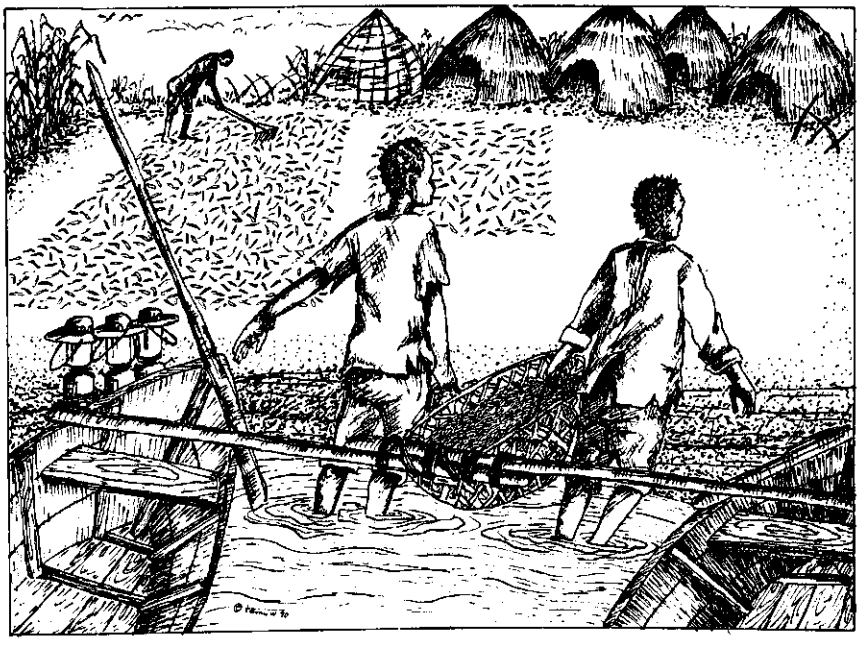

Figure 2.27 Scenery of a beach where *Rastrineobola* is dried. One of the fishermen uses a rake to shuffle the fish.

the Mwanza area is of the same type: knotless with a hexagonal-shaped mesh. Prado *et al.* (1991) reported that this webbing ranged from R 200 tex-R 280 tex. This is approximately 210/9-210/12 ply, which seems high compared with the webbing available from Mwanza Fishnet Manufacturers Ltd *(Table 2.5)*. In the FAO catalogue of small-scale fishing gear, the webbing of a lift net and a scoop net used in the light attraction fishery on Lake Tanganyika (Burundi) was specified as R 152 tex and R 160 tex respectively (FAO 1987). This is approximately 210/7 ply.

The fishermen operate in groups. A *Rastrineobola* fishing group basically consists of a net, a boat, lamps and fishermen. The number of lamps and men per fishing group differs for each type of fishery *(Table 2.8)*. The composition of the lift net units shows less variation than the composition of the scoop net and beach seine groups. The number of nets and boats per group is usually one (a catamaran is considered as one boat). Sometimes a group rents a boat or a net.

Catches of a fishing group are spread on one field, and the catch is divided among the fishermen of that group and the entrepreneur involved (if any). Several groups may live together in one camp and sometimes they even share a net, but the catches of each group are always kept apart. The entrepreneur takes ½-¾ of the catch; the rest is divided among the fishermen. Most groups are migratory; they tend to shift to other sites when catches are not satisfactory or if conditions are not favourable (*e.g.* rough water at an exposed beach).

The method of processing *Rastrineobola* is the same for each type of fishery. The fish are dried on sand *(Figure 2.26)* or on rocks by the fishermen, although a small part of the catch is sold fresh, usually about 20%. The catch is dried for 1-3 days, depending on weather conditions. *Rastrineobola* which cannot be dried in one day are usually of low quality. Low quality *Rastrineobola* is sold as chicken food. While the fish are drying, the fishermen shuffle them once in a while with locally made wooden rakes to speed up the drying process *(Figure 2.27)*. The dry weight of high quality sun dried *Rastrineobola* is 31% of their fresh weight. *Rastrineobola* fishermen all use the same units of measurement for quantifying *Rastrineobola*. For fresh *Rastrineobola* the 'debe' is commonly used. This is a tin which can contain about 20 kg of *Rastrineobola (Figure 2.28)*. Larger quantities of dried *Rastrineobola* are sold per gunny bag, each of which contains about 30 kg of high quality fish or 35-40 kg of low quality fish *(Figure 2.29)*. A bag of low quality *Rastrineobola* is heavier because of the higher water and sand content of the product.

Since *Rastrineobola* fishing is based on light attraction, concentrating fish is more difficult during full moon. Fishing is usually either suspended for a period of 7-10 days around full moon, or it is restricted to a short period before moonrise or after moonset. The landing times are very variable, depending both on the time of moonrise in the period around full moon and on weather conditions. If the fishermen are fishing on their home beach, the catch is spread on the beach immediately after hauling. In some cases the fishermen make several hauls at different places. If so, the catch is spread on the home beach after the fishing night has ended. In this case, landing takes place at sunrise (06.00 h), although it may occur later if the fishermen fish at distant locations.

Catch characteristics

Average and maximum catches per type of fishery and the average CpUE per type of fishery are presented in *Table 2.9* for the beach seine, the scoop net and the lift net fisheries. In *Figure 2.30* the catch weight - percentage frequency distribution of these three types of fishery is presented. The lift net is the most efficient in terms of catch weight/lamp-hour.

Table 2.8 Composition of artisanal *Rastrineobola* fishing groups for each type of fishery in the southern part of Lake Victoria (Mwanza region). n = number of observations. (After Mous *et al.* 1991).

	Beach seine n = 21	Scoop net n = 7	Lift net n = 10	Encircling net n = 1
Average number of fishermen per group	4.4	2.9	4	5
Average number of lamps per group	3.8	2.9	2.9	5

Table 2.9 Catch characteristics of *Rastrineobola* beach seine, scoop net and lift net fishery. Catches were recorded at 2 sites in Mwanza District. The unit of effort is defined as lamp hour. Figures apply to the period October-December 1989 only. Catches of 0 kg were not included in the calculations. Of some catches the effort could not be recorded. n = number of observations. (After Mous *et al.* 1991).

	Average catch (kg/group/night)	Maximum catch (kg/group/night)	CpUE (kg/lamp hour)
Beach seine	80 n = 71	360 n = 71	6.0 n = 31
Scoop net	77 n = 24	640 n = 24	7.2 n = 23
Lift net	480 n = 55	1950 n = 55	28.5 n = 24

Figure 2.28 A fisherman filling a tin (debe) with fresh *Rastrineobola*.

Figure 2.29 Gunny bags of *Rastrineobola* waiting for transport at the harbour of Mwanza.

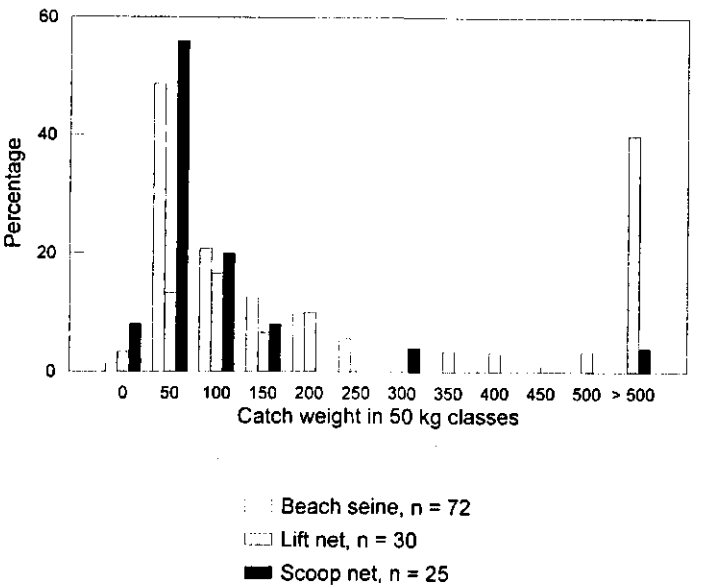

Figure 2.30 Percentage frequency of catches (50 kg categories) per night fishing in beach seine, scoop net and lift net fishery for *Rastrineobola*.

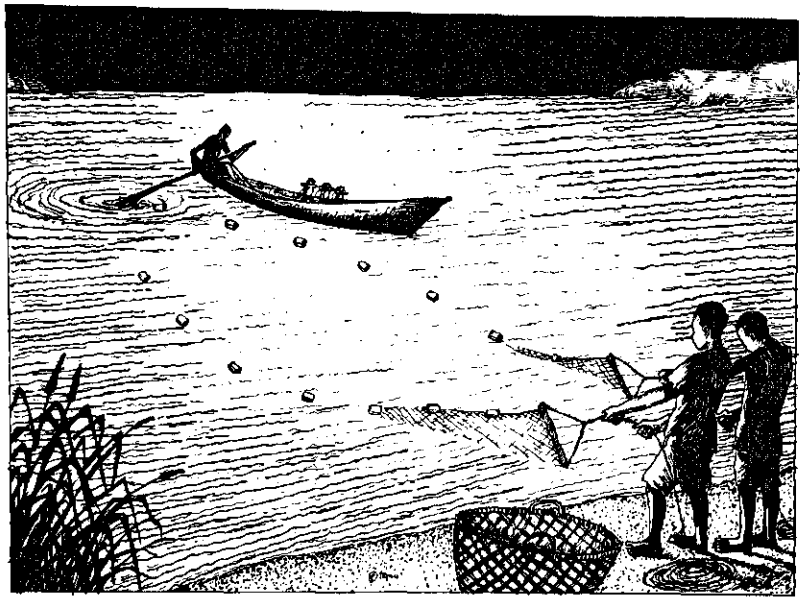

Figure 2.31 Hauling a *Rastrineobola* beach seine. The lamps were already put in the canoe.

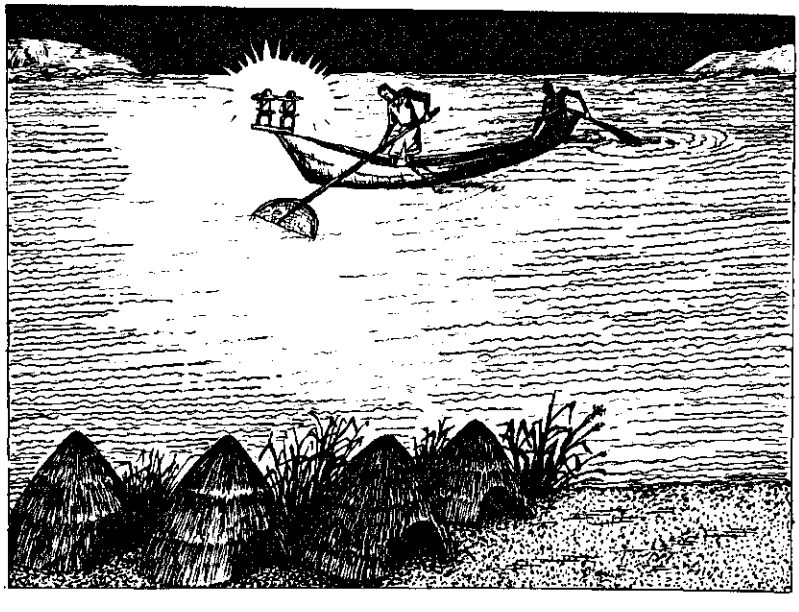

Figure 2.32 Scoop net fishery for *Rastrineobola* with the lamps attached to the canoe.

No catches realised with the encircling net have been recorded, but according to the fishermen the encircling net is more efficient than the beach seine in catching *Rastrineobola.*

The length range of the *Rastrineobola* in the catch of the beach seine, scoop net and lift net fishery was 3-8 cm TL. While the length frequency distributions differ significantly between the three types of fishery the differences cannot be explained by net selectivity, since the mesh sizes used are the same for each type of fishery. However, differences might be due to the variety of locations fished and the catch techniques involved.

The by-catch in the *Rastrineobola* fishery mainly consists of small *Lates* of 2-15 cm TL. Although *Lates* does not usually contribute significantly to the catch, one catch with at least 50% of this species has been observed.

Beach seines

Beach seines for *Rastrineobola* are set from canoes of 5-6 m, and the lengths of the nets ranges from 30-100 m. Seines used in the Mwanza region have towing ropes attached to the wings. The depth of the net ranges from 2.5-4 m and the stretched mesh size of the codend is about 8-10 mm, with the wings usually having a mesh size of 10 mm.

In the beach seine fishery, the lamps are attached to rafts, and then set in a straight line by connecting the rafts with ropes and positioning them approximately perpendicular to the shoreline. The distance between lamps is about 10-20 m and they are set up to within 200 m of the shore. After some time (approximately 3 hours) the lamps are hauled in slowly, until they are grouped together close to the shore. Next, the beach seine is set around the lamps and the net is hauled *(Figure 2.31).* This type of fishery is conducted from sandy beaches only. Okedi (1981) refers to a method where lamps are set more or less randomly along the shore, but this method has not been encountered. The fishermen are said to prefer the 'line method' because it is then possible to operate with more groups along a limited beach space.

The beach seine fishery is very susceptible to weather conditions: rain may extinguish the lamps and wind may overturn the rafts to which the lamps are attached.

Scoop nets

In the scoop net fishery, large scoop nets are used to catch the concentrated *Rastrineobola.* The length of the shaft of these nets is about 3 m and the diameter of the ring of the nets is about 1.5 m. Webbing with a stretched mesh size of 8 mm is used. The depth of the net is roughly 2.5 m.

Two types of scoop net fishery exist in the Mwanza area. The basic difference between the two is the position of the lamps while attracting fish. The lamps are either attached to the boat, or they are on small rafts, floating on the water. In the scoop net fishery with lamps attached to the canoe *(Figure 2.32),* the fishermen lower the scoop net in the water, and when enough fish are concentrated the net is lifted. The fish are stored in the canoe. In the scoop net fishery, with lamps on rafts, the lamps are set in a line as they are in the beach seine fishery. However, there is no fixed orientation of the lamps towards the coast line. The lamps are concentrated after attracting the fish, and the concentrated fish are scooped. One lamp is attached to the canoe, so that the lamps on the rafts can be placed in the canoe before scooping without losing the fish. Both techniques were introduced by fishermen from Lake Tanganyika.

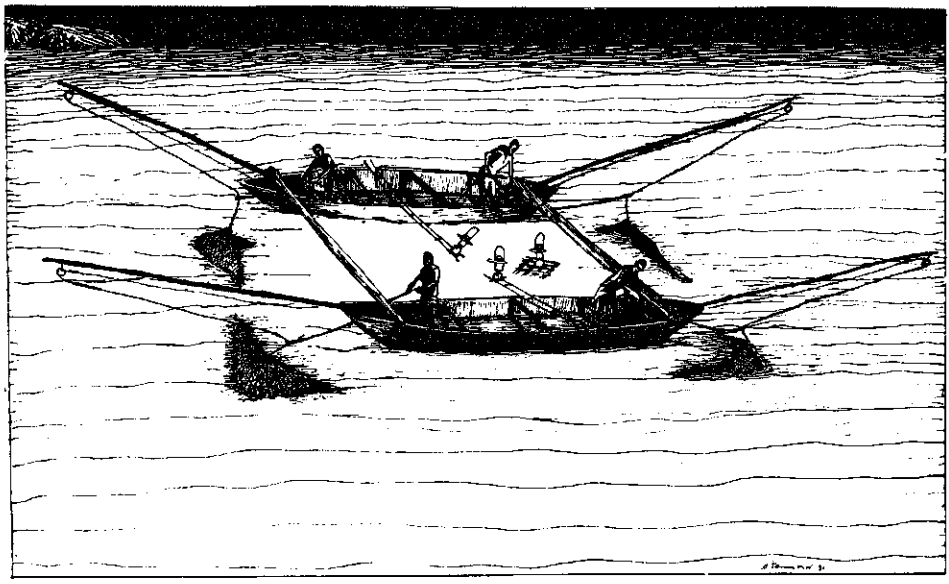

Figure 2.33 Hauling of the lift net to catch the concentrated *Rastrineobola*.

Figure 2.34 Transport of dried *Rastrineobola* to a marketing centre.

Since the lamps are set on rafts, as in the beach seine fishery, this type of fishery is also susceptible to weather conditions. However, hauling the net is less susceptible to weather conditions.

Lift nets

In the lift net fishery a catamaran is used, with the net situated underneath the vessel and kept open by outriggers. The circumference of the net is some 24 m (Nédélec 1975) and the mesh size is about 8 mm. In one case the net consisted of an upper part with a mesh size of 10 mm (not knotless), and a lower part (codend) with a mesh size of 8 mm (knotless).

The catamaran consists of two boats joined together by planks across each end. A lamp is attached to the middle of each of these planks and another lamp is placed on a raft connected to the canoe by a rope of about 10 m length. The catamaran is prevented from drifting by a weight (about 10 kg) under the net which serves as an anchor. After attracting the fish, the lamp on the raft is pulled towards the catamaran and the net is then hauled quickly *(Figure 2.33)*. Sometimes, the two boats which constitute the catamaran are disconnected, and one of the boats is used to transport dried *Rastrineobola* to a marketing centre *(Figure 2.34)*. This fishing technique is practised exclusively by fishermen from Lake Tanganyika. Since most of the lamps are attached to the catamaran, fishing is not very susceptible to weather conditions.

Encircling nets

Only one encircling net was measured. This was operated in the Mwanza Gulf and was 17 m long, 10 m deep and had no towing ropes. The mesh size was 8 mm, and the webbing of the net was knotless.

In the encircling net fishery the lamps are positioned on rafts. These are anchored at random across the fishing ground. Each lamp is treated separately and they are not concentrated before catching the fish. After a lamp has attracted fish, the fishermen connect the net to a small buoy on the anchoring line of the lamp. Then they set the net around the lamp *(Figure 2.35)*. When they reach the beginning of the net again, their boat is anchored. The lamp is kept in the middle of the net with a long stick (about 5 m) while the net is hauled by the lead line, so that the fish cannot escape through the lower end of the net *(Figure 2.36)*.

2.9 Tilapiine fishery

General

The only other fishery of current importance in Lake Victoria is on the tilapiine *Oreochromis niloticus*.

The recent revival of the tilapiine fishery is noteworthy. The introduced *Oreochromis niloticus* is virtually the only species caught. The endemic tilapiines have long been overfished due to the increasing use of smaller mesh sizes (Fryer 1972; Fryer & Iles 1972; Lowe-McConnell 1987). With the increasing importance of *Lates* in the lake, the decline of the endemic tilapiine catches has often been ascribed to this new predator. However, there are no indications that the predation pressure of *Lates* upon tilapiines is high. The native tilapiines may also have been eliminated through competition (Welcomme 1968, 1984; Lowe-McConnell 1987;

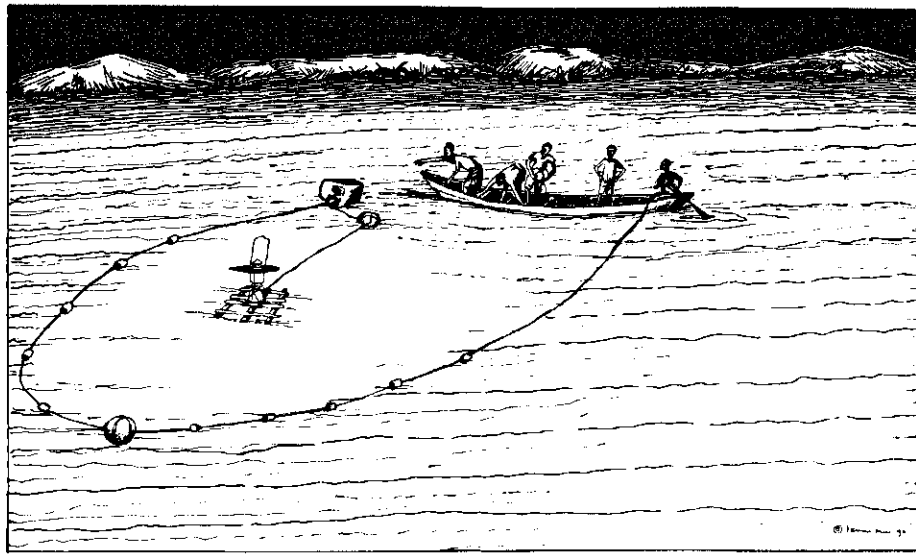

Figure 2.35 Setting the encircling net around the lamp under which *Rastrineobola* is concentrated.

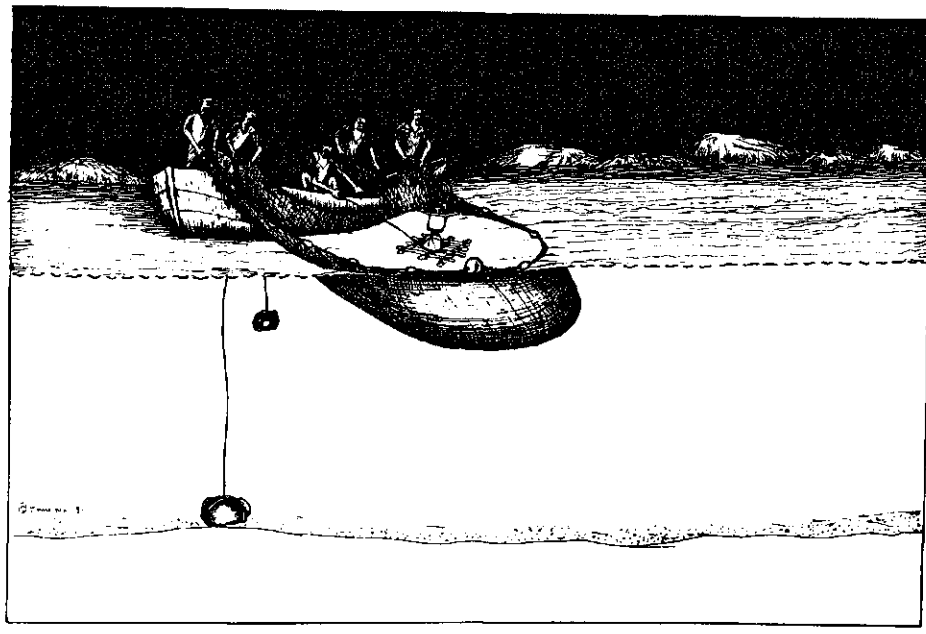

Figure 2.36 Hauling the encircling net. The large stone at the lake bottom serves as anchor for the canoe. The smaller stone is the anchoring stone of the lamp.

Ogutu-Ohwayo 1990a) and/or by hybridization with introduced tilapiines (Ogutu-Ohwayo 1990a). It seems that the large scale shift towards the use of large mesh gill nets specifically to catch *Lates*, and towards exploitation of more offshore fishing grounds, has released the fishing pressure on tilapiines. Currently, catches of *Oreochromis niloticus* are growing, as also is the mean length of the individuals caught compared with the situation at the beginning of the 1980s (CIFA 1988; Ogutu-Ohwayo 1990a; pers. obs.). In the Mwanza Gulf, the *Oreochromis niloticus* population contains large specimens of up to 50 cm TL.

In the Mwanza area *Oreochromis niloticus* is mainly exploited by traditional and artisanal fishermen. Four types of fishing gear are used: gill nets, beach seines, angling rods, and hand lines and traps. Apart from these artisanal fishing methods, a trawl fishery on *Oreochromis niloticus* began in 1990 with two trawlers operating in the Mwanza Gulf.

Since the *Oreochromis niloticus* stock occurs in very shallow inshore waters, it is easily accessible to fishermen. Therefore, it is possible for tilapiines to be fished, not only by professional and fulltime fishermen, but also by numerous laymen who principally use angling rods and hand lines, although a few use gill nets. These people fish mainly on a subsistence level.

Gill nets

Oreochromis niloticus fishermen use gill nets with stretched meshes of 2.5-4.5" (6.4-11.4 cm) which are set in shallow bays and along sheltered shores, often in the vicinity of papyrus vegetation. Since thin twines are used in the webbing (ply 210/2; 210/3 and 210/4), by contrast with the *Lates* fishery, only factory made multifilament nets are used in the tilapiine gill net fishery.

On all fishing grounds the nets are lifted at dawn. Landing time is generally in the morning between 06.00 and 08.00 h., depending on the weather conditions and distance from the fishing ground. In some places, where net theft is common, fishermen spend the whole night guarding their nets.

In addition two illegal gill net fishing methods are practised on Lake Victoria. These are as follows:

- In the evening, nets are placed in shallow water through which people can pass on foot or by canoe. After sunset, bundles of burning grass or palm leaves are carried along the adjacent shores to frighten the fish and immediately after the fire is extinguished the nets are lifted. The perpetrators then go to another area and repeat the procedure, which may occur several times during one night. The fish captured are usually small (about 20 cm).
- Instead of using burning grass to frighten the fish, the water is beaten using a paddle, or a stone tied to a rope fixed to a pole (katuli).

Beach seines

Due to the upsurge of *Lates* in the lake and the demise of the endemic tilapiines, the original beach seine fishery declined in importance during the 1980s. However, since the establishment and increase of the *Oreochromis niloticus* stock, beach seining is again becoming popular.

The beach seines used for *Oreochromis niloticus* now, are of the same type and dimensions as those formerly used for haplochromine and tilapiine fisheries. In the Mwanza area beach seines range in length from 100-400 m, with heights of 2.5-4 m, and ropes 200-400 m long. The wings are of 2 or 2.5" mesh size while the codend is constructed of 1 or 0.75" mesh.

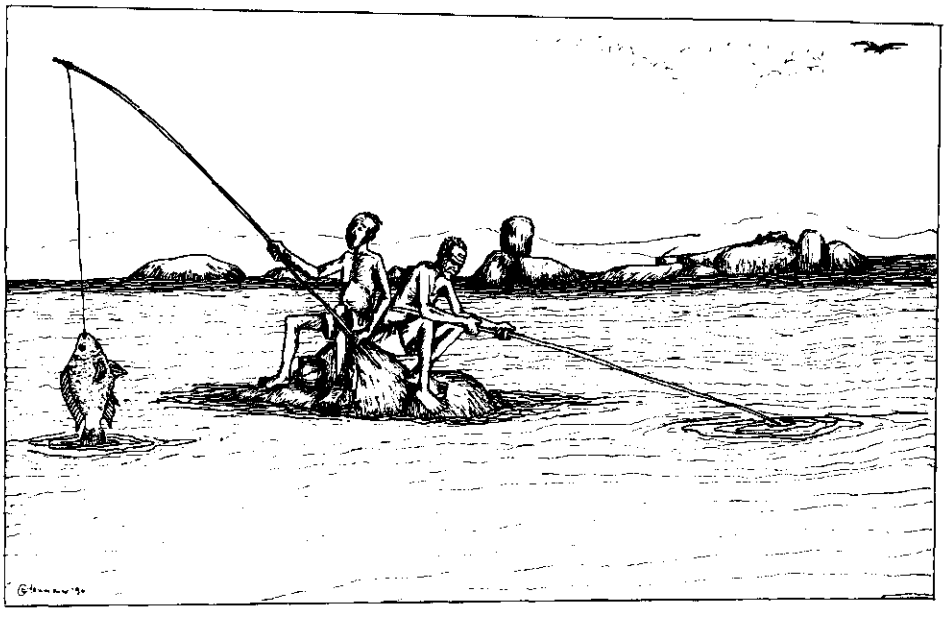

Figure 2.37 Fishermen angling for tilapiines.

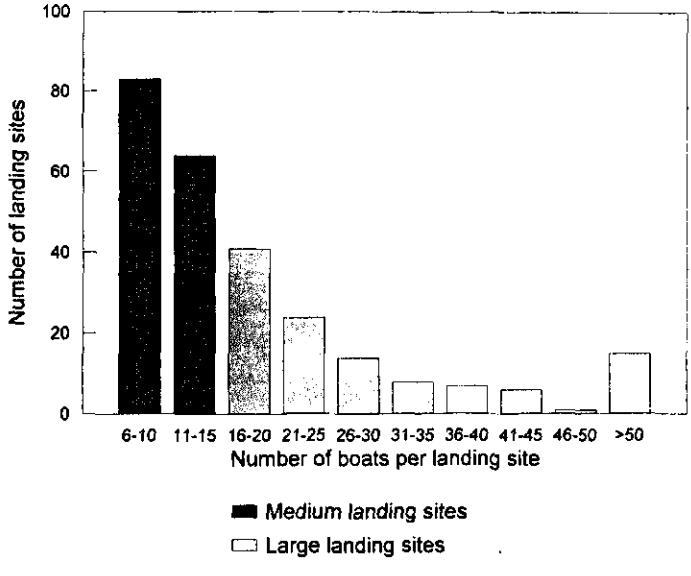

Figure 2.38 Frequency distribution of number of landing sites per class of 5 boats in the Tanzanian part of Lake Victoria. The biggest landing site had *ca.* 200 boats. Data are from the canoe census conducted by the Tanzanian Fisheries Division in 1987 and 1988.

Each net is operated by 8-20 fishermen. In the southern part of the Mwanza Gulf, fishermen started to operate a large beach seine in 1989 and claim to make remarkably high catches of 2000-3000 *Oreochromis niloticus* individuals per haul.

Angling rods and hand lines

This gear is simple, relatively inexpensive and can be operated from the rocky shores *(Figure 2.37)* or small boats. Smaller tilapiines are caught from the shore. The line with a baited hook is lowered into the water until it rests on the bottom. It is then moved slowly up and down. In most cases the baits consist of worms, but clumps of long algae are also used. Professional fishermen often use more than one rod per man. Professional angling takes place by day from early morning to 14.00-16.00 h., after which the fishermen try to market their catches. Sometimes the water is baited by pouring the left-overs from brewing beer into the lake at favoured fishing sites.

Traps

Fishing with traps or weirs is probably the only primitive fishing technique which is still used in Lake Victoria. A chamber with a narrow entrance is built with stalks of *Phragmites* reed, by setting the stalks close together in the lake bottom. Although some other fish species are also caught by this method, it is the tilapiines which form the prime target. Catches are usually low and only small individuals, up to 25 cm long, are caught. A trap is built at no cost except for labour and lasts for a few weeks. This gear is used primarily in the rainy season.

2.10 Description of the landing sites

General

Landing sites or beaches are determined by proximity to fishing grounds and local market potential. The latter is influenced by population density and the accessibility of the area. Both factors influence the number of boats or canoes which land at a given site, and also the type of fishery and the extent of post-harvest activities. The number of boats landing are here used to categorize landing sites into three groups: small, medium and large landing sites *(Figure 2.38)*. A map showing the distribution of the larger landing sites (>10 boat landings per day) along the Tanzanian coast is included in Chapter 8 *(Figure 8.1)*.

Small landing sites

Type of fishery

The number of boats landing is less than five. The boats are propelled by paddles. The fishing grounds are generally in the littoral (<6 m deep) and sub-littoral (6-20 m deep) waters. The fishermen do not normally target a specific type of fish. The fisheries are to serve the fishermen and their neighbours with fresh fish for direct consumption. The fishermen normally fish with simple gear. The majority of the gill nets in use have small mesh sizes (2-5"), and the beach seines are of the types formerly used for haplochromines. The catches comprise mostly juvenile *Lates*, although *Oreochromis niloticus* is caught along papyrus covered

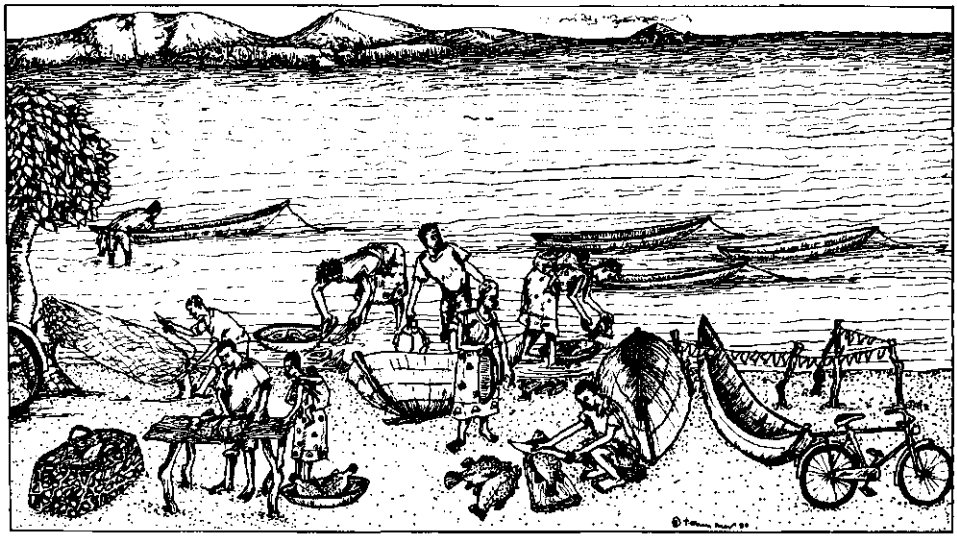

Figure 2.39 Scenery of a medium sized landing site. Some processing takes place (chopping of *Lates*, some swim bladders are drying). At this site mainly *Lates* is landed.

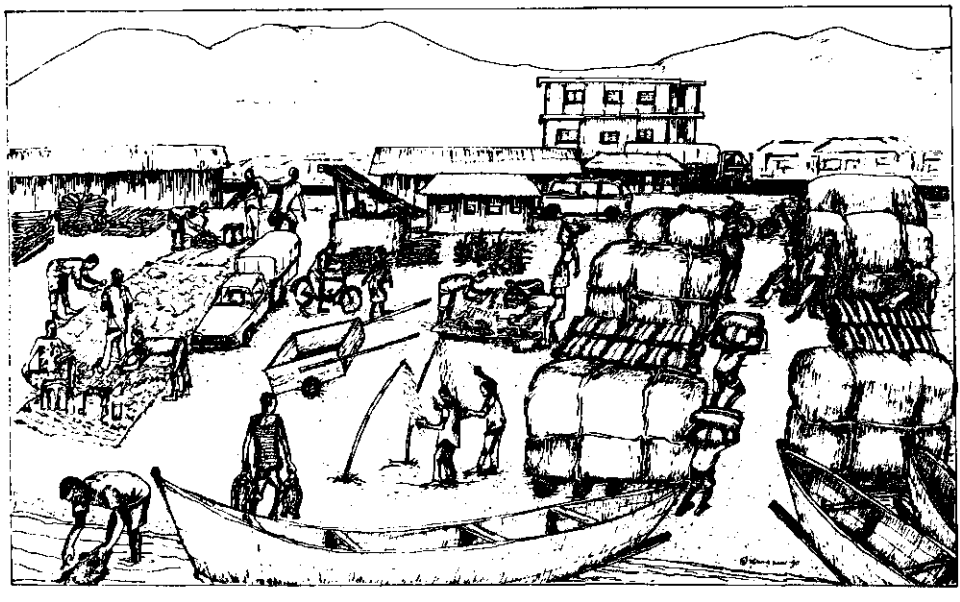

Figure 2.40 Artist's impression of Kirumba, the harbour of Mwanza. A lot of trade takes place, gunny bags of *Rastrineobola* are stored and waiting for transport. Transport takes place with wheel barrows, cars and trucks.

shores. Angling for *Oreochromis niloticus* is very common at this type of landing site. The landing sites of *Rastrineobola* fishermen frequently meet the criteria for small landing sites. These fishermen often migrate, and the number of fishing groups which can land on a certain beach is often restricted by the space available for drying *(e.g.* at Nyegezi, *Figure 1.2).*

There are no statistical data on fisheries from these landing sites and thus the catches from them are not recorded.

Post harvest activities

The main activity is the sale of fish direct to consumers who take it home to be processed for consumption.

Distribution

This type of landing site may be located anywhere along the shores of Lake Victoria, and in total there are several hundreds around the whole lake shore.

Medium landing sites

Type of fishery

The number of boats landing ranges from 5-15. The boats are mostly propelled by paddles, but sometimes with sails. The fishing grounds range from shallow littoral waters to deep offshore waters (up to 30m deep). In bays fringed with papyrus, and in shallow muddy waters, gill netting for *Oreochromis niloticus* and *Lates*, and long lining for *Lates*, *Protopterus* and *Clarias* are the predominant types of fishery. Gill net fisheries on *Schilbe* may also exist. Examples are the Chole and Busisi landing sites in the southern part of the Mwanza Gulf *(Figures 1.1* and *1.2).* At landing sites along open sandy shores, *Lates* fishery with gill nets and beach seines predominates. Examples are the Mkuyuni and Semba landing sites *(Figure 1.2).* Landing sites on island shores are mainly for the *Rastrineobola* fishery. Examples are on Bwiru and Kamasi Islands *(Figure 1.1).*

Fisheries statistical data are collected at a number of these landing sites in Tanzanian waters (Bernacsek 1986).

Post harvest activities

A number of activities are found on these landing sites, depending on their location *(Figure 2.39).* At some landing sites fishermen sell the fresh fish to local consumers or to fish mongers. The latter transport the fish by bicycle to inland markets. At other sites, like Mkuyuni, small-scale processors are found, the majority being women.

A few young men are found doing the gutting, scaling and chopping of *Lates*, whilst it is the women who clean the pieces and take them home for frying before they are sold. The fish choppers collect and dry the swimbladders of *Lates*. The salting and sundrying of *Lates*, on quite a large scale, is also practised at the Mkuyuni and Semba landing sites. Sundrying is practised at all the *Rastrineobola* landing sites.

Distribution

This type of landing site is located near populated areas. The landing sites are accessible by road at least during the dry season. There are *ca.* 150 of these landing sites along the Tanzanian part of the lake *(Figure 2.38).*

Large landing sites

Type of fishery

The number of boats landing is usually more than 15 and is as many as 60 at a few landing sites. Some of the boats use paddles or engines, but the majority use sails. The fishing grounds are generally in offshore waters (up to 40 m deep). The catches are dominated by *Lates*, with but some catfish are caught. In the rainy season some fishermen are also found targeting *Schilbe* and *Brycinus*. Examples of this category are Kirumba *(Figure 2.40)* near Mwanza town, Igombe on the southern shore of the Speke Gulf and Busulwa, also on the southern shore of the Speke Gulf near Magu town *(Figures 1.1* and *1.2)*.

Fisheries statistical data are collected at a number of these landing sites in Tanzanian waters (Bernacsek 1986).

Post harvest activities

The activities going on are similar to those of medium landing sites but more intensified. Some sites are very important for both fish landing and fish processing and marketing, for example Igombe. Here the fish are bought by fish traders who take them to other markets by car. Also, some fish are bought by processors who process them immediately and take them to nearby kilns, of which there are more than 50, for smoking. Some processors deep fry pieces of fish using the fat from *Lates*. Some traders come with lorries to transport the smoked or fried fish to inland markets or to neighbouring countries. As a result of the fishery industry some secondary business has developed at these landing sites like the sale of firewood, fruit, food and clothing.

At Kirumba, the main port for Mwanza town, over 60 boats land catches from distant fishing grounds. The majority are powered by outboard engines and are used for collecting the fish rather than for fishing. In addition a number of big sailing canoes come from the islands with dried *Rastrineobola*, smoked *Lates* and *Oreochromis niloticus*. About half of the total *Rastrineobola* catch from the Tanzanian side of Lake Victoria is landed at, and transported through, Kirumba (Mous *et al.* 1991). This site has now developed as a market centre where many other goods are also sold. The buying and selling of *Lates* is carried out by commercial brokers. Fish are chopped for frying here and *Lates* oil is sold. Netting material is sold at the landing site, especially motor car tyre twine.

Since 1992 large quantities of *Lates* are also brought straight to the fish filleting factories in Mwanza.

Distribution

Large landing sites are normally found near towns or village centres with high population densities, or at least where there are settlements in the area around the site. The roads to landing sites are generally passable throughout the year. Over 100 large landing sites are present along the Tanzanian coast of Lake Victoria *(Figures 2.38* and *8.1)*.