SPECIES COMPOSITION AND SOME OBSERVATIONS ON THE LITTORAL FISHES BASED ON BEACH-SEINING IN THE KIGOMA REGION, EASTERN COAST OF LAKE TANGANYIKA

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ABSTRACT Fishes in the inshore waters of Lake Tanganyika were sampled in the Kigoma Region between June 1984 and May 1988, using a beach-seine. This study collected 78 fish species in 14 different families. Cichlids made up 55.1% of the identified species. All but 12 of these species were identified in the previous collections at Karago, Mkuyu and Myako by Japanese researchers. Therefore, from the combined collections, 132 species of fish (19 fluviatile, 75 littoral, 24 benthic, 8 pelagic and 6 bathypelagic) have been identified in the Kigoma Region of Lake Tanganyika. Catches were mainly dominated by 'Masembe'–Juvenile cichlids, 'Kungura'–*Limnotilapia dardennei*, 'Vitumbi mbaraga'–*Varicorhinus leleupanus*, 'Kuhe'–*Boulengerochromis microlepis* and 'Ngege'–*Sarotheradon tanganicae*, which altogether accounted for 88% by number and 70.4% by weight of the fish caught. Both the number of species and abundance were higher in Area 2 than in Areas 1 and 3. This distribution is considered to reflect faunal richness rather than beach-seine efficiency in the areas. Both the efficiency of beach-seining in the inshore area and the need for protection and conservation of juvenile fishes in the nursery grounds are discussed.

Key Words: Species richness; Fluviatile species; Growth overfishing; Fecundity; Kigoma Region.

INTRODUCTION

Lake Tanganyika supports over 250 fish species. Brichard (1978) reported 144 cichlid species and 111 non-cichlids in the lake. Of these, 95% of cichlids and more than 50% of non-cichlids are endemic. These findings supplement the available literature on the fish species identified in various localities of the lake by Poll (1953; 1956), Fryer & Iles (1972), Kawabata & Doi (1972) and Kawabata (1975).

Recently, the studies by Kawabata & Mihigo (1982) and Hori et al. (1983) have led to a better understanding of the littoral fish fauna near Uvira in the northwestern end of the lake. Studies on the littoral species composition, distribution, feeding and inter-specific relationships have also been conducted in some localities of the eastern coast of the lake, for example, Mkuyu (Kawabata, 1975), Karago (Kawabata & Doi, 1972) and Myako (Kuwamura, 1987). These studies mainly made use of gill-nets, hand nets, sweep nets and underwater diving to capture fish samples and were local in nature. Much of the littoral zone has never been studied. Therefore, extensive coastal surveys may not only provide valuable information on species composition but also help to appraise the inshore fishery resources.

This paper discusses species composition, distribution, abundance and conservation, based on the results of extensive beach-seining surveys of the inshore fishery resources along the Tanzanian coast (Kigoma Region). This field study was supported by a special project entitled "Fish Specimen Collection," funded by the Tanzania Fisheries Research Institute (TAFIRI).

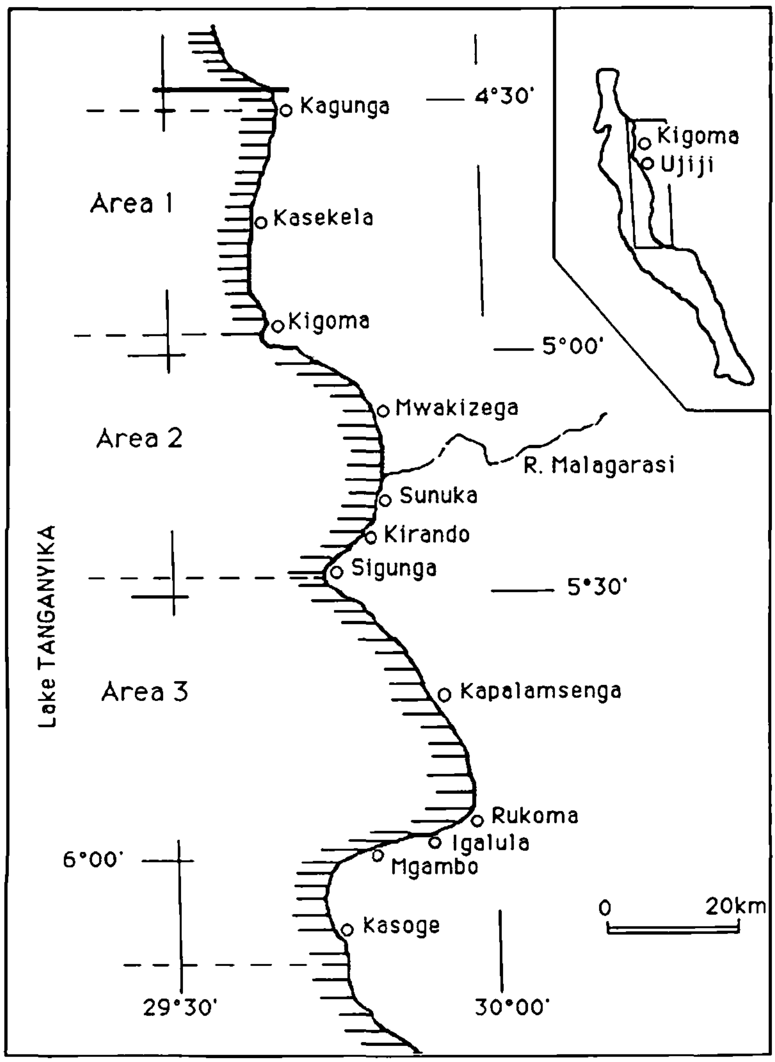

Fig. 1. Map of Lake Tanganyika showing sampling stations.

STUDY AREA, MATERIAL AND METHODS

Surveys were conducted during June 1984, November 1985, September 1986, March 1987 and May 1988. Samples were collected from 12 beach stations in the three major areas (Fig.1). The choice of these stations as suitable grounds for beach-seining was based on a pilot survey. Whilst the stations of Kasekela and Kigoma (Area 1), Kirando and Sigunga (Area 2) Mgambo and Kasoge (Area 3) were fixed for regular sampling during each survey, the rest were selected randomly. A total of 177 hauls of the seine net were conducted.

The beach-seine was operated by six fishermen using a non-motorised metal dinghy of 3 m in length. The dinghy was towed from one sampling station to another by the TAFIRI Research Vessel, FAO 81. A beach-seine with mesh sizes of 50.8 mm for wings and 6.35 mm for cod end was used to collect samples. the net of about 200 m in length was hauled from 200 metres offshore. The catch per haul within a towed distance of 200 m was therefore used as an index of relative abundance. This assumed that the beach-seine efficiency remained uniform in all the areas because there was no modification to the net over time and because all the selected stations were only those accessible to the gear. Collections were sorted into genus or species type followed by enumeration of individuals by species and weight. Representatives of each genus were immediately identified by using the key published by Brichard (1978) and local names of these collections were learned by consulting with local fishermen. All specimen of *Boulengerochromis microlepis* were checked for length, weight, sex and maturity (Bayona, 1991) while other cichlids were randomly checked for maturity by examining their gonads. Specimens were preserved in 4% formalin for further laboratory examination and taxonomic studies.

RESULTS AND DISCUSSION

I. Species Composition in Comparison with Other Studies in the Area

Tables 1 and 2 indicate that 14 families and 78 different fish species were identified in the whole study area. Of these, 55.1% (43 species) were cichlids and 44.9% (35 species) non-cichlids. These collections include some fish species which were identified only by their generic names (14 cichlids and 16 non-cichlids), for instance, *Haplochromis*, *Barilius*, *Chrysichthys*, *Barbus*, *Synodontis*, *Lamprologus*, *Clarias*, *Mastacembelus* and *Haplotaxodon*.

While this study collected fewer species than the total number so far identified in the same area by Japanese researchers (Kawabata & Doi, 1972; Kawabata, 1975; Kuwamura, 1987), it recorded 12 species which were not identified by the preceding studies, thus, increasing the number of known fish fauna in the eastern littoral zone of Lake Tanganyika (Kigoma Region). A total of 120 species (78 cichlids and 42 non-cichlids) were identified in the collections of the above-cited Japanese researchers. The addition of 12 species from this current study brings the number of the identified species in the area to a total of 132 species (86 cichlids and 46 non-cichlids). These species include *Cardiopharynx schoutedeni*, *Opthalmochromis ventralis*, *Haplochromis horei*, *Alestes imberi* and *Haplochromis* sp., which prefer the littoral habitat (Brichard, 1978); *Haplochromis burtoni* and two spp. of *Barilius* which prefer riverine habitats (Lowe-McConnell, 1975); *Hemibates stenosoma* and *Limnochromis permaxillaris* which prefer the benthic habitat (Coulter, 1968); and *Plecodus paradoxus* which is bathypelagic (Lowe-McConnell, 1975). Two of the benthic species were encountered in Area 1, partly explaining why these species could not have been collected in the previous studies which were localised in Areas 2 and 3. On the other hand, benthic species are reported to ascend to the surface waters close to the lake shore at night (Lowe-McConnell, 1975) where they are likely to be more vulnerable to beach-seining (an active gear) than to gill-netting, an in-active fishing method. However, the comparative effectiveness of the beach-seining and the other methods which were used to collect fish samples in the area can not be established based on the comparison of the collections in the existing studies. This is because of the wide diversity in the application of the sampling gears. For example, Kawabata (1975) used a combination of gill-nets, angling gear and hand nets whereas Kuwamura (1987) used a combination of hand nets, screen-nets, gill-nets and scuba diving.

A note should be made that Kuwamura (1987) reported a total of 104 spp. (77 cichlids and 27 non-cichlids) at Myako, located in Area 3 of this study. These species, distinguished by their preferred general habitats according to Lowe-McConnell (1975), form five groups: 3 fluviatile, 69 littoral, 21 benthic, 6 pelagic and 5 bathypelagic species. This contribution by Kuwamura in comparison with the collections from Karago (30 spp. of non-cichlids in 15 families by Kawabata & Doi, 1972) and Mkuyu (50 spp. with 50% cichlids by Kawabata, 1975) indicate that a

Table 1. Number of beach-seine hauls and catch for each sampling station.

Station	Number of hauls	Catch	
		Number of species	Number of individuals
Area 1			
1. Kagunga	9	23	1,001
2. Kasekela	16	22	5,907
3. Kigoma	38	37	23,505
Subtotal	63	42	30,413
Area 2			
4. Mwakizega	12	28	12,915
5. Sunuka	3	16	9,603
6. Kirando	22	29	24,584
7. Sigunga	22	35	31,635
Subtotal	59	54	78,737
Area 3			
8. Kaparamsenga	9	23	14,387
9. Rukoma	2	11	3,350
10. Igalula	1	13	3,989
11. Mgambo	28	39	28,868
12. Kasoge	15	31	3,006
Subtotal	55	53	53,600
Total	177	78	162,750

Table 2. Species composition of inshore fish in Kigoma Region of Lake Tanganyika, based on beach-seining.

Scientific name	Local name	Family name	Habitat	Total catch			
				Number	%	Weight (kg)	%
0. Mix. juvenile cichlids (<)	Masembe	Cichlidae	—	123,496	75.9	1037.4	26.7
1. *Limnotilapia dardennei*	Kungura	Cichlidae	L/U	8,160	5.0	705.6	18.0
2. *Varicorhinus leleupanus*	Kitumbi mbaraga	Cyprinidae	F*E	6,108	3.8	404.8	10.4
3. *Boulengerochromis microlepis*	Kuhe	Cichlidae	P/*	2,414	1.5	302.9	7.8
4. *Sarotheradon tanganicae*	Ngege/Sato	Cichlidae	L*S	3,009	1.8	286.6	7.4
5. *Lates microlepis*	Nonzi	Centro-pomidae	P/	1,059	0.7	269.5	6.9
6. *Lates mariae*	Sangara	—do—	P/	1,644	1.0	158.0	4.1
7. *Cardiopharynx schoutedeni*							
8. *Opthalmochromis ventralis*	Malala	Cichlidae	L/SR	2,786	1.7	95.6	2.5
9. *Tylochromis polylepis*	Ntanga	Cichlidae	L# SM	842	0.5	83.2	2.1
10. *Grammatotria lameirei*	Nungi	Cichlidae	L/P	3,400	2.1	76.8	2.0
11. *Auchenoglannis occidentalis*	Kavungwe	Bagridae	F*	154	0.1	76.3	2.0
12. *Simochromis marginatus*	Vifute	Cichlidae	L/R	1,003	0.6	57.2	1.5
13. *Tanganikallabes mortiaux*	Muhomi	Clariidae	L*R	1	0.001	60.0	1.5
14. *Alestes imberi*	Korogo	Characidae	L*U	258	0.2	31.5	0.8
15. *Dinopterus cunningtoni*	Singa	Clariidae	B*+	3	0.002	33.0	0.8
16. *Haplochromis* sp. (X)	Vilomo	Cichlidae	L/C	690	0.4	26.5	0.7
17. *Bathybates leo*	Mibanga	Cichlidae	B*M	611	0.4	22.4	0.6
18. *Lates angustifrons*	Mgomba	Centro-pomidae	P/	43	0.03	21.5	0.6
19. *Lobochilotes labiatus*	Ndafa	Cichlidae	L/R	146	0.1	14.9	0.4
20–23. *Barilius* spp. (X)	Milangala	Cyprinidae	F/*	339	0.2	11.2	0.3
24. *Alestes macropthalmas*	Manje	Characidae	F*	52	0.03	12.0	0.3
25. *Haplotaxodon microlepis*	Mbeta	Cichlidae	Bp*	246	0.2	9.9	0.3
26. *Lamprichthys tanganicanus*	Misiha	Cyprino-dontidae	L-P/*	1,424	0.9	10.9	0.3
27. *Xenotilapia sima*	Vindurwa/ Misuki	Cichlidae	Bp*	662	0.4	13.3	0.3
28. *Polypterus endlicheri congicus*	Mshekele	Polyteridae	F*	6	0.004	9.5	0.2
29. *Cardiopharynx schoutedeni*	Bilologe	Cichlidae	L/S	29	0.007	7.5	0.2
30–33. *Synodontis* spp. (X)	Gogogo/ Shanana	Mochokidae	L/R	517	0.002	6.1	0.2
34–35. *Chrysichthys* spp. (X)	Kibonde	Bagridae	B*M	34	0.2	7.1	0.2
36. *Xenotilapia longispinis*	Milunda	Cichlidae	Bp*	5	0.003	0.2	0.01

37. *Hydrocynus vitatus*	Kibebe	Characidae	F*	8	0.01	4.3	0.1
38–39. *Barbus* spp.	Mbirigi	Cyprinidae	F*	10	0.01	4.1	0.1
40–51. *Lamprologus* spp. (X)	Vilambam-awe	Cichlidae	L/R	1,209	0.7	5.0	0.1
52. *Limnothrissa miodon*	Lumbo	Clupeidae	P/	524	0.3	5.0	0.1
53. *Malapterus electricus*	Nyika	Malapteru-ridae	B# M	11	0.01	3.8	0.1
54. *Stolothrissa tanganicae*	Dagaa	Clupeidae	P/	953	0.6	3.4	0.11
55. *Lamprologus lemairei*	Nkarakata/ Vipapa	Cichlidae	L*RS	171	0.1	1.8	0.1
56. *Haplochromis/ horei*	Songama-tete	Cichlidae	L/C	81	0.03	1.7	0.04
57–59. *Mastacembelus* spp. (X)	Milombo	Mastacem-belus	L/R	16	0.01	1.7	0.04
60. *Clarias* sp. (X)	Kambale	Clariidae	L/M	2	0.001	1.7	0.04
61. *Limnochromis permaxillaris*	Mshetela	Cichlidae	B+*	351	0.2	1.1	0.03
62. *Tropheus moorei*	Msopole	Cichlidae	L/R	107	0.07	0.8	0.02
63. *Plecodus paradoxus*	Tunu	Cichlidae	Bp*/	62	0.04	0.8	0.02
64. *Lamprologus elongatus*	Mbolo ya mvuvi	Cichlidae	L/U	13	0.01	0.7	0.02
65. *Simochromis babaulti*	Mpene	Cichlidae	L/R	3	0.002	0.3	0.01
66. *Barbus* sp. (X)	Kapopo/ Funga	Cyprinidae	L-F/*	25	0.02	0.3	0.01
67. *Juridochromis* sp. (X)	Milunda	Cichlidae	L/R	5	0.003	0.2	0.01
68. *Perissodus microlepis*	Vikulikuli	Cichlidae	L/R	29	0.02	0.2	0.01
69. *Mormyrus longirostris*	Ndomo-romo	Mormyridae	F*	4	0.002	0.1	0.003
70. *Tetraodon mbu*	Kakamusi	Tetrao-dontidae	F*	1	0.001	0.1	0.003
71. *Engraulicypris minutus*	Kabangla	Cyprinidae	P/*	8	0.01	0.1	0.003
72. *Haplochromis burtoni*	Ubao	Cichlidae	F*	1	0.001	0.1	0.003
73. *Simochromis marginatus*	Mambuba	Cichlidae	L/R	3	0.002	0.1	0.003
74. *Haplotaxodon tricoti*	Mbanya	Cichlidae	B*M	3	0.002	0.2	0.01
75. *Hemibates stenosoma*	Shorana	Cichlidae	B*+	1	0.001	0.1	0.003
76. *Callochromis macrops melanostigma*	Matenda	Cichlidae	L/*SR	2	0.001	0.1	0.003
77. *Lamprologus fasciatus*	Mbunda-mchanga	Cichlidae	L/R	5	0.003	0.04	0.001
78. *Cyphotilapia frontosa*	Ndubu	Cichlidae	L/R	1	0.001	0.01	0.003
	Total	:14 families	—	162,750	(100)	3888.3	(100)

L: littoral; F: fluviatile; B: benthic; P: pelagic; Bp: bathypelagic; R: rocky; M: muddy; S: sandy; C: coastal; U: ubiquitous; (X): not identified; /: by Brichard; *: by Lowe-McConnell; +: by Coulter; #: by Fryer & Iles; (<): less Kuhe samples.

total of 16 spp., including 12 fluviatile, 1 littoral, 1 benthic and 2 pelagic species were identified in Area 2, but not in Area 3. These species, which seem to be highly associated with the Malagarasi River Basin in Area 2, include *Polypterus aethiopicus*, *Polypterus ornatipinnis*, *Mormyrus longirostris*, *Gnathonemus longibarbus*, *Cithrinus gibbosus*, *Distichodus* sp., *Labeo* sp., *Auchenoglanis occidentalis*, *Barilius moorei*, *Barilius lineomaculatus*, *Barilius serrifer* and *Barilius* sp.. All of these species were considered fluviatile by Lowe-McConnell (1975). Other species include *Hydrocynus lineatus* (littoral), *Chrysichthys stappersii* (benthic), *Lates mariae* and *Engraulicypris minutus* (pelagic). Therefore, the total of 132 spp. so far known to constitute the fish fauna of the Kigoma Region of Lake Tanganyika includes 19 fluviatile, 75 littoral, 24 benthic, 8 pelagic and 6 bathypelagic species.

Tables 2 and 3 indicate that a total of 45 littoral species were collected by the beach-seine in this study of the total 75 species so far known to prefer the littoral habitat in the eastern coast of the lake (Kigoma Region). If it is assumed that all the 177 net hauls were equally successful in recovering the littoral species, the observations can be used to establish a tentative measure of the beach-seining efficiency in the area. Gulland (1969) defined efficiency of a net as the proportion of fish within its influence that are actually caught. Because the beach-seine was used to take samples of fish inhabiting the littoral zone, it can be assumed that 75 littoral species in Areas 1, 2 and 3 were within its range. Therefore, the capturing of only 45 littoral species in 177 trials establishes 60% as the efficiency of the seine net in the area. The expected efficiency for beach-seining of littoral fishes in the area is likely to fall between 40–60%, because the distribution of some species is restricted to rocky areas or in deep mud of swampy or riverine environments where the beach-seine is ineffective.

Table 2 indicates the contribution of each individual fish species to the total catch and the effectiveness of the beach-seine in capturing species of different habitats. *Limnotilapia dardennei*, *Varicorhinus leleupanus*, *Boulengerochromis microlepis*, *Sarotheradon tanganicae*, *Lates microlepis* and *Lates mariae* respectively represented 18.0, 10.4, 7.8, 7.4, 6.9 and 4.1% in weight and 5.0, 3.8, 1.5, 1.8, 0.7 and 1.0% in number. Next to these species are *Cardiopharynx schoutedeni*, *Opthalmochromis ventralis*, *Tylochromis polylepis*, *Grammatotria lameirei*, *Auchenoglanis occidentalis*, *Simochromis marginatus*, *Tanganikallabes mortiaux*, *Alestes imberi*, *Dinopterus cunningtoni*, *Haplochromis* sp., *Bathybates leo* and *Lates angustifrons*, whose contribution declined to within 2.5–0.6% by weight. A note should be made that nearly 60% of these fishes which contributed the highest proportion of the catches by beach-seining are essentially littoral species that prefer sandy or sandy-rocky bottoms with or without vegetation (Lowe-McConnell, 1975; Brichard, 1978; Kuwamura, 1987).

On the other hand, some species comprised the lowest catch proportions by number, ranging from 0.001% to 0.003% (65–78, except 66, 68 and 71 in Table 2). Among these fishes are *Simochromis babaulti*, *Juridochromis sp.*, *Simochromis marginatus* and *Lamprologus fasciatus* whose distributions are restricted to large rocky substrates, and *Mormyrus longirostris*, *Tetraodon mbu*, *Haplotaxodon tricoti* and *Limnochromis permaxillaris* which respectively prefer rivers/swamps, estuaries, deep mud and deep sand or mud (Brichard, 1978). Habitat preference of these species suggest that some of them are not rare species but their capture was hampered by the limitations of the beach-seine. Beach-seining was usually more efficient on flat sand than in other substrates. It was impossible to operate the net over large rocky substrates, as noted earlier. Consequently, some fish species may not have been collected by this method.

II. Comparison of Species Richness and Fish Abundance by Area and Habitat Preference

Table 1 indicates a slightly higher number of species in Areas 2 and 3 than in Area 1. Also, total catches by number were higher in Area 2 than in Areas 1 and 3, despite the higher number of hauls in Area 1. This trend in species distribution is further examined by partitioning the number of species into their preferred habitats in each of the three areas (Table 3). A total of 14 fluviatile, 45 littoral, 7 pelagic, 4 bathypelagic and 8 benthic species were identified by this study (See Table 2 for species names and habitats). There is a pronounced increase in the number of both littoral and fluviatile species in Area 2 whereas the number of pelagic, bathypelagic and benthic species remained more or less the same in all the three areas. Because beach-seining was conducted in the littoral zone, mainly to collect littoral species, there is no doubt that the observed trend in species distribution reflects faunastic richness and not the beach-seine efficiency in the areas.

Beach-seine efficiency was assumed to remain constant in all the three areas because no changes were made to the net during the entire sampling period and stations suitable for hauling the net were pre-selected during a pilot survey. The confirmation of the uniform selectivity and efficiency of the net among the areas can be sought by comparing the net selectivity for species in the three areas and whether or not the trend was consistent in all the areas. Table 2 indicates that the following species were not collected in Area 1: *Simochromis marginatus, Tanganikallabes mortiaux, Lamprologus fasciatus, Tropheus moorei, Lamprologus elongatus, Simochromis babaulti, Barbus* sp. (Kapopo/Funga), *Juridochromis* sp. and *Perissodus microlepis*. Species which were not collected from area 2 were *Tropheus moorei, Simochromis babaulti, Juridochromis* sp., *Simochromis marginatus* and *Callochromis macrops melanostigma*. Species not collected from

Table 3. Number of species for each type of habitat and corresponding catch per unit effort (CPUE) as Seine Catch/haul.

Habitat type	Number of species				CPUE(kg/haul)*			
	Total H=177	Area 1 H=63	Area 2 H=59	Area 3 H=55	Total H=177	Area 1 H=63	Area 2 H=59	Area 3 H=55
Fluviatile	14	9	11	9	3.1	0.31	1.1	8.3
Littoral	45	34	43	39	8.1	2.30	17.4	4.9
Pelagic	7	6	6	6	4.3	1.00	9.1	3.1
Bathypelagic	4	3	3	4	0.2	0.10	0.3	0.2
Benthic	8	6	6	6	0.4	0.06	0.3	0.9
Total	78	58	69	64	16.1	3.80	28.2	17.1

*: Excludes the weight of mixed Juvenile Cichlids (Masembe).
H: Number of hauls.

Area 3 were *Tanganikallabes mortiaux, Clariidae* sp., *Lamprologus elongatus, Callochromis macrops melanostigma* and *Cyphotilapia frontosa*. These species in the three Areas were not caught in the net because they are mainly distributed in the rocky substrate within the littoral zone. Therefore, this consistent trend where the species with restricted distribution in rocky substrate only contributed little or nothing to the recorded catches in the areas confirms the relationship between richness, abundance and habitat. It also confirms the uniform selectivity and efficiency of the seine-net in the three areas during the study period.

Faunal richness and biomass abundance in Area 2 may result from the influence of the Malagarasi River which provides nutrients and good habitats for fish in this riverine area. The influence of the Malagarasi River on species composition, in comparison with two communities near Karago and Mkuyu is discussed by Kawabata & Doi (1972). If the catch of mixed juvenile cichlids (Table 2) is ignored in calculating catch per unit effort (CPUE) in the three areas, the highest abundance (28.2 kg/haul) seemed to occur in Area 2 in comparison with 17.4 kg/haul in Area 3 (south of Sigunga to Kasoge), and 3.8 kg/haul in Area 1 (Kagunga to Ujiji) as shown in Table 3. A similar trend is also seen when indices of relative abundance of fish are computed by including the catch of mixed juvenile cichlids (37.1 kg/haul for Area 2, 24.2 kg/haul for Area 3 and 5.8 kg/haul for Area 1). Therefore, Areas 2 and 3 indicated relatively higher abundance of fish than Area 1. Artisanal beach-seiners operating in the same areas have confirmed that better catches are made in Areas 2 and 3 than in Area 1. Although this trend is not confirmed for other habitats inaccessible to the beach-seine, it reflects a practical overview on where and which fishing grounds are likely to award better catches to artisanal exploiters (beach-seiners).

This data, however, combines the months of June 1984, November 1985, September 1986, March 1987 and May 1988, most of the months which constitute a unique, dry, windy season in May/June to November as opposed to the wet, warm season during December to April (Chapman, 1976). As abundance and distribution may vary with season, the current results reflect largely the general trend during the dry, windy season. It is therefore recommended that more data should be collected during the wet, warm season for comparison.

III. Conservation of Juvenile Fishes

Table 2 further indicates that juvenile cichlids contributed the highest, 26.7% of the total catch by weight and 75.9% by number. These were more abundant in Areas 2 and 3 than in Area 1 (Tables 1 and 2). Whilst the size of the littoral zone (0–20 m deep) in Area 2 is larger than in Areas 1 and 3 because of the pronounced shallow area of the Malagarasi Delta, there is no documented data to ascertain the areal sizes and their influence on abundance. However, the reported abundance of juveniles suggests the importance of the inshore area as a nursery ground from which some fishes are recruited to their parent stocks in deeper offshore waters. A good example of this is *Boulengerochromis microlepis* which is an open water or pelagic species but was captured from the inshore area as either an actively growing juvenile, a predator feeding on small inshore fishes, or spawner (Matthes, 1961;

Brichard, 1978; Kuwamura, 1987; Bayona, 1991).

Table 4 indicates that the beach-seine catch comprised largely juvenile fishes, especially the juvenile cichlids which accounted for 77.2% by number and 28% by weight. One haul of the beach-seine captured an average of 6.2 kg or 710 individuals. Because of the high catch efficiency for the juvenile fish (Tables 2 and 4), growth overfishing is likely to occur, especially for most cichlids which have low fecundity and small clutch size (Brichard, 1978; Nagoshi, 1983). Gulland (1983) considered growth overfishing as the progressive decline of fish biomass or mean sizes of individual species with increased fishing effort because the fish is caught before it reaches marketable size.

Based on the Fisheries Division Annual Statistics Report of 1986, Lake Tanganyika (Tanzania) had a total of 13,625 fishermen and 327 beach-seines. The Kigoma Region alone had 282 beach-seines. If these gear are operated 25 days a month at a minimum of three hauls a day, they will harvest approximately 131 tons ($282 \times 25 \times 3 \times 6.2$) or 15 million juveniles a month in the Kigoma Region. This level of harvesting, especially of the juvenile cichlids, is very high and wasteful from the view point of resource utilisation. Therefore, it is recommended that mesh size regulations for beach-seines be introduced as an initial management step towards protecting immature fishes and avoiding the foreseeable danger of stock over-exploitation. Actually, the minimum stretched-mesh size of 63.5 mm for beach-seines has been recommended for the exploitation of fishes in the coastal waters of Dar es Salaam (National Environment Management Council Report of 1988, unpublished). The protection of juvenile cichlids by the introduction of larger mesh size for beach-seines may strongly affect some fishermen who also use the same gear to capture sardines (dagaa). At least 20% of the registered beach-seines are used in traditional fishing for dagaa in specific localised beaches. Often, light-attracted concentrations of dagaa drift to shallow inshore waters where they are caught by beach-seines (6–10 mm in mesh size of the cod end). Therefore, a compromise between the conservation of juvenile cichlids and the exploitation of inshore sardines in some beaches has to be made by instituting other regulatory measures, mainly seasonal and areal closures. In the long run, however, it is better to discourage beach-seining for sardines and resort to other methods, such as lift-nets, scoop-nets and purse-seines for the exploitation of small-sized fishes of economic importance, especially sardines. These nets, despite their small mesh sizes, have no direct impact on the survival of the juvenile cichlids because they are operated in the water column (beyond 15 m deep) using light-attraction methods and they do not come in contact with the bottom where several micro-habitats provide refuge to the juvenile cichlids.

Table 4. Catch per haul for juvenile cichlids based on 177 hauls of beach-seining.

Species	Number/haul	%	kg/haul	%
Boulengerochromis microlepis	12	1.3	0.29	1.3
Other cichlids (combined)	698	75.9	5.90	26.7
Total juvenile cichlids	710	77.2	6.20	28.0

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