Analysis of Catch and Effort Data for the Fisheries of the South East Arm of Lake Malawi 1976 - 1989,
With a Discussion of Earlier Data and the Inter-Relationships with Commercial Fisheries

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ANALYSIS OF CATCH AND EFFORT DATA FOR THE FISHERIES OF THE SOUTH EAST ARM OF LAKE MALAWI, 1976-1989, WITH A DISCUSSION OF EARLIER DATA AND THE INTER-RELATIONSHIPS WITH THE COMMERCIAL FISHERIES

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TRADITIONAL FISHERIES ASSESSMENT PROJECT (MG/ODA)
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PREFACE

This Fisheries Bulletin is one of a series of working papers on the fisheries of Lake Malawi and associated waters produced by the ODA-funded Traditional Fisheries Assessment Project in 1991. They have since been edited after external refereeing but no changes have been made to the findings and recommendations made at that time. Thus, in some cases references may be found to other projects in progress which have since been completed, and all recommendations made in these reports have already been thoroughly reviewed and, where relevant and agreed, acted upon. These papers include all available data on the fisheries up to 1989 tabulated on an annual basis, and also numerous graphs of the data for various fishing gears to allow Fisheries Officers in the different areas to easily visualise the trends which have occurred in the fisheries in their areas.

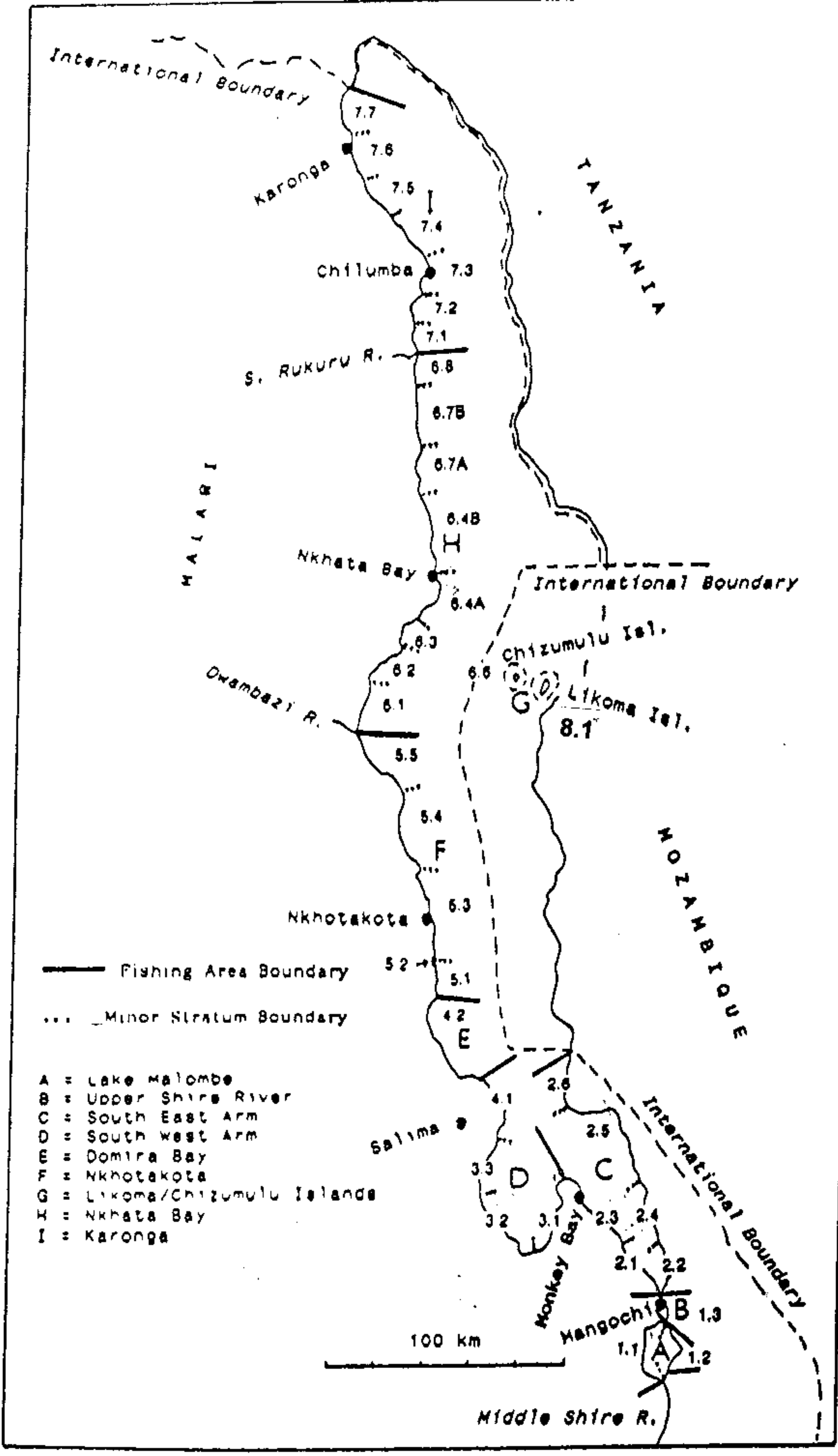
International Boundary
TANZANIA
Karonga
Chilumba
S. Rukuru R.
MALAWI
Nkhata Bay
Chizumulu Isl.
Likoma Isl.
Dwambazi R.
MOZAMBIQUE
Nkhotakota
Salima
Monkey Bay
Mangochi
Middle Shire R.
100 km
Fishing Area Boundary
Minor Stratum Boundary
A = Lake Malombe
B = Upper Shire River
C = South East Arm
D = South West Arm
E = Domira Bay
F = Nkhotakota
G = Likoma/Chizumulu Islands
H = Nkhata Bay
I = Karonga
7.7
7.6
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Figure 1

INTRODUCTION

The South East Arm of Lake Malaŵi is about 80km long, 30km wide at its northern end, and tapers steadily to the point where it terminates in the outflow to the Shire River (Fig. 1). Most of the coastline is sandy with extensive reed beds particularly on the eastern shore. A few rocky outcrops occur along the northern half of the western shore. There are three major islands, Boadzulu, Chinyankhwazi and Chinyamwezi and also several underwater rock ridges and small inshore islets. In this report the data for the stretch of coastline from the northern corner of the South East Arm, Makinjira Point, up to the Moçambique border are also included. This is an area of swamps and lagoons in the south, becoming rocky as the border is approached.

The South East Arm is the most productive part of the lake (Eccles, 1974). The gently shelving bottom and prevailing south east winds in the cool dry season generate upwelling of nutrient-rich metalimnetic water and hence relatively higher plankton and fish densities than in other parts of the lake. Because of this, the South East Arm attracts a high fishing effort and is also a focus of the major commercial fishing activities (the separation between traditional and commercial fishing for Lake Malaŵi fisheries is artificial, based on size of vessel, size of initial investment, licence regulations and method of catch data recording). There is some degree of overlap between the commercial and traditional fishermen, with catfishes particularly affected by the excessive amounts of juveniles caught in small meshed trawls, hence these fisheries cannot be treated in isolation. Although this report concentrates on the traditional fisheries, the effects of the commercial fisheries on the stocks are briefly noted and joint analyses made where both sets of fishermen exploit the same stocks.

In the 1989 annual frame survey 6,612 fishermen were recorded operating in the traditional fisheries of the South East Arm of Lake Malaŵi, for which the sampling strata are shown in Fig. 2. The number of fishing craft has fluctuated from year to year. After an initial unexplained fall in numbers from 1976-1977, the number increased steadily until 1984and has stabilised since then at about 1,500-1,600 (Fig. 3). Approximately equal numbers of boats and canoes operate in the South East Arm, though the proportion of boats increases greatly from north to south (Alimoso, *et al.*, 1991). The number of outboard engines has declined by 54% since 1983 (Fig. 4).

METHODS OF DATA COLLECTION

Statistical data on the traditional fisheries are collected and analysed using methods developed by Bazigos (1972) and implemented by Walker (1974; 1976a). A description of the methods of collecting data and the associated problems has been presented elsewhere (Alimoso, 1988). Total catches and fishing effort for each area are estimated by combining data obtained in monthly catch assessment surveys (CAS) and in annual frame surveys. The data are presented here by gear and by species group.

Commercial catch data used in this report are from full catch returns submitted by every commercial unit.

Information on the traditional fisheries pre-1976 is from Ricardo Bertram *et al.* (1942), Lowe (1952), Walker (1976b), and annual reports of the Department of Game, Fish and Tsetse Control from 1949 to 1962.

Figure 1. Lakes Malaŵi and Malombe, showing the areas into which the lakes have been divided for data analysis.

DATA ANALYSIS

The total estimated annual traditional catch in the period covered here ranged from 4,032 to 12,872 tonnes (mean = 6,734 tonnes) (Fig. 5 and Appendix I). Catches since 1983 have been generally higher than in previous years, with high Usipa (*Engraulicypris sardella*) catches boosting the 1989 catches to the highest yet recorded. Chambo (*Oreochromis* spp.), Utaka (*Copadichromis* spp.) and Usipa were the main components of the catch, 39%, 25% and 16% respectively over the 14 year period 1976-1989, though other species also contributed significantly (Fig. 6). The contribution of Usipa is grossly underestimated in these figures, primarily because of the nocturnal nature of the fishery and absence of beach recorders at such times (Lewis and Tweddle, 1990). Figure 5 shows the annual changes in species composition.

Gillnets (41% of catch) and chirimila nets (37%) caught most fish but a variety of other gears also contributed significantly (Fig. 7).

The catch data are analysed here both by fishing gear and by species. Analysis by gear has weaknesses in that some gears catch a range of species with differing life histories, while analysis by species does not take into consideration the fact that management inevitably entails control of gears, hence management regulations imposed for one species will influence catches of others. To ensure that management proposals take into account effects of gear legislation on all important species in the catch, a comparison of the results of both methods of looking at the fisheries is necessary.

The traditional fisheries of the South East Arm exploit some species which are also taken in the commercial fisheries, hence those fisheries cannot be treated in isolation. Analyses of catches of certain species groups therefore incorporate commercial catch data also.

Various surplus production models were used in analysing the data. These have proved of limited value, but Fox's (1970) surplus yield model is used in some instances to provide rough figures as a basis for discussion.

ANALYSIS BY GEAR

Gillnets

In the South East Arm, gillnets are used passively and hence catch per unit effort (cpue) is much lower than in Lake Malombe, where gillnets are often used as encircling nets and fish are driven into nets by beating the water with clubs (Tweddle *et al.*, 1991). The number of gillnets used in the South East Arm increased from 700 (a questionable, too low figure) in 1977 to a peak of 4,587 in 1983 and has since declined to 1,784 in 1989 (Fig. 8).

Figure 2. The beach recording areas of the South East Arm.

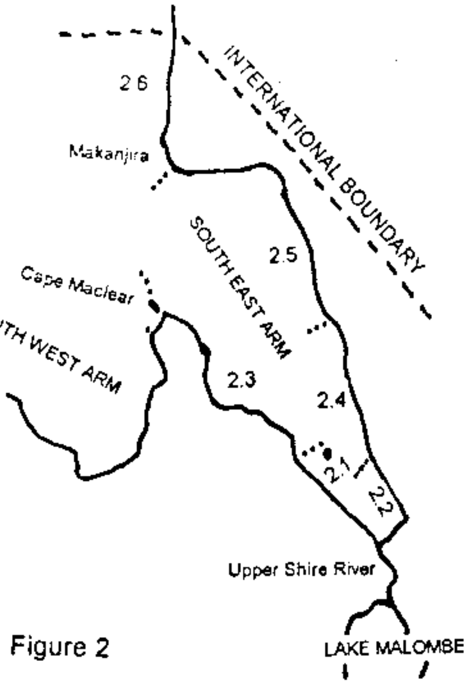
Figure 3. Changes in the number of fishing craft operating in the South East Arm, based on annual frame surveys. Dashed lines indicate missing data.

Figure 4. Changes in the number of operational boats, with and without outboard engines, based on annual frame surveys.

Figure 5. Annual catches by species groups by the South East Arm traditional fisheries.

Figure 6. Percentage by weight of the various species groups in the catches over the 14 year period 1976 to 1989.

Figure 7. Percentage of catch by weight contributed by different fishing gears over the 14 year period 1976-1989.



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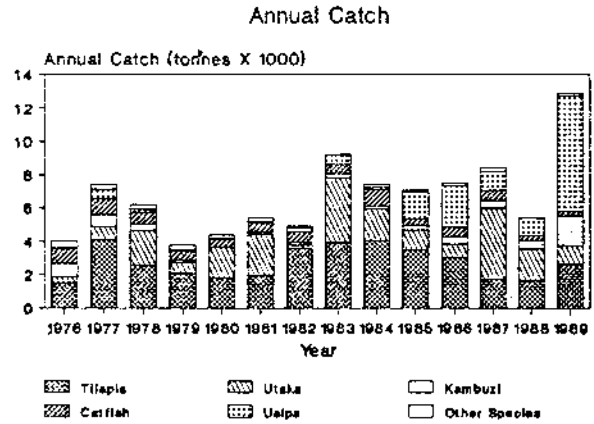

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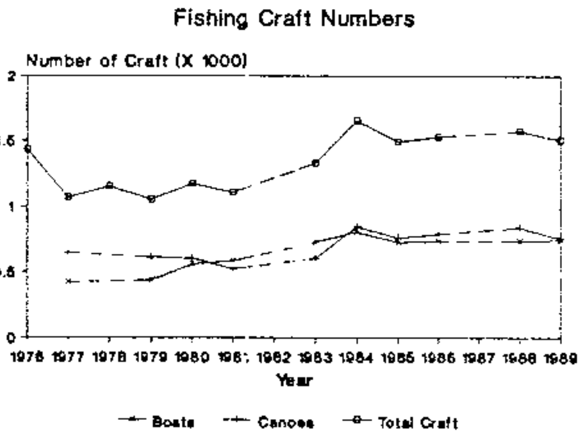

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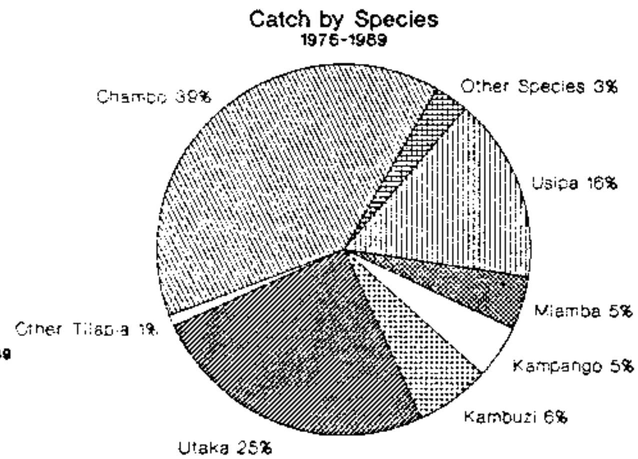

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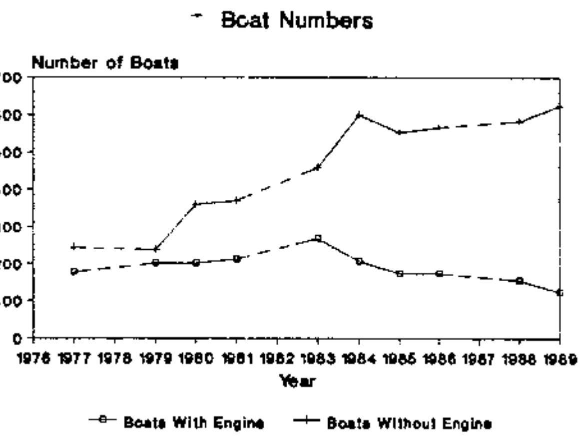

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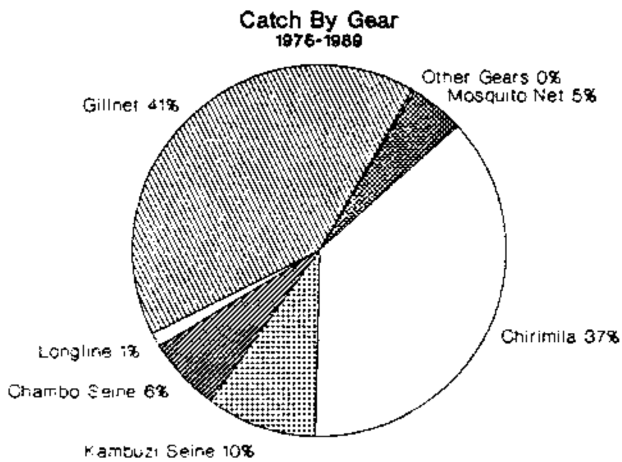


Figure 7

Figures 9 to 12 show the catch, effort and cpue data for the gillnet fishery over the 14 year period 1976-1989. There is no significant correlation between numbers of gillnets owned (Fig. 8) and estimated effort from the catch assessment surveys (Fig. 11), in fact there is a tendency for the highest effort to be associated with the lowest net ownership (r = -0.379). Cpue fluctuated in a narrow range except for the years 1982 and 1983 when Chambo increased greatly in abundance. The relative stability of the cpue is discussed later.

A yield curve plotted using such data has limited value, partly because the gillnet catches several species with differing life histories, but particularly because the high cpue of 1982-83 caused by a major increase in Chambo (which comprised 74% of the catch overall (Fig. 10) but 81% in those two years) was almost certainly due to the same environmental factors noted by Tweddle and Magasa (1989) in an analysis of the commercial Chambo fishery. To provide a basis for discussion, however, a Fox yield curve has been plotted for the data. The exponential regression of cpue against effort was significant (r = -0.549; P = 0.042) (Fig. 13B) and gave a maximum sustainable yield (MSY) estimate of 3,600 tonnes at an effort of 1.35 X 10^6 gillnet nights (Fig. 13A). Following Gulland's (1961) recommendation that effort should be averaged over the mean number of years the fish are in the fishery, because stock size and hence cpue is affected by fishing in previous years, a two year mean of effort, which has proved suitable in several Malawi cichlid-based fisheries (Turner, 1977b; Tweddle and Magasa, 1989; Tweddle, *et al.*, 1991) was tested. This gave similar results, 3,700 tonnes MSY at the same effort, though the exponential regression (r = -0.498; P = 0.084) was not significant.

Visual inspection of the catch data in relation to the calculated yield curve suggests that the estimate might be reasonable. However, data on the early stages of the gillnet fishery when effort was low are lacking. To obtain some idea of catch and effort in the past, data were collated from Ricardo Bertram *et al.* (1942), Lowe (1952), Department of Game, Fish and Tsetse Control annual reports in the 1950s, and Walker (1976b).

From the description of the fisheries in Ricardo Bertram *et al.* (1942), it seems clear that fishing activity over much of the lake was negligible, with large areas of lakeshore inaccessible after the long continuous rise in lake level from 1915 to 1939, when the survey was conducted. In some areas, beach seining was an important activity but gillnets were used only occasionally when conditions were unsuitable for beach seining. Despite this low activity, the catch rates in experimental gillnets used by the survey were low. The mean cpue for nets used in the South East Arm at Malonda and at Monkey Bay was 6.73kg/set. The nets were not set on the bottom, however, and the authors noted that the natives' bottom set nets had higher catches of Nchila (*Labeo mesops*).

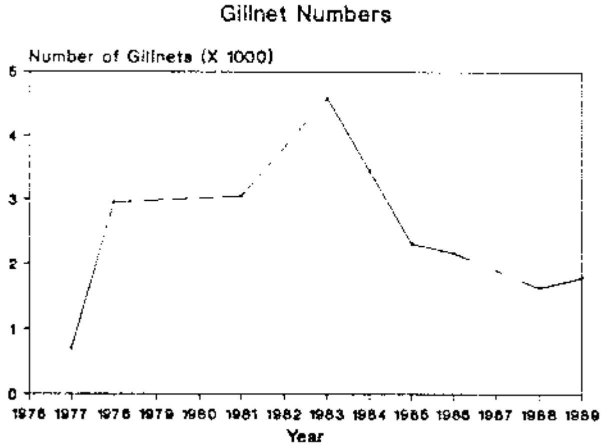
Figure 8. Number of gillnets recorded during annual frame surveys. Gaps in the data and dashed lines represent missing data.

Figure 9. Total annual catches by weight by species group in gillnets.

Figure 10. Percentage by weight of the various species groups in the gillnet catches over the 14 year period 1976 to 1989.

Figure 11. Total annual effort by gillnets, measured in number of sets of 91m (unmounted length) nets.

Figure 12. Change in average gillnet cpue from year to year, measured in kg of fish per 91m of net set per night.



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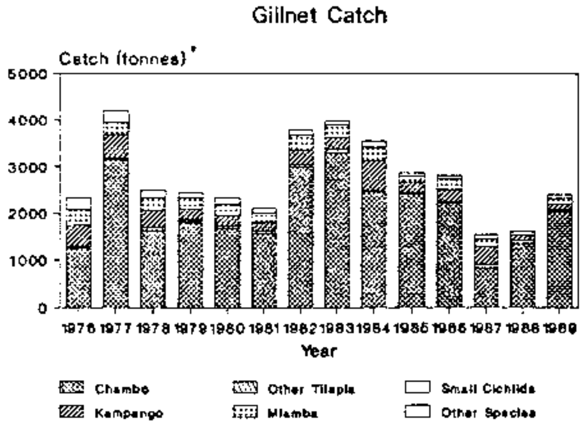

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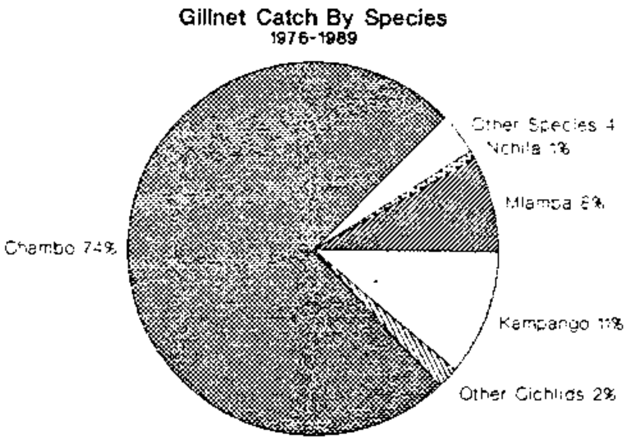

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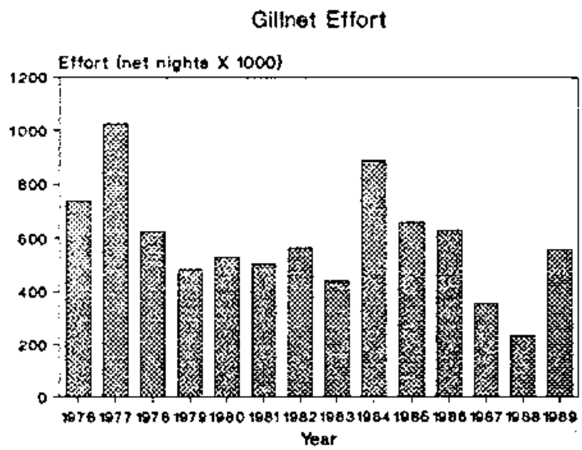

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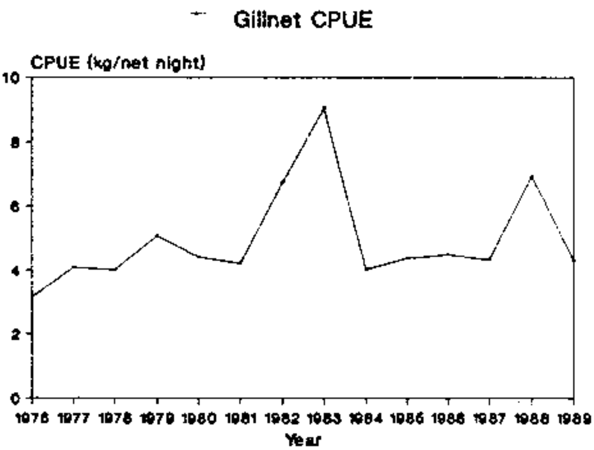


Figure 12

Lowe (1952, p. 69) described the gillnet fishery of 1945-47 as follows: "Some gillnets are used by Africans in parts of the lake where there is sufficient suitable shallow water, e.g., at Kotakota, in the Chia Lagoon, in the south-west arm and in Lake Malombe, but the gillnet fishery is at present much restricted by the presence of crocodiles and the fear of losing nets. The African gillnets are generally small. Gillnets about three inch mesh are used for Nchila and about five inch mesh for Kampango (*Bagrus meridionalis*)". These remarks suggest that gillnet effort was very low at that time.

Lowe (1952) conducted her own gillnetting trials in the South East Arm, a total of 65 sets on the bottom between September 1945 and March 1947. Results were presented as numbers of fish of the various species groups, together with the size range. No weights were given. Using length-weight data from other sources, estimates of weight have been made for Lowe's catches. The mean cpue for Lowe's 4" (102mm) net (the current minimum mesh size is 3 ¾" (95mm) and most nets are around that size) was 12kg/set, with monthly means ranging from 4kg/set in July 1946 to 37kg/set (one set only) in December 1946. The data clearly show high catches of Nchila in December and January, high Chambo catches from March to May, and very low cold season (July and August) catches. Excluding Nchila catches for reasons discussed later, the mean cpue was 8kg/set.

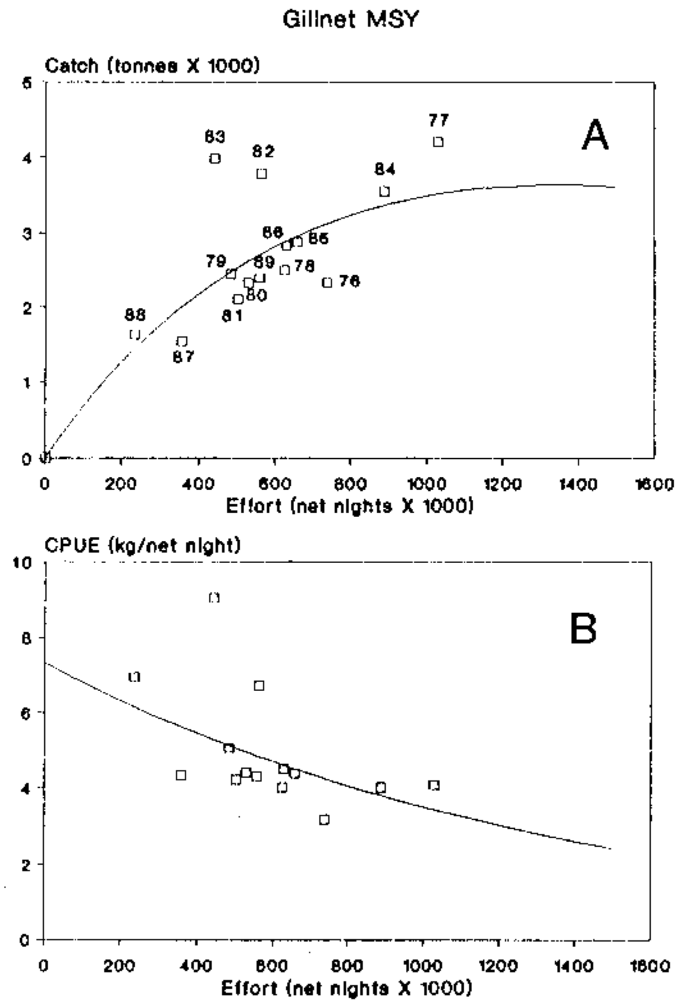
Walker (1976b) stated that statistical data collected by the beach recording system prior to 1976 were biased and unreliable. However, he did extract data on gillnet cpue from those records (which have now been destroyed) dating back to 1951 and these may be used to gain some idea of the early stages of the fishery. Gillnetting only really developed on any scale in the 1950s when nylon netting started to become freely available. Walker recorded gillnet cpue as high as 40kg/net night. The early cpue data listed by Walker are considerably higher than anything recorded in the 1930s and 1940s and must be regarded as doubtful estimates, though the introduction of nylon would have improved cpue by between 30 and 50% (Jackson *et al.*, 1963). Nevertheless, an attempt is made here to add Walker's data to that for 1976 to 1987 to see if overall catches could ever have been higher than they are at present. We use the following very rough, but conservative, assumptions: (A) The cpue of 40kg/net night can be considered to be that of the virgin fishery, with effort = 0. (B) Effort increased linearly over the period covered by Walker. There is some justification for this in that Walker (1976b) showed that net sales by Blantyre Netting Company in the Mangochi area increased approximately linearly from 1964 to 1975. (C) By 1973 effort had reached an annual level of about 0.5×10^6 net nights.

Figure 14 shows the relationship between cpue and effort using these data combined with those from 1976-1989. An exponential regression fitted to these data ($r = -0.850$, $P < 0.0001$) is highl significant and suggests an MSY of 3,430 tonnes, but at an effort level of one quarter of th calculated above for the 1976 to 1989 data, i.e. 350,000 net nights. Although the correlation is ve high, the regression does not take much account of the stable cpue at high effort levels. Also, t MSY estimate is heavily biased by the considerable standing stock which was removed in the ea years before the fishery and stock approached equilibrium.

Figure 13. (A) Estimate of sustainable yield in the gillnet fishery, all species combined, based on regression equation in Fig. 13B.

(B) Relationship between cpue and effort in the gillnet fishery.

Figure 14. Scatter diagram of cpue against effort, using the data for 1976 to 1989, shown by crosses, tog with the cpue data for the years 1950 to 1973, shown by open squares, presented in Walker (1976b). has been estimated for those data based on linear increase over time. For further explanation see text.



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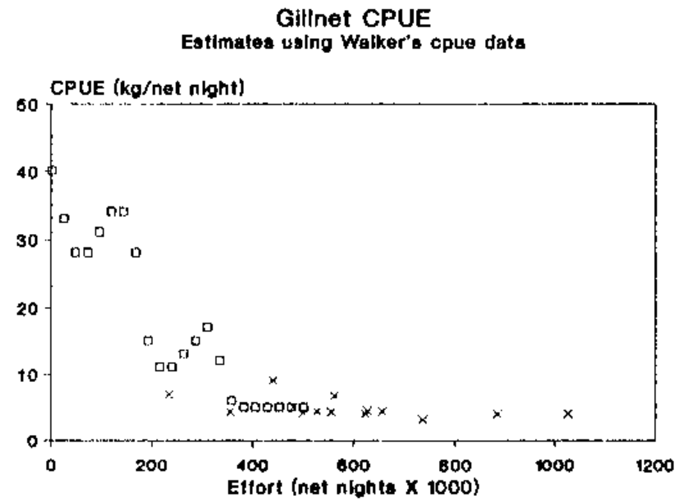


Figure 14

With starting effort levels of 100,000 net nights and 200,000 net nights, and again assuming linear increase in effort, MSY would still be attained at about 300,000 net nights effort, with MSY at 3,820 and 4,300 tonnes respectively. Correlation coefficients were much reduced and the graphs looked unrealistic. However, whatever the earlier effort levels, it seems likely that overall yields were not greater than those being consistently obtained today.

From the 1930s to the 1950s, the gillnets made high catches of Nchila (*Labeo mesops*) and catfish. Nchila are now virtually eliminated from the catches and catfish catches are very low, for reasons discussed later. Chambo cpue on the other hand has remained remarkably stable and is in fact higher now than it was in the early 1950s. This may possibly be explained by the increased fishing depth of the nets used in recent years. The stability of Chambo cpue suggests that the decline of the other species may have causes other than gillnet fishing. Nchila in particular are better protected by the gillnet mesh size regulations than are Chambo.

The annual reports of the Department of Game, Fish and Tsetse Control (GFTC) between 1955 and 1962 report on several gillnet trials. The data are haphazardly presented and in many cases no indications of weights are given. However some estimates of cpue can be derived. The data cover a variety of net depths, colours, mounting ratios, etc. Such variation is, however, the norm in the actual fishery also. It is also unclear where most of the nets were set, but they were most likely in the River Shire near the outlet of the South East Arm, or in the Arm itself. The Department had a field station at Namiasi, about 10km from Mangochi, from where nets may have been set. Despite the problems, the data reveal a consistent and dramatic decline in cpue at that time, shown in Table 1.

Table 1. The decline in cpue in experimental gillnetting conducted from Mangochi.

year	no. of sets	cpue (kg/set)
1955	72	19.15
1956		10.33
1957	138	5.28
1958	265	4.94
1959	80	2.91
1960	464	2.65
1961	22	0.93

These data cover a major period of expansion in the use of gillnets (see Table 2 later in this report). They suggest a decline even greater than that suggested by Walker, and the last few years data in Table 1 suggest catch levels considerably below those found today. The annual reports, however, make no mention of this striking decline. The historical data therefore show conflicting evidence on the scale of the decline in cpue, though the GFTC and Walker data are at least consistent in demonstrating a decline through the 1950s as the availability of nylon netting improved.

Figure 15. Number of Kambuzi seines recorded during annual frame surveys.

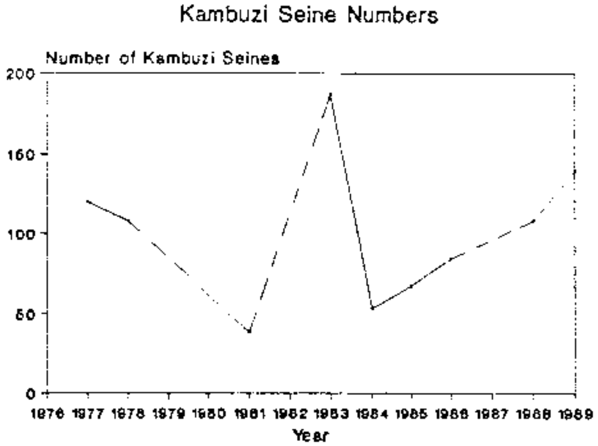
Figure 16. Annual catches of Kambuzi seines showing fluctuations in species composition.

Figure 17. Percentage by weight of the various species groups in the catches of Kambuzi seines over the 14 year period 1976 to 1989.

Figure 18. Annual recorded effort in Kambuzi seine fishery.

Figure 19. Annual fluctuations of cpue in the Kambuzi seine fishery.

Figure 20. Number of longlines recorded during annual frame surveys.



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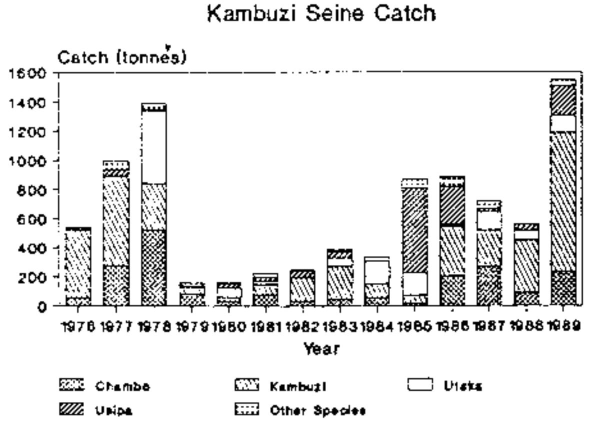

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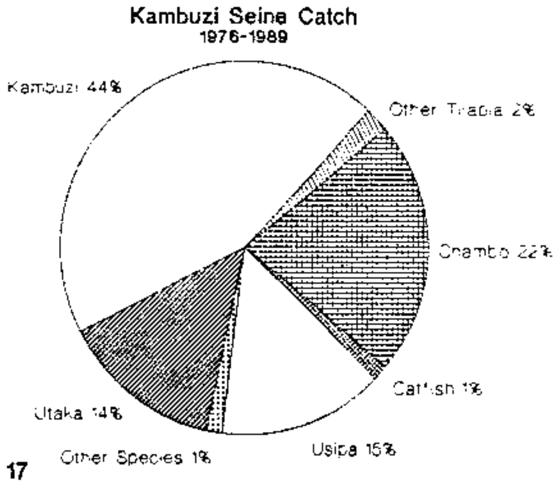

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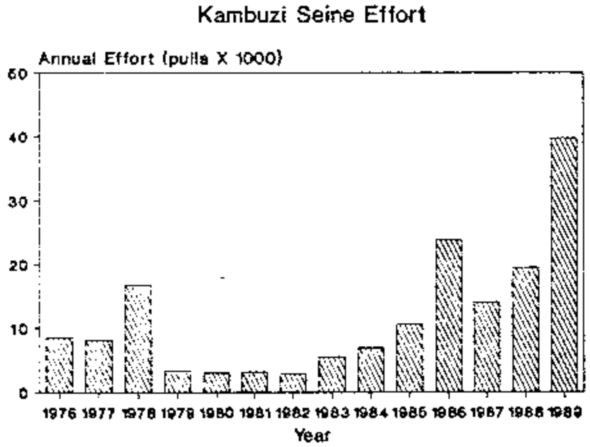

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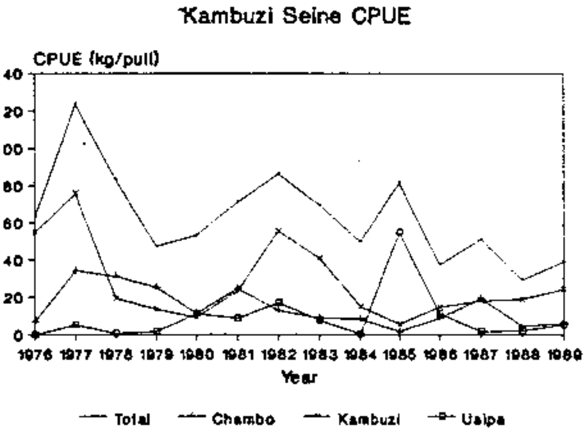

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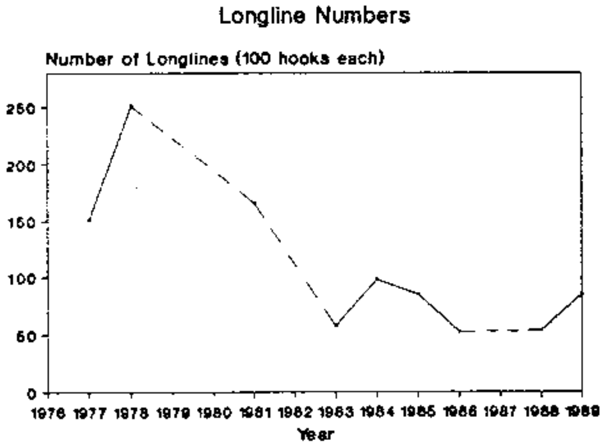


Figure 20

Much of the inconsistency in gillnet catch data from past records is undoubtedly due to differences in net dimensions and setting methods and there is no way of correcting for such differences. Even in present catch data, no indication is given of net depth, for example, though this clearly has an impact on catch rates. Nevertheless, the scale of the changes which have taken place in the gillnet fishery means that trends of declining cpue show up clearly in all the data sets, despite the range of methods which are represented in the data.

The evidence available suggests that the gillnet fishery probably produces as much now as it has ever done in the past. The 1.35 X 10^6 net night effort for MSY shown in Fig. 13 cannot be accepted as a management target, as (A) it is based on a weak correlation, (B) it is affected by the high Chambo catches of the early 1980s, without which the catches show little evidence of decline at higher effort levels, and (C) Fig. 13A shows that yields can be as high at an effort of 5-600,000 net nights. 2,000 licenced gillnets would, fished for 250-300 nights each per year, produce this amount of effort, and it is recommended that this should be the management aim.

Kambuzi seine

Kambuzi seines are small-meshed beach seines, limited by law to a length not exceeding 150m. The number recorded in annual frame surveys in the South East Arm has been highly erratic (Fig. 15). The legal minimum mesh size is 19mm, unless the net is lined with mosquito netting for the capture of Usipa, in which case operating hours are legally restricted to night time, from 6 pm to 6 am. These restrictions on Kambuzi seines are widely ignored. Four species groups, Kambuzi (small haplochromines in general), Utaka, Chambo and Usipa make up most of the catch (Fig. 16 and 17). Utaka and Kambuzi are often mixed in the same catch and tend to be lumped into whichever category is most abundant, hence the actual proportions of the two groups in recorded catches may be inaccurate. Catch, effort and cpue are shown in Figs. 16 to 19. No stock assessment based on this gear only can be made, all species groups except Kambuzi being more heavily exploited by other gears. Recording of this fishery is also very erratic because much of it is nocturnal. Nevertheless, the data do show a clear trend in the Kambuzi seine fishery towards greatly increased effort and a resultant decline in cpue. The decline is significant (linear regression; $r = -0.607$; $P = 0.021$).

The high catch of Chambo, 22% of the total (Fig. 17), gives cause for concern as much of this catch would unquestionably be immature tilapia, called Kasawala, which live close inshore. Additionally, use of this gear damages inshore cichlid nesting arenas. The gear is also misused by being set behind Chambo seine nets as they are drawn close to the shore, thus deliberately intercepting Kasawala which escape through the meshes of the large-meshed Chambo seines. The continued existence of a fishery which catches on average only 286 tonnes annually of the target species group but 143 tonnes of juveniles of the most valuable species group in the area cannot be justified. The misuse of this gear, the decline in cpue which suggests excessive exploitation, and the difficulty of controlling it are further grounds for discontinuing its use.

Longline

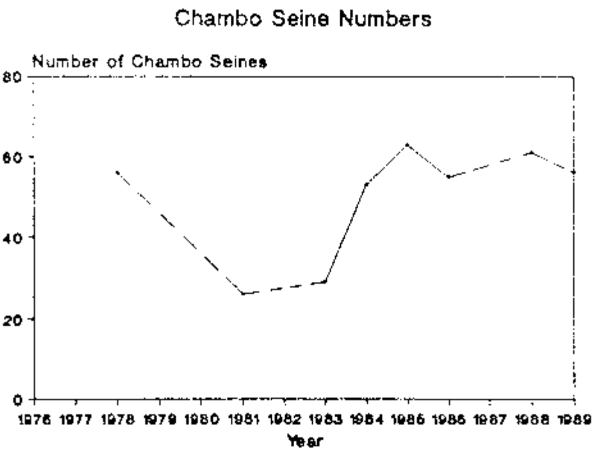
The number of longlines in the South East Arm has declined dramatically (Fig. 20). The catch and effort records (see Appendix) are erratic and unusable for any meaningful assessment. 93% of the longline catch is clariid catfish and 6% Kampango.

Figure 21. Number of Chambo seines recorded during annual frame surveys.

Figure 22. Annual recorded catches by Chambo seines.

Figure 23. Annual recorded effort by Chambo seines.

Figure 24. Annual fluctuations in Chambo seine cpue.



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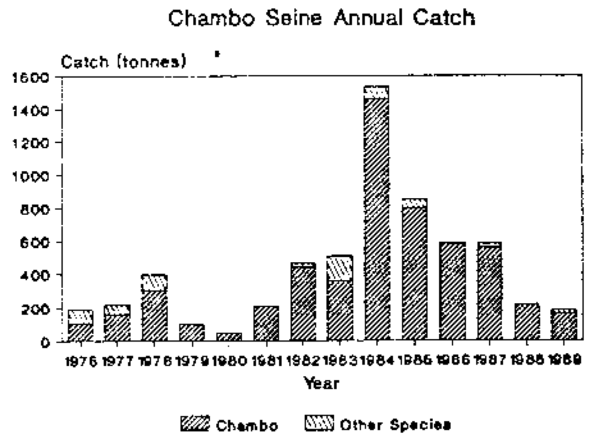


Figure 22

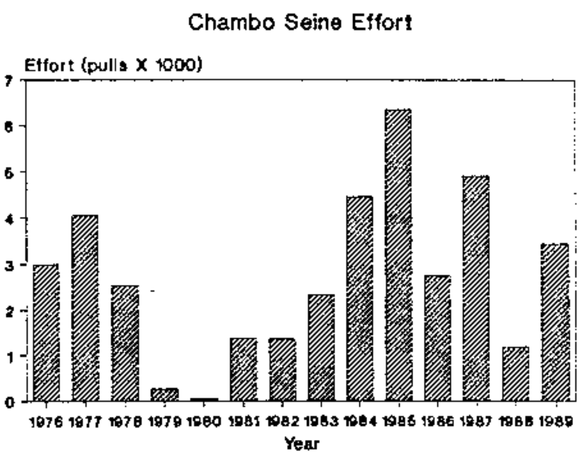


Figure 23

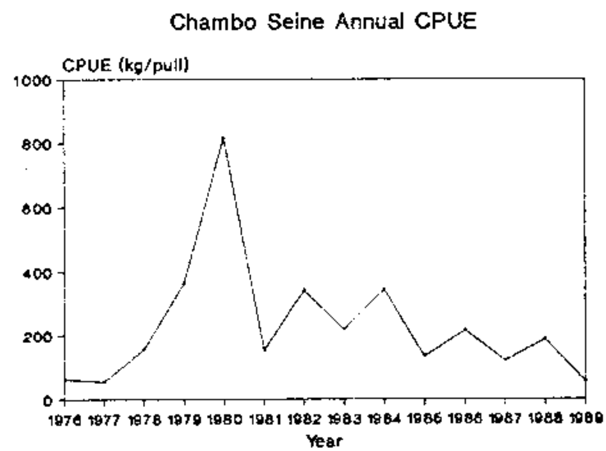


Figure 24

Chambo seine

The number of Chambo seines (beach seines with mesh size greater than 90 mm and unrestricted headline length used to catch Chambo) has in most years remained consistent, between 53 and 63 (Fig. 21). Lower numbers in 1981 and 1983 may be due to movement out of the area, or to nets being out of use due to the high lake level from 1979 having flooded suitable seining beaches, or both. The catch was primarily Chambo in all years (Fig. 22). Recording of this gear was erratic, partly because of the small number of nets and the likelihood of missing them in the sampling programme and partly because hauls are made at night when no beach recorder is present. Consequently recorded effort was very low and rather erratic with inevitable random fluctuations in cpue which mask any real trends in catch rates (Figs. 22 to 24). Nevertheless, the particularly low effort levels from 1979-1982 agree with the low recorded Chambo seine ownership in those years (Fig. 21).

Chirimila nets

The number of chirimila nets used in the South East Arm increased from 146 in 1977 to 380 by 1988 (Fig. 25). Catch, effort and cpue figures are shown in Figs. 26 to 28. Figure 26 also shows the breakdown by species. Utaka (63%) and Usipa (27%) comprised most (90%) of the catch. Catch and effort have risen over the years, in line with the increased numbers of gears in the fishery. Cpue shows a regular three year cycle which is discussed later in this report (Fig. 28). As the chirimila is aimed at the target species, either Utaka or Usipa, and fished using different techniques in each case, and as the data are very erratic, an accurate assessment of the fishery cannot be made at this stage, though the scatter diagram of cpue against effort (Fig. 29) does show a decline in cpue at higher effort levels.

Other gears

Mosquito nets. Only 5% of the South East Arm catch comes from this gear. Mosquito nets are used primarily for Usipa, which comprised 96% of the total recorded catch in this gear. The name mosquito net appears to be used for any gears lined with mosquito netting, including chirimilas and Kambuzi seines, and also two man scoop nets which are operated by diving from a canoe to drag the net through Usipa shoals. The catch and effort data shown in the Appendix are very erratic and clearly unreliable, though they do show a general trend to higher effort in recent years and they give an indication of "good" and "bad" Usipa years. Alteration of the effort unit from a haul to a fishing trip is essential to obtain meaningful data in future as the fishermen and beach recorders are extremely erratic in their estimates of the number of times they have operated the gear. This problem applies to all small active gears which are set on numerous occasions in a fishing trip. While fishing trips do vary in length, the variation is much less than that noted in "number of hauls" where large errors and inaccuracies are apparent in the majority of data.

Scoop nets. The catch recorded from this gear (Appendix) is entirely Usipa, hence it can be assumed that in this area this gear is the two man diving mosquito net mentioned above. The same criticisms re reliability of effort data apply.

Figure 25. Number of chirimila nets recorded during annual frame surveys.

Figure 26. Annual fluctuations in chirimila catches, showing contributions of different species groups.

Figure 27. Annual fluctuations in chirimila net effort.

Figure 28. Annual fluctuations in chirimila net cpue.

Figure 29. Scatter diagram of relationship between chirimila net cpue and effort.

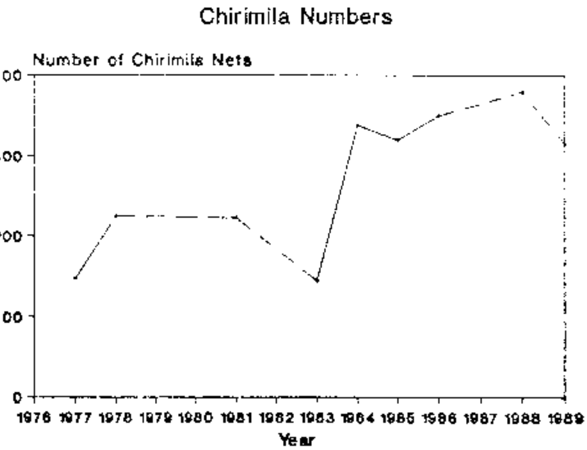
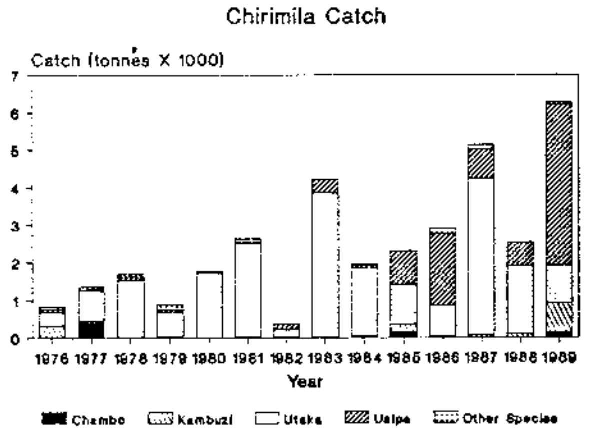


Figure 25



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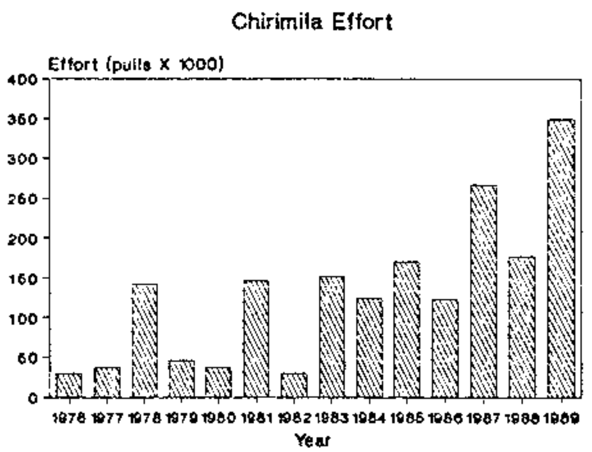

Figure 27

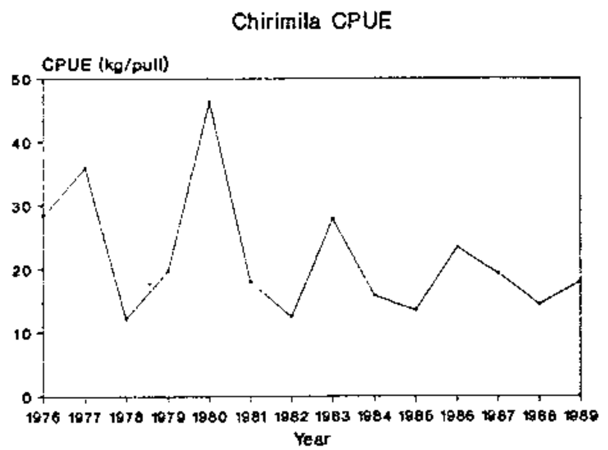

Figure 28

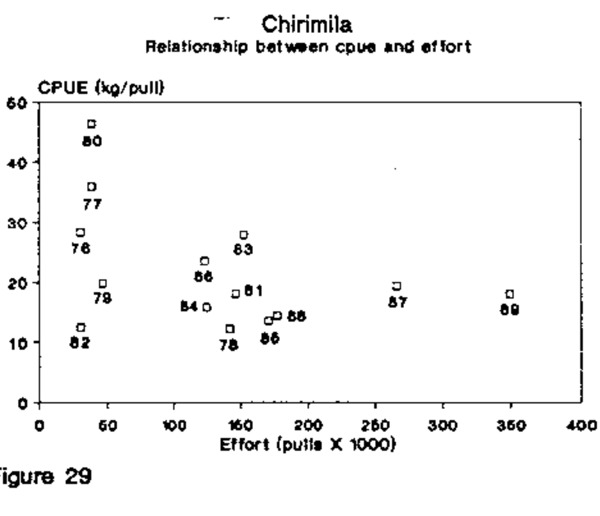

Figure 29

Fish traps. Coverage of this gear by the present statistical system is ineffective. In most ca fishing craft are not employed and the catch is not landed at any recognised beach. The d (Appendix) show only that Chambo is the main target for this gear.

Hand lines. Hand line fishermen tend to be ignored by beach recorders as unimportant and th usually land when the recorder has finished work for the day. Effort and cpue figures are nonsens and the unit of effort must be changed to a fishing trip to overcome the problem of recording numb of hauls and to improve the quality of the cpue data.

ANALYSIS BY SPECIES

Chambo (*Oreochromis* species)

This group of closely related tilapias is of major importance in the South East Arm, comprising on average 39% of the total traditional catch (Fig. 6). Annual catches ranged from 1,460 to 3,97 tonnes in the 14 years since 1976 (Fig. 30 and Appendix). Several approaches are possible i assessing the fishery and at the time of writing a major FAO project is underway to investigate the Chambo and the fishery. For the traditional fishery, data are available since 1976, with indications o earlier cpue as discussed above under the gillnet fishery. The traditional (gillnets and beach seines) and the commercial (Maldeco Fishing Company's ringnets and trawlers) fisheries are treated separately below, followed by a combined analysis.

Traditional gears only. Most Chambo were caught in gillnets, while Chambo seines also contributed a certain amount in most years (Fig. 30). All Chambo data were standardised in terms of gillnets, as (a) gillnets are the main gear, and (b) gillnets, being passive gears, theoretically provide better estimates of stock abundance than other more active gears. The effort for all traditional gears was converted into "gillnet-equivalents" using the formula:

$$\text{Total Effort} = \frac{\text{Total Chambo Catch}}{\text{Gillnet Chambo Catch}} \times \text{Gillnet Effort}$$

Figure 31B shows a scatter diagram of cpue against a two year mean of effort. Because Chambo is the major component of the gillnet catch, and gillnets catch most Chambo, this figure closely resembles Fig. 13. The correlation between cpue and effort ($r = -0.501$, $P = 0.081$) is not significant, and the scatter diagram of catch against effort (Fig. 31A) shows little correlation, although the highest cpues do occur at the lowest effort levels. Applying Fox's (1970) model to these data gives an unrealistic estimate of optimum effort. At 1.5×10^6 gillnet equivalents, this is close to the estimate for traditional and commercial gears combined, which is presented later in this report. Hence no yield curve is shown in Fig. 31.

Figure 30. Annual Chambo catches, showing the contributions by the different traditional fishery gears.

Figure 31. (A) Scatter diagram of annual catches of Chambo in the traditional fishery and total traditional effort expressed in gillnet equivalents. For explanation see text.

(B) Scatter diagram of Chambo cpue expressed in kg per 91m gillnet per night against the two year mean of effort in all traditional gears, expressed in gillnet equivalents.

Figure 32. Annual catches of Chambo in the traditional and commercial fisheries of the South East Arm.

Figure 33. Scatter diagram of Chambo ringnet cpue against Chambo gillnet cpue for the same year.

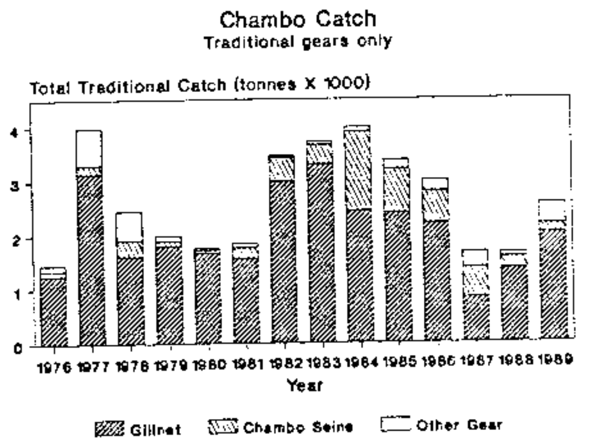

Figure 30

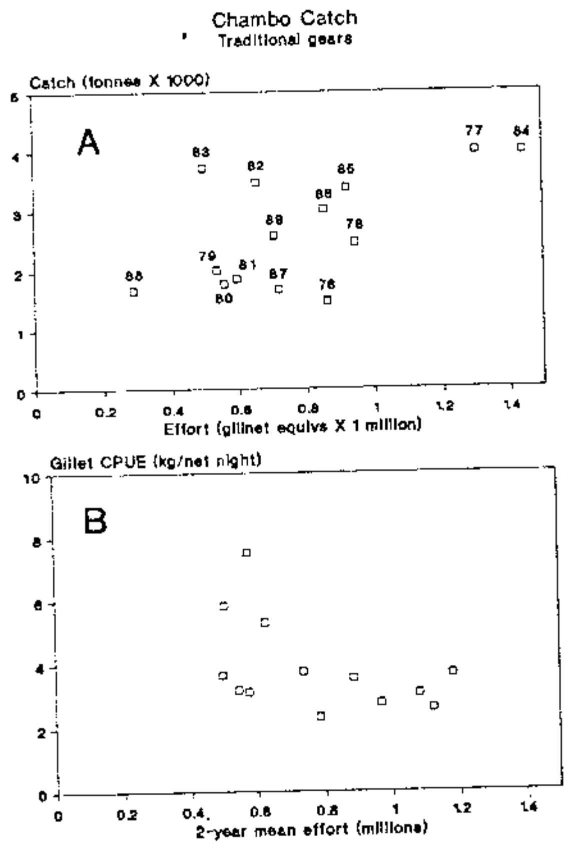

Figure 31

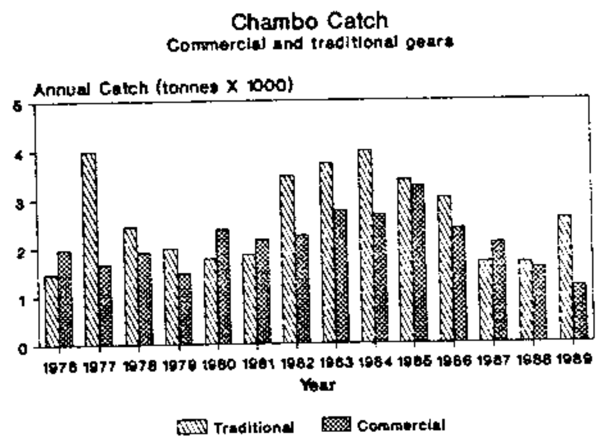

Figure 32

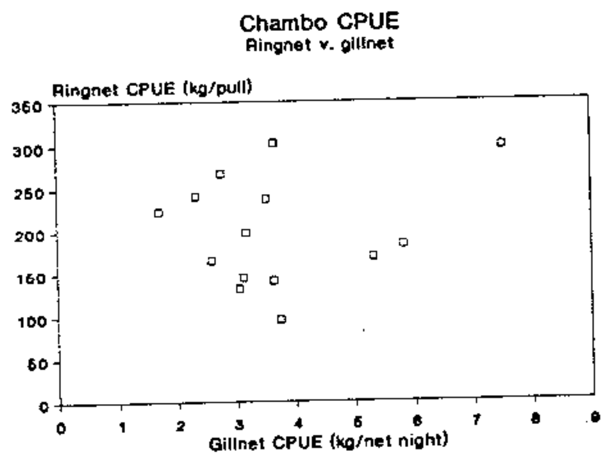

Figure 33

Commercial gears only. In the commercial fishery operated by Maldeco Fishing Company, complete catch figures are available. As in the full analysis of the commercial fishery carried out by Tweddle and Magasa (1989), data are presented here in terms of ringnet-equivalents, using a similar formula to that used above. To correlate with the traditional fishery, only data since 1976 are used. The total commercial catch of Chambo is shown in Fig. 32.

The exponential regression of cpue against effort was significant (r = -0.617; P = 0.019), although weakened by the apparent low effort combined with average cpue in 1988 and 1989. This gives an MSY estimate of 2,040 tonnes at an effort of 11,200 ringnet pulls. Schaefer's (1954) model, based on a linear regression of cpue against effort (r = -0.572; P = 0.033), gives a similar MSY of 2,160 tonnes at an effort of 11,800 pulls. The MSY figure is very similar to that determined by Tweddle and Magasa (1989) for all commercial data between 1951 and 1985 using the Schaefer model. Their MSY estimate was 2,190 tonnes at 11,360 pulls effort.

Traditional and Commercial Chambo Catches Combined. Figure 32 shows the total Chambo catch in traditional and commercial gears. In both cases the years 1982-1986 saw higher catches than normal. However, there was no correlation between cpue of the Chambo ringnet and of the dominant traditional gear, i.e. gillnet (Fig. 33).

The Fox model was used to estimate MSY for the combined gears. Two measures of effort were compared, gillnets and ringnets. Gillnets, theoretically, should give a less biased estimate of cpue, as a gillnet is a passive gear and hence fishes more randomly than an active method which targets specific shoals. However, gillnet catches are only sampled randomly in Lake Malawi, while complete catch and effort data are available for ringnets, giving the ringnet an advantage in terms of accuracy. Both methods gave similar results for the correlation between cpue and effort (ringnets:- r = -0.690; P = 0.006: gillnets:- r = -0.747; P = 0.002).

The two techniques give similar estimates of MSY (Fig. 34). Using ringnet-equivalents, MSY is calculated as 5,000 tonnes at an effort of 34,000 pulls, while using gillnet-equivalents, the MSY is 5,040 tonnes at an effort level of 1.8 x 10^6 net nights. Over the 14 year period the mean annual ringnet cpue (200kg) was 54 times greater than the mean annual gillnet cpue (3.71kg). Maldeco's licences allow a total commercial effort of about 11,000 pulls per year. Using the ringnet model, this leaves 23,000 pulls per year for the traditional sector, equivalent to about 1.2 x 10^6 gillnet nights. Using the alternative gillnet model, Maldeco's 11,000 ringnets equal about 600,000 net nights. Subtracted from the MSY effort of 1.8 x 10^6 net nights, this leaves 1.2 X 10^6 net nights for the traditional sector. Both methods therefore give similar results and suggest that the traditional effort should be about 1.2 x 10^6 net nights. In the traditional sector, 77% of the Chambo were caught in gillnets over the 14 year period. Assuming the ratio of traditional gear usage for Chambo remains fairly constant, gillnet effort should therefore be about 900,000 net nights. This estimate may be compared with the effort level for MSY (1.35 X 10^6 net nights) in the gillnet fishery alone.

Figure 34. (A) Estimate of maximum sustainable yield for the Chambo fishery (traditional and commercial gears combined) of the South East Arm, based on the regression shown in Figure 34B, with total effort calculated in ringnet pull equivalents.

(B) The relationship between ringnet cpue and total effort expressed in ringnet pull equivalents.

(C) Estimate of maximum sustainable yield for the Chambo fishery (traditional and commercial gears combined) of the South East Arm, based on the regression shown in Figure 34D, with total effort calculated in gillnet night equivalents.

(D) The relationship between gillnet cpue and total effort expressed in gillnet night equivalents.

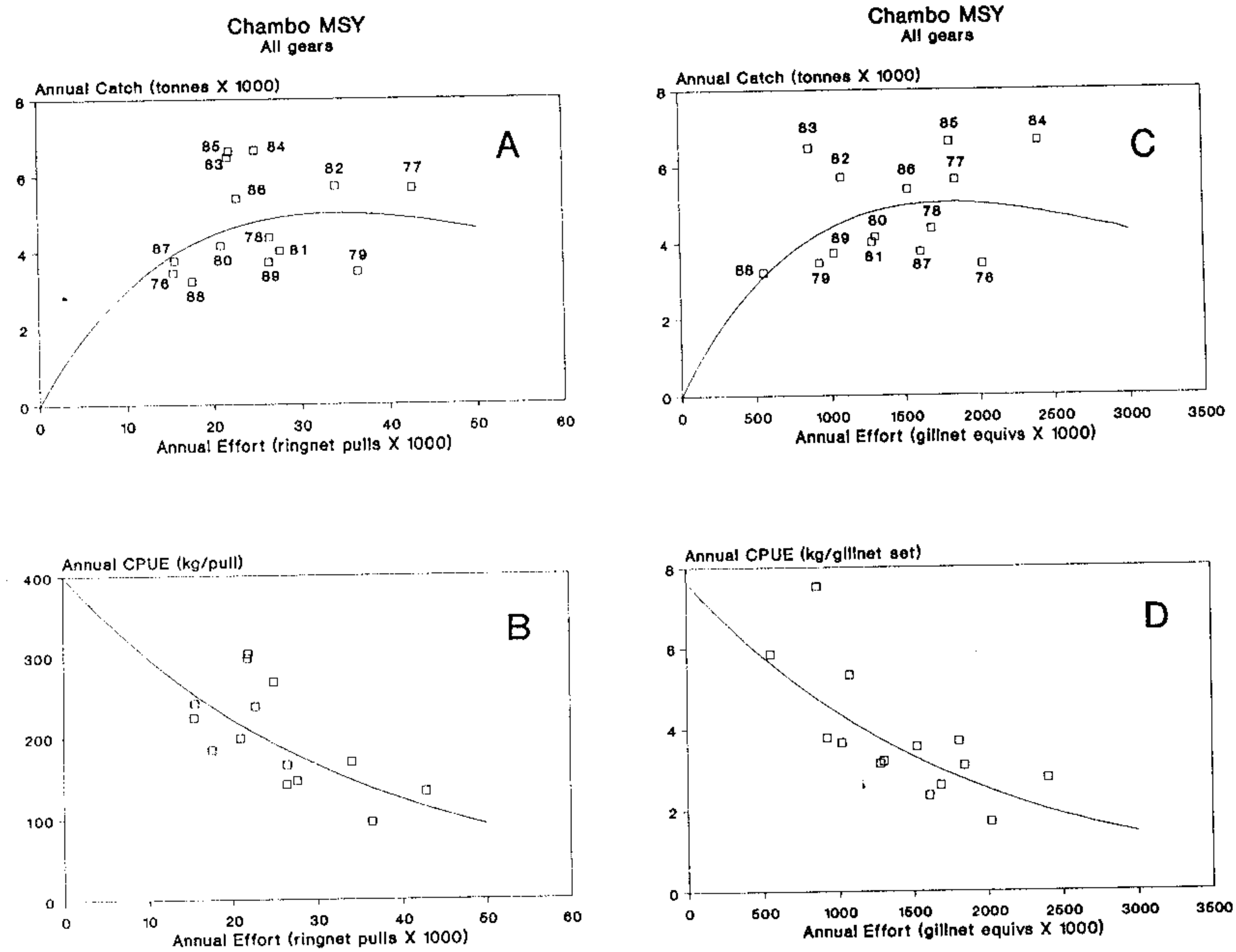
Chambo MSY
All gears
Annual Catch (tonnes X 1000)
A
Annual Effort (ringnet pulls X 1000)
Chambo MSY
All gears
Annual Catch (tonnes X 1000)
C
Annual Effort (gillnet equivs X 1000)
Annual CPUE (kg/pull)
B
Annual Effort (ringnet pulls X 1000)
Annual CPUE (kg/gillnet set)
D
Annual Effort (gillnet equivs X 1000)

Figure 24

This study does not answer the question of how much overlap there is between the offshore commercial and inshore traditional Chambo fisheries. Overall catches in both fisheries were generally high between 1982 and 1986, which suggests there might be some correlation. However, the high catches were undoubtedly a result of environmental factors (Tweddle and Magasa, 1989), and both inshore and offshore stocks might be similarly affected (Lewis, 1990). The absence of any correlation between gillnet and ringnet cpue (Fig. 32) contradicts the relationship in total catch, hence further studies into the inter-relationships of the fisheries are being made under the FAO Chambo Research Project. Until this project produces more refined estimates, the Chambo fisheries as a whole can be managed by controlling Maldeco's fishery at current levels, limiting gillnet licences as suggested in this report, enforcing the present Chambo beach seine regulations, and banning small-meshed Kambuzi seines because they catch too many juvenile Chambo.

Catfish

In this analysis, both Kampango and clariid catfishes are combined. FAO (1976) showed that catfish cpue dropped in trawl catches from 1971 to 1974 and attributed this to overfishing of juveniles in the small-meshed trawls aimed at small cichlid species.

Walker (1976b) showed that gillnet cpue for catfish declined in the 1950s and 1960s. This affected areas other than those trawled and coincided with the big increase in availability of nylon netting. Current gillnet catfish cpue is very low (Appendix), and there has been a significant decline in the annual catches for traditional and commercial gears combined since 1976 (linear regression, $r = -0.629$; $P = 0.016$) (Fig. 35). It is clear, therefore that the catfishes are less common than previously. Lower effort levels and larger minimum mesh sizes might yield higher catches than at present. Would such measures result in large enough catches to be justified?

Walker's (1976b) figure suggests a gillnet cpue of 10kg/net of catfish in the 1950s. Earlier data suggest a catfish cpue of 2.5kg/net in the 1940s (Lowe, 1952) and it is believed, as discussed earlier in this report, that Walker's figures were considerably overestimated. Walker showed a decline to 1 or 2kg/net by the late 1960s. We can only make very rough assumptions of what the maximum yield may have been. An optimistic assessment may be derived using a cpue of 5kg/net at an effort level of 250,000 gillnet nights, i.e. at half the effort reached by the 1970s. This gives a figure of 1,250 tonnes. Catches over the period covered here ranged from 391 to 1,228 tonnes per year (Fig. 35). The commercial catch is underestimated as catfishes tend to be consumed by the crew of the commercial vessels and hence go partly unrecorded. Also, smaller catfishes may not be separated from the catch as a whole.

The figures show that catfish catches declined during the 1950s and 1960s, and have declined further since the advent of trawling, which takes large numbers of juveniles because of the small meshes employed. A catfish fishery would involve the use of much larger mesh sizes than employed at present, with not less than 100 mm mesh. However, if the fisheries were managed to optimise catfish yield, the extra tonnage achieved would not exceed a few hundred tonnes and would in no way compensate for the loss of the several thousand tonnes of cichlids taken in the trawl fishery.

Nchila (*Labeo mesops* Günther)

Nchila were formerly second in importance only to Chambo in the fisheries of Lake Malawi. According to Walker (1976b) they were the main catch in gillnets. The cpue, however, crashed in the early 1960s to negligible levels and there has been no evidence of recovery at any time since. This decline coincided with the massive increase in gillnetting effort at that time, which is documented in the Annual Reports of the Department of Game, Fish and Tsetse Control. Table 2 shows annual figures for gillnet effort at four South East Arm recording stations. Disregarding the anomalous data for 1959 to 1961, which appear to be about 100 times greater than might realistically be expected, effort increased more than 100-fold during the 1950s.

Table 2. Gillnet usage at four recording stations in the South East Arm, extracted from the Annual Reports of the Department of Game, Fish and Tsetse Control. With the exception of 1959 to 1961, the data are the number of nets set during the year. The 1959 to 1961 data were based on a different, unexplained, system of measurement. They probably reflect total length in yards of net set.

Year	Malindi	Mateweri	Mpemba	Monkey Bay	Total
1949	12	120	12	6	150
1950	56	175	49	52	150
1951	0	512	226	9	332
1952	12	242	321	10	747
1953	36	30	219	37	322
1954	11	133	68	14	226
1955	209	46	212	20	487
1956	238	28	2400	57	2723
1957	634	97	1814	70	2615
1958	1188	53	2986	735	4962
1959	158243	11640	77062	117700	364645
1960	686540	278251	37807	46700	1049298
1961	255554	171249	143180	29300	599283
1962	33432 sets in S.E. Arm as a whole including unrecorded beaches				33432

The decline in Nchila catches was unexpected. While the GFTC Annual Report for 1960 documented a decline in Nchila cpue in that year, Iles (1962), in the JFRO Annual Report for the same year, suggested that South East Arm catches could be increased tenfold, from 300 tonnes per year to 3,000 tonnes, without affecting recruitment markedly. He based this on the high fecundity and high breeding mortality of the species. Catches continued to crash over the next few years.

The reasons for the decline have been a matter for much debate and in order to assess whether a recovery is possible in Lake Malawi, a review of possible factors is necessary here. *Labeo* fisheries in several parts of Africa declined at a similar time (Jackson, 1961; Cadwalladr, 1965; Skelton *et al.*, 1991), the common factor being the increased availability of nylon netting at that time. However, there were differences between the declines. In Lake Victoria, the decline of *L. victorianus* was associated with an increase in the use of floating nylon small meshed gillnets in the breeding rivers (Cadwalladr, 1965). In the Luapula River, Zambia, the decline of *L. altivelis* occurred earlier, and was blamed on the development of a large scale fishery in the late 1940s to supply increased post-war demand from the copper mines (Jackson, 1961).

In Lake Malawi, apart from the major increase in gillnet effort in general, other factors may be implicated. The very high cpue noted by Walker (1976b) might be a result of using small meshed (e.g. 64mm mesh) gillnets. The current legal minimum is 95mm mesh. This mesh size catches relatively few *L. mesops*. In experiments in 1959, the catch by weight of *L. mesops* in 97mm mesh size was only 20% of that in 66mm mesh nets and 11% by number. However, catches in the smaller mesh were almost all immature fish. Heavy fishing with small meshed gillnets may have depleted the stock. Iles (1962, p. 52) noted that it was suspected that most African fishery nets were of small mesh size.

The use of small meshed gillnets may explain why Walker's (1976b) 1950s cpues were higher than those recorded in experimental fishing with larger meshed nets (Ricardo Bertram *et al.*, 1942; Lowe, 1952; GFTC Annual Reports for the 1950s). However, Iles (1962) suggested that with the high fecundity of the species, the breeding stock could be substantially reduced without detriment to recruitment.

Another factor in the decline was excessive fishing of small juveniles with small meshed beach seine nets (A.J.P. Mzumara, pers. comm.). The juveniles were sundried in large numbers on racks. Such harvesting may have severely affected recruitment.

The factors noted so far do not explain why stocks have not recovered now that (a) use of gillnets of mesh smaller than 95mm is illegal, and (b) no juveniles are harvested in seines. Nchila are fully mature before becoming vulnerable to 95mm mesh nets, hence with the very high fecundity, stocks should have recovered if no other factors were operating.

The increased human population pressure in the vicinity of the streams used for breeding may affect stocks in two ways. (1) The fish may not be able to breed because of heavy fishing pressure in the streams themselves. (2) Increasing deforestation and agriculture may have altered the character of the streams. Lowe (1952) noted that streams were already deteriorating in quality and the situation has become much worse since (Tweddle, 1983). Deforestation and agriculture results in much faster run-off and heavy silt loads in the streams as a result of erosion of exposed soils. Streams which used to run for weeks at a time between well-wooded banks are now flash-flood streams. In consequence, eggs of Nchila laid in flooded grasslands bordering the stream are now left high and dry as the floods recede or are smothered under layers of silt.

The current situation is therefore unlikely to be altered by manipulation of the fishery. The initial decline may possibly be blamed on fishing pressure. However, if this was the case and bearing in mind that the current mesh regulations allow the fish to breed before becoming vulnerable to capture, the reduction in effort necessary to allow recovery of the stocks would be considerable. This would almost certainly lead to a decline in catches in the traditional fisheries as a whole. If deforestation is a major cause of the continued low level of the Nchila stocks, then no manipulation of effort will alter the situation.

A similar phenomenon was implicated by Huntsman (1944) in the decline of the Lake Ontario salmon in the 19th Century. Huntsman attributed this to increasing forest clearance, agriculture, and consequent siltation of spawning beds.

As it is unlikely that the original character of the streams can ever be fully restored, because of the major importance of agriculture, recovery of the Nchila stocks can only be achieved by a massive artificial rearing and continuous restocking programme. The practical and economic viability of such a programme should be investigated.

Figure 35. Annual catches of catfish, Kampango and Mlamba combined, in all gears, both traditional and commercial, in the South East Arm.

Figure 36. Annual catches of Utaka in all traditional gears in the South East Arm.

Figure 37. Effort employed for catching Utaka each year, showing chirimila net effort as in Figure 27 and total effort expressed in chirimila net equivalents.

Figure 38. Annual fluctuations in cpue for Utaka, expressed in kg per chirimila net pull.

Figure 39. (A) Estimate of sustainable yield for the Utaka fishery of the South East Arm, based on the regression shown in Figure 39B with effort calculated in chirimila net pull equivalents.

(B) The relationship between Utaka cpue in kg per chirimila net pull and the mean of two years effort expressed in chirimila net pull equivalents.

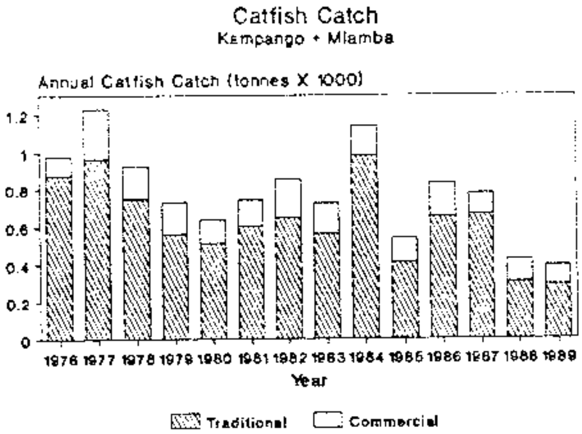

Figure 35

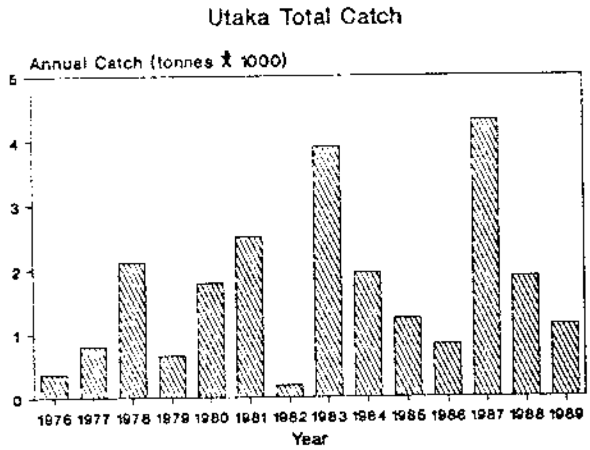

Figure 36

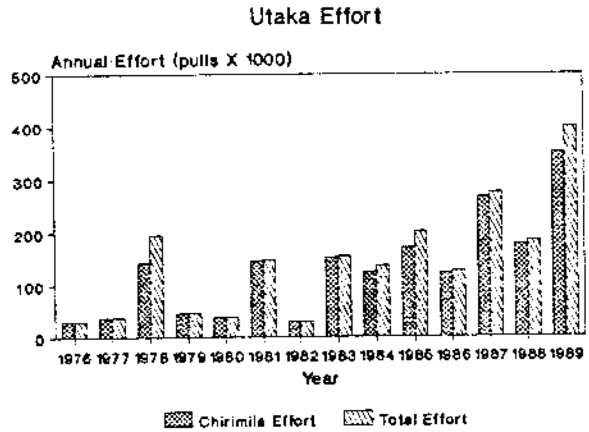

Figure 37

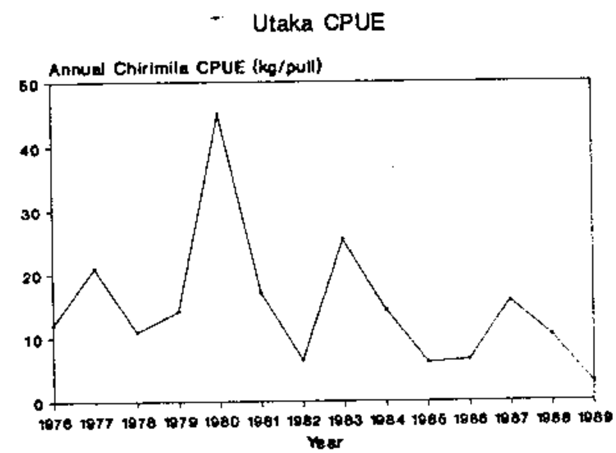

Figure 38

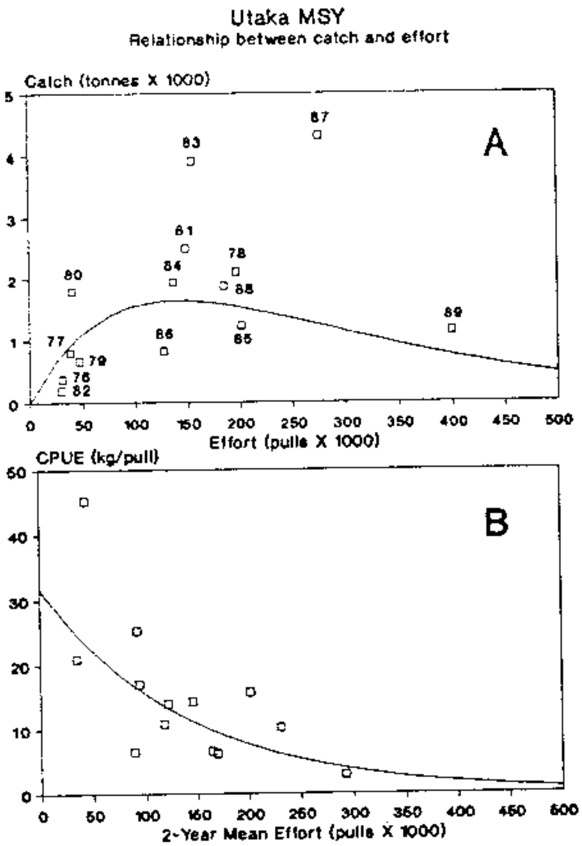

Figure 39

Utaka (*Copadichromis* spp.)

Utaka comprised 25% of the total catch of the South East Arm over the 14 year period, second in importance after Chambo. They were caught primarily in chirimila nets (Fig. 37) and hence the catch, effort and cpue graphs (Figs. 36 to 38) closely resemble those for that gear. Total effort is expressed in chirimila pull equivalents, calculated in the same way as described above for Chambo.

The erratic data, particularly for cpue, show that Utaka vary greatly in abundance from year to year, with an approximate three year cycle. A similar cyclical pattern of abundance was demonstrated by Walker (1976b), based on changes in percentage of total catch. Walker suggested a four or five year cycle.

With such natural fluctuations in stock size and the limited series of data currently available, only a tentative and very preliminary assessment of the effort which the stocks can withstand is possible at this stage. Figure 39B shows that there is a significant correlation (exponential regression, $r = -0.722$; $P = 0.005$) between chirimila Utaka cpue and the two-year mean of effort. MSY, estimated from the regression, is 1,650 tonnes at an effort level of 145,000 chirimila pulls (Fig. 39A). It must be stressed, however, that the very high effort of 1989 was associated with a very low Utaka cpue because the gear was aimed at Usipa (68% of the catch). 1985 and 1986 were also years when the gear was aimed mainly at Usipa. The Utaka cpue is therefore artificially low in several high effort years, giving a strong bias to the results. Thus the MSY estimate above is probably an underestimate for both catch and permissible effort and should *not* be used as a management target. It is presented here merely as an indicator of the trend in the Utaka fishery towards lower catches at higher effort levels. The data, though erratic, suggest that the present effort may be as high as the fishery can sustain.

Usipa (*Engraulicypris sardella*)

Because the Usipa fishery is conducted at night when beach recorders are usually absent from the beach, the data for this species underestimate catches by an order of magnitude (Lewis and Tweddle, 1990) and only give an indication of good and bad years (Fig. 5). The 1985 year-class discussed by Lewis and Tweddle (1990) was exceptionally strong, giving high catches until mid-1986. 1977, 1983, 1987 and 1989 were also years when Usipa fishing was worthwhile. The apparent exceptional catches of 1989 may have been a result of more thorough coverage of the fishery by the beach recorders following the study by Lewis and Tweddle, as casual observations of the dried fish trade suggested that actual catches were not as high in 1989 as in 1985-1986. The ability of Usipa to respond to favourable conditions so that negligible stocks can be followed by exceptionally strong year-classes (Tweddle and Lewis, 1990) mean that stocks, when present, can be heavily exploited with no serious danger of overfishing with the present fishing capacity on the lake.

The good Usipa catches of 1985 were associated with very poor Utaka catches. The reasons for this are unclear as both Usipa and Utaka should theoretically benefit from years in which there is an abundance of plankton for food. One possible reason may be that Usipa is an annual fish, whereas Utaka enter the fishery towards their second year. Thus the limnological conditions which produce strong year classes may give rise to abundant Usipa in one year and good catches of Utaka in the following year. Another factor may be that fishermen target the most abundant species group and thus relatively minor fluctuations in abundance may be exaggerated in the catch figures by the fishing methods employed.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

The South East Arm of Lake Malawi is heavily fished by both the commercial and traditional sectors. There is considerable interaction between the various components of the fisheries and there are well over 100 fish species in the catches. In such a complex situation, it is not generally possible to come up with detailed recommendations based on mathematical models for each species or gear. Such models give, at best, only a general guide to levels of effort which may be permissible. The catch and effort data presented in this report give some idea of the size of the fisheries and the changes which have occurred over the last few decades. Knowledge of the biology of the fishes has been certain extent in interpreting the data. Existing regulations for mesh sizes, etc. are based on biological data and the recommendations put forward below rely on biological knowledge as well as the results of the catch-effort data analyses.

The gillnet fishery operates primarily for Chambo. As a result of the continued low catches of the formerly important catfish and Nchila in gillnets and the probability that this situation will not change in the foreseeable future, management of the Chambo fishery should be the principal consideration in gillnet legislation.

Cpue for the gillnet fishery has remained generally stable over a range of effort levels. It is possible that the wide range of effort is a sampling artefact as the estimated effort does not correlate well with gillnet ownership. The two exceptions to the stable cpue in 1982 and 1983 reflected a genuine increase in Chambo stocks at that time. The pattern of Chambo catches suggests that the fishery is fairly stable at present effort levels. A limit of 2,000 licensed gillnets is proposed for the area. More refined estimates may be possible in future as a result of the findings of the Chambo Research Project.

It is unlikely that Nchila catches will ever recover to earlier levels because of the deterioration in breeding habitat as a result of land clearance for agriculture. The practical and economic viability of artificial rearing and restocking should be investigated.

The Kambuzi seine fishery should be discontinued in this area because: (A) much of the catch consists of juvenile Chambo, (B) restrictions on length are not adhered to, and (C) the gear is misused in several ways. A ban on the use of this gear will have a minimal effect on overall catches from the South East Arm and will probably improve them in the long term as it will halt misuse of the gear, reduce physical damage to inshore cichlid nesting arenas, and protect the inshore juvenile Chambo stocks. Juveniles of other species such as Nchila will also be protected as a result of the ban.

Usipa catches are grossly under-estimated by the present recording system, which gives only an indication of good and bad years and nothing more.

Utaka catches show a regular three year cycle. The chirimila catch and effort data suggest that the fishery may now be fully exploited in the area, though the large fluctuations in the data mean that longer term data are necessary for the formulation of management controls.

The unit of effort for the smaller active gears (mosquito nets, scoop nets and hand lines) should be changed with immediate effect to a `fishing trip' to obtain more meaningful data. Consideration may also be given to implementing this change in the chirimila fishery.

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APPENDIX I

SOUTH EAST ARM OF LAKE MALAWI

ANNUAL CATCH AND EFFORT DATA SUMMARIES

1976-1989

NOTES ON MONTHLY AND ANNUAL DATA SUMMARIES

The data in this report are presented by species group and by gear. The species groups listed by column are as follows:-

chambo	=	*Oreochromis* spp., excluding *O. shiranus*.
other tilapia	=	*O. shiranus* and *Tilapia rendalli*.
kambuzi	=	inshore cichlid (haplochromine) species.
utaka	=	*Copadichromis* spp.
chisawasawa	=	offshore, demersal haplochromines.
kampango	=	*Bagrus meridionalis* Günther.
mlamba	=	clariid catfishes.
usipa	=	*Engraulicypris sardella* Günther.
nchila	=	*Labeo mesops* Günther.
others	=	species not included in above categories, including mormyrids and some cyprinid species.

The gears are listed by row, with catch, effort and catch per unit effort (cpue) shown for each gear.

Catch is expressed in metric tonnes in all cases.

Effort is expressed as follows:-

gillnets	:	number of sets of 91 m (stretched length) net.
longlines	:	number of sets of 100 hooks.
chambo seines	:	number of hauls.
kambuzi seines	:	number of hauls.
chirimila nets	:	number of hauls.
mosquito nets	:	number of hauls.
fish traps	:	number of traps set.
handlines	:	number of hauls.
cast nets	:	number of hauls.
scoop nets	:	number of hauls.
nkacha nets	:	number of hauls.

Cpue is expressed in catch (in kg) per unit of effort as defined above.

ANNUAL SUMMARY FOR THE YEAR 1988

Gear		chambo	other tilapia	kambuzi	utaka	ch'sawa	k'pango	mlamba	usipa	nchila
gill net	catch	1363.51	0.00	0.00	9.68	33.58	111.10	74.13	0.00	9.30
	effort	233967	233967	233967	233967	233967	233967	233967	233967	233967
	cpue	5.83	0.00	0.00	0.04	0.14	0.47	0.32	0.00	0.04
long line	catch	0.00	0.00	0.46	0.00	0.00	4.08	107.05	0.00	1.67
	effort	21439	21439	21439	21439	21439	21439	21439	21439	21439
	cpue	0.00	0.00	0.02	0.00	0.00	0.19	4.99	0.00	0.08
chambo seine	catch	215.20	0.74	0.00	0.00	0.00	1.87	2.34	0.00	0.00
	effort	1183	1183	1183	1183	1183	1183	1183	1183	1183
	cpue	181.91	0.63	0.00	0.00	0.00	1.58	1.98	0.00	0.00
kambuzi seine	catch	86.95	0.39	360.64	66.63	0.00	0.77	1.65	41.67	0.82
	effort	19490	19490	19490	19490	19490	19490	19490	19490	19490
	cpue	4.46	0.02	18.51	3.42	0.00	0.04	0.08	2.14	0.04
chiri' mila	catch	0.41	0.00	74.95	1802.18	20.65	0.00	0.04	639.69	0.40
	effort	177160	177160	177160	177160	177160	177160	177160	177160	177160
	cpue	0.00	0.00	0.42	10.17	0.12	0.00	0.00	3.61	0.00
m'quito net	catch	0.00	0.00	0.76	0.00	0.00	0.00	0.00	368.05	0.00
	effort	10819	10819	10819	10819	10819	10819	10819	10819	10819
	cpue	0.00	0.00	0.07	0.00	0.00	0.00	0.00	34.02	0.00
	TOTAL CATCH	1666.07	1.13	437.01	1878.49	54.23	117.82	185.21	1049.41	12.19

ANNUAL SUMMARY FOR THE YEAR 1989

Gear		chambo	other tilapia	kambuzi	utaka	ch'sawa	k'pango	mlamba	usipa	nchila
gill net	catch	2022.08	1.24	18.73	25.67	0.13	114.81	135.61	0.00	8.89
	effort	556185	556185	556185	556185	556185	556185	556185	556185	556185
	cpue	3.64	0.00	0.03	0.05	0.00	0.21	0.24	0.00	0.02
long line	catch	0.00	0.00	0.60	0.00	0.00	1.26	2.20	0.00	0.00
	effort	843	843	843	843	843	843	843	843	843
	cpue	0.00	0.00	0.71	0.00	0.00	1.49	2.61	0.00	0.00
chambo seine	catch	165.24	1.62	0.92	0.00	0.00	1.04	11.33	0.00	0.43
	effort	3442	3442	3442	3442	3442	3442	3442	3442	3442
	cpue	48.01	0.47	0.27	0.00	0.00	0.30	3.29	0.00	0.12
kambuzi seine	catch	230.67	14.29	957.02	116.27	0.00	1.12	12.91	201.44	0.00
	effort	39724	39724	39724	39724	39724	39724	39724	39724	39724
	cpue	5.81	0.36	24.09	2.93	0.00	0.03	0.32	5.07	0.00
chiri' mila	catch	148.28	5.51	771.12	991.50	2.67	0.50	0.80	4296.20	0.16
	effort	348995	348995	348995	348995	348995	348995	348995	348995	348995
	cpue	0.42	0.02	2.21	2.84	0.01	0.00	0.00	12.31	0.00
m'quito net	catch	0.31	0.25	22.58	0.38	0.00	0.00	5.00	2405.05	0.00
	effort	26131	26131	26131	26131	26131	26131	26131	26131	2613[illegible]
	cpue	0.01	0.01	0.86	0.01	0.00	0.00	0.19	92.04	0.00
hand line	catch	0.00	0.00	3.69	0.00	0.00	0.29	2.46	0.00	0.00
	effort	10019	10019	10019	10019	10019	10019	10019	10019	10019
	cpue	0.00	0.00	0.37	0.00	0.00	0.03	0.25	0.00	0.00
nkacha net	catch	0.08	0.00	8.41	0.00	0.00	0.00	0.00	0.00	0.00
	effort	1590	1590	1590	1590	1590	1590	1590	1590	1590
	cpue	0.05	0.00	5.29	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL CATCH	2566.66	22.91	1783.07	1133.82	2.80	119.02	170.31	6902.69	9.4[illegible]

ANNUAL SUMMARY FOR THE YEAR 1986

Gear		chambo	other tilapia	kambuzi	utaka	ch'sawa	K'pango	mlamba	usipa	nchila	others	TOTAL
[illegible]	catch	2211.09	10.82	0.00	4.82	9.00	264.00	235.07	0.00	7.35	75.21	2817.36
	effort	626969	626969	626969	626969	626969	626969	626969	626969	626969	626969	626969
	cpue	3.53	0.02	0.00	0.01	0.01	0.42	0.37	0.00	0.01	0.12	4.49
ng ne	catch	0.00	0.00	0.00	0.00	0.00	3.44	3.31	0.00	0.00	0.00	6.75
	effort	496	496	496	496	496	496	496	496	496	496	496
	cpue	0.00	0.00	0.00	0.00	0.00	6.94	6.67	0.00	0.00	0.00	13.61
hambo eine	catch	582.86	0.00	0.00	0.00	0.00	1.59	0.48	0.00	0.00	0.00	584.93
	effort	2740	2740	2740	2740	2740	2740	2740	2740	2740	2740	2740
	cpue	212.72	0.00	0.00	0.00	0.00	0.58	0.18	0.00	0.00	0.00	213.48
ambuzi eine	catch	202.97	0.13	342.36	15.33	0.00	19.79	21.96	260.23	0.11	23.38	886.26
	effort	23817	23817	23817	23817	23817	23817	23817	23817	23817	23817	23817
	cpue	8.52	0.01	14.37	0.64	0.00	0.83	0.92	10.93	0.00	0.98	37.21
chiri' mila	catch	5.14	0.00	45.62	801.17	0.00	1.21	101.37	1905.84	0.00	27.34	2887.69
	effort	123188	123188	123188	123188	123188	123188	123188	123188	123188	123188	123188
	cpue	0.04	0.00	0.37	6.50	0.00	0.01	0.82	15.47	0.00	0.22	23.44
m'quito net	catch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	300.91	0.00	0.00	300.91
	effort	15091	15091	15091	15091	15091	15091	15091	15091	15091	15091	15091
	cpue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.94	0.00	0.00	19.94
fish trap	catch	2.84	6.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.13
	effort	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825
	cpue	1.56	3.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00
scoop net	catch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.69	0.00	0.00	12.69
	effort	144	144	144	144	144	144	144	144	144	144	144
	cpue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	88.13	0.00	0.00	88.13
	TOTAL CATCH	3004.90	17.24	387.98	821.32	9.00	290.03	362.19	2479.67	7.46	125.93	7505.72

ANNUAL SUMMARY FOR THE YEAR 1987

Gear		chambo	other tilapia	kambuzi	utaka	ch'sawa	k'pango	mlamba	usipa	nchila	others	TOTAL
gill net	catch	826.45	0.38	0.00	13.05	61.30	383.12	164.16	0.00	2.24	88.01	1538.71
	effort	355175	355175	355175	355175	355175	355175	355175	355175	355175	355175	355175
	cpue	2.33	0.00	0.00	0.04	0.17	1.08	0.46	0.00	0.01	0.25	4.33
long line	catch	0.11	2.78	1.61	0.00	0.00	7.07	93.46	0.00	0.00	0.99	106.02
	effort	16681	16681	16681	16681	16681	16681	16681	16681	16681	16681	16681
	cpue	0.01	0.17	0.10	0.00	0.00	0.42	5.60	0.00	0.00	0.06	6.36
chambo seine	catch	560.40	8.20	0.00	0.00	0.00	3.92	8.80	0.00	0.00	0.37	581.69
	effort	4904	4904	4904	4904	4904	4904	4904	4904	4904	4904	4904
	cpue	114.27	1.67	0.00	0.00	0.00	0.80	1.79	0.00	0.00	0.08	118.62
kambuzi seine	catch	266.13	14.79	253.37	124.38	0.00	0.83	2.56	23.91	0.03	30.19	716.19
	effort	14061	14061	14061	14061	14061	14061	14061	14061	14061	14061	14061
	cpue	18.93	1.05	18.02	8.85	0.00	0.06	0.18	1.70	0.00	2.15	50.93
chiri' mila	catch	1.47	0.00	68.01	4171.96	0.00	0.32	0.16	793.64	9.76	88.11	5133.43
	effort	266378	266378	266378	266378	266378	266378	266378	266378	266378	266378	266378
	cpue	0.01	0.00	0.26	15.66	0.00	0.00	0.00	2.98	0.04	0.33	19.27
..quito net	catch	18.95	0.00	36.23	0.00	0.00	0.00	1.67	190.11	0.00	0.00	246.96
	effort	13003	13003	13003	13003	13003	13003	13003	13003	13003	13003	13003
	cpue	1.46	0.00	2.79	0.00	0.00	0.00	0.13	14.62	0.00	0.00	18.99
scoop net	catch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	118.45	0.00	0.00	118.45
	effort	1981	1981	1981	1981	1981	1981	1981	1981	1981	1981	1981
	cpue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.79	0.00	0.00	59.79
	TOTAL CATCH	1673.51	26.15	359.22	4309.39	61.30	395.26	270.81	1126.11	12.03	207.67	8441.45

ANNUAL SUMMARY FOR THE YEAR 1984

Gear		chambo	other tilapia	kambuzi	utaka	ch'sawa	k'pango	mlamba	usipa	nchila	others	TOTAL
gill net	catch	2444.25	9.67	0.00	7.55	9.68	651.06	299.28	0.00	14.35	112.61	3548.[illegible]
	effort	884588	884588	884588	884588	884588	884588	884588	884588	884588	884588	8845[illegible]
	cpue	2.76	0.01	0.00	0.01	0.01	0.74	0.34	0.00	0.02	0.13	4.0[illegible]
long line	catch	0.00	0.00	0.00	0.00	0.00	0.43	18.01	0.00	0.00	1.02	19.[illegible]
	effort	5399	5399	5399	5399	5399	5399	5399	5399	5399	5399	539[illegible]
	cpue	0.00	0.00	0.00	0.00	0.00	0.08	3.34	0.00	0.00	0.19	3.6[illegible]
chambo seine	catch	1457.52	28.86	0.00	4.32	0.00	1.42	5.90	0.00	0.16	34.63	1532.81
	effort	4455	4455	4455	4455	4455	4455	4455	4455	4455	4455	445[illegible]
	cpue	327.16	6.48	0.00	0.97	0.00	0.32	1.32	0.00	0.04	7.77	344.0[illegible]
kambuzi seine	catch	55.86	22.93	100.28	149.74	0.00	0.10	4.59	0.73	0.72	3.76	338.7[illegible]
	effort	6848	6848	6848	6848	6848	6848	6848	6848	6848	6848	68[illegible]
	cpue	8.16	3.35	14.64	21.87	0.00	0.01	0.67	0.11	0.11	0.55	49.[illegible]
chiri' mila	catch	19.30	1.23	46.33	1776.63	0.19	0.00	0.70	94.30	0.00	22.59	1961.2[illegible]
	effort	124606	124606	124606	124606	124606	124606	124606	124606	124606	124606	1246[illegible]
	cpue	0.15	0.01	0.37	14.26	0.00	0.00	0.01	0.76	0.00	0.18	15.7[illegible]
m'quito net	catch	0.00	0.00	0.25	0.00	0.00	0.00	0.00	54.08	0.00	0.00	54.3[illegible]
	effort	2201	2201	2201	2201	2201	2201	2201	2201	2201	2201	220[illegible]
	cpue	0.00	0.00	0.11	0.00	0.00	0.00	0.00	24.57	0.00	0.00	24.[illegible]
fish trap	catch	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.2[illegible]
	effort	90	90	90	90	90	90	90	90	90	90	90
	cpue	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	2.3[illegible]
	TOTAL CATCH	3977.11	62.69	146.86	1938.24	9.87	653.01	328.48	149.11	15.23	174.64	7455.2[illegible]

ANNUAL SUMMARY FOR THE YEAR 1985

Gear		chambo	other tilapia	kambuzi	utaka	ch'sawa	k'pango	mlamba	usipa	nchila	others	TOTAL
gill net	catch	2403.46	22.46	0.00	3.31	2.33	234.84	125.99	0.00	24.83	51.53	2868.7[illegible]
	effort	656020	656020	656020	656020	656020	656020	656020	656020	656020	656020	65602[illegible]
	cpue	3.66	0.03	0.00	0.01	0.00	0.36	0.19	0.00	0.04	0.08	4.3[illegible]
long line	catch	0.00	0.00	0.00	0.00	0.00	5.31	31.37	0.00	0.00	1.12	37.[illegible]
	effort	9821	9821	9821	9821	9821	9821	9821	9821	9821	9821	982[illegible]
	cpue	0.00	0.00	0.00	0.00	0.00	0.54	3.19	0.00	0.00	0.11	3.[illegible]
chambo seine	catch	798.53	5.60	0.00	31.75	0.00	9.20	1.43	0.00	0.06	4.18	850.[illegible]
	effort	6340	6340	6340	6340	6340	6340	6340	6340	6340	6340	63[illegible]
	cpue	125.95	0.68	0.00	5.01	0.00	1.45	0.23	0.00	0.01	0.66	134.[illegible]
kambuzi seine	catch	17.24	57.05	58.95	151.96	0.00	0.07	1.23	581.90	1.16	2.00	871.[illegible]
	effort	10664	10664	10664	10664	10664	10664	10664	10664	10664	10664	10[illegible]
	cpue	1.62	5.35	5.53	14.25	0.00	0.01	0.12	54.57	0.11	0.19	81.[illegible]
chiri' mila	catch	147.09	0.00	212.13	1044.43	2.74	0.04	0.31	887.21	0.13	3.67	229[illegible]
	effort	170604	170604	170604	170604	170604	170604	170604	170604	170604	170604	170[illegible]
	cpue	0.86	0.00	1.24	6.12	0.02	0.00	0.00	5.20	0.00	0.02	13[illegible]
m'quito net	catch	0.00	0.00	0.77	0.00	0.00	0.00	0.00	155.63	0.00	0.00	15[illegible]
	effort	4995	4995	4995	4995	4995	4995	4995	4995	4995	4995	[illegible]
	cpue	0.00	0.00	0.15	0.00	0.00	0.00	0.00	31.16	0.00	0.00	3[illegible]
fish trap	catch	1.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
	effort	549	549	549	549	549	549	549	549	549	549	[illegible]
	cpue	2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2[illegible]
	TOTAL CATCH	3367.58	85.11	271.85	1231.45	5.07	249.46	160.33	1624.74	26.18	62.50	708[illegible]

ANNUAL SUMMARY FOR THE YEAR 1982

Gear		chambo	other tilapia	kambuzi	utaka	ch'sawa	k'pango	mlamba	usipa	nchila	others	TOTAL
gill net	catch	2984.95	63.07	0.00	0.00	0.70	304.70	307.92	0.00	18.07	99.10	3778.52
	effort	561813	561813	561813	561813	561813	561813	561813	561813	561813	561813	561813
	cpue	5.31	0.11	0.00	0.00	0.00	0.54	0.55	0.00	0.03	0.18	6.73
long line	catch	0.00	0.00	0.00	0.00	0.00	0.15	33.56	0.00	0.00	0.02	33.73
	effort	23097	23097	23097	23097	23097	23097	23097	23097	23097	23097	23097
	cpue	0.00	0.00	0.00	0.00	0.00	0.01	1.45	0.00	0.00	0.00	1.46
chambo seine	catch	442.17	18.02	2.46	0.00	0.00	0.23	2.03	0.00	0.00	0.48	465.39
	effort	1366	1366	1366	1366	1366	1366	1366	1366	1366	1366	1366
	cpue	323.70	13.19	1.80	0.00	0.00	0.17	1.49	0.00	0.00	0.35	340.70
kambuzi seine	catch	36.82	1.43	160.41	0.00	0.00	0.05	0.11	48.00	0.15	1.49	248.45
	effort	2882	2882	2882	2882	2882	2882	2882	2882	2882	2882	2882
	cpue	12.78	0.50	55.67	0.00	0.00	0.02	0.04	16.66	0.05	0.52	86.22
chiri' mila	catch	4.82	0.00	25.47	190.51	0.00	0.00	0.00	141.08	0.00	8.75	370.62
	effort	29789	29789	29789	29789	29789	29789	29789	29789	29789	29789	29789
	cpue	0.16	0.00	0.86	6.40	0.00	0.00	0.00	4.74	0.00	0.29	12.44
m'quito net	catch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.34	1.01	0.19	31.53
	effort	3791	3791	3791	3791	3791	3791	3791	3791	3791	3791	3791
	cpue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	0.27	0.05	8.32
fish trap	catch	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.56	1.44
	effort	101	101	101	101	101	101	101	101	101	101	101
	cpue	7.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.49	5.54	14.26
	TOTAL CATCH	3469.48	82.52	188.34	190.51	0.70	305.13	343.61	219.41	19.38	110.59	4929.67

ANNUAL SUMMARY FOR THE YEAR 1983

Gear		chambo	other tilapia	kambuzi	utaka	ch'sawa	k'pango	mlamba	usipa	nchila	others	TOTAL
gill net	catch	3301.61	59.03	0.07	4.65	6.54	253.16	263.66	0.00	18.05	68.53	3975.30
	effort	439610	439610	439610	439610	439610	439610	439610	439610	439610	439610	439610
	cpue	7.51	0.13	0.00	0.01	0.01	0.58	0.60	0.00	0.04	0.16	9.04
long line	catch	0.00	0.00	0.00	0.00	0.00	20.25	18.15	0.00	0.00	0.15	38.54
	effort	3327	3327	3327	3327	3327	3327	3327	3327	3327	3327	3327
	cpue	0.00	0.00	0.00	0.00	0.00	6.09	5.45	0.00	0.00	0.04	11.58
chambo seine	catch	358.64	135.83	6.48	0.00	0.00	0.00	0.46	0.00	0.00	6.99	508.40
	effort	2338	2338	2338	2338	2338	2338	2338	2338	2338	2338	2338
	cpue	153.40	58.10	2.77	0.00	0.00	0.00	0.20	0.00	0.00	2.99	217.45
kambuzi seine	catch	46.96	4.66	222.07	60.24	0.70	0.31	1.56	40.91	0.00	6.41	383.82
	effort	5507	5507	5507	5507	5507	5507	5507	5507	5507	5507	5507
	cpue	8.53	0.85	40.33	10.94	0.13	0.06	0.28	7.43	0.00	1.16	69.70
chiri' mila	catch	10.42	0.00	3.94	3847.61	0.00	0.43	1.80	371.17	0.00	7.30	4242.66
	effort	152264	152264	152264	152264	152264	152264	152264	152264	152264	152264	152264
	cpue	0.07	0.00	0.03	25.27	0.00	0.00	0.01	2.44	0.00	0.05	27.86
m'quito net	catch	0.00	0.00	2.03	0.15	0.00	0.00	0.00	129.06	0.00	0.00	131.24
	effort	3226	3226	3226	3226	3226	3226	3226	3226	3226	3226	3226
	cpue	0.00	0.00	0.63	0.05	0.00	0.00	0.00	40.01	0.00	0.00	40.68
hand line	catch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.12	1.12
	effort	308	308	308	308	308	308	308	308	308	308	308
	cpue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.64	3.64
	TOTAL CATCH	3717.63	199.52	234.59	3912.65	7.24	274.15	285.62	541.14	18.05	90.50	9281.08

ANNUAL SUMMARY FOR THE YEAR 1980

Gear		chambo	other tilapia	kambuzi	utaka	ch'sawa	k'pango	mlamba	usipa	nchila	others	TOTAL
gill net	catch	1678.29	47.94	0.00	0.00	4.18	218.72	243.09	0.00	25.53	106.00	2323[illegible]
	effort	527705	527705	527705	527705	527705	527705	527705	527705	527705	527705	527[illegible]
	cpue	3.18	0.09	0.00	0.00	0.01	0.41	0.46	0.00	0.05	0.20	[illegible]
long line	catch	0.00	0.00	0.00	0.00	0.00	0.21	51.63	0.00	0.00	4.37	56[illegible]
	effort	13999	13999	13999	13999	13999	13999	13999	13999	13999	13999	139[illegible]
	cpue	0.00	0.00	0.00	0.00	0.00	0.02	3.69	0.00	0.00	0.31	4[illegible]
chambo seine	catch	51.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	51[illegible]
	effort	63	63	63	63	63	63	63	63	63	63	[illegible]
	cpue	816.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	816[illegible]
kambuzi seine	catch	33.50	0.12	26.75	61.69	0.00	0.00	0.13	33.50	0.06	6.31	162[illegible]
	effort	3070	3070	3070	3070	3070	3070	3070	3070	3070	3070	30[illegible]
	cpue	10.91	0.04	8.71	20.09	0.00	0.00	0.04	10.91	0.02	2.06	52[illegible]
chiri' mila	catch	2.54	0.00	0.00	1722.18	0.00	0.00	0.00	0.00	0.82	43.12	1768[illegible]
	effort	38145	38145	38145	38145	38145	38145	38145	38145	38145	38145	381[illegible]
	cpue	0.07	0.00	0.00	45.15	0.00	0.00	0.00	0.00	0.02	1.13	46[illegible]
m'quito net	catch	0.00	0.00	0.50	6.71	0.00	0.00	0.00	8.63	0.17	0.00	16[illegible]
	effort	1570	1570	1570	1570	1570	1570	1570	1570	1570	1570	15[illegible]
	cpue	0.00	0.00	0.32	4.27	0.00	0.00	0.00	5.50	0.11	0.00	10[illegible]
fish trap	catch	0.03	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.[illegible]
	effort	134	134	134	134	134	134	134	134	134	134	1[illegible]
	cpue	0.22	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.[illegible]
hand line	catch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.45	16.[illegible]
	effort	3408	3408	3408	3408	3408	3408	3408	3408	3408	3408	340[illegible]
	cpue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.83	4.8[illegible]
	TOTAL CATCH	1765.79	48.16	27.25	1790.58	4.18	218.93	294.85	42.13	26.58	176.25	4394.[illegible]

ANNUAL SUMMARY FOR THE YEAR 1981

Gear		chambo	other tilapia	kambuzi	utaka	ch'sawa	K'pango	mlamba	usipa	nchila	others	TOTAL
gill net	catch	1561.09	60.16	0.00	0.00	0.00	185.15	195.57	0.00	15.12	92.63	2109.[illegible]
	effort	500977	500977	500977	500977	500977	500977	500977	500977	500977	500977	50097[illegible]
	cpue	3.12	0.12	0.00	0.00	0.00	0.37	0.39	0.00	0.03	0.18	4.2[illegible]
long line	catch	0.00	0.00	0.00	0.00	0.00	3.63	205.85	0.00	0.00	0.40	209.[illegible]
	effort	37239	37239	37239	37239	37239	37239	37239	37239	37239	37239	372[illegible]
	cpue	0.00	0.00	0.00	0.00	0.00	0.10	5.53	0.00	0.00	0.01	5.[illegible]
chambo seine	catch	207.58	1.21	0.00	0.00	0.00	0.20	1.08	0.00	0.00	0.95	211.[illegible]
	effort	1373	1373	1373	1373	1373	1373	1373	1373	1373	1373	137[illegible]
	cpue	151.19	0.88	0.00	0.00	0.00	0.15	0.79	0.00	0.00	0.69	153.[illegible]
kambuzi seine	catch	78.18	4.17	73.67	22.30	0.00	4.38	8.74	26.60	0.41	8.12	226.5[illegible]
	effort	3193	3193	3193	3193	3193	3193	3193	3193	3193	3193	319[illegible]
	cpue	24.48	1.31	23.07	6.98	0.00	1.37	2.74	8.33	0.13	2.54	70.[illegible]
chiri' mila	catch	3.94	0.00	28.13	2478.32	0.00	0.07	0.02	22.72	0.00	94.56	2627.[illegible]
	effort	146347	146347	146347	146347	146347	146347	146347	146347	146347	146347	1463[illegible]
	cpue	0.03	0.00	0.19	16.93	0.00	0.00	0.00	0.16	0.00	0.65	17.[illegible]
m'quito net	catch	1.04	6.65	1.32	0.00	0.00	0.00	0.00	21.49	0.00	0.38	30.[illegible]
	effort	1182	1182	1182	1182	1182	1182	1182	1182	1182	1182	11[illegible]
	cpue	0.88	5.63	1.12	0.00	0.00	0.00	0.00	18.18	0.00	0.32	26.[illegible]
scoop net	catch	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.[illegible]
	effort	138	138	138	138	138	138	138	138	138	136	1[illegible]
	cpue	2.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.[illegible]
	TOTAL CATCH	1852.19	72.19	103.12	2500.62	0.00	193.43	411.26	70.81	15.53	197.04	5416.[illegible]

ANNUAL SUMMARY FOR THE YEAR 1978

Gear		chambo	other tilapia	kambuzi	utaka	ch'sawa	k'pango	mlamba	usipa	nchila	others	TOTAL
gill	catch	1613.74	68.56	0.00	0.22	16.12	360.55	271.27	0.00	29.06	130.55	2490.06
net	effort	622051	622051	622051	622051	622051	622051	622051	622051	622051	622051	622051
	cpue	2.59	0.11	0.00	0.00	0.03	0.58	0.44	0.00	0.05	0.21	4.00
long	catch	0.00	0.00	0.00	0.00	0.00	3.69	96.08	0.00	0.00	0.35	100.12
line	effort	24079	24079	24079	24079	24079	24079	24079	24079	24079	24079	24079
	cpue	0.00	0.00	0.00	0.00	0.00	0.15	3.99	0.00	0.00	0.01	4.16
chambo	catch	301.10	1.93	1.15	77.14	0.00	1.45	1.85	0.00	0.59	10.66	395.87
seine	effort	2537	2537	2537	2537	2537	2537	2537	2537	2537	2537	2537
	cpue	118.71	0.76	0.45	30.41	0.00	0.57	0.73	0.00	0.23	4.20	156.07
kambuzi	catch	520.13	21.19	320.39	497.83	0.00	6.04	7.83	13.02	0.01	4.97	1391.41
seine	effort	16747	16747	16747	16747	16747	16747	16747	16747	16747	16747	16747
	cpue	31.06	1.27	19.13	29.73	0.00	0.36	0.47	0.78	0.00	0.30	83.08
chiri'	catch	0.74	0.00	7.97	1529.96	0.00	0.15	0.34	75.15	0.00	109.60	1723.92
mila	effort	142048	142048	142048	142048	142048	142048	142048	142048	142048	142048	142048
	cpue	0.01	0.00	0.06	10.77	0.00	0.00	0.00	0.53	0.00	0.77	12.14
m'quito	catch	9.35	0.21	4.42	7.19	0.00	0.00	0.00	96.77	0.00	0.17	118.10
net	effort	6212	6212	6212	6212	6212	6212	6212	6212	6212	6212	6212
	cpue	1.50	0.03	0.71	1.16	0.00	0.00	0.00	15.58	0.00	0.03	19.01
fish	catch	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.05	0.08
trap	effort	25	25	25	25	25	25	25	25	25	25	25
	cpue	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00	2.00	3.20
hand	catch	0.00	0.00	0.00	0.00	0.00	0.21	0.82	0.00	0.00	1.71	2.74
line	effort	1947	1947	1947	1947	1947	1947	1947	1947	1947	1947	1947
	cpue	0.00	0.00	0.00	0.00	0.00	0.11	0.42	0.00	0.00	0.88	1.41
	TOTAL CATCH	2445.05	91.89	333.94	2112.34	16.12	372.09	378.22	184.94	29.66	258.06	6222.30

ANNUAL SUMMARY FOR THE YEAR 1979

Gear		chambo	other tilapia	kambuzi	utaka	ch'sawa	k'pango	mlamba	usipa	nchila	others	TOTAL
gill	catch	1805.79	35.24	2.00	0.00	27.60	216.21	244.78	0.00	7.18	101.27	2440.07
net	effort	481869	481869	481869	481869	481869	481869	481869	481869	481869	481869	81869
	cpue	3.75	0.07	0.00	0.00	0.06	0.45	0.51	0.00	0.01	0.21	5.06
long	catch	0.00	0.00	0.00	0.00	0.00	0.78	91.14	0.00	0.00	0.07	91.99
line	effort	11319	11319	11319	11319	11319	11319	11319	11319	11319	11319	11319
	cpue	0.00	0.00	0.00	0.00	0.00	0.07	8.05	0.00	0.00	0.01	8.13
chambo	catch	100.22	0.08	0.23	0.00	0.00	0.14	0.09	0.00	0.00	0.43	101.19
seine	effort	278	278	278	278	278	278	278	278	278	278	278
	cpue	360.50	0.29	0.83	0.00	0.00	0.50	0.32	0.00	0.00	1.55	363.99
kambuzi	catch	84.66	5.05	45.45	7.52	0.00	1.90	6.66	5.02	0.46	1.51	158.23
seine	effort	3377	3377	3377	3377	3377	3377	3377	3377	3377	3377	3377
	cpue	25.07	1.50	13.46	2.23	0.00	0.56	1.97	1.49	0.14	0.45	46.86
chiri'	catch	1.17	0.04	42.96	648.17	1.90	0.00	0.00	66.97	0.00	151.65	912.86
mila	effort	46271	46271	46271	46271	46271	46271	46271	46271	46271	46271	46271
	cpue	0.03	0.00	0.93	14.01	0.04	0.00	0.00	1.45	0.00	3.28	19.73
quito	catch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.03	0.00	0.00	33.03
net	effort	2352	2352	2352	2352	2352	2352	2352	2352	2352	2352	2352
	cpue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.04	0.00	0.00	14.04
fish	catch	4.80	6.20	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.05	11.16
trap	effort	5982	5982	5982	5982	5982	5982	5982	5982	5982	5982	5982
	cpue	0.80	1.04	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.01	1.87
hand	catch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.87	12.87
line	effort	1436	1436	1436	1436	1436	1436	1436	1436	1436	1436	1436
	cpue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.96	8.96
	TOTAL CATCH	1996.64	46.61	90.64	655.69	29.50	219.03	342.78	105.02	7.64	267.85	3761.40

ANNUAL SUMMARY FOR THE YEAR 1976

Gear		chambo	other tilapia	kambuzi	utaka	ch'sawa	K'pango	mlamba	usipa	nchila	others	TOTAL
gill net	catch	1248.78	31.93	0.00	0.19	2.74	463.84	330.25	0.00	51.83	193.55	2323.1
	effort	735705	735705	735705	735705	735705	735705	735705	735705	735705	735705	7357
	cpue	1.70	0.04	0.00	0.00	0.00	0.63	0.45	0.00	0.07	0.26	3.1
long line	catch	0.00	0.00	0.00	0.00	0.00	1.13	70.84	0.00	0.00	0.52	72.5
	effort	16512	16512	16512	16512	16512	16512	16512	16512	16512	16512	1651
	cpue	0.00	0.00	0.00	0.00	0.00	0.07	4.29	0.00	0.00	0.03	4.
chambo seine	catch	106.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.00	84.77	191.2
	effort	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	300
	cpue	35.33	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	28.26	63.7
kambuzi seine	catch	56.67	0.00	465.11	1.89	0.00	0.00	1.17	0.00	0.16	9.48	534.
	effort	8469	8469	8469	8469	8469	8469	8469	8469	8469	8469	84
	cpue	6.69	0.00	54.92	0.22	0.00	0.00	0.14	0.00	0.02	1.12	63.1
chiri' mila	catch	16.81	6.63	310.00	360.32	0.00	0.79	0.82	90.63	0.50	58.71	845.2
	effort	29942	29942	29942	29942	29942	29942	29942	29942	29942	29942	299
	cpue	0.56	0.22	10.35	12.03	0.00	0.03	0.03	3.03	0.02	1.96	28.2
m'quito net	catch	0.86	0.33	0.00	0.00	0.00	0.00	0.81	2.96	0.00	22.43	27.
	effort	4182	4182	4182	4182	4182	4182	4182	4182	4182	4182	41
	cpue	0.20	0.08	0.00	0.00	0.00	0.00	0.19	0.71	0.00	5.36	6.5
fish trap	catch	30.43	3.17	0.00	0.00	0.00	0.00	3.52	0.00	0.00	1.49	38.
	effort	20146	20146	20146	20146	20146	20146	20146	20146	20146	20146	201
	cpue	1.51	0.16	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.07	1.
	TOTAL CATCH	1459.55	42.05	775.11	362.40	2.74	465.77	407.83	93.59	52.48	370.95	4032.

ANNUAL SUMMARY FOR THE YEAR 1977

Gear		chambo	other tilapia	kambuzi	utaka	ch'sawa	K'pango	mlamba	usipa	nchila	others	TOTAL
gill net	catch	3138.35	27.34	0.00	0.57	16.18	497.21	270.11	0.00	35.59	203.60	4188.9
	effort	1026039	1026039	1026039	1026039	1026039	1026039	1026039	1026039	1026039	1026039	102603
	cpue	3.06	0.03	0.00	0.00	0.02	0.48	0.26	0.00	0.03	0.20	4.0
long line	catch	0.00	0.00	0.00	0.00	0.00	8.83	175.50	0.00	0.00	0.20	184.5
	effort	30098	30098	30098	30098	30098	30098	30098	30098	30098	30098	3009
	cpue	0.00	0.00	0.00	0.00	0.00	0.29	5.83	0.00	0.00	0.01	6.1
chambo seine	catch	161.93	11.75	29.27	0.00	0.00	1.08	2.11	0.00	0.58	12.73	218.4
	effort	4058	4058	4058	4058	4058	4058	4058	4058	4058	4058	405
	cpue	39.90	2.90	7.21	0.00	0.00	0.26	0.52	0.00	0.14	3.14	54.0
kambuzi seine	catch	276.84	54.33	614.31	4.04	0.00	0.03	8.18	41.08	0.00	4.83	1003.6
	effort	8117.00	8117	8117	8117	8117	8117	8117	8117	8117	8117	811
	cpue	34.11	6.69	75.68	0.50	0.00	0.00	1.01	5.06	0.00	0.60	123.6
chiri' mila	catch	402.04	0.00	52.32	796.94	0.00	0.00	0.26	42.26	0.00	72.14	1365.9
	effort	38087	38087	38087	38087	38087	38087	38087	38087	38087	38087	3808
	cpue	10.56	0.00	1.37	20.92	0.00	0.00	0.01	1.11	0.00	1.89	35.8
m'quito net	catch	0.00	0.05	9.01	0.00	0.00	0.00	0.00	479.00	0.00	0.04	488.1
	effort	7776	7776	7776	7776	7776	7776	7776	7776	7776	7776	777
	cpue	0.00	0.01	1.16	0.00	0.00	0.00	0.00	61.60	0.00	0.01	62.7
fish trap	catch	0.32	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.8
	effort	64	64	64	64	64	64	64	64	64	64	6
	cpue	5.00	0.00	0.00	0.00	0.00	0.00	8.28	0.00	0.00	0.00	13.2
hand line	catch	0.00	0.00	0.00	0.00	0.00	0.11	0.15	0.00	0.00	0.27	0.5
	effort	240	240	240	240	240	240	240	240	240	240	24
	cpue	0.00	0.00	0.00	0.00	0.00	0.44	0.61	0.00	0.00	1.13	2.1
cast net	catch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	effort	284	284	284	284	284	284	284	284	284	284	28
	cpue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	TOTAL CATCH	3979.47	93.48	704.92	801.55	16.18	507.25	456.84	562.34	36.17	293.82	7452.0

ADJUSTMENTS FOR MISSING DATA

Where data are not available, either because of sickness of the recorder or because data have been lost over the years, estimates have been made based on catch rates in the area in question before and after the month for which the data are missing. Estimates are based on the mean effort and cpue for each species group and gear category for the month preceding and the month following the data gap. Total catches in the month are then estimated by multiplying mean cpue by mean effort.

In most years, the amount of data missing is negligible, with little effect on the accuracy of the assessments. In 1977 and 1978, however, no recording took place in any minor stratum in August hence the entire catch for those months is an estimate based on the mean of July and September data. Approximately one quarter of the 1976 data are estimates as original data have been lost, hence the data for that year can only be considered as rough estimates.

Data estimated by taking means of other months are as follows:

1976	February	- Areas 2.5 and 2.6.
	April	- Areas 2.1, 2.2, 2.3, 2.4 and 2.6.
	July	- Area 2.6.
	September	- Areas 2.5 and 2.6.
	October	- Areas 2.1, 2.2, 2.3, 2.4 and 2.5.
	November	- Areas 2.1 to 2.6.
1977	March	- Area 2.5.
	August	- Areas 2.1 to 2.6.
	December	- Areas 2.1 and 2.2.
1978	January	- Area 2.3.
	February	- Areas 2.3 and 2.6.
	August	- Areas 2.1 to 2.6.
1982	October	- Areas 2.2 and 2.6.
1983	July	- Area 2.6.
	December	- Area 2.3.
1985	December	- Area 2.3.
1988	April	- Area 2.1