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Annual Frame Survey September 2008

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EXECUTIVE SUMMARY

Frame survey results indicate that changes have occurred in all effort indicators but with significant changes being apparent in fishing gears between 2003 and 2008. The present fishing capacity is considered too great to ensure sustainability of the resources although the optimum number of fishing crafts and gears is not yet to be established due to paucity of information.

Fishers comprising of gear owners and fishing crew slightly decreased in total numbers between 2003 and 2008. Fishers have decreased from 57,854 in 2003 to 55,906 in 2009 representing a decrease of about 3.4%. The decrease was largely due to gear owners moving out of the fishery. The number of gear owners dropped from 15,542 in 2003 to 14,065 in 2008 suggesting that there were new entrants to the fishery. The influx out of the fishery by a number of gear owners is likely to be a result of diminishing profitability due to poor catches rates leading to less income. The fishing crew decreased slightly by 1.1% from 42,312 in 2003 to 41,841 in 2008 implying that the amount of labour input has remained relatively stable in the sector.

Conversely, the total number of fishing boats consisting of dugout and planked canoes, and plank boats with or without an engine slight increased during the same time. The fishing crafts increased from 15,316 in 2003 to 15,714 in 2008 representing an increase of about 2.7%. The increase was mainly due to plank boats with and without engines. Motorised plank boats increased by 65.1% from 493 in 2003 to 814 in 2008 and plank boats without engine by 12% from 2,999 in 2003 to 3,360 in 2008. In contrast, the canoes the main fishing craft accounting for about 74% of the total number of fishing crafts in 2008 dropped by 2.4% from 11,824 in 2003 to 11,540 in 2008. A notable increase in motorised boats over the period is indicative of increased investment levels in plank boats with engines.

Tremendous changes in numbers were apparent in fishing gears, which were categorised as open water seines (chilimira, matemba and nkacha), beach seines (chambo, kambuzi, mosquito and kandwindwi), gillnets (passive-mtayo, mbuka and ngongongo and active-chikwekwesa) and minor gears (traps, scoop nets, cast nets, longlines, handlines and others). Although considerable disparities exist in individual fishing gears trends, the overall numbers of fish gears show a decreasing trend from 138,769 in 2003 to 119,819 in 2008 representing a decline of about 13.7%. The decrease is due to decline in minor fishing gears.

Trends in numbers of open water seines, beach seines and gillnets indicate an increase of 12.9%, 59% and 9%, respectively between 2003 and 2008. The increase in open water seines is due to increase in chilimira nets and matemba seines. Chilimira nets increased by 13.4% from 3,079 in 2003 to 3,491 in 2008 and matemba seine by 47% from 276 in 2003 to 406 in 2008. The increase in chilimira nets is commensurate to the increase in number of motorised fishing boats. At the same time however, nkacha nets decreased by 23% from 309 in 2003 to 238 in 2008. The decrease in nkacha nets may partly explain the noted influx out of gear owners, which is a result of declining fisheries resources in particular Lake Malombe. Nkacha nets are permissible in Lake Malombe only. Beach seine nets showed an overall increase in numbers between 2003 and 2008. Kambuzi seines increased by 61.8% from 385 in 2003 to 619 in 2009, mosquito nets by 21% from 362 in 2003 to 438 in 2008, chambo seine by 198.6%

from 71 in 2003 to 212 in 2008, and kandwindwi by 133.3% from 42 in 2003 to 98 in 2008. These results suggest that beach seines seem to gain some prominence in the present years. A notable increase in fishing gear numbers was, however, observed in the numbers of gillnets.

Trends in numbers of different gillnet types could not be determined between 2003 and 2008 because prior to 2005 all different gillnet types were recorded as one type. However, gillnets have increased by 10.1% from 77,668 in 2003 to 84,647 in 2008. This increase may still be related to the availability of cheap nets in the local markets that serve the fishery an indication of increased use of gillnets. In contrast, changes in total number were significant in minor gears.

The minor gears decreased by 47.6% from 56,577 in 2003 to 29,670 in 2008. The decrease is largely attributed to fish traps and others. Fish traps decreased by 41.6% from 27,071 in 2003 to 15,814 in 2009, others by 76.2% from 24,387 in 2003 to 13,372 in 2008, cast net by 6.4% from 766 in 2003 to 717 in 2008 and scoop nets by 56.6% from 83 in 2003 to 36 in 2008. Increase in numbers, however, was noted in longlines and handlines. The number of longlines increased by 98.3% from 2,887 in 2003 to 5,726 in 2008 and handlines by 13% from 1,383 in 2003 to 1,563 in 2008.

1. INTRODUCTION

The annual frame survey, a complete census of Malawi's basic fishery characteristics is a routine activity of the Department of Fisheries for the purpose of planning and management. Normally, these surveys are conducted in the dry season (August to October) when most fish landing sites are accessible by land. During these surveys all landing sites within the main water bodies i.e. Lakes Malawi, Chilwa, Malombe and Chiuta, Upper and Lower Shire, are visited and fishermen, their gears and fishing crafts enumerated. The data collected from frame surveys together with monthly sample catch-effort data are used to estimate annual total landings and fishing effort for the various traditional fisheries. The aim of the current report is to provide information on the 2008 frame survey and update general trends of fishers, crafts and gears over the years.

2. METHODS

2.1 Data collection

The 2008 frame survey was carried out from 22nd to 30th September. Data collection followed the existing statistical stratification of main water bodies covering the fishing districts of Mangochi, Salima, Nkhatakota, Nkhata Bay, Likoma, Karonga, Zomba Chikwawa and Nsanje (Figures 1.1 to 1.7 and Annex 1) using the questionnaire forms shown in Appendix I and II. To eliminate the effect of fishers' migration, one or two officers were concurrently assigned to collect data in each stratum for a period of five days. A complete list of Depart of Fisheries staff responsible for data collection during the survey is shown in Annex 2. Fishing gears were defined by local names. Every fisherman who owns a fishing gear (formerly defined as "fisherman") was defined as a gear owner while gear operators (formerly defined as "fishing assistants") were defined as crewmembers.

2.2 Data analysis

The data were analysed by fishing district and water body. Gears were categorised according to the mode of operation. Beach seine nets included Kambuzi, Chambo, Mosquito, Wogo and Kandwindwi. Open water seines included Nkacha, Chilimira and Matemba. Gill nets were defined as passive (Mtayo) or active. One gill net unit is equivalent to 100 m in length. Active gillnets included Chikwekwesa (similar to ring netting), Chiwombera (actively chasing fish into the gill net by beating the water or canoe) and M'buka (drifting gill nets). Hook and line comprised long lining, hand lining and Chomanga. One hundred hooks is equivalent to 1 long line unit. Fish traps included those with or without a weir. Hand propelled nets included cast and scoop nets.

Trend lines were fitted using a moving average with a periodicity of three years. The moving average method is preferred to simple average because it smoothens out fluctuations in the data (Barrows and Burns, 1997). The model projects values in the forecast period based on the average value of the variable over a specific number of preceding periods. Each forecast value is based on the following formula:

$$F_{(t+1)} = \frac{1}{N} \sum_{j=1}^N A_{t-j+1}$$

where N is the number of prior periods to include in the moving average, A_j is the actual value at time j , F_j is the forecast value at time j .

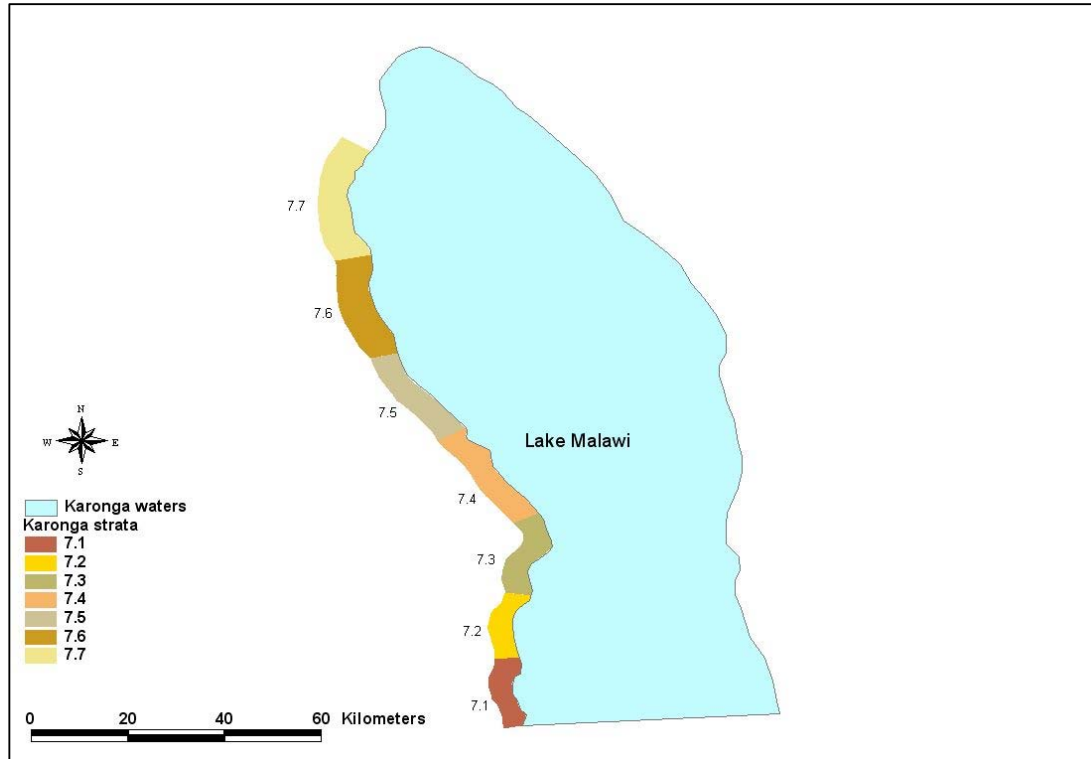


Figure 1.1: Map of northern Lake Malawi, showing minor stratum 7.1 of Rumphi district and minor strata 7.2 to 7.7 of Karonga district.

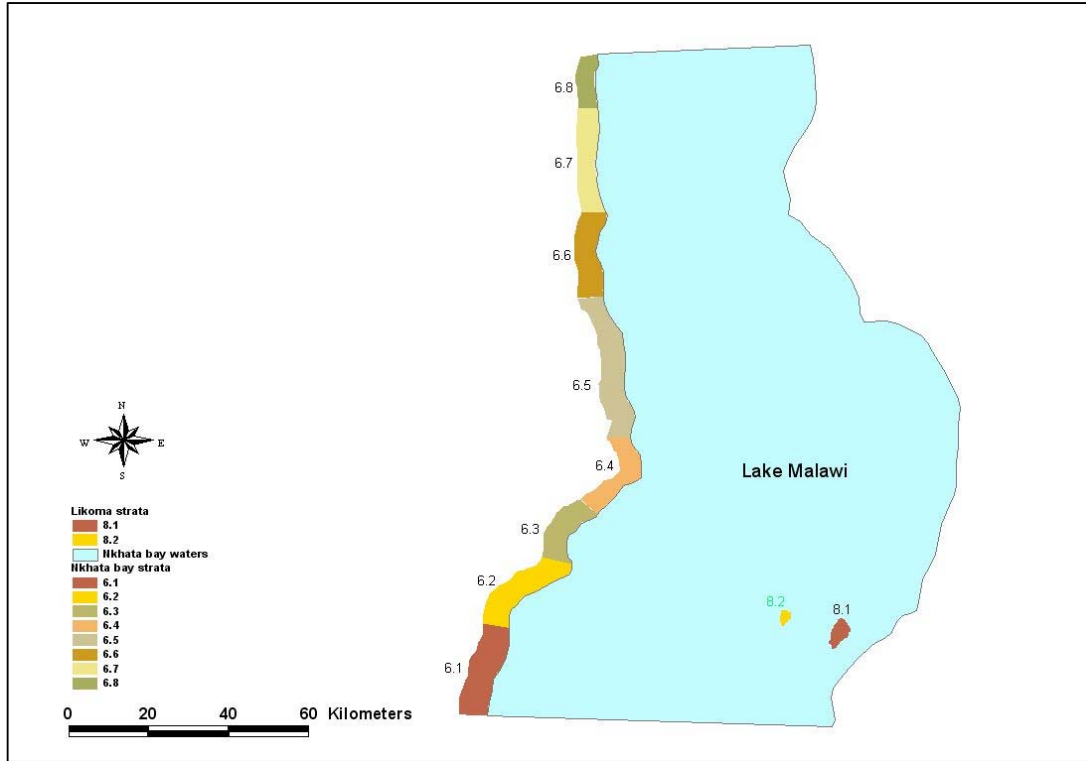


Figure 1.2: Map of northern Lake Malawi, showing minor stratum 6.1 to 6.7 of Nkhata Bay and minor stratum 6.8 of Rumphi district.

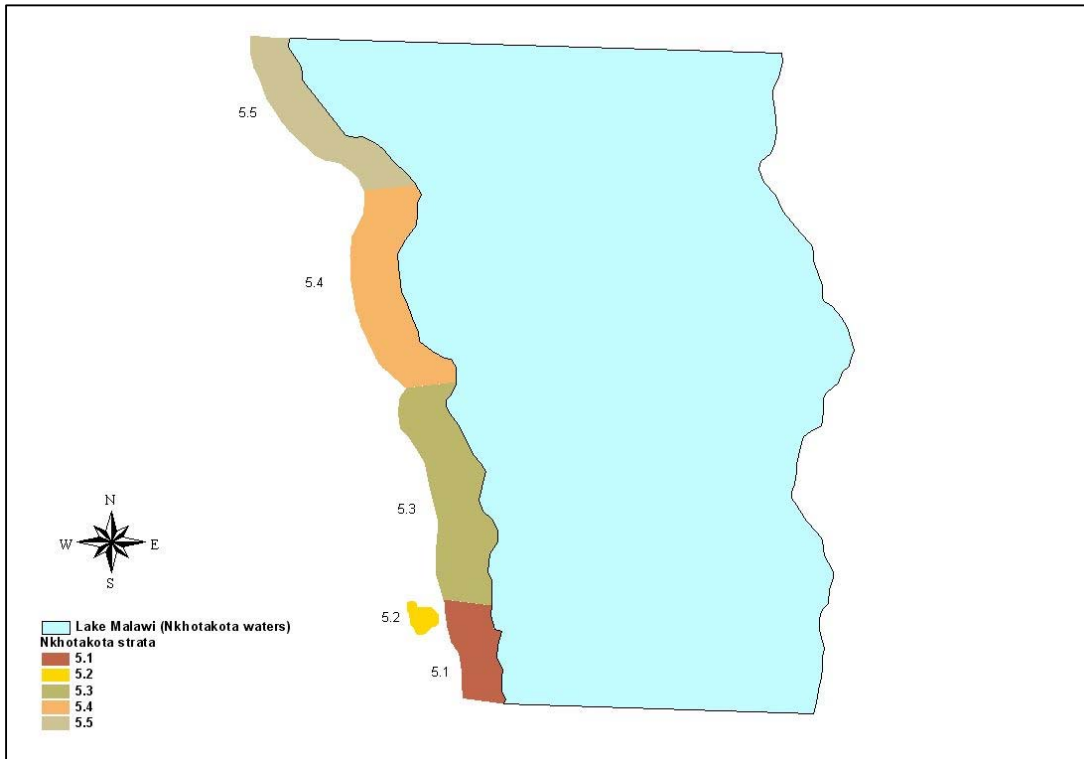


Figure 1.3: Map of central Lake Malawi showing minor strata 5.1 to 5.5 of Nkhotakota district.

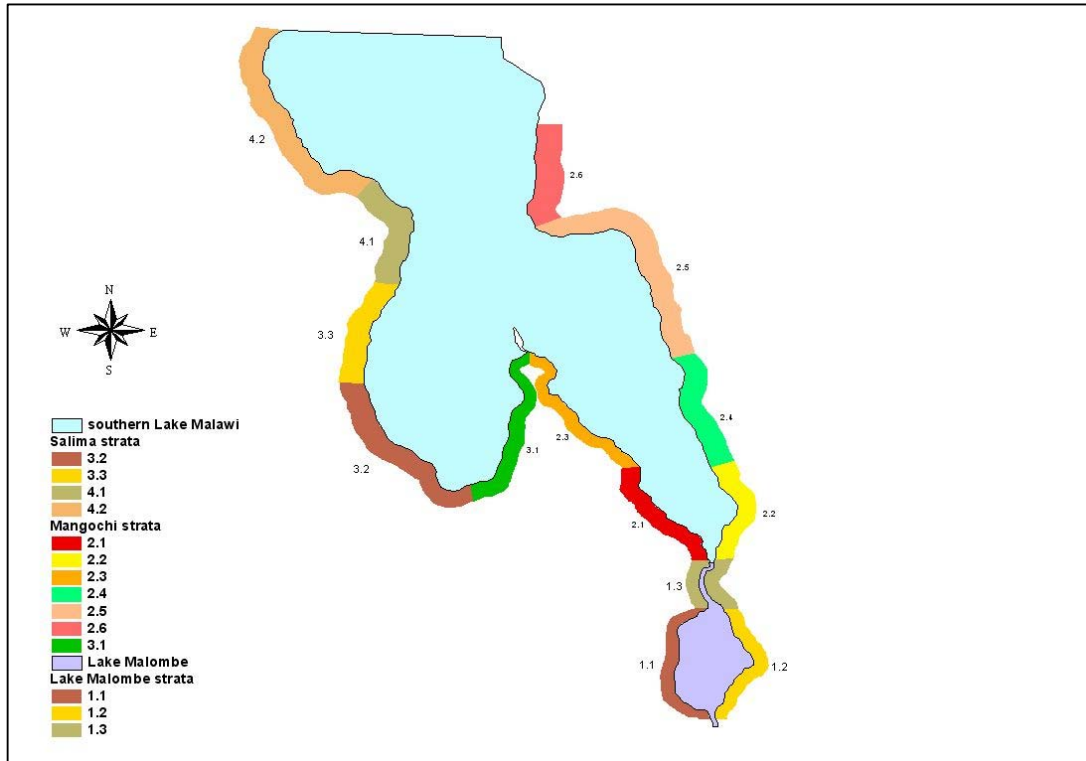


Figure 1.4: Map of Lake Malawi and Lake Malombe showing minor strata 1.1 to 4.2 of Mangochi and Salima districts.

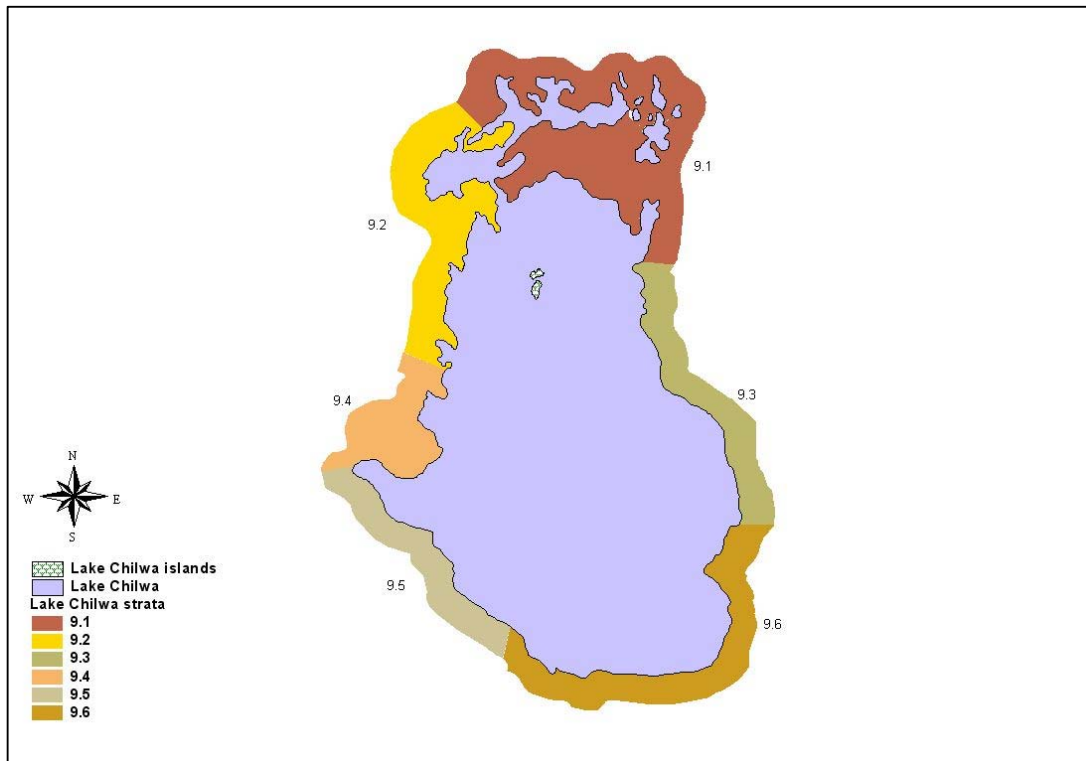


Figure 1.5: Map of Lake Chilwa showing minor strata 9.1 to 9.6. Mpoto lagoon (minor stratum 9.7) is not shown in this map.

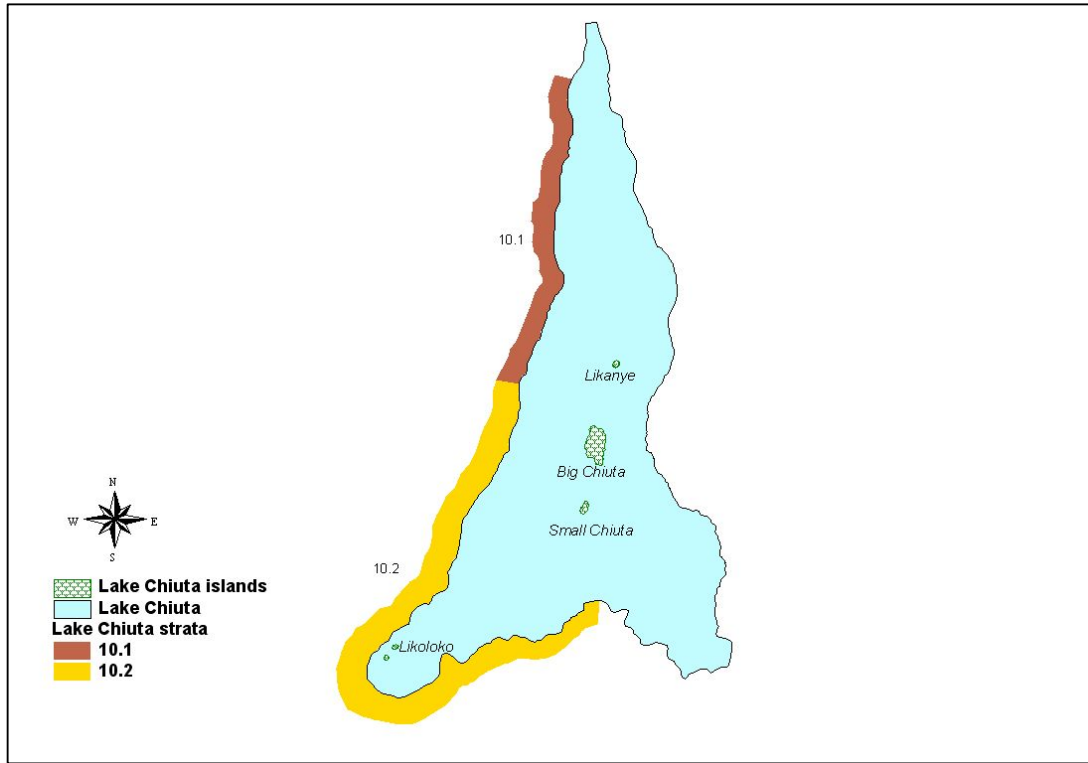


Figure 1.6: Map of Lake Chiuta showing minor strata 10.1 and 10.2.

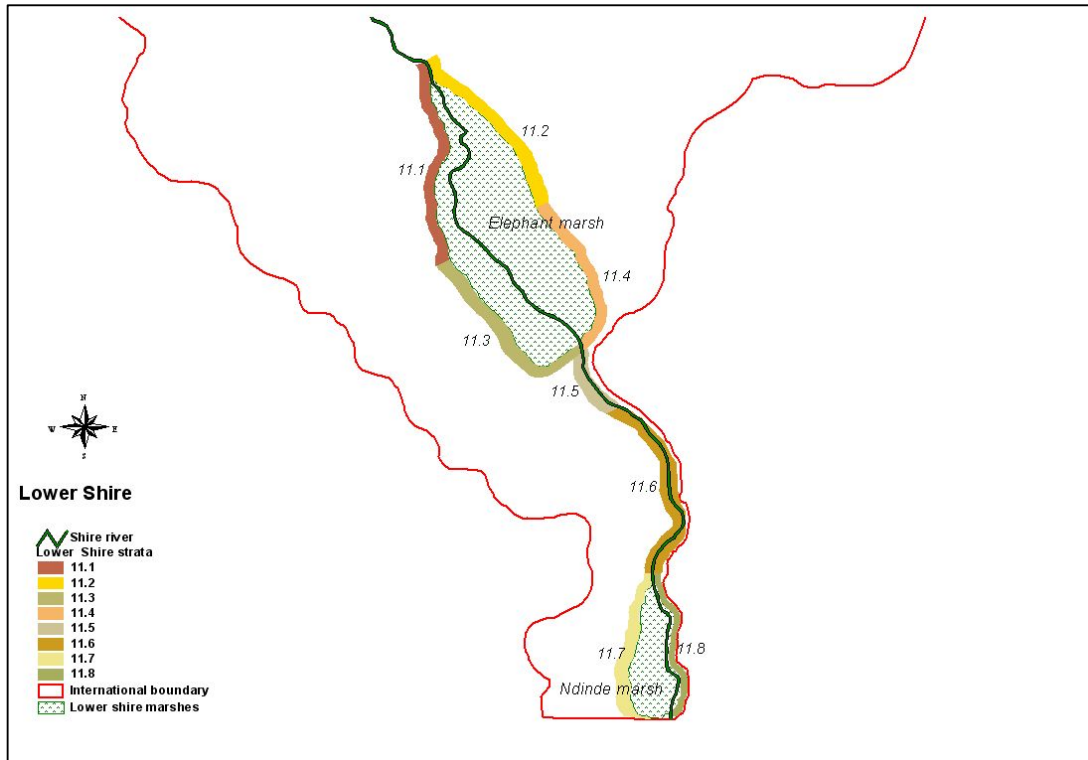


Figure 1.7: Map of Lower Shire River showing minor strata 11.1 to 11.8.

3. RESULTS

The 2008 census for fishing crafts, gear owners, crewmembers and fishing gears at both district and national levels are shown in Table 3.1.

Table 3.1: 2008 Frame Survey results of fishing crafts, gear owners, crewmembers and fishing gears by fishing district and water body.

Indicator	Fishing District/Water Body									Total (2008)	Total (2005)	
	Lake Malombe	Lake Malawi							Zomba			Lower Shire
		Mangochi	Salima	Nkhotakota	Nkhata Bay	Karonga	Likoma					
Gear owners	497	2148	1067	2244	1688	1520	549	1871	2481	14065	13303	
Crew members	3618	11719	4024	7483	4730	3371	2612	2980	1304	41841	41993	
Plank boats with engine	0	417	182	140	7	0	8	60	0	814	586	
Plank boats without engine	446	1060	321	737	214	5	10	556	11	3360	3502	
Dug out canoe	82	2303	835	1454	1840	1965	570	1066	1082	11197	11215	
Planked canoes	0	0	0	54	0	0	289	0	0	343	-	
Gill nets	616.5	10904	9770.2	15663.5	7316.38	9125.7	4296	10740	2173.08	70606	67552	
Chilimira nets	10	621	347	636	952	471	454	0	0	3491	2588	
Chambo seines/Wogo	14	196	1	0	0	1	0	0	0	212	112	
Longlines	168.6	1437.96	495	976.7	209.89	402.18	363.02	1114.8	558.23	5726	3902	
Kambuzi seines/Beach seine	5	23	41	238	87	59	0	0	31	484	438	
Mosquito nets/Usipa seine	74	133	8	93	0	23	0	37	70	438	588	
Fish traps	643	58	69	38	0	10	5	6669	8322	15814	20460	
Beach seine nets	0	0	1	35	63	5	0	0	31	135	3	
Scoop nets	0	0	0	6	0	0	0	0	30	36	14	
Nkacha nets	139	77	22	0	0	0	0	0	0	238	279	
Cast nets	10	0	4	5	0	0	0	0	698	717	535	
Handlines	2	585	56	287	164	230	138	18	83	1563	2414	
Kandwindwi	26	43	18	11	0	0	0	0	0	98	55	
Matemba seines nets	2	4	4	0	0	0	0	396	0	406	853	
Chikwekwesa	41	89	0	207	0	0	0	0	0	337	301	
Ngongongo	145	7586.5	1571	2404	0	1997.2	0	0	0	13704	20270	
Chomanga	0	0	0	0	0	0	0	5814	0	5814	13371	
Bilira	0	0	0	1	0	0	0	0	0	1	-	

3.1 Fishing crafts, gear owners and operators

Distribution and composition of fishing crafts by fishing district are shown in Figure 3.1 and Table 3.1 while countrywide trends in terms of numbers from 1993 to 2008 are shown in Figure 3.2.

As observed in Figure 3.2, the number of fishing crafts except for canoes shows a general increasing trend over the period from 1993 to 2008. Plank boats with engines increased by 39% from 586 crafts in 2005 to 814 in 2008 while planked boats without engines registered a small decrease of 4% despite the general increasing trend. Canoes including both dugouts and planked ones show a general decreasing trend over the

1993 – 2008 period. However, between 2005 and 2008 the canoes have stabilized around 11,200 crafts.

Over 15,371 fishing crafts in four categories (see Figure 3.1) were recorded during the 2008 frame survey. Dugout canoes (71%) and plank boats without engines (22%) were the most common fishing crafts followed by plank boats with engines and planked canoes with 5% and 2%, respectively.

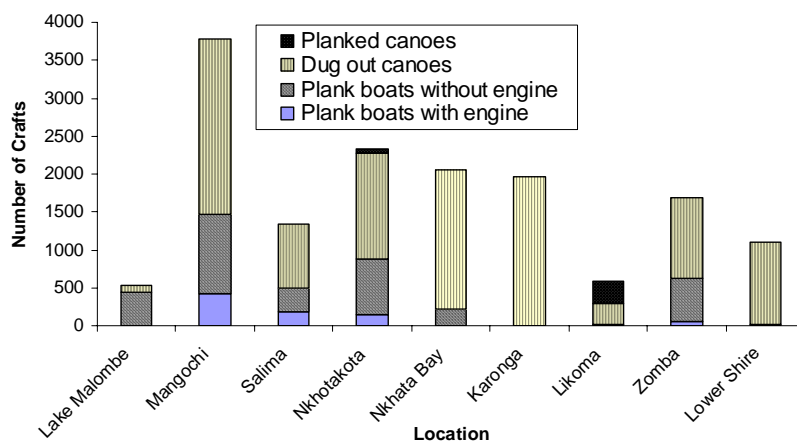
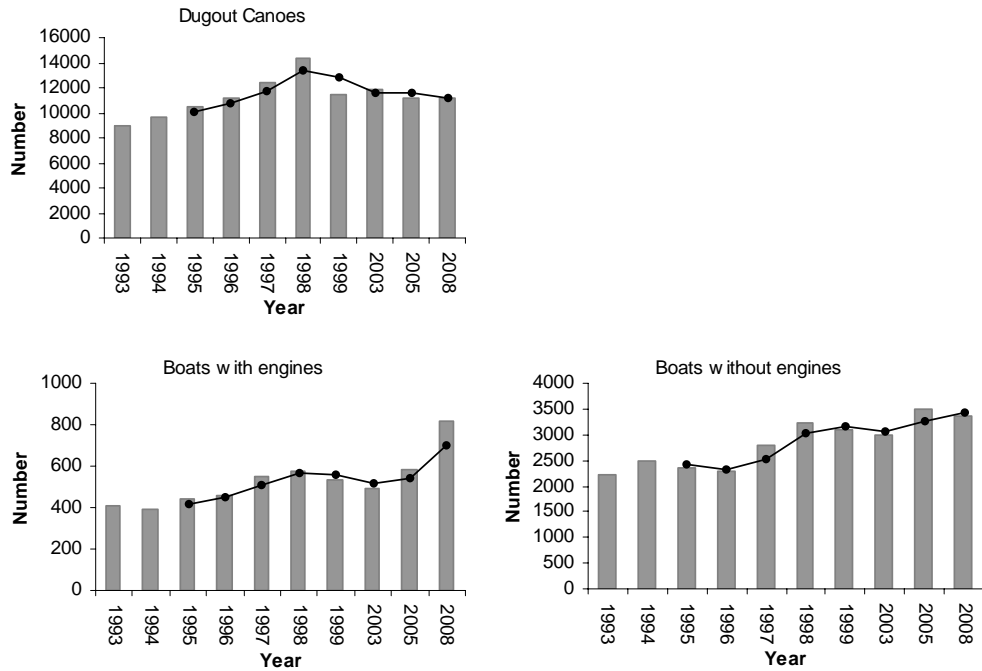


Figure 3.1: Composition and distribution of fishing crafts by fishing district and water body recorded during the 2008 annual frame survey.

Dugout canoes were fairly distributed in all fishing districts although 80% were recorded in the Lake Malawi districts of Mangochi (21%), Karonga (18%), Nkhata bay (16%), Nkhatakota (13%), Salima (7%) and Likoma (5%) while Zomba and Lower Shire accounted for 10% each, respectively. Less than 1% of the dugout canoes were registered in Lake Malombe (Figure 3.1 and Table 3.1). Planked canoes are seldom recorded separately from dugout canoes however in the 2008 annual frame survey attempts were made to distinguish planked canoes from dugouts. The available information indicates that of the 343 planked canoes recorded during the survey, all of them were from the Lake Malawi fishing districts of Likoma (84%) and Nkhatakota (16%).

Plankboats were recorded in all places except the Lower Shire. There were no plankboats in the Lower Shire River. Plankboats without engine were more abundant than with an engine. Plank boats without engine recorded were 3,360 of which Mangochi, Salima, Nkhatakota Nkhata bay Zomba (Lakes Chilwa and Chiuta) and Lake Malombe accounted for 32, 22%, 10%, 6%, 17% and 13%, respectively. In contrast, of the 814 plank boats with engines recorded during the survey, over 90% were registered in the Lake Malawi districts of Mangochi (51%), Salima (22%) and Nkhatakota (17%) while 7% were recorded in Zomba district (Figure 3.1).



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Figure 3.2: Number of plank boats with and without engines and canoes, recorded during countrywide frame surveys from 1993 to 2008. Bars indicate actual counts while solid lines indicate 3-year running averages.

There is a general increasing trend in number of fishers at country level for the period from 1993 to 2008 (Figure 3.3). The number of gear owners increased by 6% from 13,303 in 2005 to 14,065 in 2008 while that of crewmembers has stabilised around 42000 over the same period (Table 3.1 and Figure 3.3).

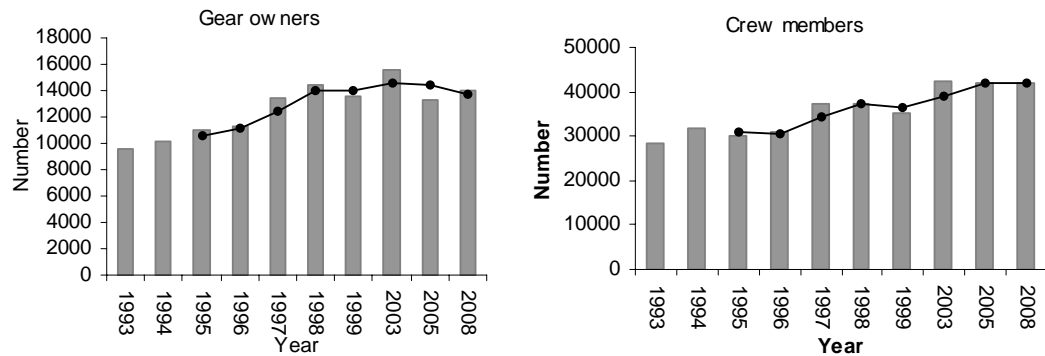


Figure 3.3: Number of gear owners and crewmembers recorded during countrywide frame surveys from 1993 to 2008. Bars indicate actual counts while solid lines indicate 3-year running averages

Of the 55,906 fishers recorded countrywide during the 2008 frame survey, the majority were crewmembers (75%) while the rest were gear owners (Table 3.1 and Figure 3.4). Over 75% of the fishers were recorded in the Lake Malawi districts of Mangochi (25%), Nkhotakota (17%), Nkhata bay (11%), Salima (9%), Karonga (9%)

and Likoma (6%) while Zomba, Lake Malombe and Lower Shire accounted for 9%, 7.4% and 6.8%, respectively.

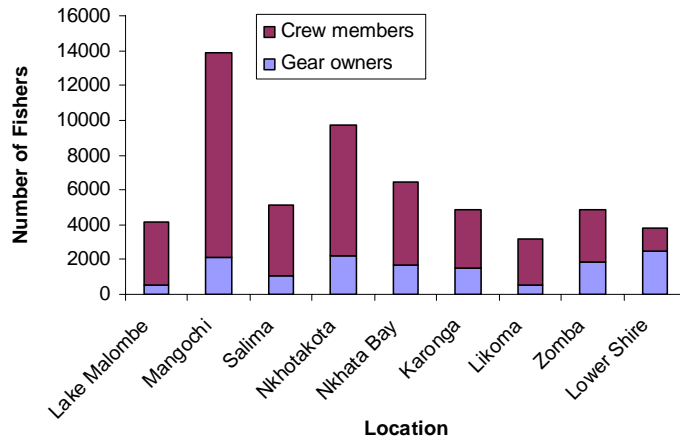


Figure 3.4: Composition and distribution of fishers by fishing district and water body recorded during the 2008 annual frame survey.

The ratio of crewmembers to gear owners shows considerable variation across the country range from 1 to 7 (Figure 3.5). Lake Malombe with 7 crewmembers per gear owner was the highest followed by Mangochi (5), Likoma (5) and Salima (4) while those falling below the country level average of 3 crewmembers per gear owner were Karonga (2), Zomba (2) and Lower Shire (1). The high ratio of crewmember to gear owner is perhaps indicative of most gear owners operating labour intensive fishing gears.

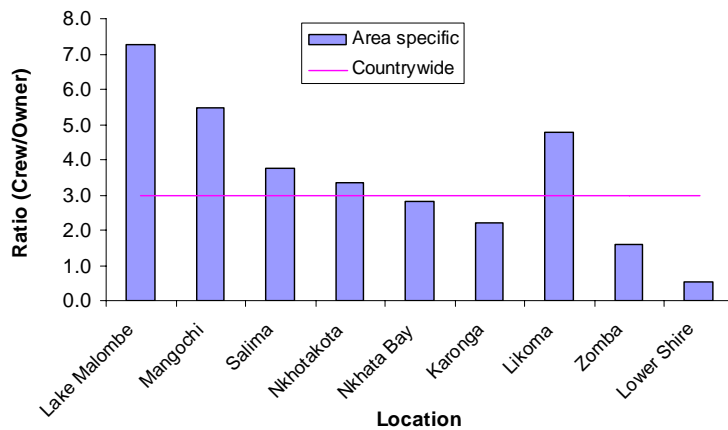


Figure 3.5: Ratio of crewmembers to gear owners by fishing district as recorded during the 2008 frame survey. The horizontal line indicates the country level value of 3 crew members per gear owner.

3.2 Fishing gears

Trends in Kambuzi, Kandwindwi, Mosquito and Chambo beach seine nets

Trends in numbers of Kambuzi, Kandwindwi, Mosquito and Chambo beach seine nets recorded during frame surveys conducted countrywide from 1993 to 2008 are shown in Figure 3.6.

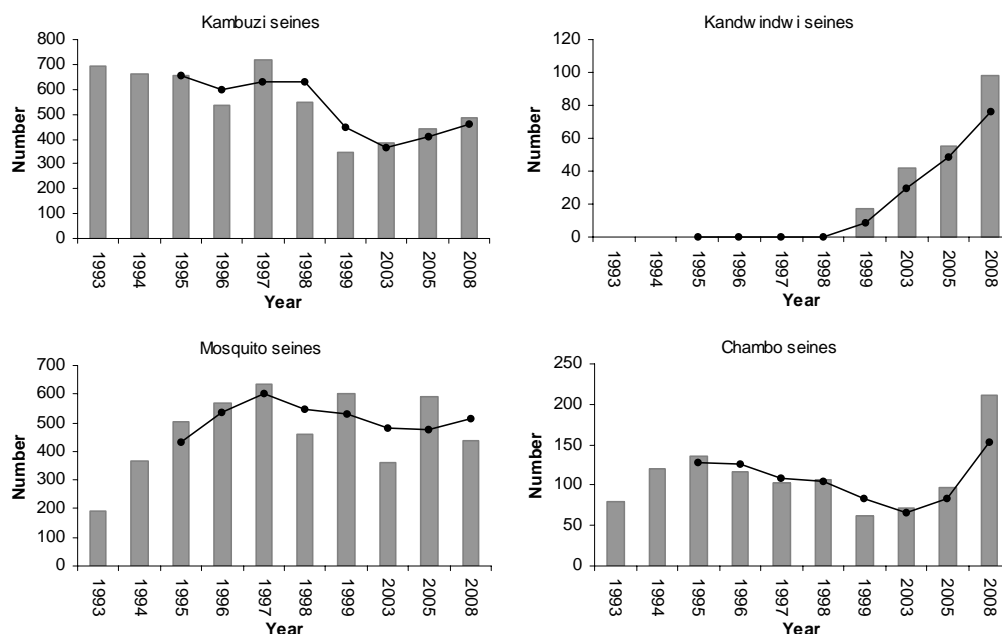


Figure 3.6: Numbers of Kambuzi, Kandwindwi, Mosquito and Chambo beach seine nets recorded during countrywide frame surveys from 1993 to 2008. Bars indicate actual counts while solid lines indicate 3-year running averages.

The number of beach seines has generally increased over the period between 2003 and 2008 (Figure 3.6). Chambo, Kandwindwi and Kambuzi beach seines have undergone the highest increases of 89%, 78% and 10%, respectively while mosquito seine nets have decreased by 26% despite the general increasing trend (Table 3.1 and Figure 3.6).

The number, distribution and composition of beach seine nets has varied according to water body or fishing district (Figure 3.7). Over 75% of the gears were recorded in the Lake Malawi fishing districts of Mangochi (32%), Nkhotakota (28%), Nkhata bay (7%), Karonga (6.7%) and Salima (5.5%) while Lake Malombe, Lower Shire and Zomba district accounted for 10%, 8% and 3%, respectively.

Of the 1,232 beach seine nets recorded in 2008, Kambuzi and Mosquito seine nets were the most abundant and accounted for 39% and 36%, respectively while Chambo and Kandwindwi seines made up only 17% and 8%, respectively.

Most of the 484 Kambuzi seines recorded during the survey were concentrated in Nkhotakota (49%), Nkhata bay (18%) and Karonga (12%) while a third of Mosquito seine nets (30%) were recorded in Mangochi, 21% in Nkhotakota, 17% in Lake Malombe and 16% in Lower Shire. Over 90% of Chambo seines were recorded in Mangochi while the rest were found in Lake Malombe. Majority of the 98

Kandwindwi seines recorded during the survey were found in the Lake Malawi districts of Mangochi (44%), Salima (18%) and Nkhotakota (11%) while the rest were recorded in Lake Malombe.

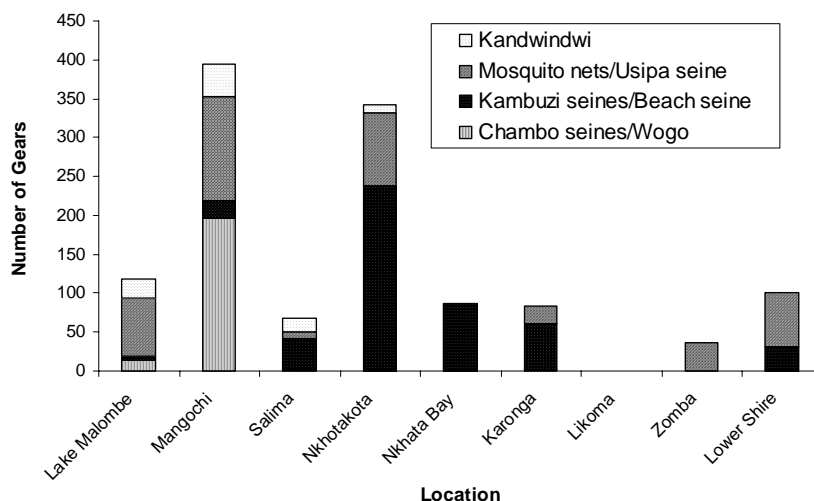


Figure 3.7: Composition and distribution of beach seine nets by fishing district or water body as recorded during the 2008 frame survey

Trends in Longlines, Handlines and Chomanga

Trends in numbers of hook and line fishing gears recorded during frame surveys conducted countrywide from 1993 to 2008 are shown in Figure 3.8. Only Longlines have shown general increasing trends over the period between 1998 and 2008 while Handlines and Chomanga have generally decreased over the same period. Upon comparison between the surveys conducted in 2005 and 2008, it has been observed that Longlines have increased by 47% while Chomanga and Handlines have decreased by 57% and 35%, respectively (Figure 3.8 and Table 3.1).

Of the three gears, Longlines and Chomanga were the most important and accounted for 44% each while Handlines made up only 12% of the total number of Hook and Line fishing gears recorded in 2008.

Distribution and importance of these gears has varied with water body (Figure 3.9). Over half of these gears were recorded in Zomba district (53%) while Lake Malawi districts and Lower Shire accounted for 41% and 5%, respectively. Lake Malombe with about 1% was the least important.

Over 68% of the Longlines were reported from Lake Malawi while Zomba, Lower Shire and Lake Malombe accounted for 19%, 10% and 3%, respectively. Majority of the Handlines (93%) were recorded from Lake Malawi districts while Lower Shire, Zomba and Lake Malombe registered 5%, 1% and 0.1%, respectively (Figure 3.9). All Chomanga were recorded from Zomba and exclusively from Lake Chilwa.

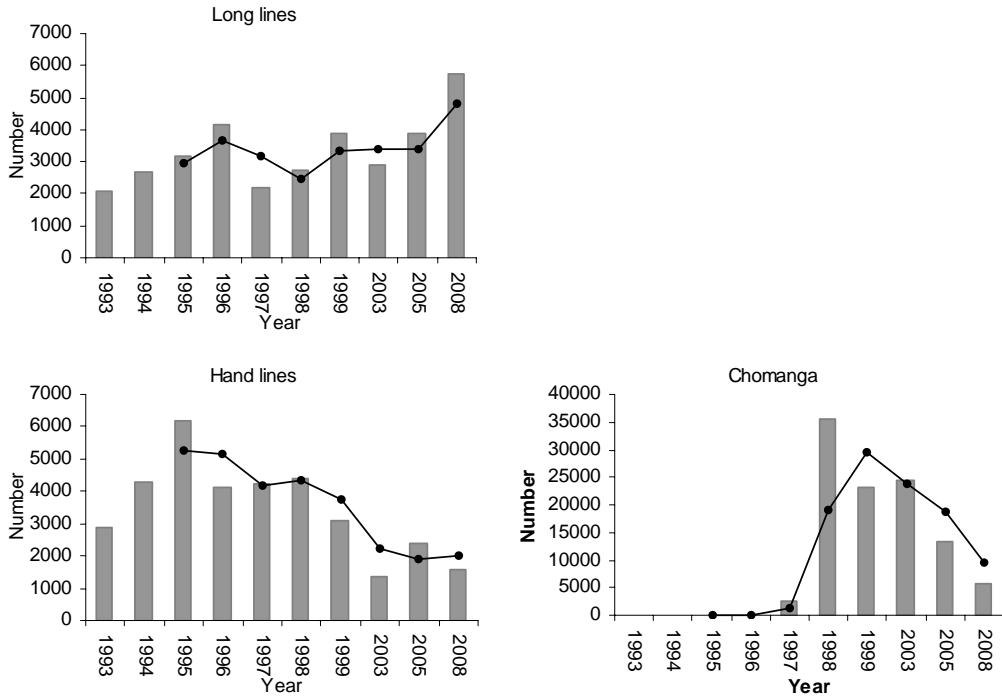


Figure 3.8: Number of Long lines, Hand lines and Chomanga recorded during countrywide frame surveys from 1993 to 2008. Bars indicate actual counts while solid lines indicate 3-year running averages.

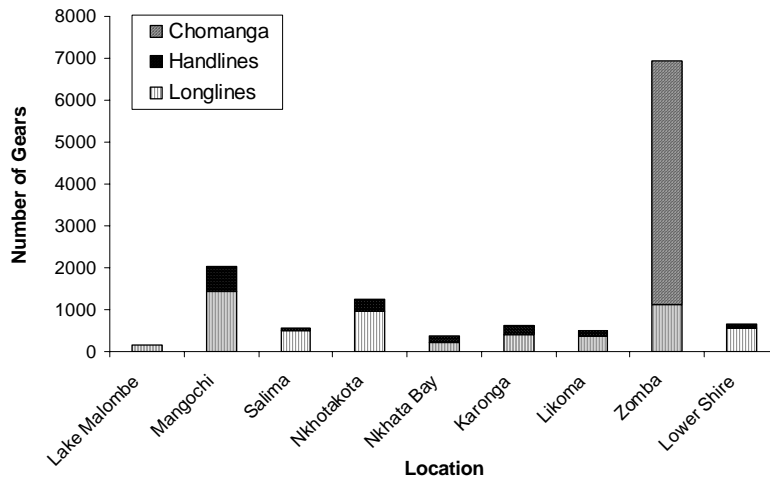


Figure 3.9: Composition and distribution of Hook and Line fishing gears by fishing district or water body as recorded during the 2008 frame survey.

Trends in Chilimira, Nkacha and Matemba open water seine nets

Trends in numbers of open water seine nets recorded during countrywide frame surveys conducted from 1993 to 2008 are shown in Figure 3.10. Only Chilimira and Matemba seine nets have shown general increasing trends between 2003 and 2008 while Nkacha seines have generally decreased over the same period (Figure 3.10). However, between 2005 and 2008 Chilimira seines increased by 35% while Matemba and Nkacha seines decreased by 52% and 15%, respectively (Figure 3.10 & Table 3.1).

Of the 4,135 open water seine nets recorded during the 2008 survey, Chilimira seines were the most abundant and accounted for 84% of all the seines recorded. Matemba and Nkacha seines accounted for 10% and 6%, respectively.

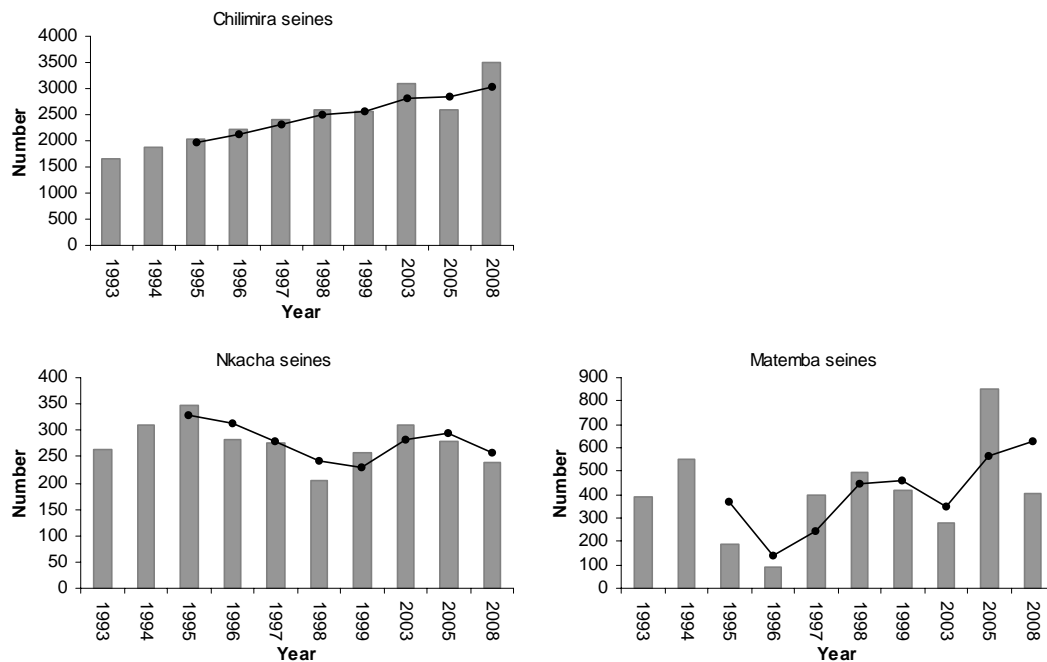


Figure 3.10: Number of Chilimira, Nkacha and Matemba open water seine nets recorded during countrywide frame surveys from 1993 to 2008. Bars indicate actual counts while solid lines indicate 3-year running averages.

Like other gears, distribution and composition of open seine nets also varied according to water body (Figure 3.11). Majority of the seines were recorded on Lake Malawi districts (86.7%) while Zomba and Lake Malombe only registered 9.6% and 3.7%, respectively. No open water seines were observed in Lower Shire (Figure 3.11).

Almost all Chilimira nets (99.7%) were recorded in Lake Malawi districts of Nkhata bay (27%), Mangochi and Nkhotakota with 18% each, Likoma and Karonga with 13% each and Salima (10%) while Lake Malombe accounted for about 0.3%. More than half (58%) of all Nkacha nets recorded were found in Lake Malombe while 42% were registered in Lake Malawi districts of Mangochi (32%) and Salima (10%). Matemba seines were mainly recorded from Zomba (97.5%) while 2% was recorded

in Lake Malawi districts of Mangochi (1%) and Salima (1%) with 0.5% from Lake Malombe (Figure 3.11).

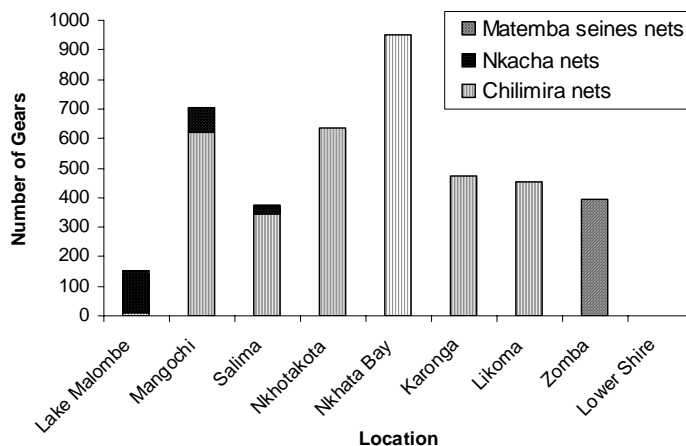


Figure 3.11: Composition and distribution of Open Water seine nets by fishing district or water body as recorded during the 2008 frame survey

Trends in Gill nets

The overall trend in the number of gill nets (including different derivatives i.e. passive and active forms) is shown in Figure 3.12. These gears have generally increased over the period between 1993 and 2008. However, between 2005 and 2008 gill nets in general increased by 5%. Of the 70,606 gill net units recorded in 2008, 80% had stretched mesh sizes greater than 20 mm (*Mtayo* & *Mbuka*), 19% were under-meshed *Mtayo* (less than 20mm stretched mesh size) while less than 1% were recorded as *Chikwekwesa* (Table 3.1).

Gill nets were recorded in all water bodies but most of them (81%) were found in Lake Malawi districts of Nkhotakota (22%), Mangochi (15%), Salima (14%), Karonga (13%), Nkhata bay (10%) and Likoma (6%) while Zomba, Lower Shire and Lake Malombe registered 15%, 3% and 1%, respectively (Figure 3.13).

Of the 337 *Chikwekwesa* units recorded in 2008, 88% were found in Lake Malawi districts of Nkhotakota (61%) and Mangochi (27%) while the rest were in Lake Malombe (Figure 3.13). Majority of *Ntaya* and *Mbuka* gill nets (76.4%) were recorded from Lake Malawi districts of Nkhotakota (23.1%), Salima (14.5%), Nkhata bay (12.9%), Karonga (12.6%), Likoma (7.6%) and Mangochi (5.7%) while Zomba, Lower Shire and Lake Malombe accounted for 19%, 3.8% and 0.8%, respectively.

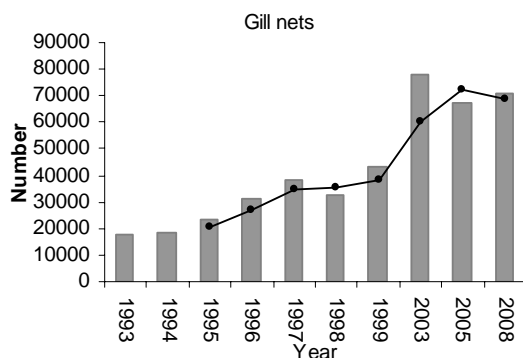


Figure 3.12: Number of gill nets recorded during countrywide frame surveys from 1993 to 2008. Bars indicate actual counts while solid lines indicate 3-year running averages.

Almost all of the 13,704 *Ngongongo* gill net sets (99%) were recorded from Lake Malawi districts of Mangochi (55%), Nkhotakota (18%), Karonga (15%) and Salima (11%) while about 1% were found in Lake Malombe (Figure 3.13).

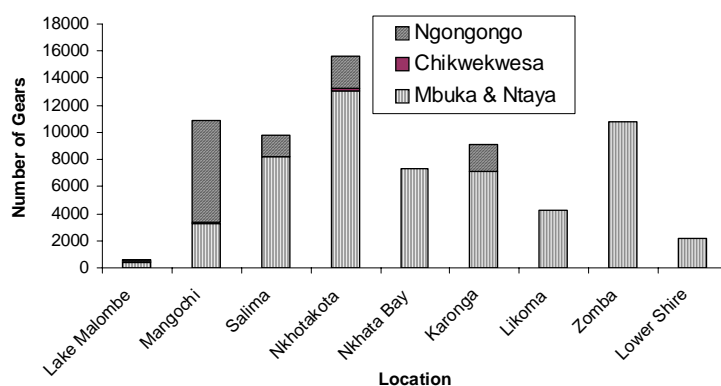


Figure 3.13: Composition and distribution of Gill nets by fishing district or water body as recorded during the 2008 frame survey.

Trends in Fish traps, Scoop nets and Cast nets

Trends in the number of Fish traps, Scoop nets and Cast nets are shown in Figure 3.14. Of the three gears only cast nets show a steady increasing trend from 1993 to 2008. The other two, Scoop nets and Fish traps have generally been declining since 1999. However, between 2005 and 2008, Cast nets increased by 34% while Scoop nets almost doubled (157%) from 14 units in 2005 to 36 in 2008. Fish traps on the other hand decreased by 23% (Figure 3.14 and Table 3.1).

Among the three, Fish traps were by far the most common gear and accounted for more than 95% of the total number of gears recorded countrywide. Cast nets with just 4.3% were second followed by Scoop nets, which were the least important (Figure .15).

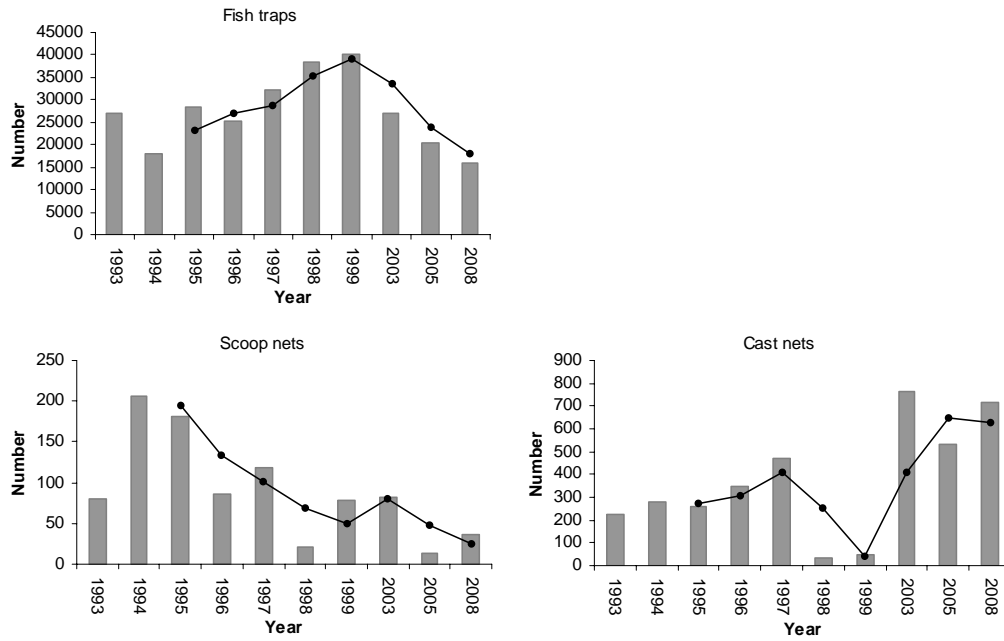


Figure 3.14: Number of fish traps, scoop nets and cast nets recorded during countrywide frame surveys from 1993 to 2008. Bars indicate actual counts while solid lines indicate 3-year running averages.

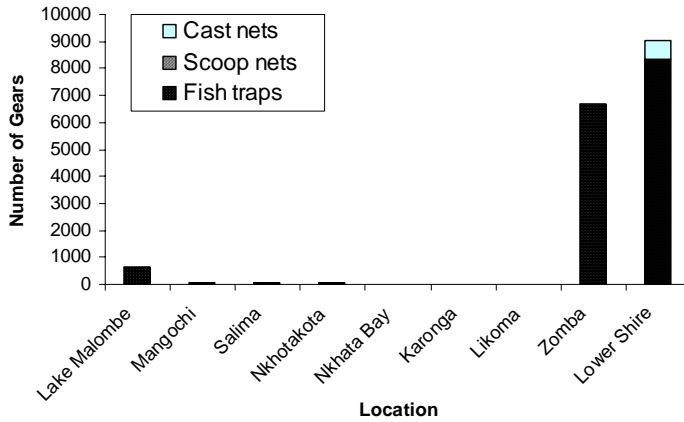


Figure 3.15: Composition and distribution of Fish traps, Scoop nets and Cast nets by fishing district or water body as recorded during the 2008 frame survey.

As observed in Figure 3.15, most of these fishing gears were recorded from Lower Shire (55%), Zomba (40%), Lake Malombe (4%) and less than 1% from Lake Malawi. Majority of the scoop nets (83%) were found in Lower Shire River while 17% were recorded from Nkhotakota. Almost all the cast nets were found in Lower Shire (97%) while the rest were registered in Lake Malombe, Salima and Nkhotakota with 1.4%, 0.6% and 0.7%, respectively. Fish traps were also concentrated in a few areas (Figure 3.15). Over half (53%) were located in Lower Shire while considerable

numbers were also recorded in Zomba (42%) and Lake Malombe with about 4%. Less than 1% of the Fish traps were encountered in Lake Malawi.

4. DISCUSSION AND CONCLUSION

Frame survey figures on all effort indicators expressed as number of fishers, fishing crafts and fishing gears indicate a general increase trend in fishing effort between 1993 and 2008. The present fishing capacity is considered too great to ensure sustainability of the resources although the optimum number of fishing crafts and gears is not yet to be established due to paucity of information. This overall picture however, masks recent effort changes in fishing effort over the past five years, which is of paramount importance for management decision making. The results indicate that changes have occurred in all effort indicators but with significant changes being apparent in fishing gears between 2003 and 2008.

Fishers comprising of gear owners and fishing crew slightly decreased in total numbers between 2003 and 2008. Fishers have decreased from 57,854 in 2003 to 55,906 in 2009 representing a decrease of about 3.4%. The decrease was largely due to gear owners moving out of the fishery. The number of gear owners dropped from 15,542 in 2003 to 14,065 in 2008 suggesting that there were new entrants to the fishery. The influx out of the fishery by a number of gear owners is likely to be a result of diminishing profitability due to poor catches rates leading to less income. Fish production from the water bodies of the country has declined sharply from around 70,000 tonnes in the early 1990s and appears to have stabilized at around 60,000 tonnes. This decline is believed to be primarily due to over fishing in Lakes Malombe, Chiuta and Chilwa, the Upper and Lower Shire River and the shallow waters of Lake Malawi. Environmental degradation has compounded the situation. Comparatively, the fishing crew decreased slightly by 1.1% from 42,312 in 2003 to 41,841 in 2008. This suggests that the amount of labour input has remained relatively stable in the sector.

Conversely, the total number of fishing boats consisting of dugout and planked canoes, and plank boats with or without an engine slight increased during the same time. The fishing crafts increased from 15,316 in 2003 to 15,714 in 2008 representing an increase of about 2.7%. The increase was mainly due to plank boats with and without engines. Motorised plank boats increased by 65.1% from 493 in 2003 to 814 in 2008 and plank boats without engine by 12% from 2,999 in 2003 to 3,360 in 2008. In contrast, the canoes the main fishing craft accounting for about 74% of the total number of fishing crafts in 2008 dropped by 2.4% from 11,824 in 2003 to 11,540 in 2008. A notable increase in motorised boats over the period suggests that investment levels in plank boats with engines have increased. This is not surprising as a number of small-scale fishers have expanded their fishing zone to deep offshore waters (> 50m) to seek better returns because of the low fish catch rates experienced in inshore waters (Banda *et al.* 1996; Seymour 2005). Motorised boats have undoubtedly improved mobility, which in turn has increased the fishing range of the fishers.

Tremendous changes in numbers were apparent in fishing gears, which were categorised as open water seines (chilimira, matemba and nkacha), beach seines

(chambo, kambuzi, mosquito and kandwindwi), gillnets (passive-ntaya, mbuka and ngongongo and active-chikwekwe) and minor gears (traps, scoop nets, cats nets, longlines, handlines and others) for the analysis. Although considerable disparities exist in individual fishing gears trends, the overall numbers of fish gears show a decreasing trend from 138,769 in 2003 to 119,819 in 2008 representing a decline of about 13.7%. The decrease is due to decline in minor fishing gears. Trends in numbers of open water seines, beach seines and gillnets indicate an increase of 12.9%, 59% and 9%, respectively between 2003 and 2008. The increase in open water seines is due to increase in chilimira nets and matemba seines. Chilimira nets increased by 13.4% from 3,079 in 2003 to 3,491 in 2008 and matemba seine by 47% from 276 in 2003 to 406 in 2008. The increase in chilimira nets is commensurate to the increase in number of motorised fishing boats. At the same time however, nkacha nets decreased by 23% from 309 in 2003 to 238 in 2008. The decrease in nkacha nets may partly explain the noted influx out of gear owners, which is a result of declining fisheries resources in particular Lake Malombe. Nkacha nets are permissible in Lake Malombe only.

The survey results show an overall increase in all beach seine nets between 2003 and 2008. Kambuzi seines increased by 61.8% from 385 in 2003 to 619 in 2009, mosquito nets by 21% from 362 in 2003 to 438 in 2008, chambo seine by 198.6% from 71 in 2003 to 212 in 2008, and kandwindwi by 133.3% from 42 in 2003 to 98 in 2008. These results suggest that beach seines seem to gain some prominence in the present years. A notable increase in fishing gear numbers was, however, observed in the numbers of gillnets. Trends in numbers of different gillnet types could not be determined between 2003 and 2008 because prior to 2005 all different gillnet types were recorded as one type. However, gillnets have increased by 10.1% from 77,668 in 2003 to 84,647 in 2008. This increase may still be related to the availability of cheap nets in the local markets that serve the fishery an indication of increased use of gillnets.

In contrast, changes in total number were significant in minor gears. The minor gears decreased by 47.6% from 56,577 in 2003 to 29,670 in 2008. The decrease is largely attributed to fish traps and others. Fish traps decreased by 41.6% from 27,071 in 2003 to 15,814 in 2009, others by 76.2% from 24,387 in 2003 to 13,372 in 2008, cast net by 6.4% from 766 in 2003 to 717 in 2008 and scoop nets by 56.6% from 83 in 2003 to 36 in 2008. Increase in numbers, however, was noted in longlines and handlines. The number of longlines increased by 98.3% from 2,887 in 2003 to 5,726 in 2008 and handlines by 13% from 1,383 in 2003 to 1,563 in 2008. However, the minor gear trend should be considered as indicative in this case due to the difficulties associated with recording of such gear types. Many minor gears are usually kept indoors and recording is usually based on the inquiry.

The fishing effort results show is an unevenly distribution of fishers, fishing boats and fishing gears. Most fishermen, fishing boats and fishing gears were found in the productive southern part of Lake Malawi particularly in Mangochi followed by Nkhotakota and Nkhata Bay making Mangochi and Nkhota kota as the most important fishing districts at present. On the other hand, the distribution patterns of fishing gears reflect physiographical area as well as target species as a result it varied with water body. All beach seines except mosquito nets have restricted distribution pattern. Mosquito nets are generally widely used in all water bodies targeting juvenile

fish. Chambo nets, kandwindwi and kambuzi are generally widely used in Lake Malawi although kambuzi has recently been introduced to Lower Shire. Chambo nets target Chambo while both kandwindwi and kambuzi small demersal fish species. Matemba seines are confined to Lakes Chilwa and Chiuta targeting small cyprinids (*Barbus paludinosus*) but their importance in Lake Chiuta has declined. Lakes Chilwa, Chiuta and Upper and Lower Shire River have weedy shores making the operation of beach seines difficult. Chilimira is exclusively used in the open waters of Lake Malawi targeting pelagic fish species. Nkacha is mostly found in Lakes Malombe and Malawi but has recently also been recorded in Lake Chilwa. The gear is generally decreasing in Lake Malombe while its importance is increasing in Lakes Malawi and Chilwa. Similarly, Cast nets, Scoop nets and Chomanga are localised. Cast nets are found in Lower Shire and Lake Malawi especially Mangochi, Salima and Nkhotakota. Chomanga is confined to Lakes Chilwa and Chiuta while Scoop nets are only found in Lower Shire and Chia lagoon. Gill nets, Handlines, Fish traps and Longlines are widely distributed in all water bodies mainly because they can be used in different habitats.

In conclusion, the fisheries have not expanded in terms of fishers, fishing crafts and fishing gears in the past five years implying that there has been no overall growth in the sector. Direct employment has remained relatively stable and observed changes in number of fishers is perhaps a reflection of inter-frame survey variation. The inter-frame survey variation is due to migration behaviour of fishers. For instance, the crew recorded in the 2008 frame survey were 1.1% less than those in 2005. Equally, no significant increase in total numbers of fishing craft and gears has occurred overtime. However, changes in numbers of fishing craft and gear types are ascribed to investment levels. Investment levels have increased commercial oriented fishing equipment such as plank boats both motorised and unmotorised and all commercial fishing gears such as beach seines, chilimira, gillnets, longline and handlines except nkacha are currently on the increase. The decrease in nkacha numbers is attributed to the fact that this fishing gear is illegal in all waters except Lake Malombe. This means that commercial fishing equipment is becoming relatively more popular than subsistence ones. The gradual shift of gear popularity is perhaps also a response to changes decreased catch rates of the target species in the subsistence fishing gears. The increase levels of investment have, however, not been accompanied by substantial changes in technology.

Finally, it is worthy noting that the pending investment in the Lake Malawi offshore fisheries resources through loan provision by the government to small-scale fishers should proceed with great precaution otherwise it will put undue pressure on already over-fished resources. Although a number of fishing crafts venture into the offshore resources presently, their continued operations in the offshore fishing grounds is constrained by fuel prices. The present fuel prices are very high forcing such operations to concentrate in inshore waters. A combination of pelagic and shallow demersal species is a common sight in chilimira catches. Enforcement through co-management arrangement may be a solution to this prevailing problem.

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Annex 1:

New and old codes, descriptions, administrative district and controlling District Fisheries Office for all minor strata assessed during annual frame surveys in Malawi.

Code	Stratum description	District	Controlling District Fisheries Office					
Lake Malombe (Figure 1.4)					7.6	Karonga Boma	Karonga	Karonga
1.1	Lake Malombe West	Mangochi	Mangochi		7.7	Kaporo	Karonga	Karonga
1.2	Lake Malombe East	Mangochi	Mangochi		8.1	Likoma Island	Nkhata Bay	Nkhata Bay
Upper Shire River (Figure 1.4)					8.2	Chizumula Island	Nkhata Bay	Nkhata Bay
1.3	Upper Shire River	Mangochi	Mangochi	Lower Shire (Fig 1.7)				
Lake Malawi (Figures 1.1-1.4)					11.1	N.W Elephant Marsh	Chikwawa	Chikwawa
2.1	S W Boadzulu Island	Mangochi	Mangochi		11.2	N.E. Elephant Marsh	Chikwawa	Chikwawa
2.2	S E Boadzulu Island	Mangochi	Mangochi		11.3	S.W Elephant Marsh	Chikwawa	Chikwawa
2.3	N W Boadzulu Island	Mangochi	Mangochi		11.4	S.E. Elephant Marsh	Chikwawa	Chikwawa
2.4	N E Boadzulu Island	Mangochi	Mangochi		11.5	Bangula Lagoon	Nsanje	Nsanje
2.5	Makanjira	Mangochi	Mangochi		11.6	River Shire - Nsanje	Nsanje	Nsanje
2.6	Fort Maguire	Mangochi	Mangochi		11.7	West Ndinde Marsh	Nsanje	Nsanje
3.1	Malembo	Mangochi	Mangochi		11.8	East Ndinde Marsh	Nsanje	Nsanje
3.2	Mtakataka	Dedza	Dedza	Lower Shire (Fig 1.7)				
3.3	Chipoka	Salima	Salima		11.1	N.W Elephant Marsh	Chikwawa	Chikwawa
4.1	Senga Bay	Salima	Salima		11.2	N.E. Elephant Marsh	Chikwawa	Chikwawa
4.2	Domira Bay	Salima	Salima		11.3	S.W Elephant Marsh	Chikwawa	Chikwawa
5.1	Nkhotakota South	Nkhotakota	Nkhotakota		11.4	S.E. Elephant Marsh	Chikwawa	Chikwawa
5.2	Chia Lagoon	Nkhotakota	Nkhotakota		11.5	Bangula Lagoon	Nsanje	Nsanje
5.3	Nkhotakota Central	Nkhotakota	Nkhotakota		11.6	River Shire - Nsanje	Nsanje	Nsanje
5.4	Nkhotakota Central North	Nkhotakota	Nkhotakota		11.7	West Ndinde Marsh	Nsanje	Nsanje
5.5	Nkhotakota North	Nkhotakota	Nkhotakota		11.8	East Ndinde Marsh	Nsanje	Nsanje
6.1	Tukombe	Nkhata Bay	Nkhata Bay					
6.2	Kande	Nkhata Bay	Nkhata Bay					
6.3	Chintheche	Nkhata Bay	Nkhata Bay					
6.4	Sanga	Nkhata Bay	Nkhata Bay					
6.5	Thotho	Nkhata Bay	Nkhata Bay					
6.6	Usisya	Nkhata Bay	Nkhata Bay					
6.7	Tcharo	Nkhata Bay	Nkhata Bay					
6.8	Mlowe	Nkhata Bay	Nkhata Bay					
7.1	Chiweta	Karonga	Karonga					
7.2	Chitimba	Karonga	Karonga					
7.3	Chilumba	Karonga	Karonga					
7.4	Nyungwe	Karonga	Karonga					
7.5	Mlare	Karonga	Karonga					

Annex 2:

List of Department of Fisheries staff involved in the 2008 frame survey

Minor stratum	Name of Recorder	Position	Minor Stratum	Name of Recorder	Position
MANGOCHI					
1.1	H Chitenjere	TA	6.6	B Basare	Boatman
1.1	J.J Nyirongo	STA	6.7	B Munthali	STA
1.2	A Symon	STA	6.7	A Mgemezulu	FS
1.3	P L Airon	FS	6.8	W Chamba	FS
1.4	T Nkumbira	FS	6.8	P Kamanga	STA
2.1	V Kaugale	FS	All	M Manase	PO
2.1	E Ngulande	TA	All	A Nkhoma	TA
2.2	K FJ Chikhungu	TA	All	A Matonyola	TA
2.2	P L Banda	TO	All	T Mhango	TO
2.3	D A Malekwa	FS	KARONGA		
2.3	R Muyereka	TA	7.1	B A Phiri	STA
2.4	S. Mususa	FS	7.2	S H Manase	FS
2.4	A J Masiye	FS	7.2	C Gondwe	TA
2.5(S)	S Phiri	FS	7.3	J Mulenga	TA
2.5(S)	R Namathanga	FS	7.3	A R Nyasulu	FS
2.5(N)	F Kokha	TA	7.4	L J Chirwa	FS
2.5(N)	A Atwabi	FS	7.4	M T Chizumira	STA
2.6	W Smith	FS	7.5	N W Mwalirino	FS
2.6	L K Chikaiko	TA	7.6	L T Sifukwe	FS
3.1	P Chimdenga	STA	7.6	H Gondwe	FS
3.1	E D Mataka	TA	7.7	C Kambewe	TA
All	DR M C Banda	P4	7.7	M Ching`ani	TA
All	A Pulaizi	P7	All	M Bezai	TO
All	M Mpeketula	PO	All	H Sungani	PO
All	G Sodzapanja	STA	All	G Kanyerere	P7
All	D Kaonga	TA	LIKOMA		
All	A Kabaghe	TO	8.1	R Banda	TA
All	D Kachilonda	PO	8.1	A Thindwa	FS
SALIMA			8.2	P Msukwa	TA
3.2	A Ndovie	STA	8.2	E Mhone	
3.2	J Nyungwa	BR	All		
3.2	S Zimpita	FS	MACHINGA		
3.3	L Muza	FS	9.1	C H Mnunkha	TA
3.3	M F Ngwira	STA	9.2	C Chimbiri	TA
3.3	J Chulu	TA	9.2	H Kalino	FS
4.1	G Mulaleya	STA	10.1	R M Gondwe	TA
4.1	D Chale	TA	10.1	D Maponje	FS
4.1	PMkaundu	FS	10.2		
4.2	F M K Kanyenda	TA	All	B Chilora	PO
4.2	C Chisesa	TA	ZOMBA		
4.2	A J K Mwale	FS	9.3	J Manjawira	TA
All	J Chamveka		9.3	I Gondwe	TA
All	A Mchikoma	TA	9.3	Chaima	Boatman
NKHOTAKOTA			9.4	N Masi	TA
5.1	E Simwaka	TA	9.4	Luwesa	Boatman
5.2	P S J Kapachika	TA	9.5	A Minyonga	STA
5.2	E M Bejamin	TA	9.5	Kawawa	Boatman
5.3	D W A Magaleta	TA	9.5	G Moyo	TA
5.4	S Chipala	TA	All	M Ngochera	P7
5.4	J K Mphasi	STA	PHALOMBE		
5.5	Y D Banda	TA	9.6	E Kumwaza	FS
5.5	P Madzikusamba	TA	9.7	B Kameko	TA
5.5	S S Chirwa	TA	All	O C K Mponda	TA
All	A Chithagala	TO	All	I K Lipato	TO
All	Makwinja	PO	NGABU		
NKHATABAY			11.1	C Kagwira	TA
6.1	A Makanjira	TA	11.2	Likongwe	TA
6.1	B G Banda	TA	11.3	C Mandala	TA
6.2	W Kondowe	STA	11.4	F Kimu	TA
6.2	P Chimphere	FS	11.4	Mang`anda	TA
6.3	S C Banda	STA	11.5	J Jingini	FS
6.3	A Kalamizu	FS	11.6	C Beka	FS
6.4	T Msiska	STA	11.6	J Kantombera	TA
6.4	I Ng`oma	FS	11.7	Ibrahim	TA
6.5	A Kadam`manja	TA	11.7	Nandilimbe	FS
6.5	W Kandawire	FS	11.8	H Goveya	TA
6.5	T Chiuma	Boatman	All	T E N Nyasulu	PO

6.6	S Gondwe	TA	All	M Kagwira	TO
6.6	D Kumwenda	STA	All	A Chimera	TA