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REVIEW OF CATCH TRENDS AND CHANGES IN FISH SPECIES COMPOSITION OF THE VOLTA LAKE DURING ITS 45 YEARS OF EXISTENCE

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Abstract

Existing catch data for the whole of the Volta lake from 1969 to 2004 and those for certain segments of the lake (Strata II, III, and IV) covering various periods were analysed in relation to lake levels, to find out changes in catch trends and species composition. The study was undertaken as a baseline activity aimed at enhancing fisheries productivity and management of the lake. Higher catches were made at the inception of the lake, with about 65,000 t being recorded in 1969. This dropped and fluctuated between 36,000 and 48,000 t from 1971 to 1994. Catches kept increasing rapidly from 1995 with about 80,000 t being recorded in 1999, the highest in the history of the lake. In relation to annual lake water level fluctuations, high catches were made during periods of low water level compared to periods of high water level. On the long term, decreasing lake water level corresponded with higher fish catches. There was a change from insectivorous fish species (e.g., *Chrysichthys*, *Schilbe* and *Synodontis*) at the initial stages of the formation of the lake to those with vegetarian food habits dominated by the tilapias. The dominance of tilapias in catches, which persisted till the early parts of the 1990s, has given way to *Chrysichthys* spp., suggesting that the composition of fish species in the lake is still undergoing changes 45 years after its formation.

Introduction

The Volta lake, which has a surface area of about 8,480 km^2, is one of the largest man-made lakes in the world. It was formed in 1964 by damming the Volta river in Ghana. The lake was created primarily to generate hydro-electric power but its fisheries have gained significant socio-economic importance in Ghana.

Damming of rivers is accompanied by ecological changes that influence fish populations and communities in many ways. One of the effects of changes in the environment is changes in species composition until a semblance of stable equilibrium is attained. The changes in species composition are because certain species do not spawn in lacustrine conditions while others, which have definite spawning grounds, e.g. the schilbeids, may no longer be able to reach such grounds as a result of barriers to their migratory routes. Also, it has often been observed that changes in environmental conditions, e.g. decrease in dissolved oxygen levels, may be so unsuitable to the extent that certain species may be eliminated after some years (Adesanya, 1969). While changes in environmental conditions in the impounded area can eliminate certain species, the same changes could also boost the populations of other species and, subsequently, influence catch trends and the fish community structure.

Elder (1965) reported that changes in the conditions of low-lying marginal areas, which often result from the impoundment of rivers, cause variations in the populations of fish inhabiting such waters. For example, increased rainfall and subsequent marginal flooding could alter populations of tilapias, which, because of their ecological requirements and reproductive

behaviour, are closely tied to the littoral regions of lakes (Welcomme, 1969)

In recognition of the potential changes in fish composition and catches in impoundments, the study aimed at identifying and documenting trends of such changes in the Volta lake over the 45 years of its existence.

Experimental

The study analysed fish catch data compiled by the Volta Lake Research Project Phase II (UNDP/FAO/VRA) between 1969 and 1977, and that of Directorate of Fisheries (DoF) from 1981 to 2004. The DoF data were generated from three major fish landing and marketing centres along the shores of the Volta lake. The first centre is Yeji, one of two major fish centres in the northern riverine segment designated as Stratum VII of the Volta lake (Fig. 1). The second and third centres are Dzemeni and Kpandu Torkor, perhaps the most lacustrine segments of the lake designated as Strata II and III, respectively. Catch data from 1989 to early part of 2006 for Kpandu/Dzemeni and from 1990 to 2006 for Yeji were also analysed.

Available catch data compiled by UNDP/FAO/VRA and DoF for the whole lake from 1969 to 2004 were analysed and related to fluctuations in water level of the lake. Data on water level of the lake were obtained from the Volta River Authority at Akosombo. Additionally, aspects of data from a current study at Dzemeni were analysed for the current species composition at that segment of the lake, and results compared to the situation during the early part of the formation of the lake.

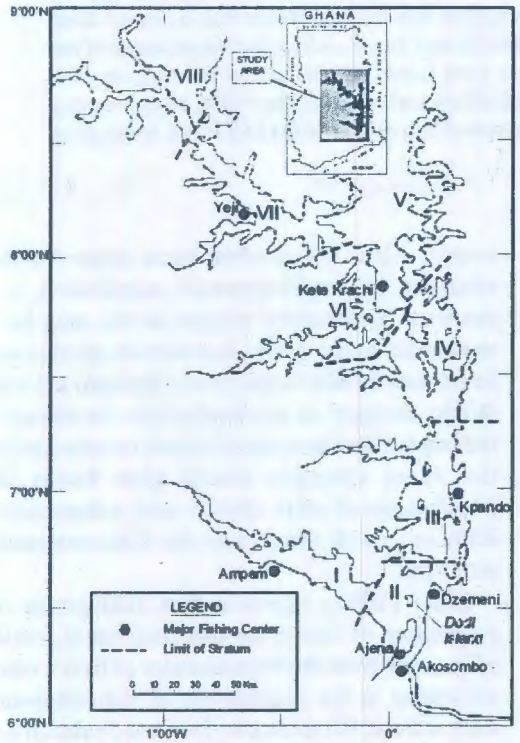

Fig. 1. Map of the Volta lake showing the various strata and the study areas

Results

Catch trends and water level fluctuations of the lake

Annual total catch estimates from surveys carried out by the Volta Lake Research Project Phase II (UNDP/FAO/VRA) from 1969 to 1977 and total catch estimates from the Directorate of Fisheries from 1981to 2004 have jointly been presented in Fig. 2, together with annual water level fluctuations of the lake.

Total fish catch dropped from 65,000 t in 1969 to between 36,000, and 48,000 t from 1971 to 1994. However, since 1995 catches have been increasing steeply till 1999 when a maximum of 80,000 t was recorded. Water level fluctuations of the lake showed an inverse relation with total catch over the years. Relationship between fish catch from Kpandu and Dzemeni and fluctuations in lake level (Fig. 3) was comparable to the situation in the whole lake (Fig. 2). Generally, high fish catch was recorded during periods of low water levels and low fish catch during periods of high water level.

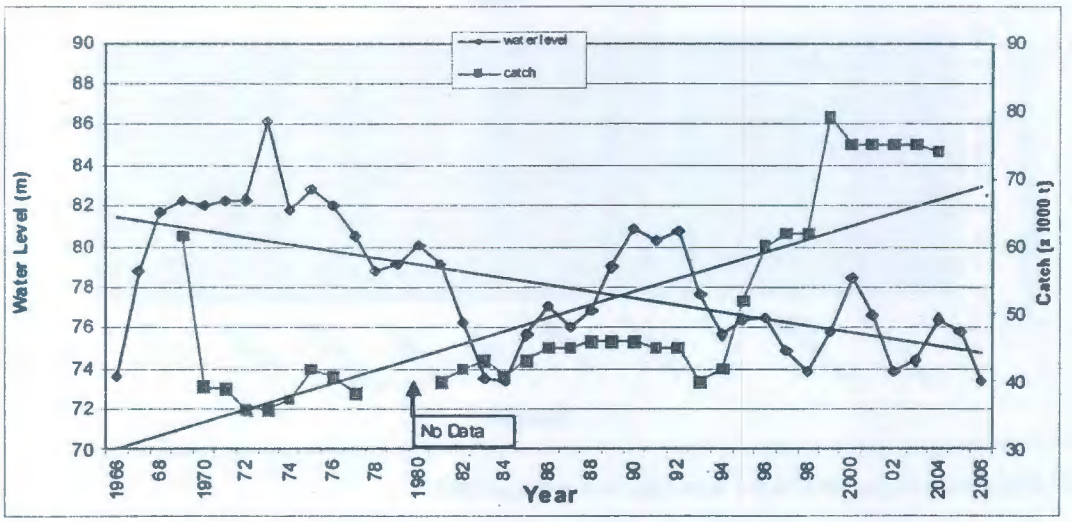

Fig. 2. Trends in total fish catch from the Volta lake from 1969 to 2004 and annual water level fluctuations

Changes in fish species composition of catch

From 1991to1998 the commercial fish landings were dominated by tilapia species throughout the lake and were followed closely by *Chrysichthys* (Fig. 4). Thus, from 1966 to1998 (34 years after the formation of the lake) tilapias dominated catches. Each of the rest of the fishes grouped under 'others' (Fig. 4) constituted less than 1.0 per cent of the catch. These fishes included mainly *Alestes*, *Brycinus*, *Distichodus*, *Gymnarchus*, *Hydrocynus* and *Lates*.

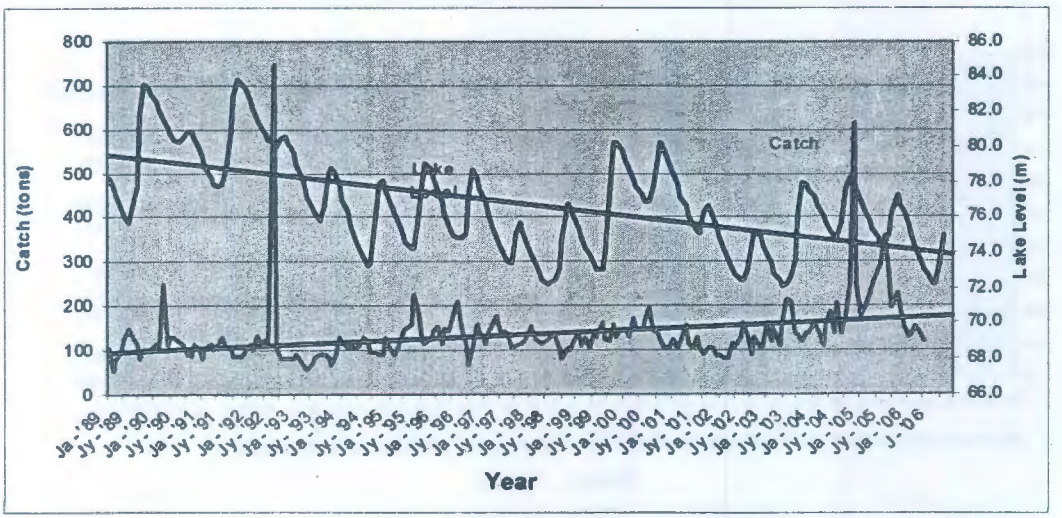

Fig .3. Lake level fluctuations and fish catch in the Volta lake at Dzemeni and Kpando (1989-2006)

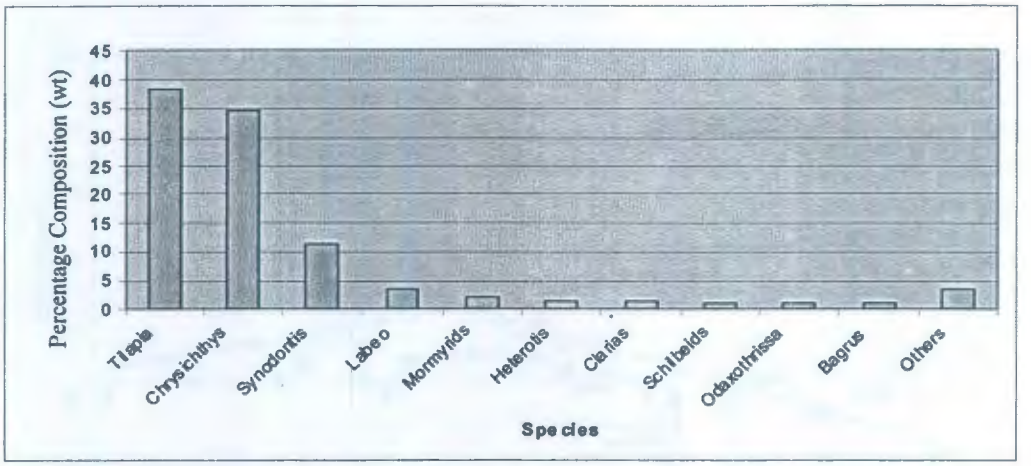

Fig. 4. Fish species composition in the Volta lake, from 1991 to 1998

Fish catch from Kpandu and Dzemeni from 1989 to 1992 (Fig. 5), was also dominated by the tilapias till 1992 when they started decreasing in the catch. Meanwhile, *Chrysichthys* emerged as the dominant group since 1992 and kept increasing consistently in the catch. *Hydrocynus*, which was the third important group in the catch in the late 1980's and early 1990's, also showed a decreasing trend just like the tilapias. Other fishes which were also important in the catch included *Synodontis* and *Bagrus*.

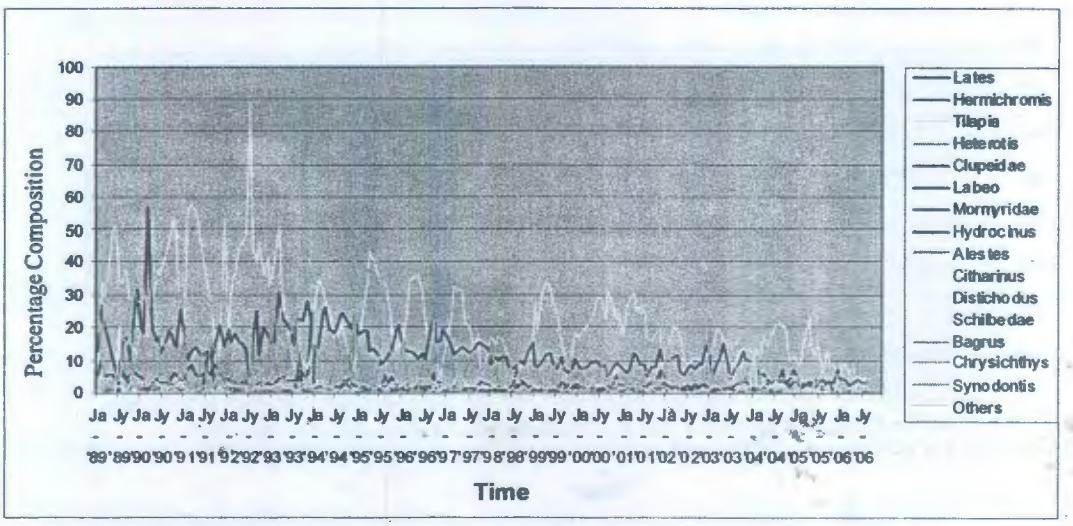

Fig. 5. Changes in fish species composition in the Volta lake at Dzemeni and Kpando (1989-2006)

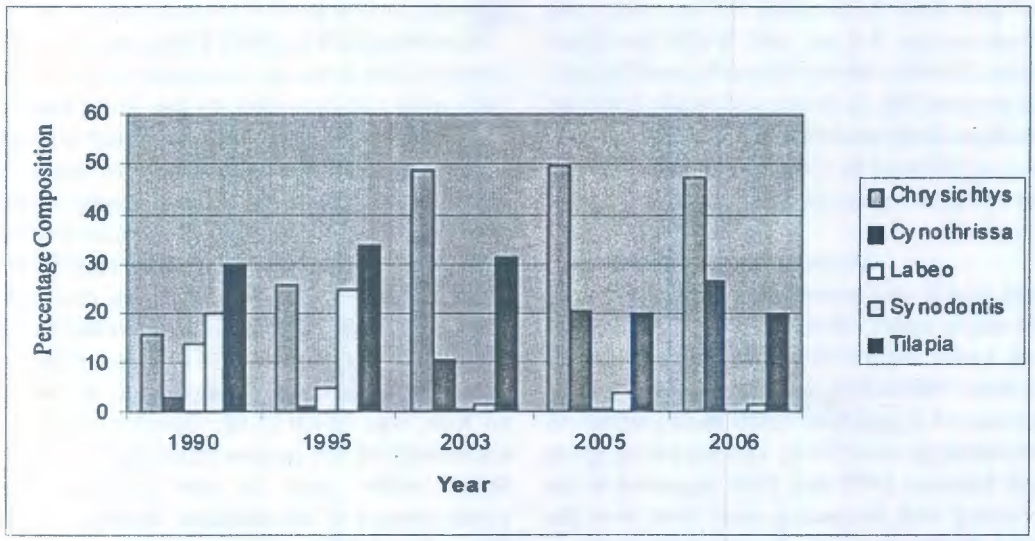

Fig. 6. Fish catch composition in the Volta lake at Yeji (Stratum VII), from 1990 to 2006.

Analysis of data compiled by the Directorate of Fisheries at Yeji (Stratum VII), showed that tilapia was again the dominant group in the1990's, forming about 30 per cent of the catch followed by *Synodontis* (20%), *Chrysichthys* (15.6%) and *Labeo* (14%) (Fig.6). Each of the other fishes, such as *Citharinus*, Momyrids, Schilbeids and *Cynothrissa* recorded in the catch constituted less than 5 per cent.

In a study between March 2007 and June 2008, *Chrysichthys* again formed the bulk of the catch, constituting 59.1 per cent, followed by the tilapias

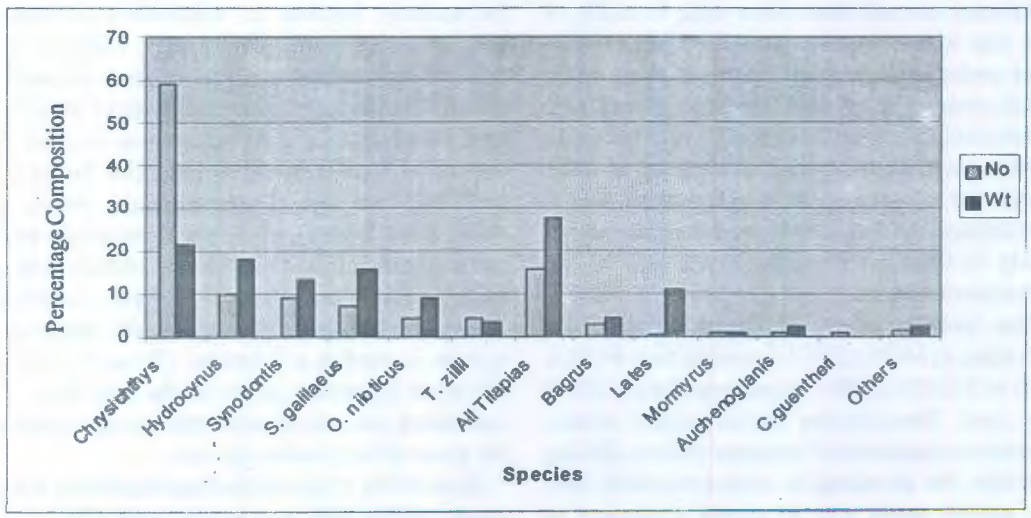

Fig. 7. Fish species composition in the Volta lake at Dzemeni (Stratum II) from March 2007 to June 2008.

15.7 per cent *Hydrocynus* 9.7 per cent and *Synodontis* spp. 8.8 per cent. Within the tilapia species, *Sarotherodon galilaeus* formed the bulk, 52.6 per cent (Fig. 7). In terms of weight, however, the tilapias dominated the catch, constituting 27.7 per cent followed by *Chrysichthys* spp 21.0 per cent and *Hydrocynus* spp. 19.7 per cent (Fig. 7).

Discussions

Catch trends and water level fluctuations

Two major issues considered in the study were catch trends and evolution of fish groups in the lake from 1969 to 2006 for either the whole lake or segments of it, and how catch trends related to fluctuations in water level. The increasing catch trend between 1995 and 1999 appeared to be associated with decreasing water level over the period. Within any particular year, higher catches were made during low water levels because fish were likely to be concentrated in the associated smaller volume of water, and also due to efficient deployment of gears which is made possible by the low water levels and its associated slow current. On the contrary, during high water levels, fishes are likely to be dispersed over larger volume of water hence difficult to capture.

Another general trend observable from Fig. 3 was that higher catches were apparently made after peaks in water level, more so when water levels remained fairly high over successive years. Persistent higher peaks in water level over longer periods could lead to expansion of niches as water floods the littoral vegetation where there would be increased food availability and adequate refuge likely to improve recruitment success in the subsequent years.

The number of canoes used on the lake according to MoFA (2003) increased from 9113 in 1971 to 24,035 in 1998 – an increase of about 263.7 per cent. Considering the increased canoe numbers as indication of increased effort or fishing pressure, the increased in catches recorded over the period could also be partly attributed to increase effort.

Changes in fish species composition of catch

According to Petr (1967, 1968), the ecological change from riverine to lacustrine condition following the damming of the Volta river at Akosombo brought about substantial changes in the fish community structure of the lake. Initially, the changes led to the disappearance of a variety of fishes among which was *Chrysichthys* spp. He also reported that during the lake's initial 2 years, some of the riverine species, especially those belonging to the family Mormyridae almost completely disappeared. The basic trend in changes in fish species composition, according to him, was towards the development of a community of fish species which had vegetarian food habits such as the tilapias. The predominance of insectivorous feeders, e.g. the Characins, Schilbeids, *Chrysichthys* and some *Synodontis*, however, kept decreasing during the first 2 years of the lake's formation (Petr, 1967, 1968, 1969). Predators were distributed throughout the lake where they found abundance of food such as the clupeid *(Microthrissa)* and the schilbeid *(Physailia pellucida)* (Petr, 1968).

Briamah (1995) reported that those species previously considered by Vanderpuye (1984) to be mainly limited to riverine conditions (*Hydrocynus* spp., *Labeo* spp, Mormyrids, Schilbeids, *Odaxothrissa mento*, *Brycinus nurse*, *Alestes baremose*, *Alestes dentex* and *Citharinus* spp.) had returned to what was originally described as most lacustrine parts (i.e. Strata I, II and III) of the lake. He attributed the 'return' of the species to areas where they previously were not commonly found to probable stabilisation of suitable conditions for their survival. Currently, *Hydrocynus* spp. is the third most important species in catches at Dzemeni (Strata II), one of the most lacustrine strata of the lake (Fig. 7), indicating that conditions in this area are suitable for some of the riverine species.

Since 1990, *Chrysichthys* kept increasing in the catch, and by 2003 had overtaken tilapias as the dominant group, constituting 47 per cent of the

catch compared to 20 per cent recorded for tilapias in 2006 (Fig. 6). This trend was similar to what was recorded at Dzemeni and Kpandu Torkor, where the composition of tilapias in the catch plummeted from about 56 per cent in the 1990's to less than 5 per cent in 2006 (Fig. 5). Over the same period at Yeji, catches of *Synodontis* and *Labeo* had also been decreasing (Fig. 6). In contrast to this trend, there was a rapid increase of *Cynothrissa* (now *Odaxothrissa mento*) in the catch from about 3 per cent in 1990 to 26.5 per cent in 2006. Interestingly, *Odaxothrissa mento* hardly appeared in the catch at Dzemini and Kpandu Torkor. The increasing trend in *Odaxothrissa mento* could be attributed to the decline in predatory species, e.g. *Lates niloticus*, *Hydrocynus* spp., *Gymnarchus niloticus* and *Clarias* spp., as shown in the catch at Yeji.

Reduction of tilapias in the catch, especially at Dzemeni and Kpandu Torkor from the early 1990's to 2006 (Fig. 5) was quite significant and could partly be attributed to persistent decrease in water level in the lake over the years leaving a wide draw down area devoid of vegetation in many places. It has been reported by Welcomme (1964) that increased rainfall and subsequent marginal flooding can alter the populations of tilapias, which, because of their ecological requirements and reproductive behaviour, are closely tied to littoral regions. He attributed the abundance of *T. esculentus* populations in lake Victoria to firstly, an increase in breeding activity induced by very heavy rainfall and secondly, to the expansion in suitable nursery areas that were made available during the early part of the period of rising water level.

Results of the study confirm the dominance of *Chrysichthys* in the lake followed by the tilapias. The omnivorous food habits of *Chrysichthys* (Vanderpuye, 1982; Dankwa *et al.*, 2009) could be a major factor for the success of the species in the lake. The success of *Chrysichthys* could also be as a result of changes in water level which do not affect their nusery grounds. Species that utilise harder bottomed and often more exposed beaches as nurseries have been found not to be affected by massive changes in water level (Fryer, 1961; Welcomme, 1964)

One of the more interesting aspects of tropical reservoirs, according to Moyle & Cech (1988), is the succession of fishes that takes place following the closure of dams. Such changes in fish species composition have been reported from many lakes, e.g. Lake Kainji (Lowe-McConnel, 1975) and Lake Kariba (Balon, 1974). In Lake Kainji for example, the species that decline after the reservoir was filled tended to be bottom feeders on aquatic insects or detritus feeders, while those that increased were piscivores, planktivores and omnivores (Lelek, 1973; Lewis, 1974; Blake, 1977). Similarly, predatory fish and planktivores increased at the initial stages of the formation of Lake Kariba. The predatory species *Hydrocynus vittatus* and *Eutropius depressirostris* constituted almost half of the recorded catch during the second year of the formation of the lake. A similar trend of decrease in insectivores and omnivores and increase in predatory and planktivores was observed in the Volta lake at its initial stages of formation.

Conclusion

Fluctuations in lake water level appeared to influence fish catch with water level showing an inverse relationship with fish catch both on the short and long term basis. The initial changes in fish species composition were from the dominance of insectivorous species, e.g. *Chrisichthys* spp. and *Synodontis* spp. towards the development of a community of fish species which had vegetarian food habits dominated by the tilapias. Currently *Chrisichthys*, an insectivorous species is dominant all over the lake. The clupeid *Odaxothrissa mento*, which hither to, was of little importance (constituted only 3% in 1990) is now second to *Chrysichthys* spp. constituting about 26.5 per cent of the catch at Yeji in 2006. The fluctuations in lake water level will greatly influence fish species composition and more

changes should be expected, especially in the composition of species that prefer swampy or vegetated litorral areas, e.g. *Heterotis*, *Gymnarchus*, *Distichodus* and *Citharinus*. The current increasing water level of the lake is likely to offer more favourable littoral conditions for such species.

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