

Preliminary surveys of the fish and fisheries of the Nzoia, Nyando and Sondu Miriu rivers, Kenya

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Abstract: Three Lake Victoria rivers were sampled to assess fish abundance and distribution in preparation for assessment of catches from the river systems. Preliminary fish abundance data indicate that fishing potential upstream is negligible but that important commercial species are present in the downstream floodplain areas. Three catfish species were recorded in the Nzoia river system that have not been found previously in the Kenyan sector of the Lake Victoria system, together with possibly two undescribed *Barbus* species.

Introduction

The importance of fisheries for Lake Victoria potamodromous fishes has been recognised by many authors in the past (e.g. Graham 1929, Cadwalladr 1965a, 1965b, Whitehead 1959) but the fisheries have been in decline since the 1940s (Muli & Ojwang 1996). Of particular concern was the decline in the fishery for *Labeo victorinus* Boulenger, which Cadwalladr (1965b) ascribed to the introduction of drifting nylon gillnets in the lower reaches of the rivers in the late 1950s. After the work of the 1960s, which consisted largely of reports on brief *ad hoc* surveys, no fisheries work was undertaken in the rivers. With recent renewed interest in biodiversity, and particularly following the Nile perch, *Lates niloticus* (L.), population explosion in Lake Victoria, new studies started on the river fish populations and fish landings (Ochumba & Manyala 1989, 1992, Muli & Ojwang 1996). The value of the fisheries in and around the rivers needs to be quantified. The present study will yield answers on the value of the fisheries, both economically and nutritionally, and will produce the biological data necessary for assessment and management of the fisheries.

Three Kenyan rivers flowing into Lake Victoria are under investigation (Fig. 1). Two of these are large rivers with recognised fishery importance, i.e. the Nzoia (Cadwalladr 1965a, 1965b) and the Sondu Miriu (Ochumba & Manyala 1989, 1992, Muli & Ojwang 1996) while the proximity of the smaller Nyando River to Kisumu allows it to be used for comparison. The surveys reported here were conducted to obtain data on species distribution and abundance to assist in the planning of the research programme.

Materials and methods

The initial surveys of the river systems were conducted using a seine net approximately 10 m long with 8 mm stretched mesh. Sampling sites were chosen both on the lakeshore plain and in the hills to cover as wide a variety of habitats as possible, but were also dependent on accessibility by road (Fig. 1). Three seine hauls were made at each site. Large fish were identified to species, measured (TL, cm below) and weighed (g) in the field. Stomach contents were taken from the larger fish and preserved in formalin for analysis in the laboratory. Small fish were preserved in formalin for later identification, measurement and stomach content analysis.

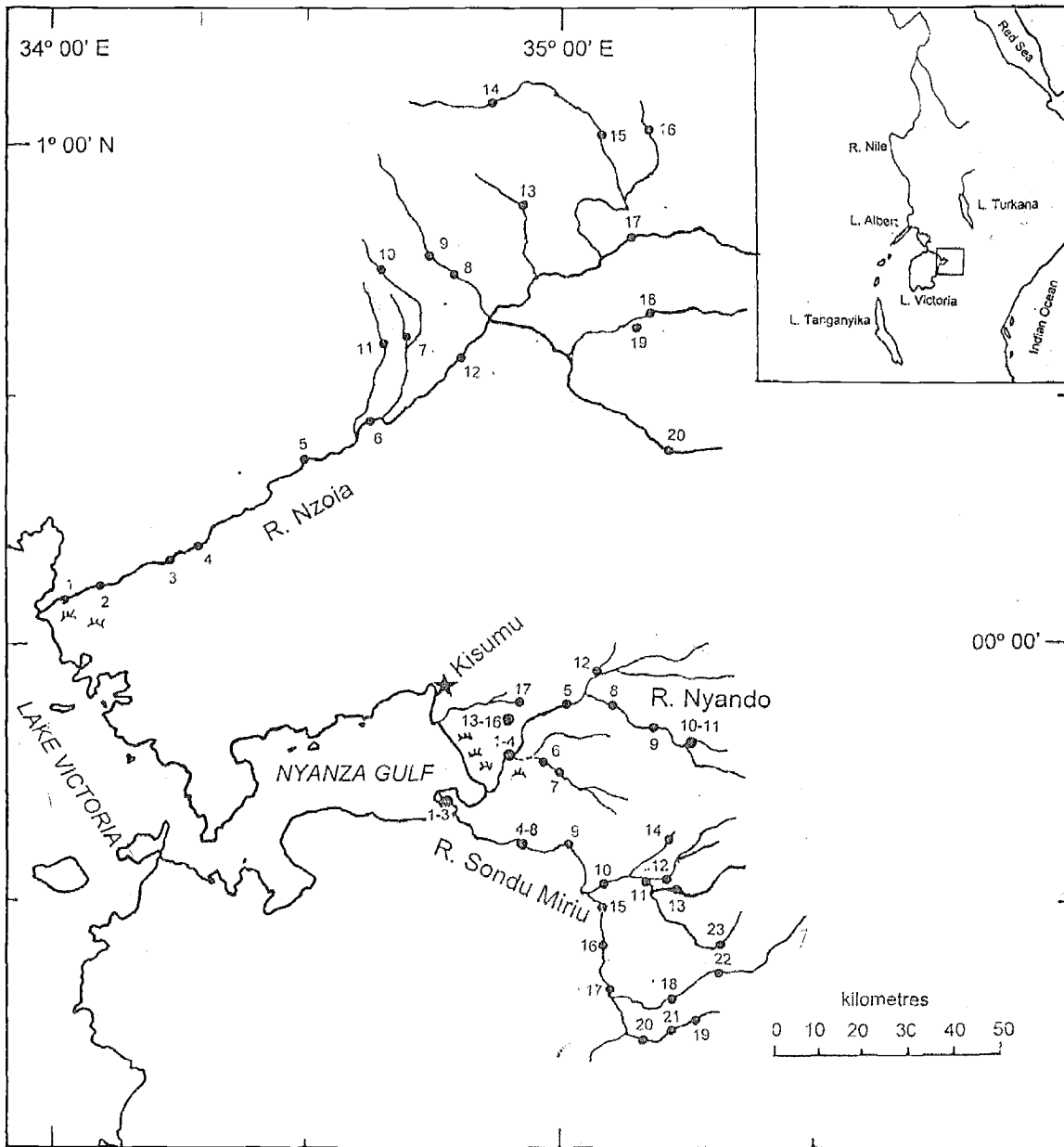


Figure 1. The Kenyan river systems sampled during the surveys, showing all sampling sites, numbered as in the tables in this paper.

Data on each site recorded included position (GPS), date of sampling, land use in the area and physical and chemical parameters of the water. Sites were identified where fishing occurs and fish are landed, for positioning of data recorders to assess the status of the fishery.

Results

Sampling site descriptions are given in Tables 1-3. Site numbers are the same as those shown in Fig. 1.

The numbers of specimens of each species caught at each sampling site in the first survey of each river system are shown in Tables 4-6.

Discussion

River Nyando and nearby streams

The River Nyando is one of the smaller rivers flowing into the lake in Kenya and is polluted in some stretches by sugar factory effluent. Its relatively small size, which allows easy sampling, and the easy accessibility by road to a variety of habitats and altitudes, made it a good choice for the preliminary study. The survey showed that this small river still has high fish diversity despite the pollution. Species distribution and abundance was shown to be strongly habitat-dependent and thus sampling has to be undertaken in all habitats to obtain a full picture of the ecology of the river fishes. While the small-meshed seine was a useful sampling tool, other methods are needed to supplement the seine, particularly in deep pools, swift flowing stretches, and heavily vegetated areas. In bigger, fast-flowing rivers, particularly in floods, sampling should be complemented by detailed recording of fishermen's catches from the variety of gears they use.

While sampling the Nyando system, the opportunity was also taken to sample some smaller streams in the vicinity as described in Table 1. The Ahero rice scheme canals yielded several species not recorded in the fast-flowing waters of the larger rivers, as discussed in the checklist below.

Preliminary annotated checklist for the fishes of the Nyando River system and small streams nearby

The species listed below are those found in the first survey of the Nyando River system and adjacent small streams. As would be expected in a brief survey with only one sampling method, not all species known to occur in the Lake Victoria catchment rivers were recorded. Most of the common species were, however, found and a clear picture obtained of population structures in various habitats. Brief notes are given on distribution and abundance of the species found. A more detailed annotated checklist will follow intensive sampling with the new electric fishing gear in all three river systems.

***Barbus altianalis* Boulenger.** Common throughout the Nyando River system in all habitats. The largest specimens, up to 20 cm TL, were taken from deeper areas with

good flow and cover in the form of emergent bankside vegetation, tree stumps, or boulders. There was no evidence of size classes in the fishes caught, with a continuous range from small juveniles to 20+ cm. No large adults were taken. The catches suggest that *B. altianalis* is not purely potamodromous but also has permanent river-dwelling populations. In this respect it resembles other large African *Barbus* species, e.g. *B. johnstonii* Boulenger in Lake Malawi rivers (Tweddle, 1996). The species is thus not threatened by predation by Nile perch in the lake itself. The presence of permanent river populations creates difficulties for assessment of the fishery for fish migrating from the lake, as the river fish will differ in growth and maturity from the migratory fishes. Their presence in samples will thus obscure the population characteristics of the migrating fishes which are believed to form the mainstay of the fishery in flood periods.

***Barbus apleurogramma* Boulenger.** A small species not exceeding 5 cm TL which is abundant on the lakeshore plain in areas with plenty of cover and slow flow. It was not found in the hilly areas, although the mesh size used was rather large for this species. Because of its size it is of no importance to fisheries.

***Barbus cercops* Whitehead.** *B. cercops* is a small (up to 8 cm TL) species which was found throughout the river systems sampled in a wide variety of habitats, from still rice irrigation channels to bankside cover in fast flowing hill streams. The three midlateral spots vary in intensity with water clarity. Because of its size, *B. cercops* is of no importance to fisheries.

***Barbus jacksonii* Günther.** This species is common throughout the sampled rivers in all habitats. While not of major importance from an economic fisheries point of view, the species does figure prominently in the hook and line catches of numerous small boys in the area, with many specimens up to 15 cm TL observed in the boys' catches. It is therefore nutritionally important for many families along the rivers, particularly in areas distant from the lake without access to lake fishes

***Barbus kerstenii* Peters.** Fairly common throughout the sampled area. This is a small species up to 7 cm TL which is of no fisheries importance.

***Barbus neumayeri* Fischer.** The rarest of the small *Barbus* species found in the Nyando River survey, *B. neumayeri* appears to have a restricted distribution in hill streams away from the lakeshore plain.

***Barbus nyanzae* Whitehead.** *Barbus nyanzae*, a species which grows to about 10 cm TL, is abundant throughout the areas sampled. Because of its small size it is of no commercial importance.

***Barbus paludinosus* Peters.** Although fairly uncommon in the samples obtained, *B. paludinosus* has the potential to support important fisheries in small lakes and dams (Kalk *et al.* 1979). The species can reach 15 cm TL or more in favourable habitats, but Kenyan specimens caught so far have not reached 10 cm.

***Barbus yongei* Whitehead.** A small species growing to about 7 cm TL, *B. yongei* is fairly common and widespread in the area but is of no commercial importance.

***Labeo victorianus* Boulenger.** *Labeo victorianus* was formerly abundant in the area and was a fish of major commercial importance during its breeding migrations up rivers in flood. Cadwalladr (1965b) documented the decline in the fishery and blamed it on the introduction of drifting nylon gillnets in the lower reaches of the rivers. The species is still common in the area and is an important commercial species warranting detailed study. The specimens caught in the present survey came from a variety of habitats though larger streams appear to be favoured. A wide range of sizes to over 20 cm TL was encountered without obvious length classes. As the survey was conducted at a time of low water levels outside the breeding season, it appears that the species has permanent river populations in addition to migratory lake stocks.

***Aethiomastacembelus frenatus* (Boulenger).** The spiny eel is fairly common in areas with cover such as submerged tree stumps, dense vegetation or rocks. It has no commercial importance.

***Schilbe intermedius* Rüppell.** This small catfish is fairly common in the lower reaches of rivers. Specimens up to 20 cm TL were taken in the survey. Catches of fishermen during floods will be examined to assess whether the species is of commercial importance during breeding migrations.

***Clarias gariepinus* (Burchell).** A species of considerable economic importance throughout Africa, *C. gariepinus* was found only in small numbers in the present survey. It was an important commercial species in Lake Victoria before the recent changes in ecology but is now rare. The larger rivers flowing into the lake may hold more, larger fish and thus further studies are needed.

***Clarias* spp. 1 & 2.** Two small clariid species were caught in the survey in small numbers. Their identity awaits detailed study. *Clarias alhuaudi* Boulenger, *Clarias werneri* Boulenger, *Clarias liocephalus* Boulenger, *Clariallabes petricola* Greenwood and *Xenoclarias eupogon* (Norman) are recorded from the Lake Victoria system.

***Oreochromis niloticus* (L.).** This tilapia is abundant on the lakeshore plain, with juveniles caught in sheltered shallow areas. It is of considerable economic importance and the relationship between the river and lake populations warrants study.

***Oreochromis leucostictus* (Trewavas).** Less common than *O. niloticus* and restricted to sheltered habitats on the lakeshore plain, this species is of minor economic importance but may be of some value in ponds.

***Ctenopoma murei* (Boulenger).** A small species growing to about 10 cm TL which is common in the sheltered environment of the Ahero rice scheme. *Ctenopoma murei* has no economic value.

***Pseudocrenilabrus multicolor* (Schoeller).** A very common small cichlid, not exceeding 10 cm TL, found in sheltered habitats on the lakeshore plain, *P. multicolor* is of no commercial importance with the exception of small numbers which may be exported live for the aquarium trade.

Haplochromis spp. Several small haplochromines were caught on the lakeshore plain. They are of considerable interest in terms of biodiversity but are of no commercial value. Sorting out the taxonomy of this group is beyond the scope of this project.

Marcusenius victoriae Worthington. Caught in small numbers in sheltered habitats on the lakeshore plain, this small mormyrid is of no commercial value.

Protopterus aethiopicus Heckel. Found largely in still, sheltered habitats, the lungfish is of economic importance on the lakeshore plain but is not found in any numbers in the larger rivers and thus will not figure prominently in the current river fish research programme. One very small juvenile was taken in the Ahero rice scheme in the present survey.

Aplocheilichthys bukobanus (Ahl). A small species, not exceeding 3 cm TL in the present survey, restricted to sheltered lakeshore plain habitats such as the Ahero rice scheme canals. Of no importance other than possibly as a minor aquarium species.

The Sondu Miriu River system

The Sondu Miriu is a large river with an extensive floodplain. It has been the subject of recent studies by KMFRI staff (Ochumba & Manyala 1989, 1992, Muli & Ojwang 1996). The lower reaches support fishing activities and have recognised fish landing sites. Data recorders will be stationed at these sites to record fish catches therefrom and assess the value of the river fishery. Upstream, the river is generally fast flowing and fishing activities are negligible.

Preliminary notes on the fishes of the Sondu Miriu River system

The fishes of the Sondu Miriu are similar to those of the Nyando River discussed above. *Lates niloticus* and *Synodontis afrofisheri* Hilgendorf were two species recorded in the Sondu Miriu that were not recorded in the Nyando River. *Barbus nyanzae*, a common species throughout the Nyando River system, was surprisingly absent from the Sondu Miriu. The fish population of the Sondu Miriu River system on the lakeshore plain (sites 1 to 9 in Tables 2 and 5) is distinct from that of the upper reaches (sites 10 to 23). Five *Barbus* species found on the lakeshore plain did not occur higher up (Table 5). In addition, seven other fish species were restricted to the lower reaches. *Barbus neumayeri* occurs on the lakeshore but is much more abundant in upland reaches and tributaries as described above in the Nyando River checklist. *Barbus paludinosus* was abundant at several sites both upstream and down. A South American poeciliid, *Gambusia affinis* (Baird & Girard) was abundant in Jamji Dam, undoubtedly introduced for mosquito control. A downstream record of this species at site 6 needs verification.

The Nzoia River system

The Nzoia River is the largest and most extensive of the Kenyan rivers flowing into Lake Victoria. Numerous tributaries arise on the slopes of Mount Elgon. The river has not been thoroughly studied since the 1960s (Cadwalladr 1965a, 1965b). The lower reaches support fisheries and data recorders will be established at the fish landing sites. Upstream, little evidence of fishing activities was observed, though angling is a common pastime for small boys in particular, providing a valuable source of protein for inshore communities.

Preliminary notes on the fishes of the Nzoia River system

At least two undescribed *Barbus* species occur in the upper reaches of the Nzoia River and its tributaries. Further investigation of the specimens collected will be made at the J.L.B. Smith Institute of Ichthyology in Grahamstown, South Africa, in due course. Three small catfish species were recorded for the first time in Kenyan rivers flowing into Lake Victoria. These were a mountain catfish, *Amphilius* cf. *jacksonii*, a rock catlet, *Chiloglanis* cf. *somereni*, and a sand catlet, *Leptoglanis* sp. Their identities will also be checked in Grahamstown. With these exceptions, the Nzoia fish fauna shows close resemblances in species composition and abundance to the faunas of the Nyando and Sondu Miriu systems.

Acknowledgements

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Table 1. Sampling sites investigated in the Nyando River, its tributaries and adjacent small streams in September 1997.

Site no.	Date	Site name	Latitude	Longitude
1	20/9/97	Nyando River (Odiembo 2)	00° 12' S	34° 55' E
<p>Site description and methods: Brown, silty, smoothly flowing river with 10-15 cm visibility, 15 m wide by up to 1 m deep, flow from 1.3 to 1.9 m.sec⁻¹. Sand/mud bottom, bend in river bounded by vertical mud bank on S.E. bank, shelving mud bank on N.W. with no cover for fish. Land use: intensive subsistence agriculture and grazing. Three small beach seine hauls over distances from 10-30 m. Time 09.00 to 09.30.</p>				
2 & 3	20/9/97	Nyando River (Odiembo 1)	00° 12' S	34° 55' E
<p>Site description and methods: Similar to site 1 but up to 2 m deep, difficult to sample. First haul produced only one <i>Labeo</i> and some small <i>Barbus</i>, so moved approximately 0.5 km downstream. Site approx. 1 km upstream from papyrus swamp bordering lake. Land use: grazing but extensive thorn scrub cover. River broken into two channels by gravel and bush island. Small channel averaged 20 cm and up to 30 cm deep, mud and coarse gravel bottom. Terrestrial vegetation debris on tree stumps in water at edge. Two small seine hauls approx 10 m long into channel. Fish in debris chased out into net by dragging out moveable branches and beating and poking around immovable stumps. catch included <i>Labeo</i>, <i>Barbus</i> spp., <i>Schilbe</i>, <i>Aethiomastacembelus</i> and <i>Clarias gariepinus</i>. One seine haul approx. 40 m in length downstream in main channel (approx. 50 m in depth) yielded few fish, only <i>Labeo</i> and small <i>Barbus</i>. Time 10.30 - 11.15.</p>				
4	20/9/97	Nyando River (Kanyauma)	00° 11' 13" S	34° 55' 04" E
<p>Site description and methods: River condition as in Site 1, 40 m wide and shallow, up to 50 cm deep. Fast flowing over sand, small stone and cobble bed, no cover. Land use: intensive subsistence agriculture and grazing. One seine haul down and across for approx. 30 m over fast cobble shallows. Time 12.00 - 12.15.</p>				
5	20/9/97	Nyando River (Ogiro)	00° 07' 26" S	35° 00' 40" E
<p>Site description and methods: 100 m upstream of bridge. River condition as in Site 1, 10-15 m wide, up to 1.5 m deep, sheer mud/rock S. bank, shelving gravel N. bank. Land use: subsistence agriculture and grazing with areas of semi-natural vegetation with large trees. One unsuccessful seine haul. 200 m below bridge, fished up into overhanging grass vegetation on steeply shelving S. bank with depth over 1 m near edge. Caught medium sized <i>Barbus altianalis</i> and <i>Labeo</i>. Seine into shallow muddy backwater with rocky, grassy edges on N. bank yielded lots of small <i>Labeo</i> and <i>C. gariepinus</i>. Time 13.00 - 14.00.</p>				
6	21/9/97	Awach River (Homa Bay Road bridge)	00° 13' 55" S	34° 57' 18" E
<p>Site description and methods: River averaging 5 m wide by 30 cm deep, slightly murky with visibility approx. 25 cm. Land use: mainly grazing with some subsistence agriculture. Seine haul 1: 25 m upstream in smooth flowing stretch (flow rate 0.25 m.sec⁻¹) with mud bottom and very little overhanging vegetation (a few twigs). Full range of fish (see catch table). Haul 2: Stony pool below main road culvert, approx. 5 m. Small <i>Barbus</i> only. Haul 3: Just downstream of other haul sites, 15 m up to gauging and irrigation take off weir. Up to 40 cm deep. <i>Barbus altianalis</i>, small <i>Barbus</i> spp and <i>Labeo</i>. Haul 4: Above main road culvert. Approx. 5 m haul in shallow grass and twig-edged stream. <i>Barbus</i> and <i>Labeo</i>.</p>				
7	21/9/97	Awach River (upstream of site 6 on dirt link road)	00° 15' 32" S	34° 59' 36" E
<p>Site description and methods: River description as in Site 6, varying from 5-10 m wide. Land use: Subsistence agriculture and grazing. Haul 1: Immediately downstream of bridge. Muddy bottom with some cobbles. Haul of approx. 25 m upstream in water up to 30 cm deep. Haul 2: Approx. 100 m downstream of bridge. Pool up to over 1 m depth, mud bottom and slow flow, but hauling, approx. 25 m, up to cobbled rapids at head of pool. Haul 3: From bridge upstream for 30 m over cobbled bottom into steady flow, ending at inflowing riffles. Depth up to 1 m at head of pool. Similar species range in each haul. Time 10.00 - 10.45.</p>				

Table 1 continued. Sampling sites in the Nyando River, its tributaries and adjacent small streams.

Site no.	Date	Site name	Latitude	Longitude
8	21/9/97	Nyando River (Chemelil bridge)	00° 07' 26" S	35° 05' 40" E
<p>Site description and methods: River 15 m wide with steady flow. Water dark brown, bottom of blackened gravel and sand. Smell of molasses. Land use: sugar cane area with significant amounts of semi-natural vegetation. Three seine hauls in water up to 1 m depth, no fish. One <i>Clarias</i> seen rising for air. Time 11.00 - 11.15.</p>				
9	21/9/97	Nyando River (Muhoroni bridge)	00° 09' 52" S	35° 10' 57" E
<p>Site description and methods: Site above sugar factories effluents. River murky but grey, not brown. River with slow flow, about 15 m flowing down towards stony riffles. Land use: sugar cane in hilly terrain. Haul 1: In pool about 5 m by 2 m by 30 cm deep with grass-fringed bank. Catch included <i>Barbus nyanzae</i> and <i>B. neumayeri</i>, a <i>Clarias</i> sp. and <i>B. altianalis</i>. Haul 2: Across fast flowing stretch about 5 m wide into overhanging vegetation. Lots of <i>B. nyanzae</i> in catch. Haul 3: In slower flow above riffles into vegetation lined bank. Similar catch. Hauls 4 & 5: Below riffles below road bridge in pool up to 1.5 m deep. Nil catch. Time 11.45 - 12.30.</p>				
10	21/9/97	Limitid River (Nyando River trib. at Oyani)	00° 12' 02" S	35° 15' 00" E
<p>Site description and methods: Stream approx. 5 m wide by up to 0.5 m deep. Water silty grey. Mud-bottomed pool above rocky rapids below road bridge. Land use: sugar cane and subsistence agriculture in hilly terrain. Hauled for 10 m. Time 13.00 - 13.15.</p>				
11	21/9/97	Limitid River / Nyando River junction	00° 12' 03" S	35° 14' 36" E
<p>Site description and methods: Limitid R. approx. 5 m wide. Nyando R. approx 10 m wide, combining into river about 12 m wide by up to 1 m deep. Banks 90% overhanging reed-lined. Land use: sugar cane and subsistence agriculture in hilly terrain. Two hauls of seine up into reeds below junction and one approx. 10 m above junction in Limitid R. Catch <i>Barbus altianalis</i> and <i>B. nyanzae</i>, with <i>B. cercops</i> in Limitid R. only. Time 13.45 - 14.15.</p>				
12	21/9/97	Kibigori River (a.k.a. Abuda River, trib. of Nyando R.)	00° 03' 39" S	35° 04' 19" E
<p>Site description and methods: Silty stream 4 m wide and up to 30 cm deep, flow 1 m.sec⁻¹. Banks lined with overhanging grass and shrubs. Land use: mainly semi-natural vegetation, some subsistence agriculture and grazing. Two hauls, one around the pool created by the bridge foundations above the bridge and one up into the bankside vegetation in the faster stream above the pool. Time 14.45 - 15.15.</p>				
13 & 14	26/9/97	Ahero Rice Scheme (Nyatini)	00° 10' 08" S	34° 54' 30" E
<p>Site description and methods: Complex culvert arrangements where various rice irrigation canals join before passing through single culvert under main road. Water very murky, visibility virtually nil. Sample 13 is fish purchased from local seiners. Sample 14 is from four fine meshed seine hauls made in the canals and the junction area. Depth up to 0.5 m, muddy bottom with concrete structures at junctions, some emergent vegetation including <i>Nymphaea</i>.</p>				
15	26/9/97	Ahero Rice Scheme (large pond)	00° 10' 08" S	34° 55' 00" E
<p>Site description and methods: Large, approx. 100 m long, deep, murky pond of unknown depth. Under fishing management of local people. Seine fishing observed, small sample purchased, not including several haplochromine and tilapiine species. Seine mesh too large to catch smaller species.</p>				
16	26/9/97	Ahero Rice Scheme (by Irrigation Board)	00° 08' 39" S	34° 55' 32" E
<p>Site description and methods: Sluice gate area downstream of road. Complex concrete structures. Main area fished 5 m wide channel by 40 cm deep, moderate flow, mud, rock and concrete bed. Three seine hauls made.</p>				

Table 1 continued. Sampling sites in the Nyando River, its tributaries and adjacent small streams.

17	26/9/97	Miriu River (Ahero Rice Scheme)	00° 07' 42" S	34° 56' 21" E
<p>Site description and methods: Stream above main rice area. Very little flow. Above bridge, very muddy pool about 10 m wide by up to 40 cm deep, much emergent vegetation, particularly along edges. Mud bottom ending in concrete sill under bridge. Two hauls made down pool, one into bank, one to concrete sill. Below bridge, mud and stone bed, about 10 cm deep, slightly deeper below concrete sill. One haul made.</p>				

Table 2. Sampling sites for River Sondu Miriu, with site characteristics noted on first sampling survey.

Site No.	Date	Site Name	Latitude	Longitude
1	13/8/98	S. Miriu R. (Komumbo)	00° 18' 30''S	34° 46' 21''E
Site description. Side channel of main river 10 m wide by 50 cm deep. No flow, water red-brown, visibility 0.15 m. Muddy substratum. Vegetation; <i>Phragmites</i> and <i>C. rotundas</i> lined banks. Land use; subsistence farming and livestock grazing. Three seine hauls made over 70 m stretch.				
2	13/8/98	S. Miriu R. (Akoko)	00° 19' 01''S	34° 46' 44''E
Site description. Main river, large, up to 50 m wide by unknown depth. Water red-brown, turbid, visibility 0.18 m. Muddy substratum. Banks steep with <i>Phragmites</i> on the southern banks. Land use; subsistence farming and livestock grazing.				
3	13/8/98	S. Miriu R. (Nyandho)	00° 19' 06''S	34° 46' 39''E
Site description. Entrance to large floodplain pool about 60 m wide from main river, channel about 5 m wide by 1 m deep. Water brown, visibility 0.25 m. Substratum mud/sand. Vegetation; <i>Phragmites</i> lining both sides of the channel. <i>Eichhornia. crassipes</i> in the channel. Land use; subsistence farming and livestock grazing.				
4	17/8/98	S. Miriu R. (Wath lang'o)	00° 21' 10''S	34° 56' 46''E
Site description: Main river, 40 m wide, fast flowing. Water fairly clear, visibility 0.25 m. Sand/mud substratum. Vegetation; tall <i>Phragmites</i> on southern bank. Land use; subsistence farming and livestock grazing.				
5	17/8/98	S. Miriu R. (Gari)	Error in recording	34° 57' 11''E
Site description: Main river, 30 m wide. Fairly turbid, visibility 0.12 m. Substratum; sandy with pebbles. Vegetation; <i>Phragmites</i> on southern bank. Land use, subsistence farming and livestock grazing.				
6	17/8/98	S. Miriu R. (Masogo)	00° 24' 31''S	35° 55' 55''E
Site description: Main river, 25 m wide. Turbid, visibility 0.12 m. Muddy substratum. Vegetation; some macrophytes in the middle of the river, trees and shrubs on the southern bank. Land use; subsistence farming and livestock grazing.				
7	17/8/98	S. Miriu R. (Kanyamwaya)	00° 24' 35''S	34° 55' 13''E
Site description: Main river, 25 m wide. Visibility 0.2 m. Muddy substratum. Vegetation; similar to site 6. Land use; subsistence farming and livestock grazing.				
8	17/8/98	S. Miriu R. (Kobilo)	00° 23' 16''S	34° 55' 05''E
Site description: Main river, 40 m wide. Visibility 0.22 m. Sandy substratum. Vegetation; macrophytes on southern bank. Land use; subsistence farming and livestock grazing.				
9	13/8/98	S. Miriu R. (Sondu Bridge)	00° 23' 50''S	35° 01' 01''E
Site description: Main river, 20 m wide, very fast flowing and turbulent. Stone/pebble substratum. Vegetation; trees on one bank of the river and short macrophytes on the other. Land use; hilly terrain, subsistence farming. Sampled about 50 m below road bridge in small eddy by grassy, rock-edged islet. Also sampled about 100 m above bridge in small backwater about 3 m wide.				

Table 2 continued. Sampling sites for River Sondu Miriu.

10	14/8/98	Yurith R. (Kipranye Bridge)	00° 28' 41''S	35° 04' 59''E
Site description: Tributary of Sondu Miriu, 30 m wide, unknown depth, very fast flowing and turbulent. Visibility 0.2 m. Rocky substratum. Vegetation; eucalyptus trees, <i>Typha</i> and grass. Land use; subsistence farming. Six seine hauls made at rocky, vegetation-lined edges.				
11	14/8/98	Yurith R. (Ainapkoii Bridge)	00° 27' 57''S	35° 10' 46''E
Site description: Fast flowing river about 10 m wide by 1 m deep. Rock/mud substratum. Vegetation; trees, shrubs, grass, <i>Typha</i> and <i>Vossia</i> sp. on both banks. Land use; subsistence farming. Car wash area.				
12	14/8/98	Yurith R. (Jamji dam)	00° 28' 26''S	35° 12' 38''E
Site description: Dam about 150 m wide for supply of water and generation of power to tea estate. Water slightly murky, visibility 0.48 m. Black bass introduced to dam by KMFRI in 1986. Vegetation; trees upstream and <i>Typha</i> and grass on the shore. Land use; large scale tea farming.				
13	14/8/98	Yurith R. (Changoi)	00° 28' 52''S	35° 13' 09''E
Site description: River 5-7 m wide by 40 cm deep, fast flowing. Water slightly murky, visibility 0.48 m. Rocky substratum, steep banks. Vegetation; trees, shrubs and dense bankside vegetation on both sides of the river. Land use; large scale tea farming. Two sites (13a and 13b in Table 5) about 200 m apart fished.				
14	14/8/98	Yurith R. (Baye)	00° 23' 31''S	35° 13' 05''E
Site description: Small muddy stream about 1 m wide by 20 cm deep. Vegetation; predominantly lined by short grass, with <i>Typha</i> , <i>Vossia</i> , eucalyptus and shrubs. Land use; cattle grazing.				
15	15/8/98	Kipsanoi R. (Nyanderema)	00° 31' 23''S	35° 05' 47''E
Site description: Fast flowing river 25 m wide. Visibility 0.22 m. Substratum sand, pebbles and mud. Vegetation; trees on one side of the river. Land use; subsistence farming.				
16	15/8/98	Kipsanoi R. (Kapsimbiri)	00° 35' 36''S	35° 05' 05''E
Site description: Tributary of Sondu Miriu R., 25 m wide. Water brown and turbid, visibility 0.18 m. Substratum sand/mud. Vegetation; trees and grass on one bank. Land use; large scale tea farming.				
17	15/8/98	Kipsanoi R. (Jebilat)	00° 40' 55''S	35° 05' 46''E
Site description: River 20 m wide. Water turbid, brown, visibility 0.12 m. Substratum sand/mud. Vegetation; eucalyptus and acacia trees. Land use; large scale tea farming.				
18	15/8/98	Kipsanoi R. (Soymet)	00° 42' 36''S	35° 13' 02''E
Site description: River 15 m wide, visibility 0.2 m. Rocky substratum. Vegetation; <i>C. rotundas</i> on one bank. Land use; subsistence farming.				
19	15/8/98	Sesei R. (Sesei Bridge)	00° 44' 25''S	35° 15' 10''E
Site description: River 10 m wide, 1.5 m deep. Gentle flow, visibility 0.3 m. Rocky substratum. Vegetation; grass on both banks. Land use; subsistence farming.				
20	16/8/98	Sesei tributary (Magitiu)	00° 47' 31''S	35° 09' 06''E
Site description: Stream 3 m wide. Water brown and turbid, visibility 0.08 m. Substratum muddy. Vegetation; shrubs and grass. Land use; subsistence farming and cattle grazing.				

Table 2 continued. Sampling sites for River Sondu Miriu.

21	16/8/98	Sesei tributary (Olmagae)	00° 47' 31''S	35° 12' 36''E
Site description: Stream 3 m wide. Visibility 0.06 m. Muddy substratum. Vegetation; shrubs and grass, very similar to site 20. Land use; subsistence farming and cattle grazing.				
22	16/8/98	Kipsanoi R. (Kipkoros)	00° 39' 14''S	35° 18' 44''E
Site description: River 15 m wide, very fast flowing. Water fairly clear, visibility 0.3 m. Substratum rocks/pebbles. Vegetation; macrophytes on both sides of the banks. Land use; subsistence farming and livestock grazing.				
23	16/8/98	Itare R. (Korwa)	00° 35' 36''S	35° 18' 48''E
Site description: Large river 35 m wide, >2 m deep, fast flowing. Mud/rock substratum. Vegetation; trees forming a canopy upstream, grass and macrophytes. Land use; subsistence farming.				

Table 3. Sampling sites for River Nzoia, with site characteristics noted on first sampling survey.

Site No.	Date	Site Name	Latitude	Longitude
1	20/10/98	Nzoia river (Burangasi)	00° 05' 36''N	34° 01' 24''E
<p>Site description: River about 80 m wide, current 1.3 m s⁻¹. Water brown, turbidity 450 NTU. Substratum mud. Vegetation; <i>Phragmites</i> reeds on both banks. Area susceptible to flooding. Land use; subsistence farming.</p>				
2	20/10/98	Nzoia river (Hawagaya)	00° 07' 34''N	34° 05' 53''E
<p>Site description: River about 70 m wide, current 1.4 m s⁻¹. Water very brown, turbidity 319 NTU. Muddy substratum. Vegetation; <i>Phragmites</i> on both banks. Land use; subsistence farming.</p>				
3	20/10/98	Nzoia river (Nyandombo)	00° 10' 38''N	34° 14' 34''E
<p>Site description: River about 60 m wide, current 1.4 m s⁻¹. Water very brown, turbidity 670 NTU. Sandy substratum. Vegetation; <i>Phragmites</i>, eucalyptus trees and shrubs on both sides of the river. Land use; subsistence farming.</p>				
4	20/10/98	Nzoia river (Ugunja Bridge)	00° 12' 42''N	34° 17' 47''E
<p>Site description: River about 80 m wide, current 1.4 m s⁻¹. Water very brown, turbidity 390 NTU. Sandy substratum. Vegetation; <i>Vossia</i>, papyrus, trees and shrubs on both sides of the river. Land use; subsistence farming.</p>				
5	21/10/98	Nzoia river (Mumias Bridge)	00° 22' 34''N	34° 28' 19''E
<p>Site description: River narrower than at sites 1-4, width 40 m, fast flowing, current 3.3 m s⁻¹. Water brown, turbidity 308 NTU. Sandy substratum. Vegetation; <i>Phragmites</i> on both banks. Land use; subsistence farming and large scale sugar cane farming.</p>				
6	21/10/98	Nzoia river (Kharanda Bridge)	00° 27' 36''N	34° 37' 09''E
<p>Site description: River 40 m wide, current 3.3 m s⁻¹. Water brown, turbidity 213 NTU. Muddy substratum. Vegetation; trees and shrubs on both banks. Land use; small scale sugar cane farming.</p>				
7	21/10/98	Kuywa river (Matisi Bridge)	00° 37' 34''N	34° 40' 40''E
<p>Site description: Tributary of River Nzoia, 10 m wide entering a 25 m wide eddy, used as a cattle drinking site. Current 1.3 m s⁻¹. Water brown, turbidity 53.3 NTU. Muddy substratum. Vegetation; sheer mud banks with overhanging vegetation of <i>Vossia</i> sp., eucalyptus trees, shrubs and <i>Typha</i>. Land use; small scale sugar cane farming.</p>				
8	22/10/98	Kibisi river (Misikhu Bridge)	00° 45' 01''N	34° 46' 24''E
<p>Site description: Tributary of River Nzoia, 10 m wide by 40 cm deep, current 0.9 m s⁻¹, narrowing to pass under bridge. Stony bottom under bridge, very soft mud upstream where seining carried out. Water brown, turbidity 58.2 NTU. Vegetation; emergent vegetation consisting of eucalyptus trees, <i>Acacia</i> sp. and <i>C. rotundas</i> on one bank, bare mud on opposite as site used as cattle watering point. Land use; subsistence agriculture, grazing and bush.</p>				

Table 3 continued. Sampling sites for River Nzoia.

9	22/10/98	Kibisi river (Kimilili Bridge)	00° 45' 42''N	34° 43' 44''E
<p>Site description: River 3 m wide and up to 80 cm deep, current 0.9 m s⁻¹. Turbidity 540 NTU. Muddy substratum. Vegetation; emergent <i>Vossia</i> and <i>C. rotundas</i> on both banks, eucalyptus trees in swamp upstream. Land use; subsistence agriculture and grazing.</p>				
10	22/10/98	Kuywa river (Chenjeni)	00° 44' 59''N	34° 37' 10''E
<p>Site description: Junction of small stream with River Kuywa. Stream 8 m wide by 1 m deep, current 1.4 m s⁻¹. Turbidity 80 NTU. Muddy substratum with some boulders. Vegetation; much overhanging vegetation (trees and shrubs) on both banks. Land use; subsistence sugar cane and maize farming.</p>				
11	22/10/98	Chwele river (Makotelo)	00° 36' 12''N	34° 38' 01''E
<p>Site description: Small stream 7 m wide and >1 m deep, current 1 m s⁻¹. Water silty grey, turbidity 256 NTU. Substratum; bedrock/boulders, silt and mud. Vegetation; much overhanging vegetation on both banks. Land use; subsistence farming.</p>				
12	23/10/98	Nzoia river (Broderick Falls)	00° 36' 26''N	34° 48' 13''E
<p>Site description: Below the falls. Fast-flowing, 30 m wide by 1.5 m deep, current 2.5 m s⁻¹. Turbidity 96.5 NTU. Stony substratum. Vegetation; palm trees and other shrubs on both banks. Land use; subsistence farming.</p>				
13	23/10/98	Ewaso Rongai river (Kiminini bridge)	00° 54' 31'' N	34° 56' 46''E
<p>Site description: River 20 m wide, current 1.3 m s⁻¹. Turbidity 96.2 NTU. Muddy substratum. Vegetation; eucalyptus trees, acacia and shrubs on both banks. Land use; subsistence farming.</p>				
14	23/10/98	Kimothon river (Endebes)	01° 04' 54''N	34° 51' 35''E
<p>Site description: Small stream in foothills of Mt. Elgon, 5 m wide by 50 cm deep with wider area at cattle watering point, gently flowing, current 0.7 m s⁻¹. Water cold (14.6°C). Water red-brown, turbidity 75.4 NTU. Muddy substratum. Vegetation; mud banks with some emergent grasses. Land use; cattle grazing and subsistence farming.</p>				
15	23/10/98	Subwani river (Naisabu)	01° 01' 32''N	35° 04' 12''E
<p>Site description: Stream 10 m wide by 1 m deep and fairly featureless, current 1.3 m s⁻¹. Red-brown and murky, turbidity 26.8 NTU. Muddy substratum. Vegetation; mud banks with overhanging vegetation but not submerged, palm trees and shrubs. Land use; subsistence farming.</p>				
16	23/10/98	Ainomaget river (Surungai)	01° 01' 41''N	35° 10' 13''E
<p>Site description: Stream 15 m wide and 4-5 m deep, diverted from original course. Current 0.7 m s⁻¹. Clear, turbidity 12.1 NTU. Sand and gravel substratum. Vegetation; eucalyptus trees, <i>Typha</i>, <i>C. rotundas</i> and floating macrophytes. Land use; for subsistence farming.</p>				
17	24/10/98	Little Nzoia river (Moi's Bridge)	00° 54' 40''N	35° 07' 17''E
<p>Site description: River below bridge, widening from 10 to 30 m in big eddy. Current 1.3 m s⁻¹. Water murky brown, turbidity 64.9 NTU. Bottom of mud and sand with bedrock outcrop and laterite northern bank. Vegetation eucalyptus trees and shrubs on both banks. Land use; subsistence farming.</p>				

Table 3 continued. Sampling sites for River Nzoia.

18	24/10/98	Chepkoilel river (Soy Bridge)	00° 40' 30''N	35° 09' 56''E
<p>Site description: Small stream 10 m wide by 40 cm deep, current 1 m s⁻¹. Water grey-brown, turbidity 28.1 NTU. Boulder/sand substratum, riffles and a deeper pool, difficult to sample using a seine net. Vegetation; overhanging shrubs, rush-lined banks, also fig trees. Land use; subsistence farming.</p>				
19	24/10/98	Sambut dam	00° 37' 34''N	35° 09' 06''E
<p>Site description: Dam 60 m wide used by EATEC owners for recreation. Contains introduced tilapia for sport fishing. Muddy substratum. Vegetation; <i>Typha</i>, <i>C. rotundas</i> and other trees. Land use; subsistence farming.</p>				
20	24/10/98	Olare Onyokie river (Airport Bridge)	00° 24' 06''N	35° 12' 11''E
<p>Site description: River about 300 m below large dam near Eldoret airport, 8 m wide by 40 cm deep, fast flowing over rocky substratum. Water grey, turbidity 59.7 NTU. Vegetation; macrophytes, trees and shrubs on both banks. Also side channel 20 m long by 2 m wide by 30 cm deep, heavily overgrown with little flow. Difficult to sample with seine net. Land use; subsistence farming.</p>				

Table 4. The number of specimens of each species recorded in the September 1997 survey of the River Nyando and adjacent streams.

Species	Number of fish																
	Site number 1	2&3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
<i>Barbus altianalis</i>		1															
<i>Barbus apleurogramma</i>					11	2	65	4	4	4	24	9					
<i>Barbus cercops</i>	41	5	13	17	3	1	2					87	210		49	81	
<i>Barbus jacksonii</i>	1	3				2	2	18	3				1			10	
<i>Barbus kerstenii</i>	1	7	8			6						16		1			
<i>Barbus neumayeri</i>						4					1	22	9		5	6	
<i>Barbus ryanzae</i>	99	22	11	43	22	20		6									
<i>Barbus paludinosus</i>	1	1	3					40	14	9	1					8	
<i>Barbus yongei</i>	1	12	9									8	7			1	
<i>Labeo victorianus</i>		6	1	15	7	9											
<i>Aethiomastacembelus frenatus</i>	1	2															
<i>Schilbe intermedius</i>	1	11	5														
<i>Clarias gariepinus</i>	1	2		1	1	1											
<i>Clarias</i> sp. 1								1				1		1		1	
<i>Clarias</i> sp. 2																	
<i>Oreochromis niloticus</i>					1								26		1		
<i>Oreochromis leucostictus</i>													3				
<i>Ctenopoma murei</i>												6	9	1	2	7	
<i>Pseudocrenilabrus multicolor</i>												3	18	2	50	7	
<i>Haplochromis</i> sp.												1	1				
<i>Marcusenius victoricae</i>												1			3		
<i>Protopterus aethiopicus</i>															1		
<i>Aplocheilichthys bukobanus</i>															4	3	

Table 5. The number of specimens of each species recorded in the August 1998 survey of the Sondou Miriu River system.

Species	Number of fish																									
	Site number	1	2	3	4	5	6	7	8	9	10	11	12	13a	13b	14	15	16	17	18	19	20	21	22	23	
<i>Barbus altianalis</i>																										
<i>B. apleurogramma</i>					1																					
<i>B. cercops</i>			36	3						5																
<i>B. jacksonii</i>	17		54																							
<i>B. kerstenii</i>	7			1	1																					
<i>B. neumayeri</i>	5				5	2	8	143	1							4	1	5	1	286	60	107	16			
<i>B. paludinosus</i>	116		1		2	3	10	483									65	6	2	1	34	45	24	11	19	
<i>B. yongei</i>	2		21																		16	379	88			
<i>Labeo victorianus</i>	1																									
<i>Clarias gariepinus</i>	2																									
<i>Clarias</i> spp.									4							10				12	11	9				2
<i>Synodontis afrofishcheri</i>	1				8																					
<i>Oreochromis niloticus</i>	1				1	3	8	5	2	3																
<i>O. leucostictus</i>					2	1	1			8																1
<i>O. spp.</i>																										
<i>Pseudocrenilabrus multicolor</i>	3		12																							8
haplochromines	6		9		2	1																				
<i>Lates niloticus</i>																										
<i>Marcusenius victoricae</i>	1				2																					
<i>Gambusia affinis</i>							3?																			25

Table 6. The number of specimens of each species recorded in the October 1998 survey of the Nzoia River system.

Species	Number of fish																				
	Site number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<i>Barbus altianalis</i>				15	17	3		45	1	2	1	2	4	1				1			1
<i>B. aploleurogramma</i>	1	4																			
<i>B. cercops</i>	3		33	64	124		29			1	1	4	1								
<i>B. jacksonii</i>	3	1		1			29				2										
<i>B. kerstenii</i>	2			3	37		21			3	1										
<i>B. neumayeri</i>			1				252	12	6	4	1	6	60	6	11	1	71	1			
<i>B. nyanzae</i>	1				3		33				15					2					
<i>B. paludinosus</i>					54																
<i>B. spp. (unidentified)</i>							3														
<i>Labeo victorianus</i>		2																			
<i>Schilbe intermedius</i>	1	8																			
<i>Clarias gariepinus</i>						1															
<i>Amphilius cf. jacksonii</i>									1												
<i>Chiloglanis cf. somereni</i>																					
<i>Chiloglanis sp.</i>							11														
<i>Leptoglanis sp.</i>			4								1										1
<i>Oreochromis niloticus</i>																					
<i>O. leucostictus</i>	14								1												21
<i>O. spp.</i>																					
<i>Tilapia zillii</i>																					15
<i>Pseudocrenilabrus multicolor</i>	20	2	1						2							12					6
haplochromines	16	2																			