Aspects of the fishery of the Eastern Caprivi, Namibia

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ABSTRACT

Surveys of fishermen and fishing activities during 1975, 1976 and 1980 show that more than 700 people were part-time fishermen. Large mesh gill nets were used to catch predominantly large cichlid species and catfish. The total annual gill net catch in 1980 was estimated at more than 700 000 kg but may be considerably higher. Experimental gill net catches yielded higher catches in the small mesh nets, indicating a resource that was underutilized by the commercial fishery. Traditional fishing was considered to be complementary to the existing gill net fishery, cropping at least 54 different fish species. Although gill-net fishing could be rewarding provided the fish could be marketed, scarcity of nets and risk elements posed limits on the growth of this industry. Management and control are recommmended to conserve fish stocks and prevent possible overharvesting.

INTRODUCTION

In contrast with the rest of the generally dry interior of Namibia (previously South West Africa), the areas on the northern and eastern border have perennial or temporary rivers with wide seasonal floodplains on which local traditional subsistence fisheries have developed.

Caprivi, at the northeastern corner of Namibia has a few valuable natural resources that are as yet only partially exploited: indigenous forests (Von Breitenbach 1968), tourism and fish.

Aspects of the fish life in Lake Liambezi and other parts of the aquatic systems of Caprivi (Van der Waal & Skelton 1984; Van der Waal 1985), the limnology (Seaman *et al.* 1978) and fisheries of Lake Liambezi (Van der Waal 1980) have been investigated.

Although Lake Liambezi is the largest single water body in Caprivi, producing more than 600 000 kg of fish in 1973-74 (Van der Waal 1980) it may not be the most important in terms of production compared to the extensive floodplains and swamps of Caprivi which together can cover up to 35% of its total surface of 11600 km² (Curson 1947.)

Not only do fish form an important part of the diet of the people of Caprivi but they were formerly exported to Zambia, up to 56 000 kg per month in 1964-65 (Beatty 1969). As shown by Van der Waal (1980), catches in Lake Liambezi declined sharply from 1973 to 1976, concurrent with a rise in water levels of the lake. A subsequent dry period caused a drop in water levels and shrinkage to less than 10% of the normal area of the lake in July 1985 with a concurrent decline of the fishery. The lake dried up completely in 1986.

In order to obtain a picture of the fishery activities in the rest of Caprivi and to make recommendations regarding its management, surveys were undertaken in June-July 1975, January-July 1976 and March-November 1980. The results are reported on in this paper.

METHODS

Three surveys were conducted by one to six trained Basubia fisheries guards visiting all villages within reach of open water in their areas. At each village, net owners were approached and questioned regarding their nets, other fishing apparatus, ownership of dug-out canoes *(Mikolo,* Lozi) and frequencies of fishing activities. The catch of 1-3 days in an area was then monitored at the various landing sites and the number of each fish species caught per effort was recorded, as well as information on disposal of fish, prices, income and problems experienced by fishermen.

To obtain a picture of the available fish stocks and relative abundance of fish species, a series of experimental nets, similar to those used in Lake Liambezi (Van der Waal 1976, 1980), were set out in representative localities in June-December 1975.

STUDY AREA

Caprivi lies in the huge flat inland sand-filled Kalahari Basin. As a result of the 1:7 000 gradient of the Zambezi River between Katima Mulilo and Kasane (Du Toit 1926) and 1:13 000 of the Linyanti-Chobe between the Savuti Channell and Kasane (Mackenzie 1946), both the Zambezi River and Linyanti-Chobe Rivers form wide floodplains or swamps (Figure 1). These two systems have different hydrological regimes with subsequently different effects on habitats, vegetation and aquatic life. Thirty kilometres after entering Caprivi, the Zambezi River opens out to form a wide floodplain. This floodplain constricts again at the eastermost tip of Caprivi where a basalt dyke across the river forms the sill of the floodplain. The Zambezi River shows a typical summer flood regime, with a peak in January-April. The mean flood level is 5,2 m above low level (Curson 1947), but extremes of 2,0 - 8,0 m have been recorded (Kruger 1963). The floodplains of the Zambezi and Chobe east of Ngoma are covered by coarse perennial grasses with thick stemmed aquatic grasses *(Echinochloa* sp.) in lower lying areas. A

number of permanent canals (kasayas) not normally connected to either the Zambezi or Chobe, run north to south. These waters form refuges for fish during the annual dry period.

The Chobe River takes its origin in Lake Liambezi (which seldomly overflows into the Chobe) but it functions more as a drainage of the southern part of the Zambezi Floodplain in Caprivi. This river changes flow direction annually. It drains the Chobe Swamp east of Lake Liambezi towards the Zambezi until the Zambezi River starts rising and the Chobe reverses its flow, changing direction again towards the Zambezi a short period after the Zambezi floods start subsiding (Figure 2). Before the next rainy season, there is also a period of little flow in the upper parts of the river.

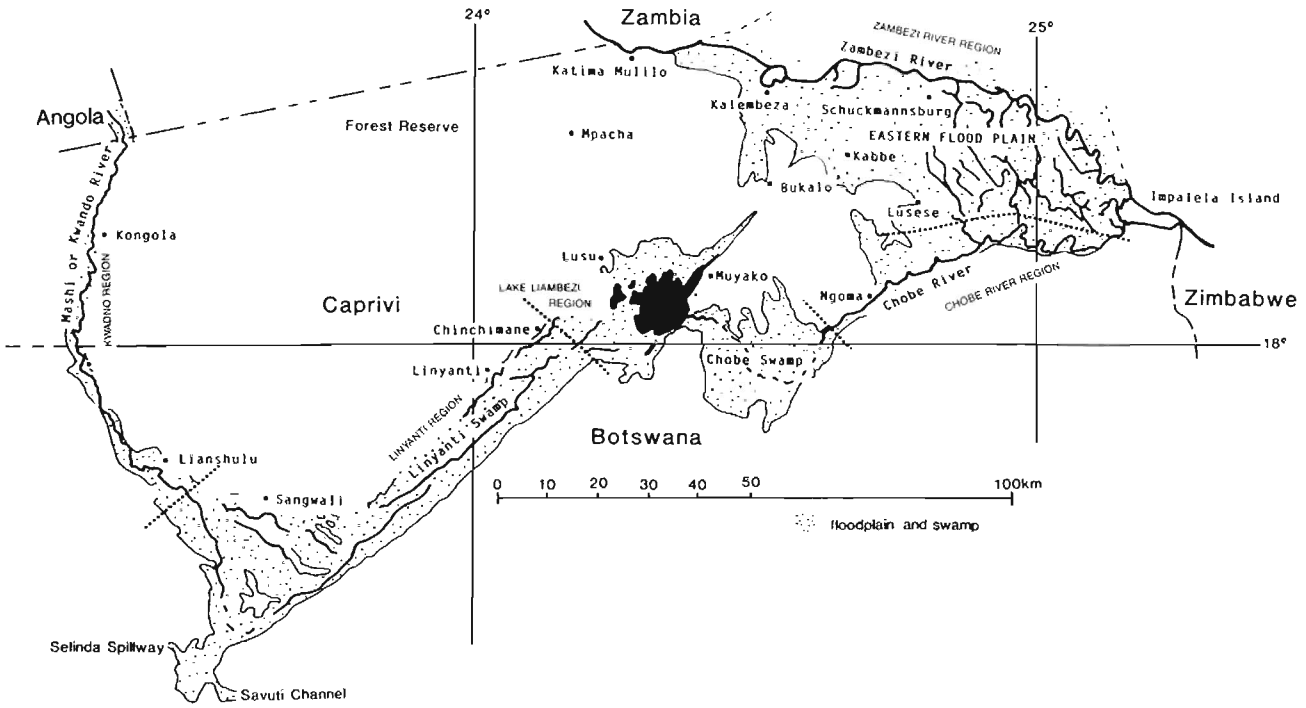

FIGURE 1: Map of Caprivi showing fishing regions.

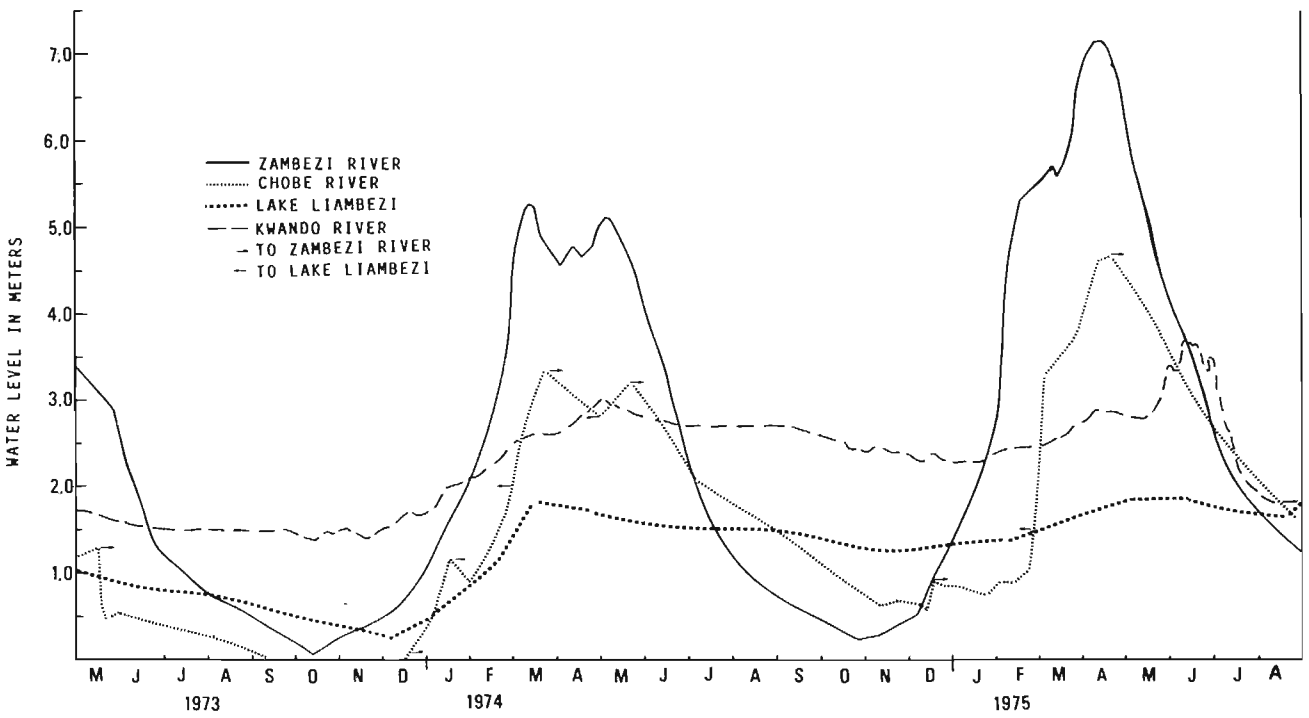

FIGURE 2: Water levels of rivers and Lake Liambezi from 1973 to 1975

In contrast, the Kwando River (Mashi locally) runs in a well defined river valley, 3-5 km wide, bordered by a narrow grass covered floodplain. It winds through a *Phragmites mauritianus* dominated swamp system with many side channels, oxbows and forest-clad islands. The Kwando River floods in Caprivi only in June with the level usually rising 1-2 m (Du Toit 1926; Kruger 1963). After a sharp bend near the inlet of the Magwegana (Selinda) Spillway, the system is named the Linyanti Swamp, characterized by a weakly developed open river blocked at many places by reed beds, meandering from the well defined southern bank to the gradually sloping northern edge of a floodplain on the Caprivi side (Du Toit 1926). Floods reach this section only by July or August and usually do not raise the water level by more than 30 cm.

The end of this system opens out to form a *Phragmites* swamp that contains an ephemeral shallow (0-5 m deep) open sheet of water, Lake Liambezi (Seaman *et al.* 1978; Van der Waal 1985).

RESULTS AND DISCUSSION

Fishermen

During 1975 and 1976 it was possible to survey parts of Caprivi. In 1980 a special attempt was made to cover the whole area but transport problems in the eastern-most part of the Zambezi Floodplain prohibited surveys. The data collected on fishing activities and fishermen should therefore be regarded as minimum values. Table 1 shows that the greatest number of fishermen, (i.e. tribesmen owning and regularly using modern gill nets) lived in the Zambezi, Zambezi Floodplains and Chobe regions, the territory occupied by the traditionally floodplain living and fishing Basubia tribe (Curson 1947). These people inhabit the many forested ridges of the Zambezi Floodplains but migrate with their cattle westwards to higher lying *Colophospermum mopane* woodland west of Kabbe during the flood season. When floods recede, they return to fish and cultivate fields before the rainy season. The total number of fishermen in the Zambezi-Zambezi Floodplain - Chobe Region (Figure 1) in 1980 was estimated at more than 450. In the rest of Caprivi, including Lake Liambezi, only 234 fishermen were surveyed in 1980. The Kwando Region (Figure 1) is inhabited by the Mafwe and Mambukushu tribes. From Lianshulu eastwards, the Linyanti Region (Figure 1) is occupied by the Bayeyi tribe, pastoralists and gardeners. Fishing does not form an important activity of these tribes.

The fishermen fishing Lake Liambezi are mostly of Subia origin and come to the Lake specifically to fish. As shown by Van der Waal (1980), the number of fishermen fishing Lake Liambezi decreased from a maximum of 120 in 1973-74 to a minimum of 17 during one month of 1976. A slight recovery to 47 occurred in 1980. The decline was shown to be partly connected to a temporary lowering in the catch per unit effort with rising lake levels during the 1973-1976 period (Van der Waal 1980). Since 1981, very little flood water from either the Zambezi or the Linyanti Swamp entered the Lake with a resulting decline in water level to 3 m below the 1973 level in 1985, the lake shrinking to only 20 km² by July 1985.

The frequency distribution of the number of years the fishermen had fished with gill nets (Table 2) showed two distinct peaks: The first, 1-5 years and the second 20-30 years, especially in the region occupied by the Basubia. The large number of fishermen that had fished only a few years may indicate that many persons switched to fishing as a part-time occupation.

Fishing Equipment of Fishermen

Modern nylon gill nets were used together with traditional equipment to catch fish. This study concentrated mainly on gill nets but some information on traditional equipment was also collected. Gill nets were bought (if obtainable) as unmounted "blanks" and then mounted by the fishermen themselves or nets

TABLE 1: Number of fishermen and nets recorded in three surveys in Caprivi.

	Survey Year	Region					TOTAL
		Kwando	Linyanti	Liambezi	Chobe	Zambezi & Floodplains	
Number of fishermen recorded	1975	a	a	57	171	136 b	364
	1976	a	28	30	187	277	522
	1980	50	137	47	111	219b (Estimated 340)	564
Gill nets recorded	1975	a	a	445	621	664	1 730
	1976	a	73	187	552	1 598	2 410
	1980	95	330	257	447	797	1 926
Ratio of nets per fishermen	1975	a	a	7,8	5,1	4,9	5,9
	1976	a	2,6	6,5	3,0	5,8	4,4
	1980	1,9	2,4	5,5	4,0	2,9	3,3

a = no survey conducted
b = eastern half of area not surveyed

TABLE 2: Frequency distribution of the number of years fishermen have fished (1980 survey).

No. of years	Number of records		
	Zambezi, Floodplains, Chobe, Liambezi	Linyanti, Kwando	TOTAL
0 – 1	44	39	83
2	25 } 93	63 } 136	88 } 229
3 – 5	24	34	58
6 – 10	20	14	34
11 – 15	14	5	19
16 – 20	13	10	23
21 – 25	60	10	70
26 – 30	40	7	47
31 – 35	11	–	11
36 – 40	15	2	17
41 – 45	2	–	2
46 – 50	1	–	1
51 – 60	7	–	7
61 – 70	6	–	6
Total	282	184	466

were braided from nylon multifilament twine. Only a footrope was used. The floats, doubly bent stems of tall *Cyperus* sp. or 10-15 cm pieces of the highly buoyant stems of *Sesbania sesban* were tied directly to the top meshes at 1 m intervals. The bottom rope was twisted from the inner bark of *C. mopane, Adansonia digitata* or from hessian bag rags and woven directly into the bottom meshes. Gill nets hung 2-2,5 m deep and were mounted at about 50 percent of the stretched length. They were set out in series for 1-10 days at one site, inspected each morning and fish removed. As most of the water systems were shallow (< 2 m), nets often reached from just under the surface down to the bottom. In deeper water, nets were weighted at irregular intervals with brick-shaped fired clay weights. Information on mesh sizes of gill nets used by fishermen is presented for 1976 and 1980 (Table 3). Mesh sizes used ranged from 51 to 152 mm with a higher occurrence of larger mesh nets in the Lake Liambezi, Chobe and Floodplain regions (127 mm) and smaller mesh gill nets in the Kwando, Linyanti and Zambezi regions (76 and 102 mm). Mesh size is one of the principal factors determining not only the size of fish-caught but, as has been shown by Van der Waal (1980), the species caught. The difference of gill net mesh sizes recorded in the various regions of Caprivi could be ascribed to two factors. It might be a genuine mesh size preference, fishermen using the most efficient mesh size for the particular area, or the unavailability of factory-made large mesh gill nets in the more remote areas along the Kwando, Linyanti and Zambezi Rivers. Gill nets were more freely available from both Zambia and Botswana before the deterioriation of international relationships. Shortage of nets in Caprivi was temporarily alleviated in 1975 when 500 nets were sold in a few months by the Caprivian Department of Agriculture. The effect of this inflow of nets was partly evident in the high percentage of 127 mm nets in the 1976 survey in the more accessible eastern regions of Caprivi (Table 3).

The shortage of gill nets for fishing was further illustrated by the steady declining ratio of nets owned per fisherman over the three surveys (Table 1), falling gradually from 5,9 nets per fisherman in 1975 to only 3,3 in 1980. Table 4 gives particulars on ages of gill nets recorded from a sample of 111 fishermen from the eastern part of Caprivi in 1980. No gill nets older than three years were recorded, reflecting the extensive net damage incurred by hippopotami, crocodiles and others. With a total of more than 2 000 nets and a life expectancy of less than two years, nearly 1 000 nets had to be replaced annually.

Table 5 gives information on origins of gill nets, showing a heavy dependence on nets from neighbouring countries or on self manufacture. The remoteness of the Kwando, Linyanti and parts of the Zambezi regions was illustrated by the high percentage of self-made nets.

The second item required for fishing in Caprivi was the dugout canoe. Table 6 summarizes information collected on ownership of mikolo, size and prices in 1975, 1976 and 1989. A ratio of 1,16 mukolo per fisherman was established in 1980 for the Zambezi and Floodplain regions, illustrating the dependence of the fishing industry on the availability of mikolo, mostly bought from Mafwe tribesmen living just south of the Forest Reserve between Kasheshe and Sibinda (Figure 1). Only one mukolo could be hewn from a tree, which were becoming limited in many areas and were protected in the Forest Reserve. Table 6 summarizes data on some measurements of mikolo used in Liambezi in 1975 and the tree species from which they were made. The majority of mikolo were cut from valuable timber species, presently exploited and exported from Caprivi. The recorded ages of mukolo indicated that they might be used up to 40 years. Table 6 also illustrates the considerable inflation in mukolo prices, possibly influenced by the scarcity of suitable tree trunks. Of all the wood species used in the construction, only kiaat and possibly sausage trees stay buoyant and can offer some flotation after capsizing. Of the mikolo surveyed, more than 70 percent would sink.

Fish Catches

Catch per unit effort

The catch per unit effort (c p u e) of commercial gill nets operated by Caprivian fishermen is shown in Table 7. Only small samples over a short period were available but some tendencies in the c p u e in the different regions were evident. In the eastern parts higher returns per net were achieved than in the Kwando (personal observations) and Linyanti regions. The catches recorded for Lake Liambezi for 1975 and 1976 were mean values for those years based on samples of

TABLE 3: Percentage composition of commercial gill net mesh sizes used in Caprivi.

Mesh size of gill nets (mm)	Region																		Percentage composition		
	Kwando			Linyanti			Liambezi			Chobe			Zambezi & Floodplains			Total no. recorded					
	1975	1976	1980	1975	1976	1980	1975	1976	1980	1975	1976	1980	1975	1976	1980	1975	1976	1980	1975	1976	1980
51	–	–	11,4	–	–	1,5	–	–	–	–	–	0,2	0,3	–	1,4	3	–	27	0,2	–	1,4
64	–	–	3,2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	0,1
76	–	–	37,9	–	–	35,2	–	0,2	3,1	–	3,0	6,7	0,6	0,2	17,2	6	23	328	0,3	1,0	17,0
89	–	–	11,4	–	–	1,8	–	–	4,3	–	24,9	5,4	–	–	2,4	–	133	70	–	6,1	3,6
102	–	–	26,3	–	–	28,8	1,2	3,1	12,1	3,1	20,0	32,5	26,4	16,4	23,8	278	343	486	14,3	15,6	25,3
114	–	–	1,1	–	37,3	4,2	32,2	20,3	13,2	46,4	11,8	10,5	42,1	44,2	12,6	793	747	196	40,9	34,0	10,2
127	–	–	3,2	–	62,7	23,9	65,2	72,6	63,8	50,3	40,3	44,2	29,7	39,2	39,7	841	945	761	43,4	43,0	39,5
140	–	–	3,2	–	–	4,2	1,1	3,3	3,5	–	–	0,5	0,2	–	3,0	7	6	51	0,4	0,3	2,7
152	–	–	3,2	–	–	0,3	0,3	0,5	–	0,2	–	–	0,7	–	–	9	1	4	0,5	0,1	0,2
Number recorded	a	a	95	a	75	330	445	187	257	517	534	446	975	1 402	797	1 937	2 198	1 925	–	–	–

a = no survey conducted

TABLE 4: Recorded ages of gill nets owned by fishermen in the Zambezi and Chobe regions in 1976.

Age of net	Number	Percentage
< 1 year	102	16,6
1 year	248	40,3
2 years	203	32,9
3 years	63	10,2
Average age: 1,45 years		

TABLE 5: Origin of gill nets used in Caprivi, 1980 survey.

Origin	Region					Mean
	Kwando	Linyanti	Liambezi	Chobe	Zambezi & Floodplains	
Nets bought, percentage	6,1	18,0	73,9	90,6	66,1	50,9
Nets selfmade, percentage	93,9	82,0	26,1	9,4	33,9	49,1
Zambezi & Floodplains: Number of nets bought from:	CDC, Katima Mulilo Zambian shops Botswana shops				52 51 9	

TABLE 6: Data on mikolo used in Caprivi.

Average number of mikolo owned by fishermen (1980 survey)	1,16
Max number owned per fisherman	4
Number of mikolo counted	131

Dimensions of mikolo, Lake Liambezi, 1975 (n = 35)

	Lenght (cm)	Inner width (cm)	Inner depth (cm)
mean	593	56	28
max	734	79	32
min	513	44	23

Wood species used for construction of mikolo

Species	Common name	*Lozi	Liambezi 1975	1976 Survey
Pterocarpus angolensis	Kiaat	Mulombe	10	22
Baikiaea plurijuga	Rhodesian teak	Mukusi	9	29
Guibortia coleosperma	False mopane	Muzauli	9	19
Kigelia africana	Sausage tree	Mupolota	3	3
Afzelia cuanzensis	Pod mahogany	Mwande	2	7
Acacia nigrescens	Knobthorn	Mukotokoto	1	5
Acacia albida	Ana tree	Muunga	–	2
Combretum hereroense	Russet Bushwillow	Mububu	1	–
Lonchocarpus capassa	Apple leaf	Mupanda	1	–

Age of mikolo	Liambezi, 1975	Survey, 1976	Survey, 1980
Mean age, years	4,17	6,57	6,29
Max. age	17	15	40
Number surveyed	33	88	129

Prices of mikolo			
Mean cost	R23,86	R35,61	R 66,05
Max	–	R67,00	R200,00
Min	–	R15,00	R 10,00
Cattle	–	1,15	1,09
Bought with cattle (%)	–	46	8

* Lozi names from Breytenbach, 1968

393470 and 148190 fishes recorded (Van der Waal 1980) (not included in totals of Table 7).

The average length of a mounted net determined from a sample of 113 nets on the Zambezi Floodplain in 1980 was 42,95 m, (range 10-67 m) compared to 44,5 m recorded for Liambezi in 1975 (Van der Waal 1980).

Catch per fisherman per fishing day

There was a steady drop in number of fish caught per fisherman over the study period. This could be attributed to a lower c p u e in some regions (Zambezi, Floodplains and Chobe) and to fewer nets owned per fisherman. The lower c p u e might be associated with smaller floods during the later years (Welcomme 1974).

Fishing effort and total catch

It was difficult to establish the real effort of fishermen on the basis of three surveys. Table 8 summarizes information collected from questionnaires on which an estimate of total crop was made, using cpue, number of fishermen recorded and frequency of fishing activities as recorded in questionnaires. The estimated total mass cropped in 1980 was based on an average fish mass of 580 g, determined from a sample of 3723 fish from commercial nets weighed in 1980 in the Zambezi-Chobe regions and Lake Liambezi.

The estimated total annual harvest of 773 000 kg in 1980 may be an underestimate for the whole of Caprivi as the annual harvest removed from Lake Liambezi alone in 1973-74 was 637 000 kg of fresh fish (Van der Waal 1980). The annual harvest may vary

TABLE 7: Catch per unit effort of commercial gill nets in Caprivi as determined during surveys in 1975, 1976 and 1980.

Surveys	Year	Region					Total weighted mean
		Kwando	Linyanti	Liambezi	Chobe	Zambezi & Floodplains	
Number of fish caught per net set over a one night period	1975	a	a	2,4	4,2	5,9	4,2
	1976	a	1,6	2,2	4,7	4,1	3,2
	1980	a	a	2,9	3,0	2,6	2,8
Number of fish on which cpue is based	1975						15 973
	1976						23 304
	1980						4 204
Mean number of fish caught per fishermen per night	1975	a	a	18,9	21,5	28,7	23,0
	1976	a	4,2	13,5	13,9	23,9	13,9
	1980	a	a	13,9	16,4	15,5	15,3
Potential income per active fishing day at ruling fresh fish prices	1975	a	a	R1,43	R4,38	R1,80	R2,54
	1976	a	R1,03	R1,82	R0,74	R2,70	R1,57

a = not recorded

TABLE 8: Frequency of fishing activities and annual total crop computed from 1980 data.

	Region					
	Kwando	Linyanti	Liambezi	Chobe	Zambezi & Floodplains	Mean
Number of days fished per week	2,3	2,8	5,9	2,1	3,0	3,1
Frenquency fished during the year:						
Whole year (recorded as 200 days)	49,0%	47,7%	97,9%	61,0%	77,2%	
Winter season (recorded as 60 days)	28,6%	14,1%	0,0%	38,7%	8,7%	
Infrequently (recorded as 30 days)	22,5%	38,2%	2,1%	0,0%	14,1%	
Estimated number of mandays fished per year	6 140	15 900	9 230	16 180	55 640	103 090 (Total)
Estimated number of fish caught per year	9 200	66 800	128 300	265 400	862 400	1 332 100 (Total)
No. of fishermen	50	137	47	111	340	685
Estimated mass of fish cropped in 1980 (one fish = 580 kg)	5 300 kg	38 700 kg	74 400 kg	153 900 kg	500 200 kg	772 600 kg (Total)

considerably from year to year. The c p u e of commercial gill nets in the Zambezi and Floodplain regions fell from 5,9 fish in 1975 to 2,6 in 1980. Similarly, a drop from 4,0 fish per netting effort in the 1973-74 period to 2,2 in 1975-76 was recorded in Lake Liambezi (Van der Waal 1980).

Species composition of commercial catches

Table 9 presents a list of fish species recorded in commercial and experimental gill nets. All the larger fish species of Caprivi were represented in commercial catches, with the exception of *Barbus codringtonii, Labeo lunatus* and *Serranochromis (Sargochromis) greenwoodi* (Van der Waal & Skelton 1984). While these exceptions all grow to a size large enough to be caught by commercial gill nets, they are stream-loving or rare (Bell-Cross 1974).

The composition of commercial gill net catches recorded during the 1975 and 1976 surveys is summarized in Table 10. In all regions, commercial catches

TABLE 9: Fish species recorded from commercial and experimental gill nets in surveys during 1975, 1976 and 1980 in Caprivi.

Species	Standard English name	Lozi name	Commercial gill nets	Experimental gill nets
Marcusenius macrolepidotus (Peters, 1852)	Bulldog	Nembele	×	×
Mormyrus lacerda Castelnau, 1861	Western bottlenose	Ndikusi	×	×
Petrocephalus catostoma (Günther, 1866)	Churchill	Ninga	–	×
Hydrocynus vittatus (Castelnau, 1861)	Tigerfish	Ngweshi	×	×
Alestes lateralis Boulenger, 1900	Striped robber	Mbaala	–	×
Hepsetus odoë (Bloch, 1794)	African pike	Molumesi	×	×
Barbus peochii Steindacher, 1911	Dashtail barb	Mbaala	–	×
Labeo lunatus Jubb, 1963	Upper Zambezi labeo	Linyonga	–	×
Auchenoglanis ngamensis Boulenger, 1911	Zambezi grunter	Sabela	–	×
Schilbe mystus (Linnaeus, 1758)	Silver catfish	Lubango	×	×
Clarias gariepinus (Burchell, 1822)	Sharptooth catfish	Ndombe	×	×
Clarias ngamensis Castelnau, 1861	Blunttooth catfish	Nkoma	×	×
Synodontis leopardinus Pellegrin, 1914	Leopard squeaker	Singongi	×	×
Synodontis macrostigma Boulenger, 1911	Large-spot squeaker	Singongi	×	×
Synodontis nigromaculatus Boulenger, 1905	Spotted squeaker	Singongi	×	×
Synodontis woosnami Boulenger, 1911	Upper Zambezi squeaker	Singongi	×	×
Oreochromis andersonii (Castelnau, 1861)	Threespot tilapia	Njinji	×	×
Oreochromis macrochir (Boulenger, 1912)	Greenhead tilapia	Muu	×	×
? Pharyngochromis cf. *darlingi* (Boulenger, 1911)	Zambezi happy	Makatenge	–	×
Serranochromis (Sargochromis) carlottae (Boulenger, 1905)	Rainbow happy	Likumbwa	×	×
Serranochromis (Sargochromis) codringtonii (Boulenger, 1908)	Green happy	Mbuma	×	×
Serranochromis (Sargochromis) giardi (Pellegrin, 1904)	Pink happy	Siyeo	×	×
Serranochromis (Sargochromis) greenwoodi (Bell-Cross, 1975)	Greenwood's happy	–	-	×
Serranochromis (Serranochromis) angusticeps (Boulenger, 1907)	Thinface largemouth	Mushuna	×	×
Serranochromis (Serranochromis) longimanus (Boulenger, 1911)	Longfin largemouth	Njenga	×	×
Serranochromis (Serranochromis) macrocephalus (Boulenger, 1899)	Purpleface largemouth	Njenga	×	×
Serranochromis (Serranochromis) robustus jallae Boulenger, 1896	Nembwe	Nembwe	×	×
Serranochromis (Serranochromis) thumbergi (Castelnau, 1861)	Brownspot largemouth	Nembwe	×	×
Tilapia rendalli rendalli (Boulenger, 1896)	Northern redbreast tilapia	Mbufu	×	×
Tilapia sparrmanii Smith, 1840	Banded tilapia	Situhu	–	×
Ctenopoma multispinis Peters, 1844	Manyspined climbing perch	Mbundu	–	×

were dominated by large cichlids, especially *Oreochromis andersonii, O. machrochir,* larger *Serranchromis* species and also *Clarias gariepinus.* The different fish community characters of the various regions are also represented in the records of commercial catches e.g. the highest occurrence of *Hydrocynus vittatus* was from the Chobe Region, where they were common while *Hepsetus odoe* and *C. gariepinus* were better represented in catches in the Linyanti and Chobe regions.

Experimental Gill Net Catches

Catch per unit effort

The results of 18 settings of the experimental gill nets in representative localities in Caprivi from June to December 1975 (low water level conditions) are summarized in Table 11 and Figure 3.

There was a consistent decline in numbers caught per unit effort from the 25 to 190 mm mesh gill nets in all

TABLE 10: Species composition of commercial gill net catches in Caprivi, 1975 & 1976 surveys combined, expressed as percentages.

	Region				
	Linyanti	Liambezi	Chobe	Zambezi & Floodplains	Mean
M. macrolepidotus	0	0,7	0	0	0,2
M. lacerda	0	0,9	0,5	0,8	0,6
H. vittatus	0,1	0,4	2,9	0,5	1,0
H. odoë	6,2	1,7	5,2	0,6	3,4
S. mystus	0	0,7	1,2	0	0,5
C. gariepinus	21,5	5,5	16,0	4,7	11,9
C. ngamensis	0	1,2	0,1	0,1	0,4
Synodontis spp	0	0,8	1,6	0,4	0,7
O. andersonii	25,4	43,1	24,4	43,3	34,1
O. macrochir	23,9	25,8	9,4	31,0	22,5
S. codringtoni & S. giardi	6,2	4,7	10,5	2,5	6,0
S. angusticeps	3,9	5,0	7,8	9,7	6,6
S. macrocephalus & S. longimanus	0	2,9	11,3	3,0	4,3
S. robustus & S. thumbergi	0	1,5	3,3	0,9	1,4
T. r. rendalli	13,1	5,2	5,9	2,5	6,7

TABLE 11: Catch per unit effort of a fleet of experimental gill nets set in the various regions of Caprivi in 1975.

A. – Mean number of fish per 50 m net per night.

	No of settings	Stretched mesh size, mm										
		25	50	60	80	96	100	127	140	160	190	Mean of fleet
Kwando	3	60,0	35,2	33,5	7,0	7,0	6,2	2,6	3,5	1,0	1,1	15,7
Linyanti	4	12,5	18,8	17,1	6,5	10,9	5,3	1,3	0,6	0,2	0,4	7,4
Liambezi	56	180,2	140,6	147,4	73,8	16,9	16,8	4,4	2,5	1,4	0,7	58,5
Chobe	4	226,3	166,0	77,2	22,1	36,2	43,1	7,3	6,3	2,2	1,0	58,8
Zambezi & Floodplains	7	2 130,0	222,1	51,2	22,6	23,9	27,2	10,2	4,4	1,9	1,0	249,5
Mean number	–	521,8	116,5	65,3	26,4	19,0	19,7	5,2	3,5	1,3	0,8	–

B. – Mean mass of fish caught (kg) per 50 m net per night.

	No of settings	Stretched mesh size, mm										
		25	50	60	80	96	100	127	140	160	190	Mean of fleet
Kwando	3	7,0	3,7	4,7	2,5	4,0	3,7	3,6	6,4	1,6	2,1	3,9
Linyanti	4	1,1	2,2	3,1	2,1	7,1	2,9	1,3	1,8	0,6	1,8	2,4
Liambezi	56	9,3	18,4	24,8	19,8	8,3	7,4	3,5	3,4	2,1	0,9	9,8
Chobe	4	5,2	13,5	8,7	9,9	28,0	34,5	8,1	7,1	5,8	2,7	12,4
Zambezi & Floodplains	7	39,2	25,3	8,9	8,4	12,0	18,5	11,8	5,8	4,6	3,2	13,8
Mean mass, g	–	12,4	12,6	10,0	8,5	11,9	13,4	5,7	4,9	2,9	2,1	–

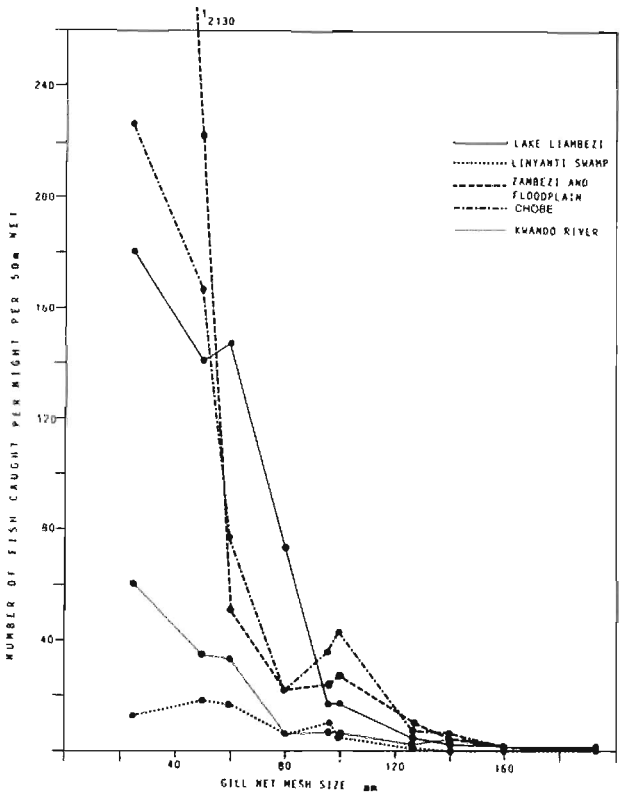

FIGURE 3: Catch per unit effort (number of fish) for a fleet of experimental gill nets in Caprivi in 1975.

regions but more so in Lake Liambezi, Chobe, Zambezi, and Floodplains.

The c p u e in terms of mass showed a different picture, with prominent peaks in the catches of the nets differing in the regions (Figure 4). In the Kwando and Linyanti regions, catches were generally low with a tendency for lower catches in the larger mesh nets.

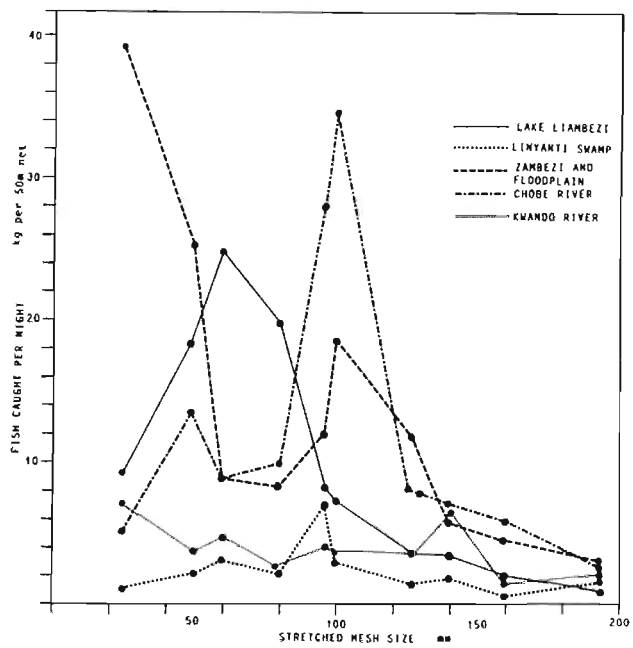

FIGURE 4: Catch per unit effort (kg of fish) for a fleet of experimental gill nets in Caprivi in 1975.

Lake Liambezi showed a distinct peak (Figure 4) of 25 kg/50 m/night in the 60 mm mesh gill net. In the Chobe Region this peak was shifted to 100 mm whilst the Zambezi and Floodplain regions had a second high in the 25 mm mesh gill net, reflecting the high concentrations of small fish that had migrated from the Floodplains to the Zambezi and permanent waters providing refuges during the dry season. Table 12 compares commercial catches recorded in 1976 with comparable experimental catches in the 127 mm mesh net. Experimental catches were generally higher than recorded commercial gill net catches. As shown by Van der Waal (1980), commercial gill nets used in Caprivi are inefficient because of the net mounting techniques used (absence of a topline with proper floats (Ratcliffe 1972) and the habit of leaving nets at one locality for extended periods.

TABLE 12: Comparison between commercial and experimental catch per unit effort of 127 mm mesh gill nets in 1976.

Catch per unit effort; No of fish / 50 m net per night

Region	Commercial	Experimental
Linyanti	1,9	1,3
Liambezi	2,6	4,4
Chobe	5,5	7,3
Zambezi & Floodplains	4,8	10,2
Mean	3,7	5,8

Compostition of experimental gill net catches

The composition of experimental gill net catches is summarized in Table 13 and Figures 5 & 6. Smaller fish species of the families Mormyridae, Schilbeidae and Mochokidae made up a significant portion of total catches. The larger cichlids that form the basis of the commercial fishery (Table 10) represent only 30% of experimental catches.

Table 13 illustrates the different fish communities in the various regions. The Kwando system offers habitat for fish favouring flowing water such as *H. vittatus* and those favouring backwaters, e.g. *H. odoe,* mormyrids and mokochids. The mormyrids are particularly well represented in catches from Linyanti and Liambezi where extensive reed swamps harbour aquatic insect larvae. The same tendency is evident for the mochokids with the highest catches from Lake Liambezi (16,3% of experimental catches). The high catches of *C. gariepinus* in the Linyanti Swamps are unexpected but *C. ngamensis* seems to prefer the slower moving and swamp water habitat of the Kwando and Linyanti. The cichlids *O. andersonii* and *O. macrochir* form relatively higher percentages of catches in the Kwando and Chobe, similar to those of *Tilapia rendalli* and *S. giardi,* both feeding specialists on aquatic vegetation and molluscs respectively. The occurrence of *S. thumbergii* in the Kwando - Linyanti - Liambezi and of *S. longimanus* in Lake Liambezi closely reflects their recorded distribution by Van der Waal & Skelton

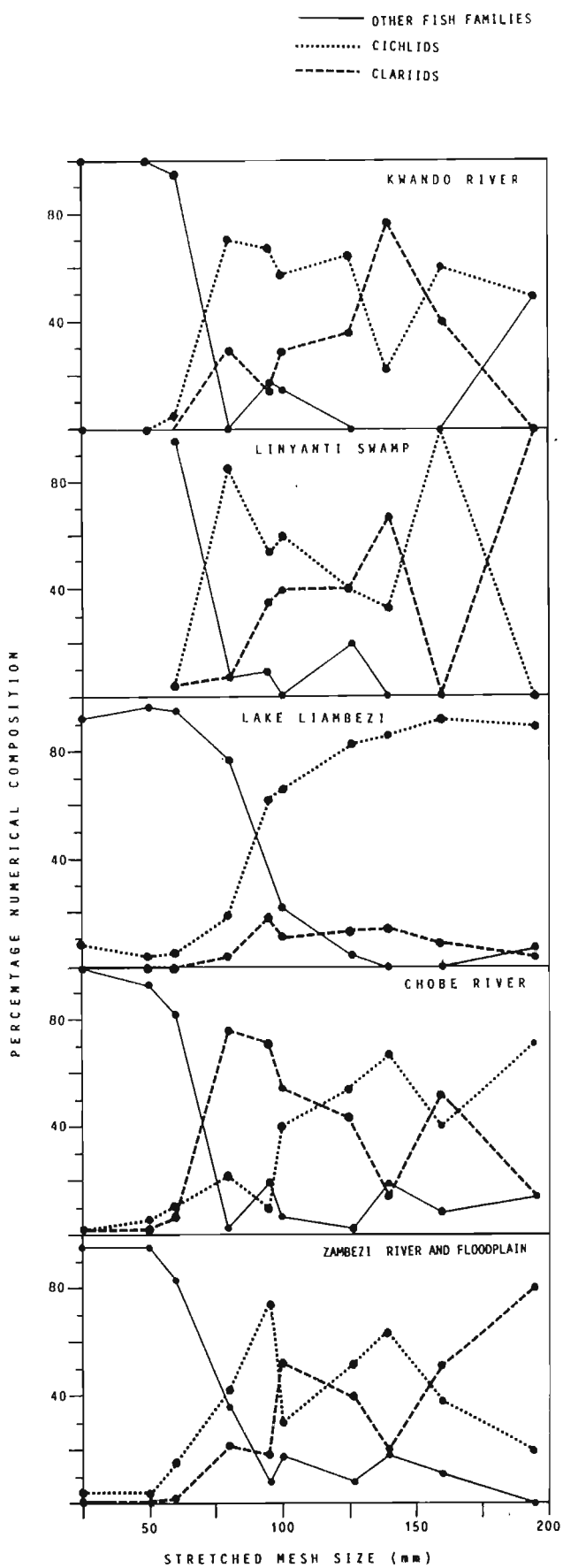

FIGURE 5: Composition of experimental gill net catches in Caprivi in 1975, expressed as percentages of numbers of fish caught.

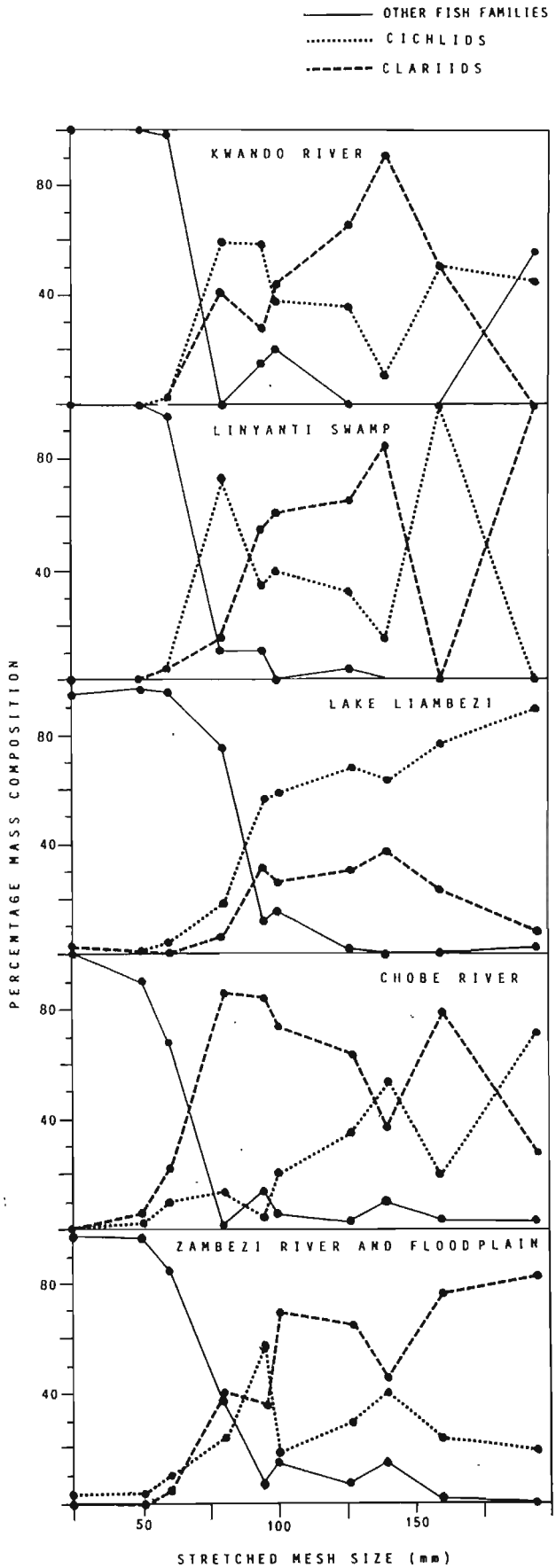

FIGURE 6: Composition of experimental gill net catches in Caprivi in 1975, expressed as percentages of mass (kg) of fish caught.

TABLE 13: Composition of experimental gill net catches in regions of Caprivi expressed as percentages.

Species	Region					
	Kwando	Linyanti	Liambezi	Chobe	Zambezi & Floodplains	Average
M. macrolepidotus	3,8	13,6	19,3	5,0	7,1	9,7
M. lacerda	0,8	0,9	0,1	5,2	1,3	1,7
P. catostoma	4,1	2,1	11,6	0,4	0,9	3,8
H. vittatus	5,8	-	0,1	13,1	10,3	-
A. lateralis	0,8	0,2	2,1	–	4,7	1,6
H. odoë	9,7	1,3	2,9	9,9	2,1	5,2
B. poechii	-	0,1	0,9	–	0,9	0,4
L. lunatus	–	–	–	0,5	0,4	0,2
S. mystus	13,8	4,7	32,2	13,5	15,0	15,8
C. gariepinus	14,4	3,0	0,7	8,1	15,3	14,1
C. ngamensis	4,4	5,1	0,8	0,4	2,0	2,5
S. leopardinus	0,2	0,1	13,6	1,3	–	1,7
S. woosnami	2,2	6,2		3,1	1,9	4,0
S. macrostigma	0,7	0,1	2,6	–	0,3	0,7
S. nigromaculatus	2,0	0,5	1,1	0,1	1,4	1,0
O. andersonii	15,3	1,1	1,3	6,1	4,3	5,6
O. machrochir	4,8	0,5	1,1	3,9	0,7	2,2
S. darlingi	–	0,1	2,2	–	–	0,5
S. carlottae	0,2	0,1	0,1	1,0	1,8	0,6
S. codringtoni	2,8	1,0	0,9	0,3	0,5	1,1
S. giardi	3,8	2,3	0,3	4,0	1,3	2,3
S. greenwoodi	-	0,2	–	–	–	0,1
S. angusticeps	3,1	8,4	0,9	7,0	8,6	5,6
S. longimanus	–	–	0,6	–	0,1	0,1
S. macrocephalus	-	14,2	2,7	12,1	16,4	9,0
S. robustus jallae	2,8	2,6	0,1	2,0	2,1	1,9
S. thumbergi	0,2	0,2	0,3	–	–	0,1
T. r. rendalli	4,2	1,1	0,8	2,5	0,4	1,8
T. sparrmanii	0,2	0,2	0,9	0,5	0,2	0,4
Number of fish collected	200	140	15 014	1 200	2 999	

(1984) where a variety of collection methods were employed.

Economic Aspects of the Commercial Fishery in Caprivi

Gill nets are not thought of as being foreign imported equipment in Caprivi as there is reference to gill nets by Selous (1893). The recorded fishery activities had been kept on at least that level since 1963 when 3 000 kg of fresh and up to 56 000 kg of dried fish were exported monthly from Caprivi to Zambia (Beatty 1969). In the early 1970's a flourishing fish market existed at Satau on the Botswana side of Lake Liambezi, where fish were purchased fresh by Zambian traders (Van der Waal 1980). Table 14 summarizes prices of fresh landed fish in the regions over the study period. There was a steady inflationary trend in fish prices as has also been recorded for Lake Liambezi in the 1973-1976 period (Van der Waal 1980).

One aspect that draws attention was the variation in fish prices realized in the different regions. The percentage of fish that was actually sold, also had to be considered (Table 14). These data indicate that in 1980 fish was sold as fresh fish mainly in the Liambezi and

TABLE 14: Fish prices for locally caught fish in Caprivi expressed as cents per kg ungutted fresh fish.

Year	Region				
	Kwando	Linyanti	Liambezi	Chobe	Zambezi & Floodplains
1975	–	–	12,6	33,9	10,8
1976	–	29,2	22,5	11,6	18,8
1980	–	–	41,9	43,6	45,8
Percentage of catch sold – the rest was consumed or dried					
1980	0	18	89	48	17

Chobe regions that were accessible by vehicle. Some of the dried fish was sold but only at half of what it could have earned as fresh fish. Fish was bought in villages or at landing sites by traders who transported fish to centres such as Bukalo, Ngoma and especially Ngweze near Katima Mulilo. In 1979 a fish market was built there where fresh fish was available daily. From 1979 to 1986 a concession was granted to a white entrepreneur who operated a transport service, and bought fish mainly at Lake Liambezi, refrigerated it and supplied the Ngweze market as well as institutions, e.g. the Caprivi Hospital.

In Table 15 the capital investment of a fisherman as well as his income, is compared for the 1975-1976 and 1980 periods. A fisherman can make a profit of 4,6-5,4 times his investment in a mukolo and his gill nets. The only other input is his labour (consisting of the setting of nets, daily inspection, removal of fish and occasional net repairs, recorded as 160 work days per year) (Table 8).

TABLE 15: Capital investment and income of fishermen in Caprivi in 1975/76 and 1980.

Capital	1975/1976	1980
Mukolo	R 29,74	R 66,05
Gill nets	R 6,00	R 15,00
No of nets per fisherman	5,9	3,3
Total	R 65,14	R115,55
Daily income per fisherman	R2,05	R4,09
Expected income per 160 working days per year (Table 8)	R328,00	R654,40
Nett profit (50 percent of nets and 20 percent of mukolo replaced annually)	R304,36	R616,44

From an economic point of view, the occupation of fisherman must be an attractive one. The large number of new recruits to the fishing industry in recent years also points in this direction (Table 2).

There were however a number of drawbacks prohibiting large scale self-employment in this sector:

1. Uncertainty or absence of a market for fresh products (Table 14).
2. Risk factor in using non-floating mikolo by persons that can't swim.
3. Risk in using mikolo on lakes inhabited by hippopotami (a real risk).
4. Variation in catches (from place to place, season to season and year to year (Table 7).
5. Extensive gill net damage by crocodiles, otters and hippos.
6. Shortage of gill nets and nylon twine.
7. Shortage of suitable trees available for mukolo construction with subsequent price rise of mukolo (Table 6).

Traditional Fishery

Traditional fishing equipment consists of a variety of traps, fences and funnels. These techniques must have developed over a long period because of the variety and sophistication achieved. When modern nylon gill nets became available, the fishery enjoyed a great boost. It is interesting that so large a proportion of the fishermen however still practice traditional fishing alongside gill netting (Table 16).

Twenty-four fish species not recorded in either commercial or experimental gill nets were identified from inspections of traps, funnels and fish kraals during 1976 (Table 17). Although no special attention could be given to the catches of traditional gear, the following general observations could be made. As soon as the Zambezi floods had subsided sufficiently to allow the Basubia to return to their permanent homes on the Zambezi Floodplain, fences *(Siyandi,* Lozi) were erected in conjunction with small (70-150 cm) kraals *(Sibanga,* Lozi) or valved traps *(Lukuko,* Lozi, *Mohono,* Sisubia) that caught mainly young cichlids returning back to the Zambezi as well as many mormyrids, *S. mystus, Clarias* spp., *H. odoe* and young mochokids.

It was noted that larger fish were caught in fish kraals *(Njamba,* Lozi) that were usually built across deeper (up to 100 cm deep) flowing drainage channels than in the valved traps *(Lukuko).* These last traps caught more swamp loving fish species by the end of the flood period on the Zambezi Floodplains, e.g. mormyrids, small *Barbus* sbpp., young *Oreochromis* spp., *T. sparrmannii* and *Ctenopoma* spp. There was also a specialized fishery during June and July at Impalela Island at the eastern tip of Caprivi that caught predominantly "ninga" *(Hippopotamyrus discorhynchus),* employing long open funnels *(Lifula,* Lozi) in the strongly flowing current at the rapids.

TABLE 16: Ownership of traditional fishing equipment used for fishing during part of the year in 1980.

	Region					Mean
	Kwando	Linyanti	Liambezi	Chobe	Zambezi & Floodplains	
Percentage owning traditional gear	44	70	85	72	78	70
Number of fishermen questioned	50	137	47	111	219	564 (Total)

TABLE 17: Fish species recorded exclusively from traditional fishing activities in 1976.

Pollimyrus castelnaui	(Boulenger, 1911)
Hippopotamyrus discorhynchus	(Peters, 1825)
Micralestes acutidens	(Peters, 1852)
Rhabdalestes maunensis	(Fowler, 1935)
Barbus paludinosos	Peters, 1852
B. eutaenia	Boulenger, 1904
B. tangandensis	Jubb, 1954
B. multilineatus	Worthington, 1933
B. unitaeniatus	Günther, 1866
B. lineomaculatus	Boulenger, 1903
B. bifrenatus	Fowler, 1935
B. barotseensis	Pellegrin, 1920
B. barnardi	Jubb, 1965
B. haasianus	David, 1936
B. radiatus	Peters, 1853
Coptostomabarbus wittei	David & Poll, 1937
Clarias theodorae	Weber, 1897
C. stappersii	(Boulenger, 1915)
Aplocheilichthys johnstonii	(Günther, 1893)
A. katangae	(Boulenger, 1912)
A. hutereaui	(Boulenger, 1913)
Tilapia ruweti	(Poll & v.d. Audenarde, 1965)
Ctenopoma ctenotis	(Boulenger, 1919)
Afromastacembelus frenatus	Boulenger, 1914

In the Kwando Region with its less pronounced flood season (Figure 2), fences with kraals *(Chibanga,* Sifwe) or traps were used to catch fish both with rising and receding floods, catching cichlids, *Clarias* spp., *Schilbe mystus* and *Synodontis* spp. In the Linyanti Region similar methods were used. Additionally, bunds *(Maalelo* or *Mundo,* Lozi) were erected across flooded valleys when floods started to recede, using sods, clay and grass or even pieces of wood with soil to build a narrow (<20 cm) wall of up to 60 cm high and up to 30 m long which then retained water for more than a month longer than would otherwise have been the case. Traps with fine slits of not more than 7 mm *(Lukuko,* Sifwe) were then inserted in the wall. The catch consisted mainly of small *Barbus* spp., *Clarias theodorae* and young *Clarias* spp., *S. mystus,* young *Oreochromis* spp., *T. sparrmannii* and *Ctenopoma* spp.

A few other methods of collecting fish were employed traditionally in Caprivi. No fisherman was without a multi-barbed fish spear *(Muwayo,* Lozi, *Muso,* Sisubia) which was used to collect *Clarias* spp. during spawning runs or guarding cichlids at nests in shallow water. A push basket *(Singunde,* Lozi, *Nchumba,* Sifwe) similar to the "fonya" used by the Amathonga people of Mocambique and Natal, but with a handle on top, was used in muddy pools to catch young clariids. The draw basket *(Lishino,* Lozi) with a vertical handle, was used to collect small (5-8 cm) fish in weedy places. No fish poison was used locally in spite of knowledge of the ichthyocidal properties of some tree pods and bark.

All fish collected with traditional equipment was used with the possible exception of *Afromastacembelus frenatus* which had too many snake-like characteristics!

In the Kwando and Linyanti regions catches did not permit trade, but large catches made in the Zambezi, Floodplain and Chobe regions necessitated the drying of the small fish that were then bartered locally or might eventually reach the market at Ngweze.

Production

The estimated gill net catch of 773 000 kg in 1980 represented an annual cropping rate of 3 kg ha^{-1}, accepting a total combined water surface of 250 000 ha of rivers, lakes, swamps and floodplains. This catch figure may be an underestimate as it reflects the catches during a year (1980) with the lowest recorded c p u e (mean 2,8 fish per commercial net). Lake Liambezi alone (30 000 ha) produced more than 600 000 kg of fish in 1973-74 (Van der Waal 1976). The extent of the traditional fishery in Caprivi was also substantial, as 70% of fishermen owning nets also used traditional gear. The total annual fish catch of Caprivi is therefore estimated at close to 1 500 tons of fish during a normal flood year, representing a cropping rate of 6 kg ha^{-1}. This figure is comparable to the reported 4,7 kg ha^{-1} of the Barotse Floodplain, 200 km north of Caprivi (Welcomme 1974a) but considerable higher than the 0,5 kg/ha^{-1} of the under-utilized Okavango Swamps (Welcomme 1974b).

The data presented for both experimental and commercial gill netting operations showed a marked lower c p u e in the Kwando and Linyanti Swamp (Figure 3). Apart from the fact that this *Phragmites* dominated swamp system was less productive than the grass covered floodplain river system of the Zambezi and Chobe rivers, the fish community might also suffer from the results of more than two decades of intensive tsetse fly control where dieldrin was used to spray target tree trunks along water courses (Bachman, personal communication, 1976). Analyses of fish tissues collected in the Kwando River in 1978, showed the presence of dieldrin and aldrin (South African Bureau of Standards, 1979).

A comparison between the commercial fishery and the traditional fishery shows that the fish community was cropped in a more balanced way by the traditional traps and funnels, where 54 species were recorded, compared to only 21 species from commercial gill nets. Even the use of 25, 50, 60 and 80 mm experimental gill nets increased the total number of species collected to only 30. In fact, the traditional fishery could be considered to be completely complementary to the gill net fishery as it caught predominantly small species and the young of larger species in only small numbers.

RECOMMENDATIONS

1. The structure of the fishery should not be drastically altered. It had healthy components of traditional, artisenal and professional fishermen.
2. Small mesh gill nets should be introduced. The recorded fishing pressure on large cichlids and *Clarias* could be relieved and a more balanced

cropping achieved by introducing 50, 60 and 80 mm stretched mesh gill nets.

3. A licence system on all gill nets owned, should be introduced. The gill net fishery in 1980 removed more than 770 000 kg of fish valued at R350 000 in 1980. No income to the local authority was generated from this. With all signs of an expanding gill net fishery, overfishing may become a serious possibility. Regulation and control could then be necessary.
4. Importation and distribution of gill nets and nylon twine should be controlled. The availability of nets and twine was found to be the most important factor limiting the fishery. This situation can easily be used to start managing the gill net fishery.
5. The maximum number of fishermen operating regularly with gill nets in Caprivi should be limited to not more than 2 000. This results in a ratio of 1 fisherman per 100 ha or an expected cropping rate with gill nets in the order of 10 kg ha^{-1} as has been found in Lake Liambezi (Van der Waal 1976) and agrees with recommendations for African fisheries (Henderson & Welcomme 1974; Welcomme & Hagborg 1975). This proposed limit is applicable only on condition that the fish population is cropped by gill nets in a balanced way.
6. A small plank boat building industry should be developed near Katima Mulilo, catering for the needs of fishermen and people living on the floodplains. A more rational use of the timber resources can be accomplished and simultaneously a more stable, non sinkable boat provided.
7. A tourist angling industry should be developed. With more than fifteen larger predatory fish species, Caprivi is an angler's paradise. Judicious development of tourist angling safaris where local fishermen use their mikolo and knowledge, can generate valuable income to the local population and authorities.
8. The gill net fishery should be intensively monitored, so that any changes in fishing pressure, change in c p u e and catch composition can be evaluated.
9. The traditional fishery in Caprivi should be urgently studied. No information is available on the extent of this fishery nor its impact. Regular monitoring of the fishery should be undertaken after the basic study has been completed to evalutate any changes in intensity or catches.
10. The hydrology of Caprivi should be studied as it has such profound effect on the wetlands and fisheries.
11. The floodplains and swamps of Caprivi should receive special conservation status to prevent any haphazard development, settlement, construction of roads and bridges or overutilization of resources. Special attention should be given to the Zambezi Floodplain where the lechwe *Kobus leche* population has been shot to extinction (Grobler pers. comm. 1988), the Linyanti Swamp, Kwando River basin and Nkasa and Lupala Islands to restore game populations there, which play such an important role in the nutrient recycling process (Bruton & Jackson 1983).
12. A monitoring programme for insecticide levels in fish and predators should be initiated to determine the levels of, particularly, dieldrin and DDT (currently still used for mosquito control in houses and huts).

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REFERENCES

BEATTY, D. M. F. 1969. Results of a fish marketing survey in Zambia, 1964-5. Ministry of Rural Development, Dept. of Wildlife, Fisheries and National Parks, Zambia. pp. 94.

BELL-CROSS G. 1974. A fisheries survey of the Upper Zambezi River System. *Occ. Pap. natn. Mus. Rhod.* B5 (5): 279-338.

BREITENBACH, F. VON W. 1968. Long-term plan of forestry development in the Eastern Caprivi Zipfel. Report to Department of Forestry, Pretoria, pp. 164.

BRUTON, M.N. & JACKSON, P. B. N. 1983. Fish and fisheries of Wetlands. *J. Limnol. Soc. sth. Afr.* 9(2): 123-133.

CURSON, H. H. 1947. Notes on Eastern Caprivi Strip. *S. Afr. J. Sci.* 43: 124-157.

DU TOIT, A.L. 1926. Report of the Kalahari Reconnaissance of 1925. Pretoria: Government Printer. Pretoria: pp. 69.

HENDERSON, H.F. & WELCOMME, R.L. 1974. The relationship of yield to morpho-edaphic index and numbers of fishermen in African inland fisheries. FAO/CIFA Occ. pap. No. 1. pp. 19.

KRUGER, C.E. 1963. The Eastern Caprivi Zipfel. Internal report, Department of Cooperation and Development. pp. 12

MACKENZIE, L.A. 1946. Report to the Director of Irrigation on the Kalahari Expedition, 1945, Report to Ministry of Lands, Cape Town. pp. 35.

RATCLIFFE, C. 1972. The fishery of the lower Shire River area. *Fisheries Bulletin* No 3 Zomba. pp. 79.

SEAMAN, M. T., SCOTT, W. E., WALMSLEY, R. D., VAN DER WAAL, B. C. W. & TOERIEN, D.F. 1978. A limnological investigation of Lake Liambezi, Caprivi. *J. Limnol. Soc. sth. Afr.* 4 (2): 129-144.

SELOUS, F.S. 1893. Travels and adventures in South East Africa. Reprint 1972. Bulawayo: Books of Rhodesia.

VAN DER WAAL, B. C. W. 1976. 'n Visekologiese studie van die Liambezimeer in die Oos-Caprivi met verwysing na visontginning deur die bantoebevolking. PhD thesis, Rand Afrikaans University. pp. 192.

VAN DER WAAL, B. C. W. 1980. Aspects of the fisheries of Lake Liambezi, Caprivi. *J. Limnol. Soc. sth. Afr.* 6(1): 19-31.

VAN DER WAAL, B. C. W. 1985. Aspects of the biology of the larger fish species of lake Liambezi, Caprivi, South West Africa. *Madoqua* 14(2): 101-144.

VAN DER WAAL, B. C. W. & SKELTON, P. H. 1984. Checklist of fishes of Caprivi. *Madoqua* 13(4): 303-320.

WELCOMME, R. L. 1974a. A brief review of the floodplain fisheries of Africa. *African journal of Tropical Hydrobiology and Fisheries.* Special Issue No. 1: 67-76.

WELCOMME, R. L. 1974b. The fisheries ecology of African Floodplains. Consultation on fisheries problems in the Sahelian zone. FAO report, FI/FPSZ/74/4. pp. 40.

WELCOMME, R. L. & HAGBORG, D. 1975. Towards a model of a floodplain fish population and its fishery FAO/CIFA/75/Inf. 9. pp. 30.