Analysis of catch and Effort Data for the Fisheries of Southeast Arm of Lake Malawi

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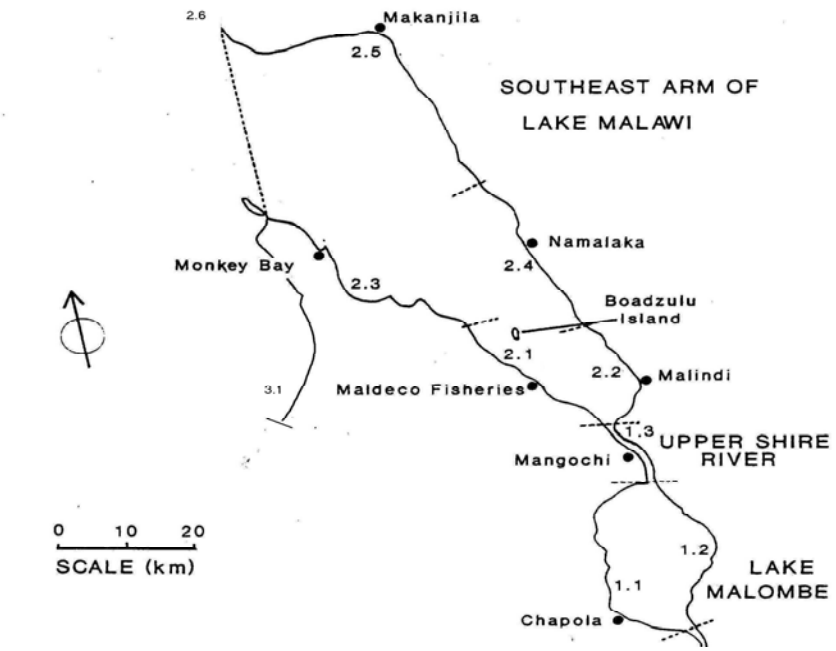


Figure 1. Map of the southeast arm of Lake Malawi

Summary
Trends in total annual catches in southeast arm of Lake Malawi increased from a level of 4,000 tonnes in 1976 to a peak of 15,000 tonnes in 1996 due to good catches of utaka and usipa in that year. Chilimira was the main contributing gear towards the total annual catch in this part of Lake Malawi. Ownership of important gears such as gill nets, chilimira nets and mosquito nets showed increasing trends one time. Ownership of nkacha nets and its operation in this area has been described in this paper. Species composition for gillnet fishery was mainly dominated by large cichlids (chambo and mbaba) and the catfish group. Seine net fishery was dominated by small sized cichlids such as juvenile chambo, kambuzi and utaka. Despite some limitations, catch and effort data is still an important tool in the management of fisheries resources and therefore should be continued as a tool for monitoring exploitation of stocks in the small-scale fisheries sector. Efforts should therefore be intensified towards supporting the already existing management structures, notably the participatory management efforts.

Introduction

The southern part of Lake Malawi is split into two sections, southeast and southwest arm. Of the two, the southeast arm (Figure 1) is more productive and accommodates small-scale, pair-trawl and commercial or large-scale fisheries (Bulirani *et al*. 1999). There has been excessive fishing effort in the southeast arm of the lake and the important chambo fishery was reported to be declining in this area (Palsson, *et al*. 1999; Weyl, 1999). The purpose of this report is therefore to update catch and effort data that is available for the southeast arm of Lake Malawi from 1976 to 1999 so as to highlight some important trends in production and exploitation regimes of the main fisheries.

Materials and Methods

The southeast arm is divided into six statistical minor strata (Figure 1) for the purposes of fisheries data collection and management. The catch and effort has been monitored in this part of the lake since early 1970s. Initially, data collection was done using catch assessment surveys (CAS) developed by Bazigos (1974). The 1991 FAO Chambo Project established the Malawi Traditional Fisheries (MTF) and this system has since replaced CAS as data collection system in Mangochi district. The main difference between CAS and MTF is that CAS is boat-based whereas MTF is gear-based. This difference implies that MTF is more effective at yielding better catch and effort estimates than CAS (Alimoso 1988, FAO 1993, Weyl *et al*. 1999). In this analysis, some species groups were combined e.g. mlamba and kampango were grouped as catfish. In many cases, all species or gears that contributed minimal to the total catch were grouped together as 'Others' in the analysis of the gears and species. Kambuzi and utaka species were treated as quite distinct groups in this analysis, unlike the case with Lake Malombe where these species are considered synonymous (Weyl, 1999).

Data analysis

Total catch

Large fluctuations were noticed in the catch estimates of the southeast arm of Lake Malawi over the period 1976 to 1999 (Figure 2). Estimated total catch ranged from 4,000 tonnes in the late 1970s to about 15,000 tonnes in 1996. The highest catch was realised in 1996. The main contributing gears to the total catch were chilimira nets, gillnets, kambuzi seines and chambo seines. Species composition also showed some changes in that chambo dominated the catches from 1976 until late 1980s. Then chambo was replaced by kambuzi species, which became increasingly important in this part of the lake since early 1990s. Annual catches were high in 1996 due to high usipa and utaka catches in that year (Figure 3).

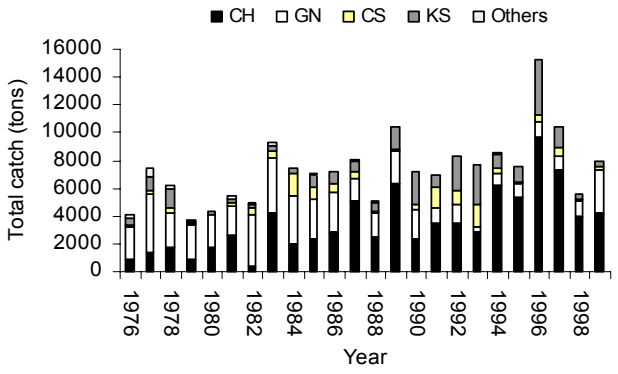


Figure 2. Annual catch by gear in southeast arm of Lake Malawi 1976-1999

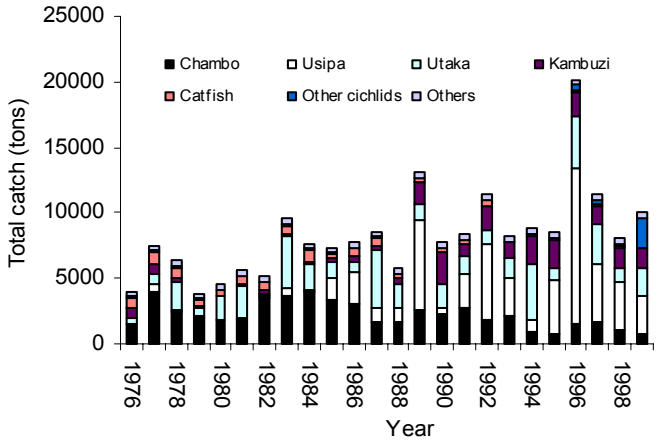


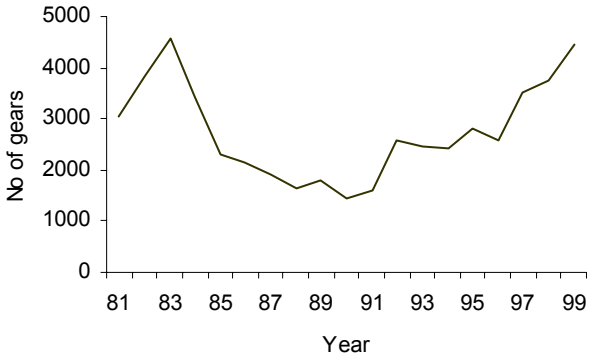
Figure 3. Annual catch by species for all gears in southeast arm 1976-1999

Analysis by gear

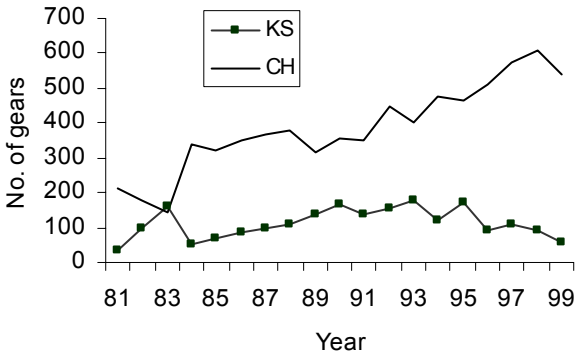
Gear ownership

Trends in number of important fishing gears in the southeast arm of Lake Malawi are shown in Figure 4. Ownership of gillnets showed increasing trends prior to 1983, followed by a decline in numbers until early 1990s when the trend in ownership started peaking up. Ownership of chilimira nets showed increasing trends from 50 gears in 1981 to 600 gears in 1998 and dropped to a level of 540 gears in 1999. Ownership of kambuzi seines showed relatively stable trends throughout the period under consideration. Prior to 1989, ownership of handlines and longlines was negligible in that these gears were lower than 200 in number respectively. After 1989, ownership of these gears showed large fluctuations with handlines peaking up to 1,400 gears in 1994 and longlines came to a high of 600 gears in 1995. Since 1994, ownership of handlines has been showing declining trends, and this might be a basis for the present data collection systems not considering handlines as important fisheries in southeast arm (Weyl *pers obs*). Ownership of kambuzi seines started peaking up in 1993 and has been showing declining trends since then. As for chambo seines, trend in ownership has declined since 1981. Nkacha nets became introduced in the southeast arm of Lake Malawi since 1992, with ownership trends showing some fluctuations and reaching 70 gears by 1999. Ownership of fish traps has been showing fluctuations since 1991 and reached a peak of 180 gears in 1998, followed by a sharp decline in ownership to a level of 60 gears in 1999.

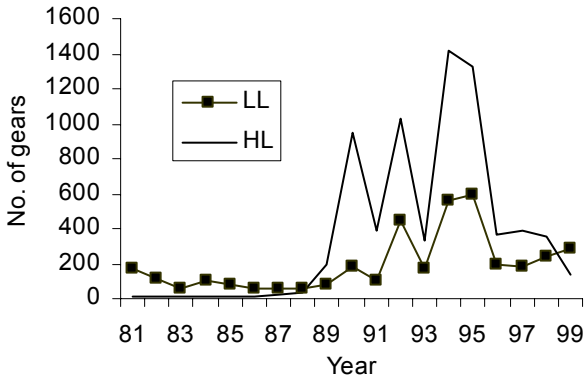
Gillnets



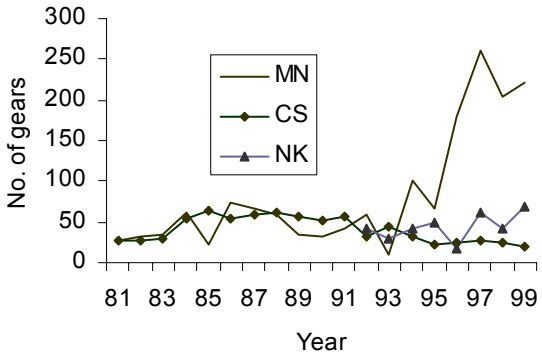
Chilimira nets & Kambuzi seines



Handlines & Longlines



Mosquito nets, Chambo & Nkacha nets



Fish traps

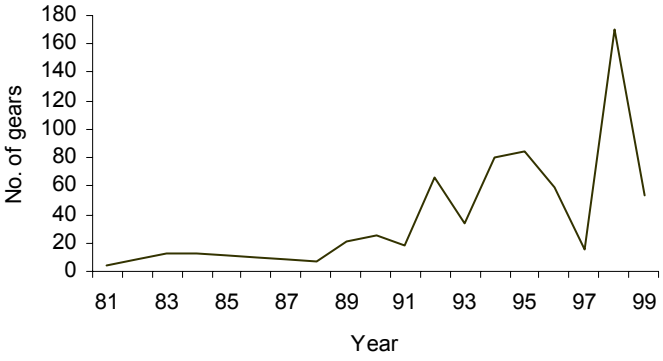


Figure 4. Annual trends in fishing gear ownership in southeast arm, 1981-1999.

Gillnets

In the past, gillnets were mainly operated as a passive gear in that they were set in the evening only to be retrieved during the morning of the next day. The situation is now taking another dimension such that some of the gears are being used actively as is the case with seine nets. In some cases, gillnets are being used during the night by beating the water so as to drive fish towards the set nets (Manase *per obs*). Annual catch estimates, CPUE estimates and catch composition are shown in Figures 5, 6 and 7.

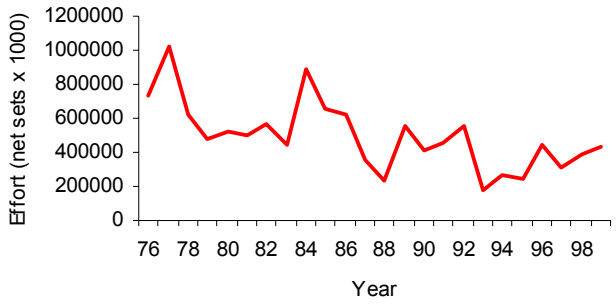


Figure 5. Effort for gillnets sets per year for the period 1976-1999 in southeast arm.

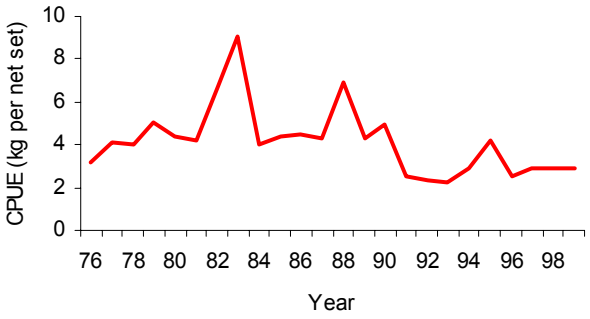


Figure 6. CPUE (kg per gillnet set) for the period 1976-1999 in southeast arm.

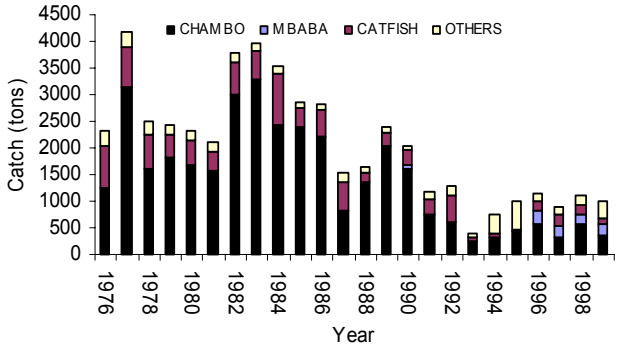


Figure 7. Total catch and species composition in gillnet fishery of southeast arm, 76-99.

Annual gill net effort showed increasing trends from 1993 to 1999 with some fluctuations since late 1970s (Figure 5). Estimates of gillnet CPUE showed increasing trends from late 1970s up until mid 1980s, followed by declining trends (Figure 6). Good chambo catches during this period were responsible for the increased CPUE trends. CPUE estimates of the gillnet fishery showed a general declining trend from 9 kg per net set in 1983 to a low level of 3 kg per net set in 1998.

Total catch for the gillnet fishery showed a general declining trend from 5,000 tons in the late 1970s to 500 tons in 1993 (Figure 7). The species composition of this fishery has been the chambo, mbaba, catfish and others. The dominant species in the gillnet fishery has been chambo. Therefore, the declining trend in annual gillnet catches can be attributed to the decline of chambo. Interestingly, CPUE appears to be increasing probably due to either declining trends in fishing effort for gears targeting chambo stocks or due to increase in CPUE of other species.

Chilimira nets

The chilimira net fishery operates both during day and night using light attraction. This distinction has not been considered in this analysis. Annual effort estimates, CPUE estimates and total annual catch for the chilimira net fishery are shown in Figures 8 and 9. Effort in this fishery has increased since the 1970s. CPUE estimates in this fishery have had large fluctuations, especially around 1980 where a high level of 45 kg per haul was achieved. This dropped to 10 kg per haul in 1982, followed by relatively small fluctuations and declining CPUE trends (Figure 8).

The species composition of the chilimira net fishery showed that utaka contributed 50% to the total catch, usipa contributed 30%, kambuzi 10%, chambo 3% and other species 7%. Catches generally increased from the late 1970s and reached highest recorded level of over 8,000 tonnes in 1996 due to good utaka and usipa catches in that year (Figure 9).

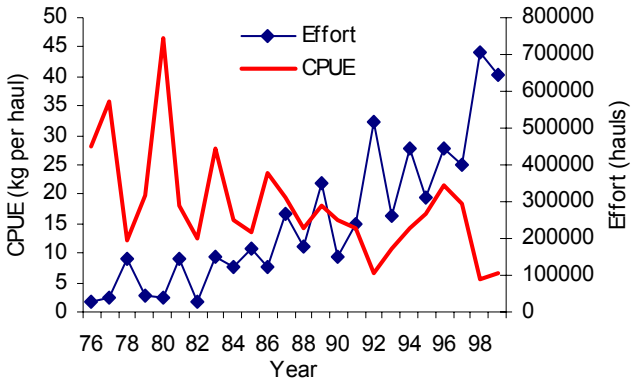


Figure 8. Chilimira effort (hauls per year) and CPUE (kg per haul) for southeast arm.

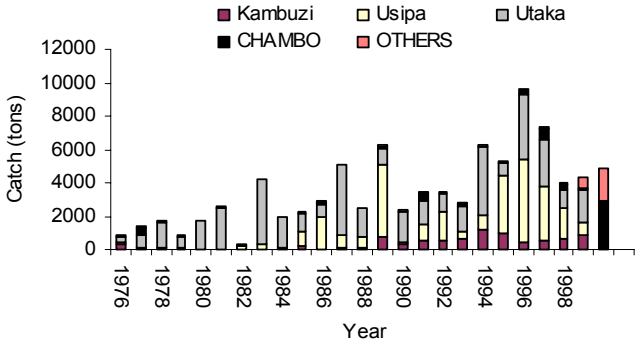


Figure 9. Total catch and species composition for chilimira fishery of southeast arm

Chambo seines

Annual effort estimates, CPUE estimates and total catch for the chambo seine net fishery are shown in Figures 10 and 11. Annual effort in this fishery showed increasing trends until 1991 followed by a decline.

CPUE estimates reached a peak of 800 kg per haul in 1980, followed by relatively low and stable levels thereafter. The CPUE for this fishery is currently below 100 kg per haul (Figure 10).

The species composition of chambo seine net fishery showed that chambo was the main target species and contributed about 95% to the total catch of this fishery (Figure 11). Good catches in this fishery were realised in 1984 and 1991 through 1993 where declining trends of catches followed.

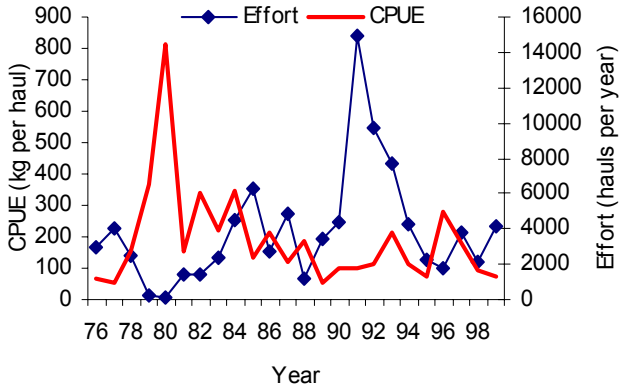


Figure 10. Chambo seine net effort (hauls per year) and CPUE (kg per haul) in southeast arm, 1976-1999.

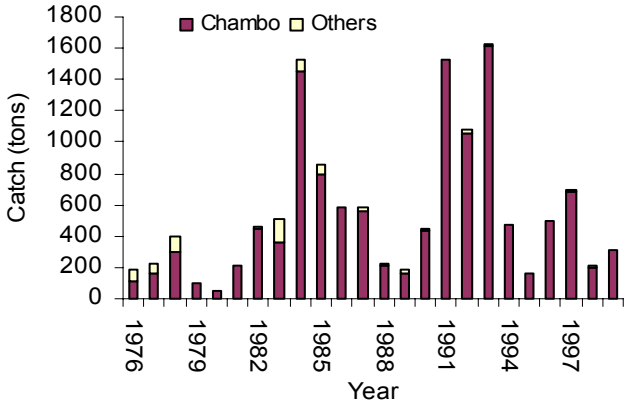


Figure 11. Total catch and species composition of chambo seine net fishery in southeast arm, 1976-1999.

Kambuzi seines

Annual effort estimates, CPUE estimates and catch composition for the kambuzi seine fishery are shown in Figures 12 and 13. Annual effort showed increasing trends from late 1970s to early 1990s and effort declined since then. CPUE estimates showed declining trends with lowest level around 1991 followed by large fluctuations until late 1990s. The trends showed two peaks, one in 1993 and the other peak in 1996 probably due to recording errors or due to usipa catch fluctuations (Figure 12). Total annual catch for this gear reached low levels from 1976 to late 1980s followed by good catches. The highest catch recorded was 4,000 tons in 1996 due to good usipa and utaka catches. Thereafter, the total catch dropped to 400 tons (Figure 13). Catch composition showed that the kambuzi seine fishery was dominated by kambuzi (45%), usipa (37%), utaka (6%), chambo (5%) and other species (7%).

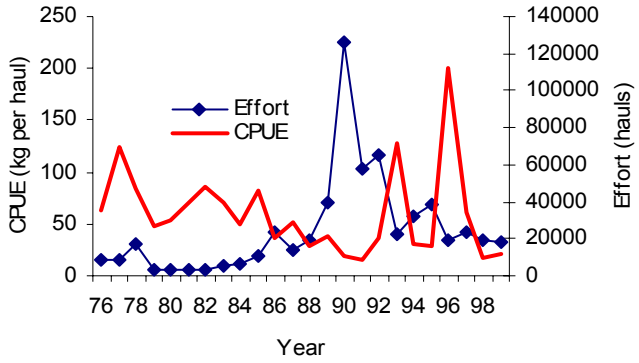


Figure 12. Kambuzi seine effort (hauls) and CPUE (kg per haul) in southeast arm during 1976-1999 period.

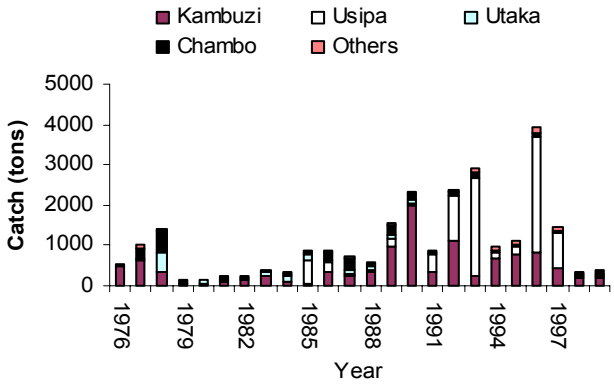


Figure 13. Total catch and species composition for kambuzi seine fishery in southeast arm during 1976-1999 the period.

Nkacha nets

Annual effort estimates, CPUE estimates and catch composition for the nkacha net fishery are shown in Figures 14 and 15. Nkacha gear is believed to have originated from Lake Malombe and introduced in Lake Malawi particularly in the southeast arm in 1989, following good chambo catches in this area (Alimoso *et al* 1991). The nkacha nets in the southeast arm started booming up around 1993 and registered a high level of some 70 gears in 1999. Annual effort showed increasing trends from 1989 through 1995, followed by declining trends. The decline in effort trends could be attributed to low chambo catches and that some fishermen could be opting for other fishing areas or other fishing gears e.g. gillnets. CPUE estimates registered increasing trends from the late 1980s to 1992 and then declining trends followed (Figure 14). As for catch composition, the nkacha net fishery was mainly dominated by kambuzi (42%), usipa (38%), utaka (7%), chambo (5%) and other species (8%). Catches showed increasing trends from 20 tons in 1989 to 700 tons in 1996, followed by declining trends since then (Figure 15).

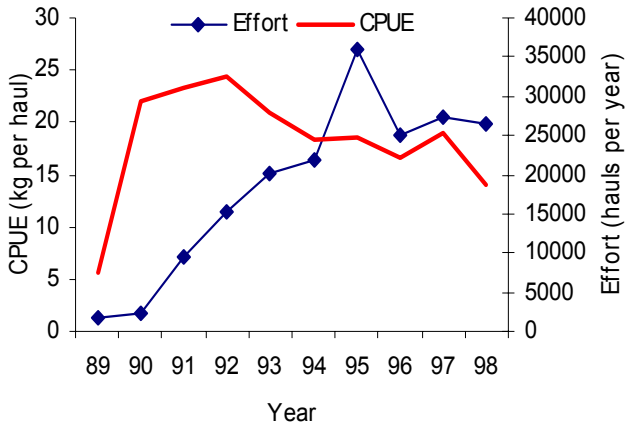


Figure 14. Nkacha net effort (hauls) and CPUE (kg per haul) in southeast arm during 1976-1999 period.

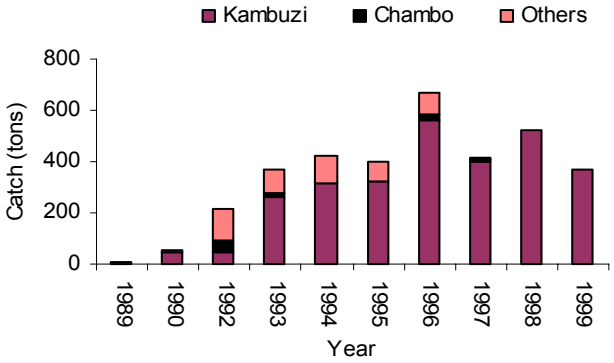


Figure 15. Total catch and species composition for nkacha net fishery in southeast arm during 1976-1999 the period.

Mosquito nets

Annual effort estimates, CPUE estimates and catch composition for the mosquito net fishery are shown in Figures 16 and 17. Effort trends fluctuated throughout the period under consideration with a remarkable drop in 1993. The CPUE trends were stable and low from 1976 to 1994, followed by large fluctuations (Figure 16). Catch composition mainly comprised usipa (Figure 17), and this species accounted for 98% of the total catch. The catch trends showed low levels from 1976 to late 1980s and then catches started peaking up with some noticeable fluctuations, suggesting that this gear was only assessed during times of good catches.

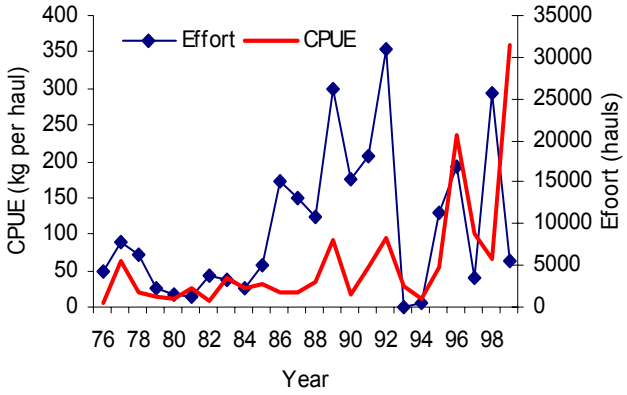


Figure 16. Mosquito net effort (hauls) and CPUE (kg per haul) in southeast arm during 1976-1999 period.

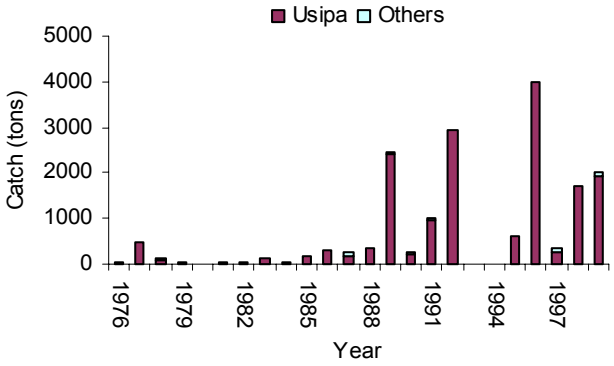


Figure 17. Total catch and species composition for mosquito net fishery in southeast arm during 1976-1999.

Analysis by Species

Chambo

Chambo in the southeast arm of Lake Malawi is mainly harvested by gillnets and chambo seines (Figure 18). Gillnets accounted for 65%, chambo seines accounted for 23% of the total catch. Chilimira nets and kambuzi seines each contributeed about 5% of the total chambo catch. Catch trends for chambo in this part of the lake showed noticeable fluctuations from a high level of about 4,000 tons in the late 1970s to a low of about 600 tons in 1999. The total catch for chambo showed a steady decline since early 1990s (Figure 18). This was probably due to declines in CPUE in the main harvesting fisheries, notably gillnets and chambo seines (Figure 19) and this is indicative of an over-fished stock.

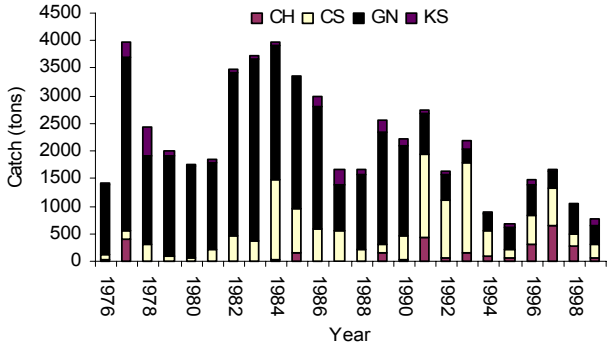


Figure 18. Total chambo catch by the main fishing gears in southeast arm, 1976-1999.

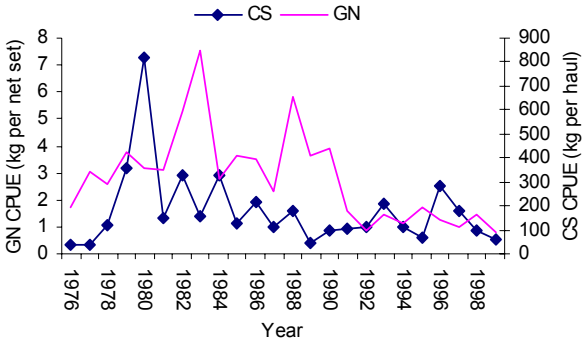


Figure 19. Chambo CPUE (kg per net set) in gillnet (GN) fishery and Chambo CPUE (kg per haul) in chambo seines (CS) fishery of the southeast arm, 1976-1999.

Utaka

Chilimira nets generally exploited this group of species and contributed over 90% to the total utaka catch in the southeast arm (Figure 20). Utaka catch did not show a definite trend. However, there were noticeable fluctuations in the catch over the years. Good catches of this species were realised in 1983, 1987, 1994 and 1996. Utaka CPUE estimates for chilimira net fishery showed declining trends since reaching a peak of 45 kg per haul in 1980 (Figure 21).

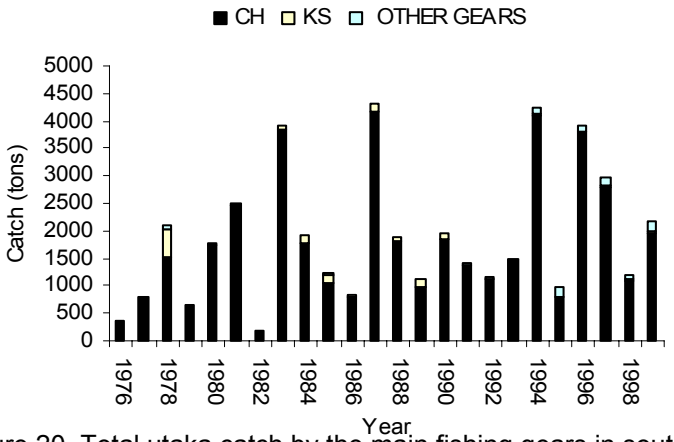


Figure 20. Total utaka catch by the main fishing gears in southeast arm, 1976-1999.

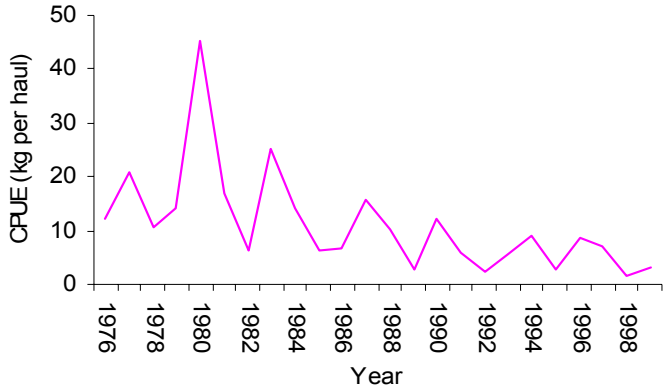


Figure 21. Utaka CPUE in the chilimira net (CH) fishery of southeast arm, 1976-1999.

Usipa

The main gears harvesting usipa in the southeast arm included chilimira nets, mosquito nets and kambuzi seines that contributed 51%, 31% and 17% to the total usipa catch respectively (Figure 22). A good year for usipa catches was in 1996 and this corresponded with high utaka CPUE levels in mosquito net and kambuzi seine fishery (Figure 23).

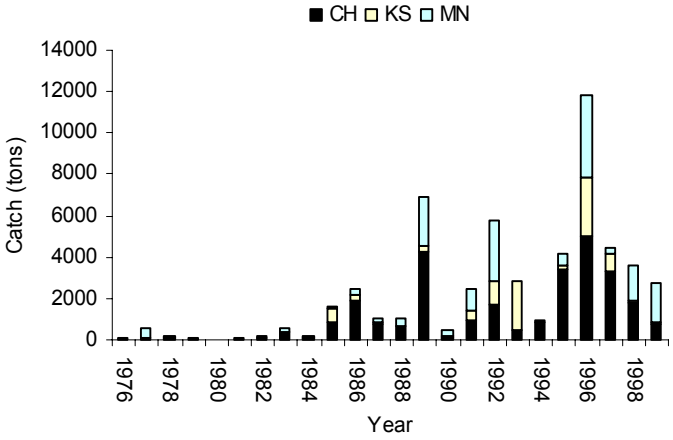


Figure 22. Total usipa catch by the main fishing gears in southeast arm, 1976-1999.

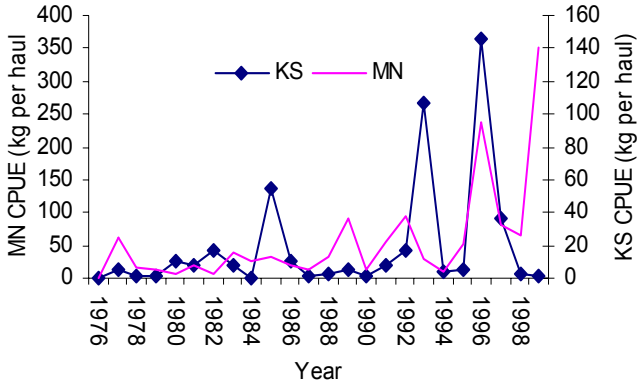


Figure 23. Usipa CPUE for mosquito net (MN) fishery and the kambuzi seines (KS) fishery of southeast arm, 1976-1999.

Kambuzi

Fishing gears used to exploit kambuzi in the southeast arm included kambuzi seines, chilimira nets and nkacha nets and contributed 48%, 38% and 12% to the total catch respectively (Figure 24). The high catches occured in the late 1980s though there was a decline in catch corresponding to declining CPUE for these fisheries (Figure 25).

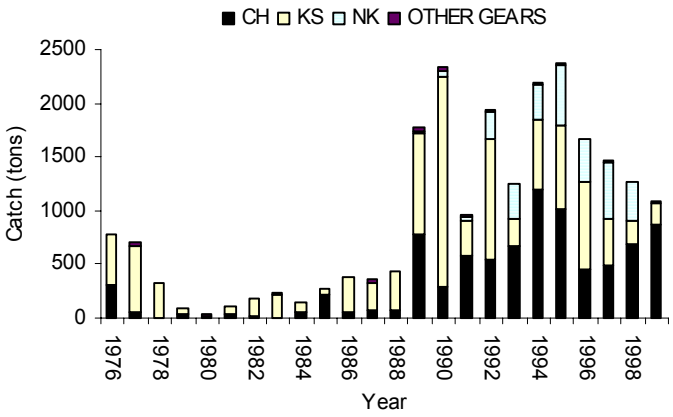


Figure 24. Total kambuzi catch by the main fishing gears in southeast arm, 1976-1999.

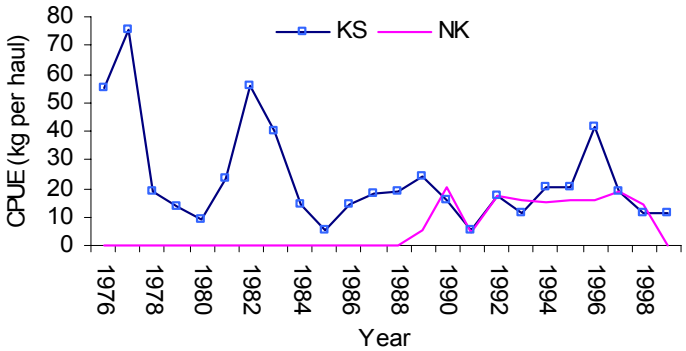


Figure 25. Kambuzi CPUE (kg per haul) in the kambuzi seine (KS) and nkacha net (NK) fishery of southeast arm, 1976-1999.

Discussion

The scientific basis of managing fisheries resources in Malawi has been limited to fisheries catch and effort data despite the fact that data collection and analysis has been inefficient over the past years (Weyl, 1999).

In the analysis, some important gears or gear operations were not adequately represented due to the realisation that the present data collection systems did not give them due consideration. For instance, there was little catch and effort data on gears like handlines and longlines. In addition, night fishing for chilimira net fishery may not be adequately represented in this analysis. Furthermore, a number of modifications occurred in the operation of gillnets such that, many were active rather than passive gears. In addition, a large proportion of gillnets in the southeast arm were reported to have illegal mesh sizes (Weyl, *et al*. 2000). All these changes occurred without being properly recorded by the current data collection systems. Hence, underestimation of catch and effort in gillnets cannot be ruled out.

Since late 1970s, species catch composition in the southeast arm of the lake was dominated by chambo until the early 1990s when small-sized species such as kambuzi started dominating the catches. This species change could be attributed to high fishing pressure where species strive to adapt to a given stress so as to maintain their place in a given species assemblage. Long lived k-selected species such as chambo, would therefore become replaced by short-lived r-selected species such as kambuzi species (Manase 2000, Turner *et al.* 1992).

Fisheries management regulations in the waters of Malawi are based on technical restriction of fishing gears such as gear type, mesh size and gear length as well as restrictions on fishing areas and fishing times. The small-scale fisheries regulations are primarily confined to mesh size, gear size limitations and closed seasons for beach seines. However, none of these regulations incorporated such gears as handlines, traps, scoop nets and cast nets, though these fishing gears contribute to the excessive fishing pressure occurring in the fisheries of Malawi (Manase, *pers obs*). Management recommendations made by the chambo project in southeast arm centred on strategies aimed at rebuilding chambo stocks within 5 years for a resultant annual yield of 1000 tons. Since such recommendations risked some fishers' livelihood as a result of banning some gears, it was evident that no tangible efforts were taken towards implementing the management strategies. This has resulted into excessive fishing effort with respect to dramatic increase of the number of different fishing gears as well reduction of mesh size for many gears and gillnets in particular. It is alarming that over 95% of all gillnet fishers used illegal mesh sizes (< 85mm) (Weyl *et al* 2000). The use of small-meshed nets is a threat to sand-nesting cichlids apart from the destruction of lakebed that acts as a nesting ground for some important species (Seisay *et al* 1992). A well known example of the small-meshed nets include the illegally operated nkacha nets which are believed to have originated from Lake Malombe, a closest water body to the southeast arm (FAO, 1993). Discouraging use of small meshed gears and limiting fishing effort would therefore be important options to consider in ensuring sustainable harvesting of the stocks.

Conclusion

Despite some limitations to the data collected, analysis of catch and effort returns serves in the management of fisheries resources, and therefore should be continued to monitor the status of the stocks exploited by the small-scale fisheries sector. Considering the declining trends for some important species such as chambo stocks in the southeast arm of Lake Malawi, it is necessary to discourage fishers from illegal fishing practices. Efforts should therefore be intensified towards supporting the already existing management structures, notably the participatory management efforts.

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