

# INTEGRATED CO-MANAGEMENT OF ZAMBEZI / CHOBE RIVER FISHERIES RESOURCES PROJECT

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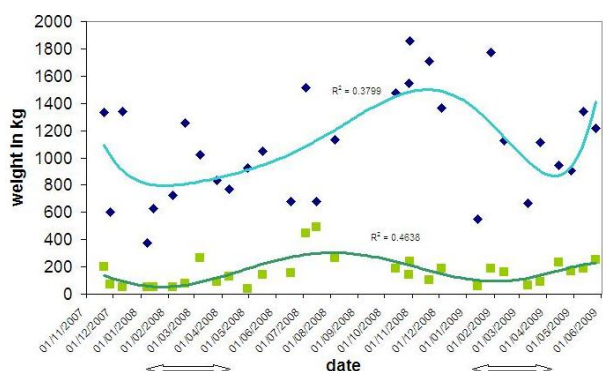
## The Katima Mulilo Fish Market Data Analysis, November 2007 – May 2009 February 2011



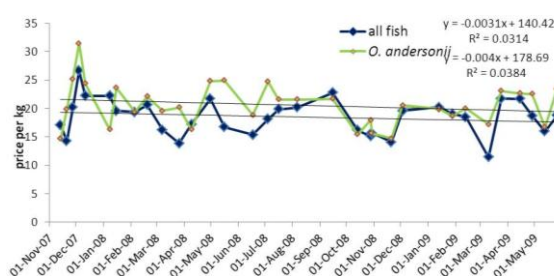
Fresh fish on sale at Katima Mulilo urban market



Dried fish on sale at Katima Mulilo urban market



Recorded daily weights of fish entering market, arrows indicate flood season



Monthly average market price per kg

by: Ben C.W. van der Waal, Clinton J. Hay & Tor F. Næsje

Technical Report no. MFMR/NNF/WWF/Phase II/2



**THE KATIMA MULILO FISH MARKET**  
**NOVEMBER 2007 – MAY 2009**

**PRELIMINARY REPORT TO**  
**MINISTRY OF FISHERIES AND MARINE RESOURCES, NAMIBIA**

**Ben C.W. van der Waal, Clinton J. Hay and Tor F. Næsje**

**Integrated Management of the Zambezi/ Chobe River System**  
**Fishery Resource Project**

**A joint project between the Ministry of Fisheries and Marine Resources, World Wildlife Fund (WWF) and Namibia Nature Foundation (NNF)**

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**Summary**

This report is a part of the ongoing study of the fish markets in Katima Mulilo, which started in 2002 with the WWF project “Shared Fisheries Resource Management on the Zambezi/Chobe River”. During the present study period from November 2007 to May 2009, the objective was to collect baseline data that can be used for long-term planning of the fishery in the region.

Valuable information was collected during this survey that can be used for long-term planning of the fishery of the region. This is all the more important if it is coupled to monitoring of fishers activities and changes in catch per unit effort.

The sale of both fresh and dried fish is undertaken by females only. Fish for sale are mainly transported by taxi from the Kalimbeza-Lisikili area as well as further east from the flood plain and Chobe River, with some fish also brought in from Lake Liambezi since 2008. The average number of fish vendors was 70 (range 41 to 105) but no clear seasonal trend or change over the study period could be detected.

The mean weight of fresh fish traded per day was 1081kg together with 162kg dried fish (equivalent of 808 kg fresh fish), totalling 1889kg fresh fish equivalent per day or around 567 tonnes per year. The contribution of the market to the local economy is thus considerable, with an average value of N\$18.25 per kg for fresh fish; this represents N\$10.3 million per year.

The species composition of fish offered for sale at the market does not reflect the fish composition as monitored by biological surveys conducted by the MFMR in the local rivers. The majority of fish sold at the market were tilapias and other cichlids, which also was the highest priced. There appears to be a selection for tilapias and other cichlids by the fishers above other fish. Analysis of fish surveys have demonstrated pressure on tilapia populations caused by the selective fishery.

Small specimens of the main tilapias *O. andersonii*, *O. macrochir* and *T. rendalli* were offered at the market. These fish are still immature and have not had an opportunity to breed. In an overfished population, such selective fishing may become very detrimental. Smaller mesh nets (70-90mm) seem to be predominantly used but catch fish of lower value and at the same time have negative impact by removing a sector from the fish population that has not yet contributed to recruitment. Medium sized fresh tilapias fetch a higher price than smaller fish or larger fishes.

Pricing by the fish vendors is done without any weighing and based on judgement of size. This resulted in very large variation in price per kg for both fresh and dry fish. For most species the medium sized fish were sold at a higher price (N\$/kg) than either smaller or larger individuals. This difference could be as great as threefold.

As the fish sold on the Katima Mulilo Fish Market are caught locally the results in the present report should be linked to the monitoring of fishers activities and catch per unit effort in the Caprivi Region.



**Plate 1** General photo of the fish market – fresh fish section

## **Acknowledgements**

Our thanks are due to the Ministry of Fisheries and Marine Resources for the support in conducting surveys at the fish market. The data collection was undertaken by the Integrated Management of the Zambezi/Chobe River System Fishery Resource Project workers, Robert Kaapala, Collins Makandauko, Malumo Malumo, Tessa Mayumbelo, Hazel Songa, and technicians at the Katima Mulilo office of the MFMR, Michael Ekandjo and Albert Mutelo. The data were entered by Hazel Songa as well as Robert Kaapala and Collins Makandauko. We also appreciate the good relations with the fish vendors at the market who allowed us to inspect and enumerate the fish on offer. The manager of the fish market and his team are also thanked for their willingness to allow the surveys and for the physical support and meetings when required.

## **Abbreviations**

EUS – Epizootic Ulcerative Syndrome

MFMR - Ministry of Fisheries and Marine Resources

cpue – catch per unit effort

ZCFP - Integrated Management of the Zambezi/ Chobe River System Fishery Resource Project





**Plate 2** View of dry fish corner of Katima Mulilo Open market

## Introduction

The fish market in Katima Mulilo has steadily grown in significance since the 1970s, when a cold room was in operation, from where fish caught at Lake Liambezi were distributed. With the development of fishing activities with gillnets and improvement of transport, more fish has been canalised to the fish market in Katima Mulilo. The Katima Mulilo Open Market, including the new fish market, was opened officially in 2006 as a joint project between the Katima Mulilo town council and Lux Development. This modern market, with 108 fish stands in the clean and tiled fish hall, is a great improvement on the previous fish market in Ngweze near Katima Mulilo, which itself was an attempt to create facilities of the previous informal fresh fish market since the 1980s (Abbott et al. 2007).

Before 2001 the market consisted of a concrete table below a corrugated roof for dried fish while fresh fish were sold from bags spread on the ground (Purvis 2001). A market committee representing other sectors as well, managed the market and determines fees. Vendors of fresh and dried fish were however not happy and suggested improvements and more support from the Town Council (Purvis 2001, 2002). In 2002 the market consisted of a roofed enclosure with a gate

in which 8 concrete benches, divided into 96 stalls, were placed. Observations by Abbott (2005) on the operation of the market reflect in detail the present situation, including the form in which fish is sold, preserved, presented and priced.

On pricing Abbott (2005) found a relationship between fish size and price for the most abundant species, *O. macrochir* (greenhead tilapia), with  $r^2$  values of 0.83 for dry and 0.88 for fresh fish. Seventeen fish species were recorded on the market and the daily gross weight of fish weighed between 08:00 and 12:00 ranged from 60 to 670kg fresh (mean 430kg) for fresh and 47kg dry fish (Abbot 2005).

The need for regular monitoring of the market as means to monitor the fisheries activities in the region forms part of the tasks of the Integrated Management of the Zambezi/ Chobe River System Fishery Resource Project (ZCFP).

Answers to the following questions were sought during the surveys:

- occupancy of the market stalls
- characterization of persons selling the fish
- amount of fresh and dried fish brought to the market per day
- species composition of fish offered for sale in terms of species and type
- size composition of fish species offered for sale
- relationship between size and price
- estimation of total value of the fish

## Methods

Regular market surveys, one to three times monthly, were undertaken at the Katima Mulilo Open Market during the period 13 November 2007 to 12 May 2009. The survey was done by a team of four persons from the MFMR and ZCFP. Two persons would record all the fish entering the market. A hanging scale slung under a pole tripod with a large platform below was used to weigh crates or bags of fish carried into the market, together with registration of the place of origin. This weighting station was strategically placed at the entrance of the market complex near the drop off point for passengers and goods so that every fish vendor had to pass and the fish containers could be weighed. The weighing started at 08:00 and lasted till 16:30. However, some fish may have missed registration if the persons arrived early in the morning as the fish markets opening hours were between 07:00. and 18:00.

The other two persons would move between the vendors and select every third stall to record the fish species offered for sale, and count all fish of each species available on the table. They also

recorded the individual total or fork length to the nearest mm on a measuring board, and the body weight to the nearest g with an electronic balance. Dried fish were similarly identified, counted and the weight of individual fish or bundles, determined.

Vendor characteristics were obtained during the afternoon when most fish vendors would be present. A questionnaire was filled in for every new fish vendor in order to obtain some socio-economic background of the individual fish vendors (see Appendix I).

As local fishers and vendors do not discriminate between certain fish species (eg *Sargochromis* spp and some *Serannochromis* spp) all the helpers working at the market, had to be trained intensively in the identification of these species.

Data were entered in and analysed with Excel.



**Plate 3.** Dried tilapia offered on the market. No salting or smoking is applied.



### Number of fish vendors at different seasons

In contrast to net based fishing which is completely dominated by males (Abbot et al. 2003), the vending of fish is exclusively undertaken by females. No males were ever recorded selling fresh or dried fish at the fish market.

The number of vendors and use of market stalls varied considerably from one survey day to the next (**Table 1**). The average number of persons per day was 70 and the average occupancy of the vendor stalls at the market was 67% and varied from 39 to 99%. The majority of stalls were used to sell dry fish with dry fish vendors more common in 15 out of 18 survey dates. Significantly more stalls were on average occupied by dry fish vendors (42%) than fresh fish vendors (28%) (t-test,  $p < 0.001$ ). The least number of stalls were in use during the wet season of 2008, while the longest period of high occupancy was during spring 2008 (**Figure 1**). The lower total occupancy of stalls in December 2007 and January 2008 can be linked to the closed season declared by the MFMR as result of the outbreak of EUS fish disease in the region.

### Daily amount of fish entering the market

The actual amount of fresh and dried fish supplied to the market, was determined from total weight of fresh and dried fish recorded during a survey day. The daily total weight of fresh fish brought to the market fluctuated between 374 and 1855kg fresh fish (average of 1081kg) and between 36 and 492kg dry fish (average of 162kg). Based on the observed reduction of weight of a sample of tilapia from wet weight to dry weight of 80% (Van der Waal 1976), the wet weight of the dried fish correspond to 182 to 2461kg. The daily average wet weight for fresh and dried fish over the entire survey period were 1081kg for fresh fish and 808kg for dried fish. The total wet weight of fish (both fresh and dried) brought daily to the market varied between 648 and 3765kg with an average of 1889kg.

More fresh fish is supplied to the market than dried. Although there is a considerable variation in the total daily weight of fish brought to the fish market, a trend line with best fit (highest correlation) showed a higher weight during early summer for fresh fish and a higher amount for dried fish during winter time (**Figure 2**). Dry fish supplies to the market were low during the rainy season with fresh fish following no specific pattern. The supply was higher during the spring season, when water levels drop and fish become easier to catch in the river and channels and the drying process is easier. (**Figure 2**).

## Total turnover of fish at the fish market

In order to estimate the total turnover of the fish market, an assumption is made that all fish entering the market daily is not removed from the market but kept there until sold. Fresh fish are generally kept in plastic or cool boxes beneath the tables with blocks of ice and left there till fish are sold. Dried fish are similarly stored beneath tables and left overnight under supervision of the security guards. Assuming 300 selling days per year, and using the average values of fresh and dried fish weighed during the market surveys, 324 580kg fresh and 48 494kg dry fish were traded per year. To obtain a total annual turnover of the market as fresh fish, a conversion of 1 to 5 from dried to fresh fish was used. The total of all fish traded at the Katima Mulilo Market during 2008 period is then estimated at 1889kg per day or 567 tonnes of fresh fish per year.

## Species offered for sale

A species list of all fish species on sale at the Katima Mulilo Open Market is presented in **Table 3**. Some fish species were only offered as dried fish. They were part of the small dried fish harvest with traditional fish traps brought in from the floodplains at the end of the flood season and contained a variety of at least 23 different small species, dominated by adult *Barbus*, *Rhabdalestes* and *Aplocheilichthys* spp (**Table 3**). For the regular market surveys, only the larger, frequently available fish species were included whilst the smaller and rare fish species were ignored. Their contribution is, however, included in the total weight of fish recorded. A total of 60 of the presently 83 known fish species from Caprivi, were represented at the market. The total number of identified fish species offered as fresh or dried was 43 and 49, respectively. Some species that were never observed for sale at the market included rock living species such as *Clariallabes platyprosopos*, *Amphilius uranoscopus*, *Hippopotamyrus* spp, *Nannocharax macropterus*, *Chiloglanis* spp, the sand living species *Zaireichthys* spp or fish that is snake like and not considered fit for human consumption such as *Aethiomastacembelus* spp.

In spite of the great diversity of fish species available at the market, the cichlid species were clearly the most frequently for sale (**Table 4**). Among the fish species offered for sale, the four most important were all cichlids representing 79% of the fish in numbers and 73% in weight. These four species were *Oreochromis andersonii* (36% in numbers and 31% in weight), *Tilapia rendalli* (18% in numbers and 18% in weight), *O. macrochir* (15% in numbers and 14% in weight), and *Serranochromis macrocephalus* (10% in numbers and 10% in weight) (**Table 4** and **Figure 3**). The cichlid family, represented by 12 species, constituted 84% of the fish offered for sale in numbers and 78% by weight.

In total 21 of the larger fish species were regularly recorded as fresh fish on the market. Other fish on the market included the larger fish species *Hydrocynus vittatus*, *Hepsetus odoe*, *Mormyrus lacerda* and *Clarias* spp. as well as some smaller species such as *Schilbe intermedius*, *Marcusenius altisambesi*, *Labeo* spp. and *Synodontis* spp. However, the weight of the non-cichlids was by far dominated by *H. vittatus* and *Clarias* spp. which alone represented 16% of the total weight. Due to their large individual weight, *H. vittatus* and *C. gariepinus* were more important in weight than numbers. All the other fish species occupied only 6% of the weight.

### **Length distribution of fish species sold fresh at the market**

The length distribution of the nine most important cichlids, two large clariids, tigerfish and African pike sold fresh at the market, are illustrated in **Figures 4 to 8** and **Table 5**. All the larger fish species recorded and measured in the market during the period November 2007 to December 2008 were included in these figures.

The length distribution of the four cichlids, that represent the most important species sold at the fish market, had a single mode distribution (**Figure 4 and 5**), and a significant proportion of the individuals were immature (**Table 6**). Most of the individuals, 72%, of the dominating species, *O. andersonii*, were between 18 and 25cm, while the most important length group was 20-21cm. Approximately 80% of the individuals for sale were immature. Fifty seven percent of the *T. rendalli* were between 18 and 23cm, while the most important length group was 20-21cm. Approximately 35% of the *T. rendalli* on offer were immature. Fifty six percent of the *O. macrochir* were between 18 and 23cm, while the most important length group was 20-21cm. Approximately 71% of the *O. macrochir* offered on the market were immature. Fifty seven percent of the *S. macrocephalus* were between 22 and 27cm, while the most important length group was 24-25cm. Approximately 46% of the *S. macrocephalus* were immature.

A large size range for both *H. vittatus* and *C. gariepinus* were offered for sale varying between 22 and 48cm for *H. vittatus* and between 20 and 52cm for *C. gariepinus* (**Figure 6 and 7**). The length distribution showed more than one mode. Again about 35% of *H. vittatus* and 51% of *C. gariepinus* sold at the market were immature (**Table 6**).

### **The price of fresh fish**

The fish price of whole fresh fish for sale was recorded for individual fish to determine the actual price per fish size. The mean price of all fish offered for sale varied between N\$11.40 in March 2009 to N\$26.70 in December 2007 (**Table 7 and Figure 9**). However, the mean price of all fish could vary substantially over short periods and between consecutive survey dates. No inflation

related increase in general fish price was discernable, rather a general decrease (see trends in **Figure 9**).

As expected, cichlids achieved the highest price on the market (**Table 8 and Figure 11**). The cichlids *S. giardi*, *O. andersonii*, *T. rendalli* and *O. macrochir* all had a mean price close to N\$20 per kg fresh whole fish. Species such as *H. vittatus* and *M. lacerda* reached prices of N\$13 per kg, while fresh *Clarias spp.* and *S. intermedius* were on sale for approximately N\$6 per kg (**Table 8**) and **Figure 9**.

As comparison, the recorded mean price of the most prevalent fish species on the market, *O. andersonii*, was added in **Figure 9**. There is a close correlation between prices for *O. andersonii* and the mean of all fish, but with more deviation in the first half of the surveys.

The recorded fish prices of different fresh fish species is summarised in **Table 8** and also graphically illustrated in **Figure 10**. The mean fish price varied from just over N\$6 per kg for *C. gariepinus* to N\$21 per kg for *S. giardi* and *T. rendalli*. The cichlids consistently fetched higher prices than the catfishes or other fish species and were from 1.5 up to 3.3 times more expensive than the other species (**Table 8**).

### **Change in fish price for different size classes of fish**

The fresh fish prices (N\$ per kg) varied more than threefold between species (**Table 8 and Figure 10**), but the price also varied within species and varied with size and between individual fish vendors (**Figure 11**). The price of fish of the same species and size could vary four to five times, for example *O. andersonii* of approximately 25-27 cm was priced from N\$10 to 50 per kg, and *T. rendalli* and *O. macrochir* of 23-25 cm was priced from N\$10 to 40 per kg. In general, smaller fish were less expensive per kg than larger fish. A large individual might be sold for 4-5 times more per kg than a smaller individual (**Figure 11**). However, for the three most important fish species sold the cichlids *O. andersonii*, *T. rendalli* and *O. macrochir*, the largest fish seemed to be sold for less per kg than medium sized fish.

The variation in the price paid for fresh *O. andersonii*, demonstrates the very wide range of prices paid for this and other fish species (**Figure 12**). Most commonly *O. andersonii* were sold for N\$16-21 per kg. But many smaller ones (**Figure 11**) were sold at lower prices than the mean N\$20 per kg and could thus have fetched a better price if they were harvested at a larger size.



## Species composition of the dry fish at the Katima Mulilo Open Market

Dry fish sales were separated from fresh fish sold on the fish market and monitored separately. On many days, more stalls on the market were occupied with dry fish than fresh fish. Certain smaller fish species that were dried were only available for short seasons and were not always monitored, partly as it was difficult to identify or weigh such small fish.

The importance of dry fish species was registered during the regular market surveys (**Table 9 and Figure 12**). Cichlids completely dominated the dry fish market and reflect the pattern of fresh fish offered for sale. The diversity of dried fish for sale was large and includes fish species that were relatively rare as fresh fish for example *M. lacerda*, *M. altisambesi*, *B. lateralis*, *L. lunatus*, *Synodontis* spp and mixed small *Barbus*, juvenile *Labeo cylindricus* and mormyrids. The only fish species where numbers and weight at the fish market do not correspond were the large *Clarias* spp. and also the small *S. intermedius*.

## Individual weight of dried fish offered for sale

The individual weight of dried fish on offer at the market was also recorded (**Figure 13**). The large catfishes as well as some larger predatory cichlids were the heaviest, but the most important cichlids had a relatively low average weight of only 78g for *O. andersonii*, 70g for *O. macrochir* and 76g for *T. rendalli*. This represents live fish of less than 400g, for fish that can reach weights of 3kg (Skelton 2003).

In the weight distribution analysis (**Figure 14 to 17**) all the cichlids show a single mode. The modal of *O. andersonii* and *O. macrochir* lies at only 40g; but in *T. rendalli* the mode is 60g (**Figure 14**). Other cichlids also had a single mode but the peak for species such as *S. macrocephalus* was higher, at 80g. The weight distribution of the catfishes and *H. vitattus* are spread over a large range of weights with more than one mode of which the first lies at weights of 80g for the two *Clarias* species and 40g for *H. vitattus* (**Figure 17 and 18**). The modes for *H. odoe* and the mormyrid *Mormyrus lacerda* also have more than one mode with the first mode at higher weights of 70g (**Figure 18**). The mormyrid *Marcusenius altisambesi* is also better reflected in dry fish catches and shows two modes, reflecting smaller fish caught in traditional traps on the floodplain and larger fish from small mesh gillnets (**Figure 19**). The same applies for *S. intermedius*.

## The price of dried fish

The mean price per kg for all dried fish sampled regularly during the surveys is summarised with Standard Deviation in **Figure 18**. The price per kg is highest for the cichlids: *S. angusticeps* (N\$68.00), *O. macrochir* (N\$62.10), *O. andersonii* (N\$59.30) and *T. rendalli* (N\$57.30). Other cichlids and non-cichlid fish have comparable prices of between N\$40 and N\$50 per kg with catfishes lower at N\$24.00 and small dried barbs the lowest price of only N\$10.90.

The price per kg of dried fish was analysed for the abundant species *O. andersonii* to determine the distribution of price per kg. A normal distribution between N\$15 and N\$115 per dried kg was found with a mode at N\$55 but with extreme recorded prices between N\$5 and N\$195 per kg dry weight. This observed large variation in price per kg was further analysed for all the major species.

Price variation is higher in the smaller fish and in many species there is a weak trend to a decrease in price per kg with increase in size. Individual sellers also appear to stick to a certain price/weight ratio, explaining the parallel series on many of the graphs.

## Comparison between fresh and dry fish sales

The fresh and dry fish for sale on the market over the study period are compared in **Figures 21** and **22** and **23** and summarised in **Table 10**. For ease of comparison, the cichlids were separated from the rest of the fish. *Oreochromis andersonii* dominates both fresh and dried fish with the high number reflecting the actual small size of most fish on offer. The cichlids, *O. andersonii*, *T. rendalli*, *O. macrochir* and *S. macrocephalus* form the bulk of cichlids, and represented 79% of the number and 73% weight of fresh fish. In dried fish these cichlids form a lower percentage of 58% and 53% in numbers and weight, respectively. The other 8 recorded cichlids constituted a very small portion of fish for sale.

Non-cichlids form a total of 16 and 23% of numbers and weight of fresh fish, respectively, but this increases to 45 and 41% for dried fish. This group is strongly dominated by *C. gariepinus*, *H. odoe*, *H. vittatus*, *S. intermedius* and *C. ngamensis*, while other species such as mormyrids and cyprinids form a very small portion of fish on offer (**Figure 16**).

The fresh and dry fish on sale show many similarities but differ in aspects such as a higher portion of dried fish is non-cichlids, especially clariids mormyrids and cyprinids.

The composition of the fish fauna in the rivers in the Caprivi, as monitored by experimental gill nets (22-150 mm) (Hay and van der Waal 2009) differs from the composition offered for sale at the fish

market (**Table 11** and **Figure 24**). In the rivers *Schilbe intermedius*, *Brycinus lateralis*, *Hydrocynus vittatus* and *Petrocephalus catostoma* were the most important fish species, which in most years constituted more than 80% of the total Index of Relative importance (IRI). *Tilapia sparrmanii* was the most commonly collected cichlid, but constituted a small percentage of the total IRI. The economically important *O. andersonii* and *O. macrochir* at the market are not even listed among the 23 most important species from the experimental gill nets.

## Discussion

The importance recently allocated to inland fisheries with proper legislation, regional offices and staffing in the Caprivi Region in place, is in agreement with the recommendations made earlier by Purvis [2002] who conducted a study on the importance of fishing in the floodplains and identified serious weaknesses in the management to the fisheries. An analysis of the fish market at Katima Mulilo is seen as part of the information needed for continued management of a valuable local resource.

The fish market is dominated strongly by cichlids and especially *Oreochromis* spp. The picture of the fish community structure in the Zambezi and floodplains does not reflect this dominance by cichlids. The selection for cichlids and especially *O. andersonii* and *O. macrochir* is clear from the data and can be ascribed to two factors: the selection of effective fishing gear for these species and secondly the way in which this gear is used or set.

Occupancy rate of stalls by fresh fish vendors increased with the onset of the flooding season with a decrease during the winter months, similar to the dry fish vendors but their numbers further increased after the decline of the fresh fish vendors and dominated the occupancy during the spring when the river was low. According to Abbott et al. (2003), the occupancy rate for fresh fish vendors declined between September and May with the onset of the flood when catches usually decline with an increase in the water coverage.

More dry fish than fresh fish vendors were present on the markets during both survey periods. Despite the fact that on average a higher number of market stalls were occupied during the survey done by Abbott et al. (2003), less fish entered the market than the present survey. The hours surveyed per day were slightly shorter during the earlier survey, although it is expected that the majority of the vendors will enter the market early during the day.

The dry fish peaked in August 2008 during the low water and start of the warmer period. Fresh fish peaked when water levels were lowest with daily volumes of 1½ tonnes per day.

The number of fish species for sale at the market was 60 compared to 17 species listed by Abbott et al. (2003) during 2002 and 2003. The present study listed 21 large species, indicating a high diversity of small size species entering the market. One reason for the observed diversification could be lower catches of large individuals forcing people to search for other species as replacement. Also, a market for smaller and cheaper species has developed as the tilapias must be regarded as expensive. With the improvement of roads and vehicles, small floodplain species are also now entering the market especially during the receding phase of the flood.

The recorded diversity of fish for sale reflects a recent trend of trading in all fish species and sizes available. During earlier studies on fish sales in the region, only larger fish species were observed at markets or stalls. Smaller fish caught with traditional traps and funnels were used and consumed locally and never sent to the market, with exception of dried mormyrids collected during the ninga fishery in June at the rapids at Impalila Island.

The cichlids are the preferred fish family dominating the fish sales with *Oreochromis andersonii* the most important species. The analysis done on the species sampled during the biological surveys indicated that this species has been impacted by the fishing and cannot be considered abundant in the Zambezi River at all, especially large individuals (Hay and van der Waal, 2009). Being the most important species at the market does indicate that this species is targeted by the subsistence fishery probably for its taste and high prices realized.

This may indicate that a specific species group is targeted by the fishery and only a limited variety of mesh size nets are used. The modes of the fish lengths of the major tilapia are rather low for these fish species if compared to the lengths they can attain. The modal length of only 20cm of *O. andersonii* and *O. macrochir* is certainly below the 50% size at maturation of these species (Van der Waal 1976). In Lake Liambezi, the minimum length for reaching maturity was recorded as 23 and 27cm for *O. macrochir* females and males and 26cm for females and males of *O. andersonii*, respectively. These two species also grow to more than 50cm length in the Zambezi and in Lake Liambezi *O. andersonii* up to 42cm and *O. macrochir* up to 38cm were recorded (Van der Waal 1981). In contrast, minimum breeding lengths of only 10 and 11cm were reported for *T. rendalli* in Lake Liambezi (Van der Waal 1981).

The cichlids show a single modal peak in the length frequencies of fish sold on the market but in *C. gariepinus* and *H. vittatus* more than one clear modal or peak in length frequencies is seen, reflecting different size/age groups and/or net selectivity. Modal lengths of *Serranochromis* spp. are somewhat higher than for the *Oreochromis* spp. but most cichlid fish for sale are still fish that are immature or have only bred once. Even for *H. vittatus* and *C. gariepinus* and *C. ngamensis* the mean and modal lengths are small and below the minimum length for 50% maturity. The general



small size of fish on offer reflects the extensive use of smaller mesh gill nets (70-80mm) by the fishers as reported by Naesje et al. (2003). This aspect requires further investigation.

The ranges of price per kg in most fishes are very wide. This reflects absence of a weighing scale for the vendors and possibly an inability to judge the weight of a fish from size. Other factors may play a role – prices seemed to decrease towards the end of the day when fish vendors wanted to get rid of left over fish. The price also changed over time as illustrated in **Figure 10** and this may affect prices as well and finally demand may also have an effect on realized fish prices.

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## Appendix1 Tables

**Table 1.** Number and proportion of fish selling stalls occupied in the Katima Mulilo Open Market from November 2007 to May 2009. Total number of stalls was 108.

Date	Fresh	Mixed	Dried	Total	Percentage occupied
13-Nov-07	17	2	25	42	40.7
20-Nov-07	24	6	41	65	65.7
27-Nov-07	12	2	47	59	56.5
04-Dec-07	15	3	56	71	68.5
11-Dec-07	24	4	17	41	41.7
08-Jan-08	24	1	18	42	39.8
15-Jan-08	16	2	36	52	50.0
05-Feb-08	16	2	39	55	52.8
19-Feb-08	26	3	31	57	55.6
7-Mar-08	47	0	26	73	67.6
26-Mar-08	26	2	42	68	64.8
09-Apr-08	48	3	15	63	61.1
30-Apr-08	30	2	21	51	49.1
16-May-08	40	0	57	97	89.8
17-Jun-08	47	11	30	77	81.5
04-Jul-08	50	0	40	90	83.3
16-Jul-08	11	1	70	81	75.9
06-Aug-08	37	2	68	105	99.1
15-Sep-08	16	5	74	90	88.0
13-Oct-08	28	3	49	77	74.1
28-Oct-08	28	0	49	77	71.3
29-Oct-08	37	0	45	82	75.9
20-Nov-08	34	0	25	59	54.6
03-Dec-08	21	2	41	62	59.3
13-Jan-09	23	3	40	63	61.1
28-Jan-09	28	0	55	83	76.9
12-Feb-09	26	3	64	90	86.1
10-Mar-09	26	0	38	64	59.3
24-Mar-09	47	5	43	90	88.0
14-Apr-09	28	2	52	80	75.9
28-Apr-09	20	0	42	62	57.4
12-May-09	28	0	35	63	58.3
<b>Average</b>	<b>28.1</b>	<b>2.2</b>	<b>41.6</b>	<b>69.7</b>	<b>66.6</b>
<b>SD</b>	11.0	2.3	15.4	16.4	15.4

**Table 2.** Weight (kg) of fresh and dried fish brought to the Katima Mulilo Open Market between 08:00 and 16:00 from November 2007 to May 2009. The weight of dried fish is converted to wet weight with an assumption of 80% reduction in weight.

<b>DATE</b>	<b>FRESH FISH</b>	<b>DRIED FISH</b>	<b>Wet weight of dried fish</b>	<b>Total wet weight</b>
20-Nov-07	1332	202	1013	2346
27-Nov-07	599	68	343	942
11-Dec-07	1341	48	244	1585
08-Jan-08	374	54	274	648
15-Jan-08	626	50	253	879
05-Feb-08	727	49	249	976
19-Feb-08	1254	79	398	1652
7-Mar-08	1021	265	1328	2349
26-Mar-08	832	91	456	1288
9-Apr-08	769	128	642	1411
30-Apr-08	924	36	182	1106
16-May-08	1047	144	722	1769
17-Jun-08	676	153	766	1442
4-Jul-08	1516	449	2248	3765
16-Jul-08	681	492	2461	3142
6-Aug-08	1131	264	1321	2452
13-Okt-08	1474	185	925	2399
28-Okt-08	1549	142	711	2260
29-Okt-08	1855	242	1210	3065
20-Nov-08	1708	105	528	2236
3-Dec-08	1367	189	946	2313
13-Jan-09	549	60	304	853
28-Jan-09	1776	189	946	2722
12-Feb-09	1127	159	798	1925
10-Mar-09	667	64	324	991
24-Mar-09	1114	89	445	1559
14-Apr-09	944	231	1157	2101
28-Apr-09	907	168	844	1751
12-May-09	1337	189	945	2282
26-May-09	1218	252	1262	2480
<b>Average per day</b>	<b>1081</b>	<b>162</b>	<b>808</b>	<b>1889</b>



**Table 3.** List of fish species collected in Caprivi with indication of species recorded fresh or dried at the Katima Mulilo Open Market from November 2007 to May 2009 (some names (\*) updated from Skelton 2001).

Family	Scientific name	English	Local name	Identified on market	
				fresh	dried
Mormyridae (snoutfishes)	<i>Mormyrus lacerda</i>	Western bottlenose	Ndikusi	0	0
	<i>Hippopotamyrus ansorgii</i>	Slender stonebasher	Niinga		
	<i>Hippopotamyrus szaboi</i> *	Zambezi stonebasher	Niinga		
	<i>Cyphomyrus discorhynchus</i>	Zambezi parrotfish	Sakulo	0	0
	<i>Marcusenius altisambesi</i>	Bulldog	Nembele	0	0
	<i>Petrocephalus catostoma</i>	Churchill	Niinga, Kupandula	0	0
	<i>Pollimyrus castelnaui</i>	Dwarf stonebasher	Niinga		0
Cyprinidae (barbs, yellowfish, labeos)	<i>Barbus afrovernayi</i>	Spottail barb	Mbaala		0
	<i>Barbus barnardi</i>	Blackback barb	Mbaala		
	<i>Barbus barotseensis</i>	Barotse barb	Mbaala, Linyonga		
	<i>Barbus bifrenatus</i>	Hyphen barb	Mbaala		0
	<i>Barbus eutaenia</i>	Orangefin barb	Mbaala		0
	<i>Barbus fasciolatus</i>	Red barb	Mbaala, Linyonga		
	<i>Barbus haasianus</i>	Sickle-fin barb	Mbaala		0
	<i>Barbus kerstenii</i>	Redspot barb	Mbaala Linyonga		0
	<i>Barbus lineomaculatus</i>	Line-spotted barb	Mbaala		
	<i>Barbus multilineatus</i>	Copperstripe barb	Mbaala		0
	<i>Barbus paludinosus</i>	Straightfin barb	Linyonga, Mbaala	0	0
	<i>Barbus poechii</i>	Dashtail barb	Mbaala, Ijungwe	0	0
	<i>Barbus radiatus</i>	Beira barb	Mbaala, Liminolale	0	0
	<i>Barbus thamalakanensis</i>	Thamalakane barb	Mbaala		0
	<i>Barbus unitaeniatus</i>	Longbeard barb	Mbaala, Linyonga		0
	<i>Coptostomabarbus wittei</i>	Upjaw barb	Mbaala		0
	<i>Labeobarbus codringtonii</i>	Upper Zambezi Yellowfish	Linyonga	0	
	<i>Labeo cylindricus</i>	Redeye labeo	Linyonga, Liminolale young:	0	0
	<i>Labeo lunatus</i>	Upper Zambezi labeo	Linyonga	0	
<i>Mesobola brevianalis</i>	River sardine	Mbaala		0	
<i>Opsaridium zambezense</i>	Northern barred minnow	Mbaala	0	0	
Distichodontidae (citharines)	<i>Hemigrammocharax machadoi</i>	Dwarf citharine	Mbaala		0
	<i>Hemigrammocharax multifasciatus</i>	Multibar citharine	Mbaala		0
	<i>Nannocharax macropterus</i>	Broadbar citharine	Mbaala		
Characidae (characins)	<i>Brycinus lateralis</i>	Striped robber	Mbaala	0	0
	<i>Micralestes acutidens</i>	Silver robber	Mbaala		0
	<i>Rhabdalestes maunensis</i>	Slender robber	Mbaala		0
	<i>Hydrocynus vittatus</i>	Tigerfish	Ngweshi	0	0
Hepsetidae (African)	<i>Hepsetus odoe</i>	African pike	Mulumesi, Mweru	0	0

pike)					
Claroteidae (claroteid catfishes)	<i>Parauchenoglanis ngamensis</i>	Zambezi grunter	Siabela	○	
Amphiliidae (mountain catfish)	<i>Zaireirichthys cf doraе*</i>	Chobe sand catlet			
	<i>Zaireichthys rotundiceps*</i>	Spotted sand catlet			
	<i>Amphilius uranoscopus</i>	Stargazer mountain catfish			
Schilbeidae (butter catfishes)	<i>Schilbe intermedius</i>	Silver catfish	Lubango	○	○
Clariidae (air-breathing catfish)	<i>Clariallabes platyprosopos</i>	Broadhead catfish	Silutupi, Ndombe, Nenge/		
	<i>Clarias gariepinus</i>	Sharptooth catfish	Ndombe Mbundamusheke Mangwana	○	○
	<i>Clarias liocephalus</i>	Smoothhead catfish	Lihwetete Mabozwe, Ndombe		
	<i>Clarias ngamensis</i>	Bluntfoot catfish	Nkoma, Sitama	○	○
	<i>Clarias stappersii</i>	Blotched catfish	Lihwetete, Mabozwe	○	
	<i>Clarias theodoraе</i>	Snake catfish	Kaminga, Kakokwe	○	○
Mochokidae (squeakers, suckermouth catlets)	<i>Chiloglanis fasciatus</i>	Okavango suckermouth	Singongi		
	<i>Chiloglanis neumanni</i>	Neumann's suckermouth	Singongi		
	<i>Synodontis nigromaculatus</i>	Spotted squeaker	Singongi	○	
	<i>Synodontis woosnami</i>	Upper Zambezi squeaker	Singongi	○	
	<i>Synodontis macrostigma</i>	Largespot squeaker	Singongi	○	
	<i>Synodontis macrostoma</i>	Largemouth squeaker	Singongi		
	<i>Synodontis leopardinus</i>	Leopard squeaker	Singongi	○	
	<i>Synodontis thalakanensis</i>	Bubblebarb squeaker	Singongi	○	
	<i>Synodontis vanderwaali</i>	Finetooth squeaker	Singongi	○	
Aplocheilidae (annual killifishes)	<i>Nothobranchius sp</i>	Caprivi killifish	Mbaala		
Poeciliidae (topminnows)	<i>Aplocheilichthys hutereaui</i>	Meshscaled topminnow	Mbaala		○
	<i>Aplocheilichthys johnstoni</i>	Johnston's topminnow	Mbaala		○
	<i>Aplocheilichthys katangae</i>	Striped topminnow	Mbaala		○
	<i>Aplocheilichthys sp</i>	Pigmy topminnow	Mbaala		
Cichlidae (cichlids)	Cichlidae	Cichlids, 'bream'	Papati		
	<i>Hemichromis elongatus</i>	Banded jewelfish	Liulungu	○	
	<i>Oreochromis andersonii</i>	Threespot tilapia	Njinji	○	○
	<i>Oreochromis macrochir</i>	Greenhead tilapia	Muu	○	○
	<i>Pharyngochromis acuticeps</i>	Zambezi river bream	Mbanda	○	
	<i>Pseudocrenilabrus philander</i>	Southern mouthbrooder	Kambanda		○

	<i>Serranochromis altus</i>	Humpback largemouth	Naluca, Mushuna	○	○
	<i>Serranochromis angusticeps</i>	Thinface largemouth	Mushuna	○	○
	<i>Serranochromis longimanus</i>	Longfin largemouth	Ngenga, Njenga		
	<i>Serranochromis macrocephalus</i>	Purpleface largemouth	Ngenga/Njenga	○	○
	<i>Serranochromis robustus</i>	Nembwe	Nembwe	○	○
	<i>Serranochromis thumbergi</i>	Brownspot largemouth	Ngenga	○	
	<i>Sargochromis carlottae</i>	Rainbow bream	Imbuma (Mbuma)	○	○
	<i>Sargochromis codringtonii</i>	Green bream	Imbuma	○	○
	<i>Sargochromis giardi</i>	Pink bream	Siyeo	○	○
	<i>Sargochromis greenwoodi</i>	Deepcheek bream	Ngenga		
	<i>Tilapia rendalli</i>	Redbreast tilapia	Mbufu	○	○
	<i>Tilapia ruweti</i>	Okavango tilapia	Situhu		○
	<i>Tilapia sparrmanii</i>	Banded tilapia	Situhu	○	○
Anabantidae (labyrinth fishes)	<i>Microctenopoma intermedium</i>	Blackspot climbing perch	Singulungwe		○
	<i>Ctenopoma multispine</i>	Manyspined climbing perch	Singulungwe	○	○
Mastacembelidae (spiny eels)	<i>Aethiomastacembelus frenatus</i>	Longtail spiny eel	Musioka		
	<i>Aethiomastacembelus vanderwaali</i>	Ocellated spiny eel	Musioka		

**Table 4.** Composition of the larger fish species on sale at the Katima Mulilo Open Market from November 2007 to May 2009, expressed as percentage total numbers and weight recorded in all market surveys. Species listed in order of importance.

Species	% of numbers	% of total weight
<i>O. andersonii</i>	36.2	31.4
<i>T. rendalli</i>	18.1	17.9
<i>O. macrochir</i>	15.4	14.2
<i>S. macrocephalus</i>	9.6	9.9
<i>H. vittatus</i>	3.4	9.7
<i>H. odoe</i>	3.2	2.7
<i>M. lacerda</i>	2.7	2.6
<i>S. intermedius</i>	2.4	0.9
<i>C. gariepinus</i>	2.4	5.9
<i>T. sparrmanii</i>	1.5	0.6
<i>M. altisambesi</i>	1.1	0.3
<i>S. giardi</i>	1.1	1.4
<i>S. codringtonii</i>	0.9	1.0
<i>S. carlottae</i>	0.8	0.5
<i>C. ngamensis</i>	0.5	0.5
<i>L. lunatus</i>	0.2	0.1
<i>S. angusticeps</i>	0.2	0.2
<i>Synodontis spp.</i>	0.2	0.01
<i>S. robustus</i>	0.1	0.2
<i>S. altus</i>	0.1	0.1
<i>H. elongatus</i>	0.1	0.02

**Table 5.** Length frequencies of cichlids and other fish species measured on the Katima Mulilo Open Market from November 2007 to May 2009.

Length group (cm)	<i>O. andersonii</i>	<i>O. macrochir</i>	<i>T. rendalli</i>	<i>S. angusticeps/altus</i>	<i>S. macrocephalus</i>	<i>S. robustus</i>	<i>S. carlottae</i>	<i>S. codringtonii</i>	<i>S. giardi</i>	<i>T. sparrmanii</i>	<i>H. elongatus</i>
10	1		1		2						
12	6	4	1							5	
14	17	19	19		1				1	37	1
16	38	36	24		1				1	4	
18	218	105	120	2	16		6	7	1		1
20	313	120	144		22		4	5	5		
22	258	100	119	1	59		13	6	9	3	
24	189	52	73	1	86		2	8	5	2	
26	104	41	56	6	60		1	4	11	3	
28	61	43	37	1	32	2	2		3		
30	52	20	21		25	1		1	3	2	
32	36	13	20		25			1			
34	14	11	14		10			1	1		
36	17	4	14		11	1					
38	12		10		5						
40	6	3	2		2			1	1		
42	4	2	2								
44	2	1			2						
46	1	2									

48	1									
50	1									
52	3									
54										

**Table 5.** Length frequencies of cichlids and other fish species measured on the Katima Mulilo Open Market from November 2007 to May 2009.

Length group (cm)	<i>C. gariepinus</i>	<i>C. ngamensis</i>	<i>S. intermedius</i>	<i>H. vittatus</i>	<i>H. odoe</i>	<i>M. macrolepidotus</i>	<i>M. lacerda</i>	<i>L. lunatus</i>	<i>Synodontis spp.</i>
10			1						
12									2
14			2	1		12			
16	1		6			15		1	2
18			18	2		12	1	3	3
20	4		24	3	2	1	1	4	
22	1		28	7	11		1		
24	4	2	10	11	23		6		
26	3	1	1	16	31		34		
28	5			10	18		20		
30	4			4	15		20		
32	5	1		5	7	1	7		
34	5	5		7	5		5		
36	6	4		7	4		3		
38	8	5		3	2				
40	9			6					
42	8			9					
44	3			8			1		
46	1			9					
48	3			7					
50	3			1					
52	5								
54	2			1					
56	1								
58				4					
60				3					
62									
64				1					
66									
68	1								
70	2								
72	1			1					
74	1								
76									
78									
80									
82									
84									
86	1								

88									
90	1								

**Table 6.** Mean length and weight, length at 50% maturity and the proportion of fish offered for sale that was smaller than the length at 50% maturity for the most important fish species at the Katima Mulilo Open Market from November 2007 to May 2009. The 50 % maturity given is for females when available.

Fish species	Mean length of fresh fish	Proportion of fish smaller than length at 50% maturity	Length at 50% maturity	Mean weight (g) of fresh fish
<i>C. gariepinus</i>	44.4	51	40**	822.1
<i>H. vittatus</i>	36.7	35	28**	920.4
<i>M. lacerda</i>	28.8			312.3
<i>H. odoe</i>	27.8	44	27**	279.5
<i>S. macrocephalus</i>	26.5	46	22*	334.4
<i>S. giardi</i>	25.4	85	30*	431.1
<i>S. codringtonii</i>	23.5	0	17*	346.1
<i>O. andersonii</i>	23.4	80	27*	283.0
<i>T. rendalli</i>	23.4	35	21*	320.8
<i>O. macrochir</i>	22.9	71	25*	299.2
<i>S. intermedius</i>	21.1	51	22**	141.5

\* Fishbase

\*\* Hay et al. 2002

**Table 7.** Mean price per kg of fresh whole fish recorded on the Katima Mulilo Open Fish Market from November 2007 to May 2009.

<b>Date of survey</b>	<b>Mean fresh fish price, (N\$)</b>
13-Nov-07	17.1
20-Nov-07	14.2
27-Nov-07	20.2
4-Dec-07	26.7
11-Dec-07	22.2
8-Jan-08	22.2
15-Jan-08	19.6
5-Feb-08	19.4
19-Feb-08	20.6
7-Mar-08	16.3
26-Mar-08	13.9
9-Apr-08	17.2
30-Apr-08	21.7
16-May-08	16.7
17-Jun-08	15.4
4-Jul-08	18.1
16-Jul-08	19.9
6-Aug-08	20.2
15-Sep-08	22.8
13-Oct-08	16.2
28-Oct-08	15.1
29-Oct-08	15.7
20-Nov-08	14.1
3-Dec-08	19.6
13-Jan-09	20.2
28-Jan-09	19.0
12-Feb-09	18.5
10-Mar-09	11.4
24-Mar-09	21.7
14-Apr-09	21.7
28-Apr-09	18.7
12-May-09	16.0
26-May-09	18.8
<b>mean price</b>	<b>18.25</b>

**Table 8.** Prices (N\$) per kg for the various species of whole fresh fish on the Katima Mulilo Open Fish Market from November 2007 to May 2009.

Species	Mean	Lowest	Highest	SD
<i>S. giardi</i>	20.9	13.3	33.8	3.9
<i>T. rendalli</i>	20.6	6.3	46.5	8.5
<i>O. andersonii</i>	19.9	4.4	57.5	8.2
<i>O. macrochir</i>	19.9	3.6	52.1	7.7
<i>S. codringtonii</i>	18.0	9.4	32.0	5.0
<i>S. macrocephalus</i>	17.0	6.5	34.1	4.8
<i>H. vittatus</i>	13.2	4.3	26.4	4.5
<i>M. lacerda</i>	12.9	4.3	32.5	4.1
<i>H. odoe</i>	10.7	4.0	20.3	3.8
<i>S. intermedius</i>	6.5	3.9	10.4	1.7
<i>C. gariepinus</i>	6.1	1.9	15.4	2.9

**Table 9.** Composition of dry fish on sale at the Katima Mulilo Open Market from November 2007 to May 2009.

Fish species	% number	% weight
<i>O. andersonii</i>	21.0	19.6
<i>S. macrocephalus</i>	16.6	16.0
<i>O. macrochir</i>	14.1	12.0
<i>C. gariepinus</i>	8.6	15.0
<i>H. odoe</i>	8.4	8.1
<i>S. intermedius</i>	8.1	3.7
<i>H. vittatus</i>	7.5	7.3
<i>T. rendalli</i>	6.0	5.7
<i>C. ngamensis</i>	4.4	7.2
<i>M. lacerda</i>	1.8	2.3
<i>M. altisambesi</i>	1.0	0.4
<i>B. lateralis</i>	0.6	0.3
<i>Synodontis spp</i>	0.4	0.3
<i>S. giardi</i>	0.4	0.4
<i>L. lunatus</i>	0.3	0.3
<i>S. altus</i>	0.3	0.5
<i>S. angusticeps</i>	0.2	0.3
<i>S. codringtonii</i>	0.2	0.1
<i>S. carlottae</i>	0.1	0.2
<i>B. codringtonii</i>	0.1	0.2
<i>T. sparrmanii</i>	0.1	0.03
<i>L. cylindricus</i>	0.1	0.4



**Table 10.** Summary of percentage composition of fresh and dry fish at the Katima Mulilo Open Market from November 2007 to May 2009.

Fish species	Fresh		Dried	
	number	weight	number	weight
<i>O. andersonii</i>	36.2	31.5	21.0	19.6
<i>T. rendalli</i>	18.1	17.9	6.0	5.7
<i>O. macrochir</i>	15.4	14.2	14.1	12.0
<i>S. macrocephalus</i>	9.5	9.7	16.6	16.0
<i>C. gariepinus</i>	8.6	15.0	5.9	2.4
<i>H. odoe</i>	8.4	8.1	2.7	3.2
<i>S. intermedius</i>	8.1	3.7	1.0	2.6
<i>H. vittatus</i>	7.5	7.3	9.7	3.4
<i>C. ngamensis</i>	4.4	7.2	0.5	0.5
<i>M. lacerda</i>	1.8	2.2	2.6	2.7
<i>T. sparrmanii</i>	1.5	0.6	0.1	0.03
<i>S. giardia</i>	1.1	1.4	0.4	0.4
<i>M. altisambesi</i>	1.0	0.4	0.3	1.1
<i>S. codringtonii</i>	0.9	1.0	0.2	0.1
<i>S. carlottae</i>	0.8	0.5	0.1	0.2
<i>B. lateralis</i>	0.6	0.3	-	-
<i>Synodontis spp</i>	0.4	0.3	0.1	0.2
<i>L. lunatus</i>	0.3	0.3	0.1	0.2
<i>S. angusticeps</i>	0.2	0.2	0.2	0.3
<i>B. codringtoni</i>	0.1	0.2	-	-
<i>S. robustus</i>	0.1	0.2	-	-
<i>L. cylindricus</i>	0.1	0.4	-	-
<i>S. altus</i>	0.1	0.1	0.3	0.5
<i>H. elongatus</i>	0.1	0.01	-	-

**Table 11.** Composition of annual (dry season) experimental fish catches with sets of graded gillnets (16 to 150mm mesh) at five stations on the Zambezi and Chobe Rivers from 1997 to 2007 expressed as % Index of Relative importance (IRI) (modified from Hay 2009).

Fish Species	IRI %
<i>Brycinus lateralis</i>	37.4
<i>Schilbe intermedius</i>	24.9
<i>Hydrocynus vittatus</i>	9.3
<i>Clarias gariepinus</i>	4.9
<i>Synodontis</i> spp.	4.6
<i>Marcusenius altisambesi</i>	3.5
<i>Petrocephalus catostoma</i>	2.6
<i>Barbus poechii</i>	2.3
<i>Micralestes acutidens</i>	2.0
<i>Hepsetus odoe</i>	1.9
<i>Barbus paludinosus</i>	1.6
<i>Pharyngochromis acuticeps</i>	1.1
<i>Tilapia sparrmanii</i>	1.0
<i>Serranochromis robustus</i>	0.4
<b><i>Tilapia rendalli</i></b>	0.4
<b><i>Oreochromis andersonii</i></b>	0.3
<i>Serranochromis macrocephalus</i>	0.2
<i>Pseudocrenilabrus philander</i>	0.2
<b><i>Oreochromis macrochir</i></b>	0.2
<i>Barbus radiatus</i>	0.1
<i>Rhabdalestes maunensis</i>	0.1
<i>Clarias ngamensis</i>	0.1
other species	0.9

Appendix 2: Figures

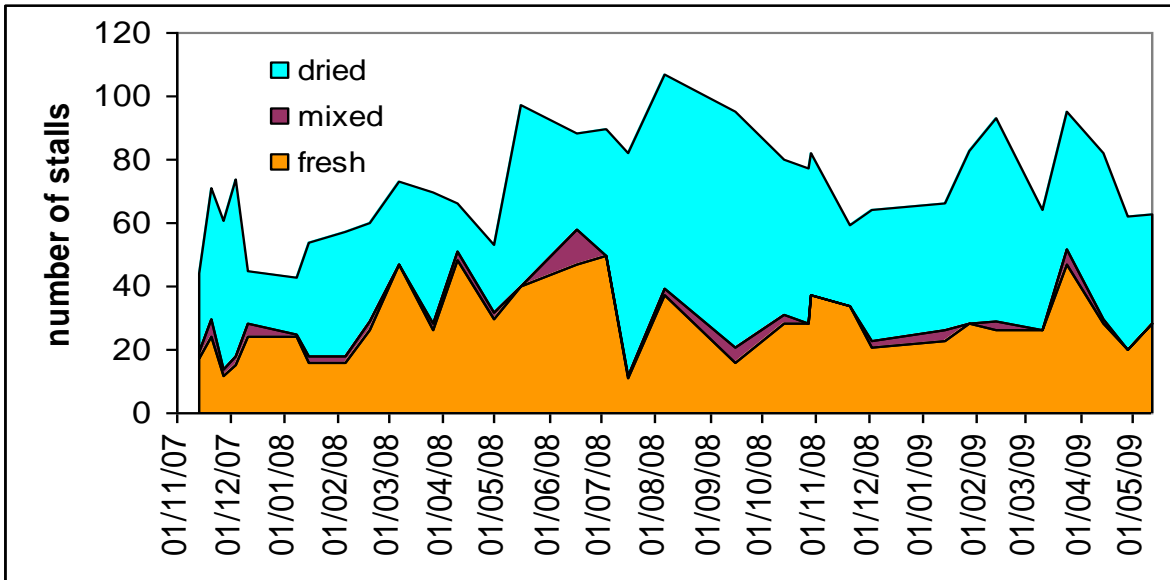


Figure 1. Variation in occupancy of fish stalls at the Katima Mulilo Open Market from November 2007 to May 2009.

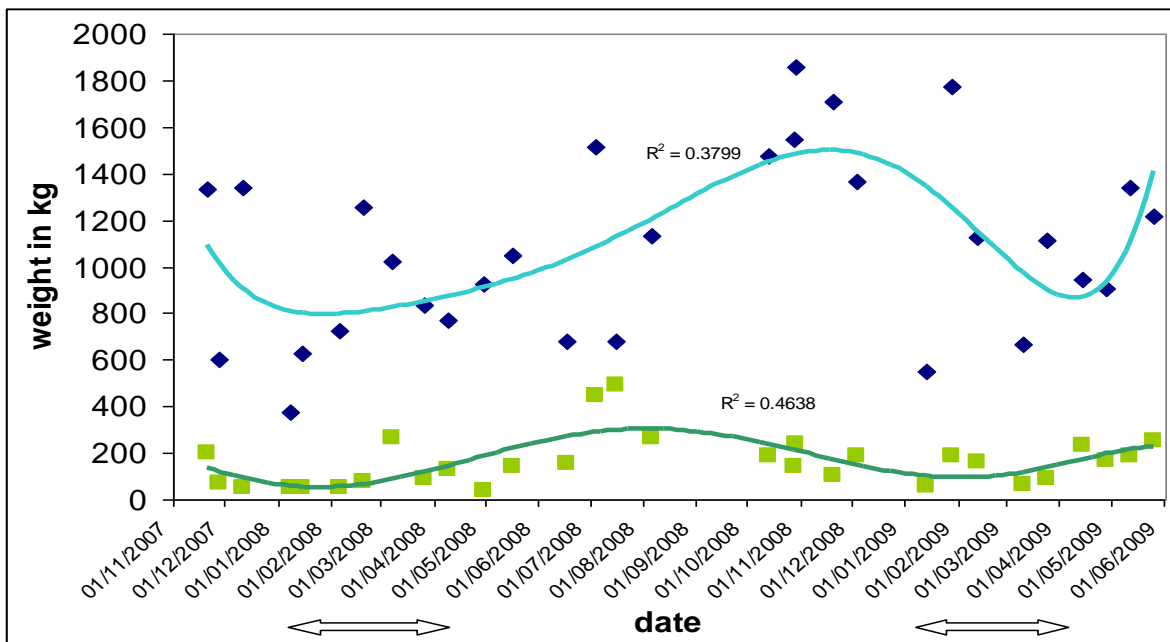
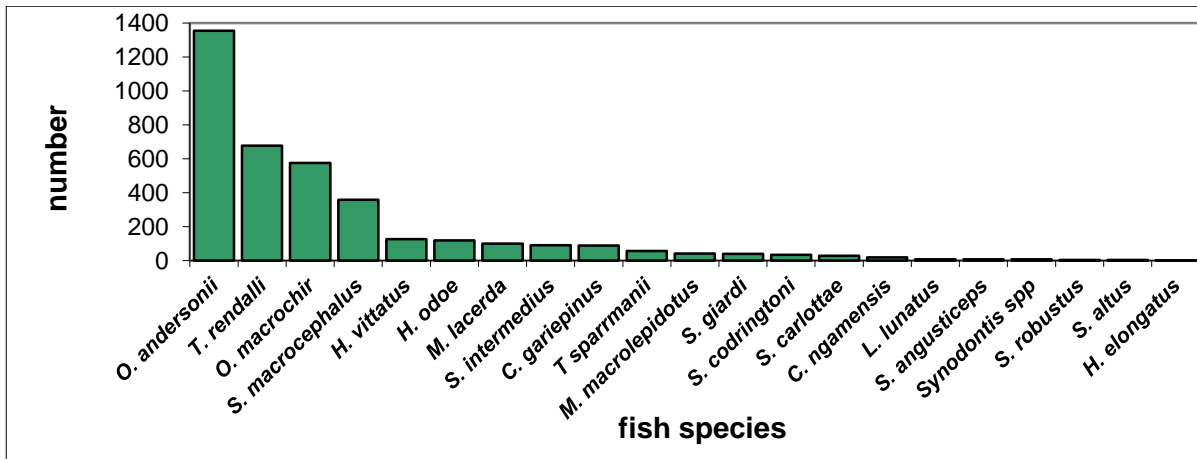
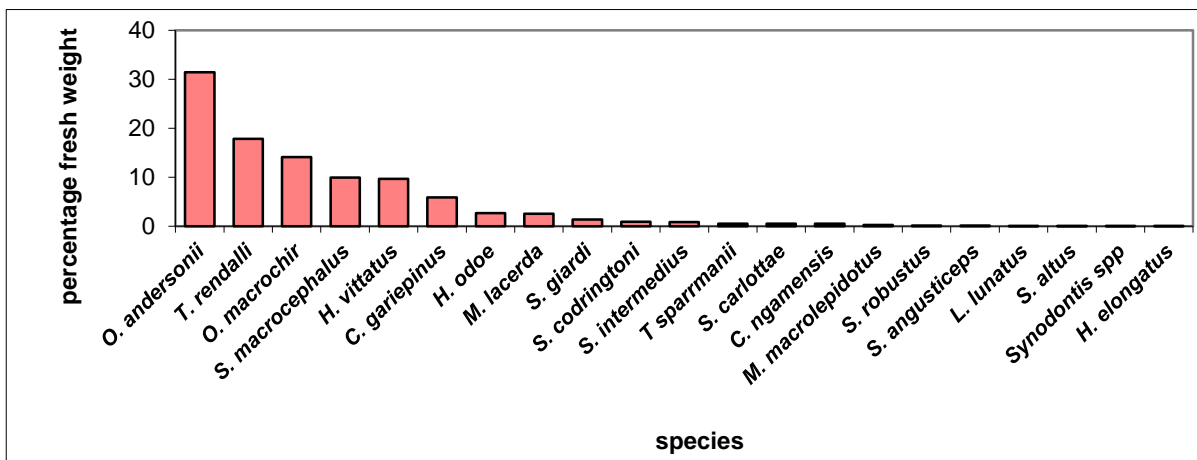


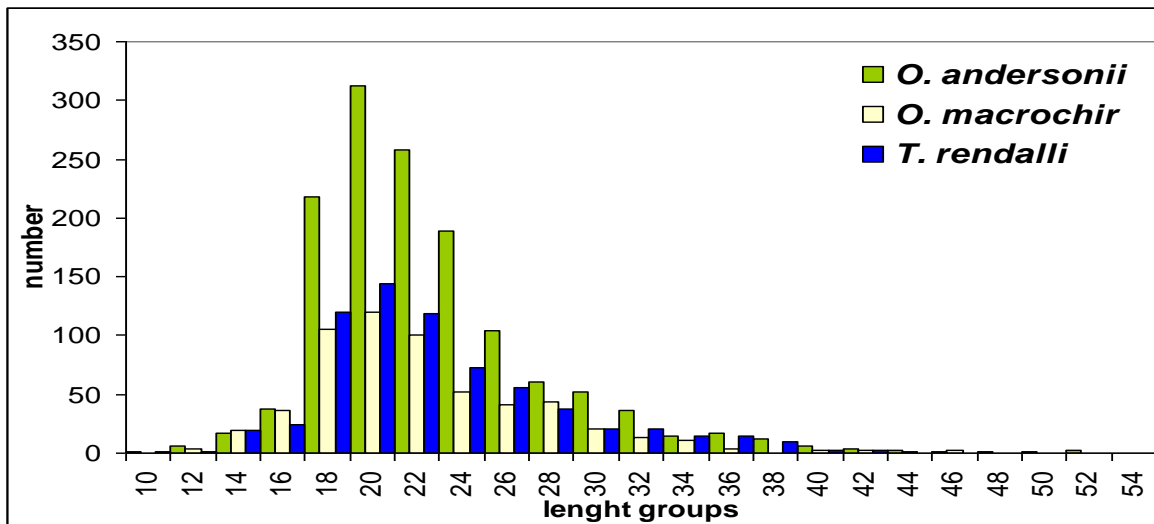
Figure 2. Total recorded weight of fresh (blue symbols) and dried (green symbols) fish daily entering the Katima Mulilo Open Market from November 2007 to May 2009. Arrows indicate flood seasons in 2008 and 2009. Trend lines (multinomial) show observed correlation factors.



**Figure 3a** Species composition as total number inspected of fresh fish at the Katima Mulilo Open Market.



**Figure 3b** Species composition of fresh fish on the Katima Mulilo Open Market as percentage weight.



**Figure 4.** Length frequency distribution of *O. andersonii*, *T. rendalli* and *O. macrochir* sampled at the Katima Mulilo Open Market from November 2007 to May 2009.

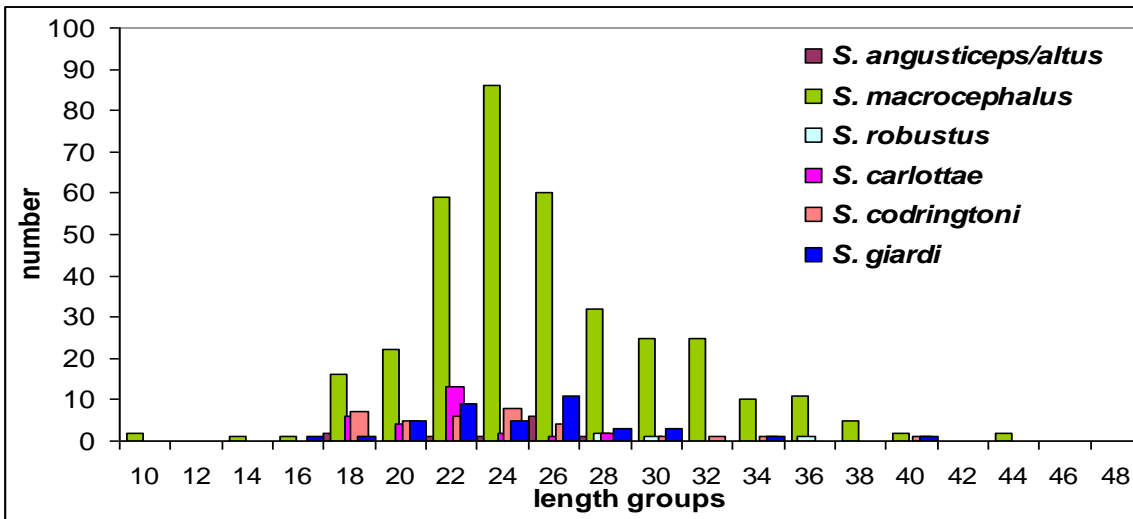


Figure 5. Length frequency distribution of several large cichlids sampled at the Katima Mulilo Open Market from November 2007 to May 2009.

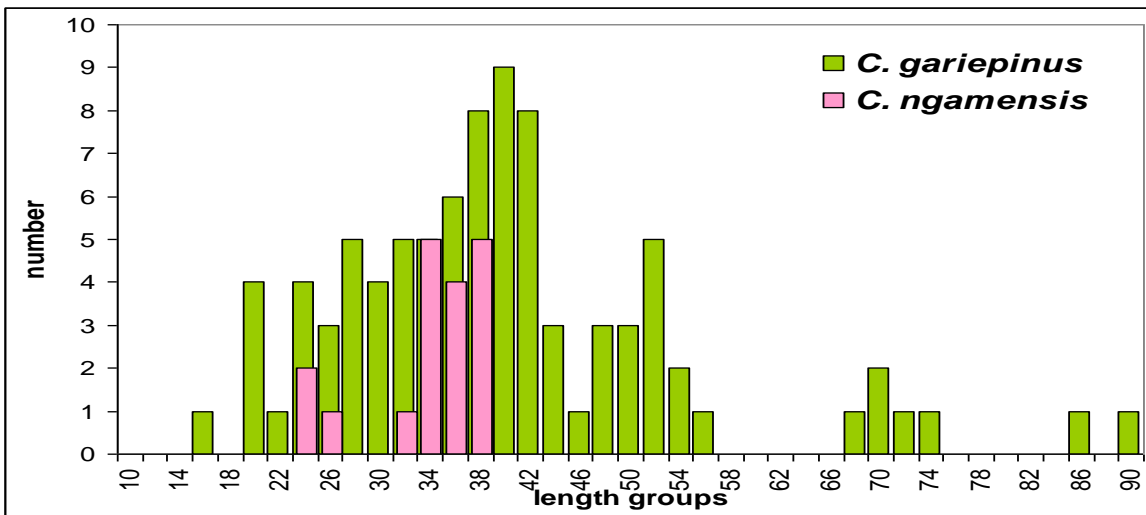


Figure 6. Length frequency distribution for *C. gariepinus* and *C. ngamensis* sampled at the Katima Mulilo Open Market from November 2007 to May 2009.

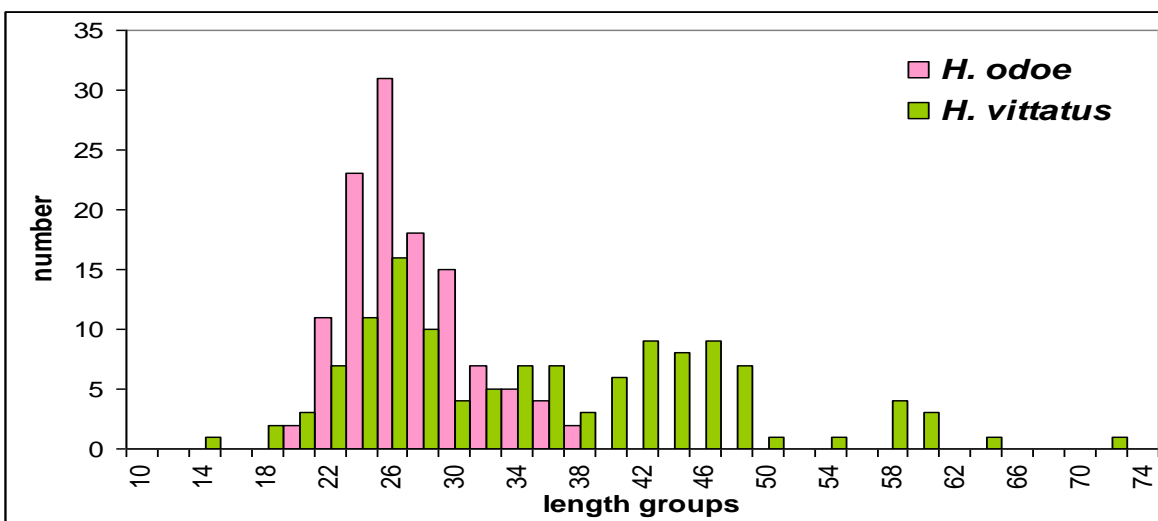
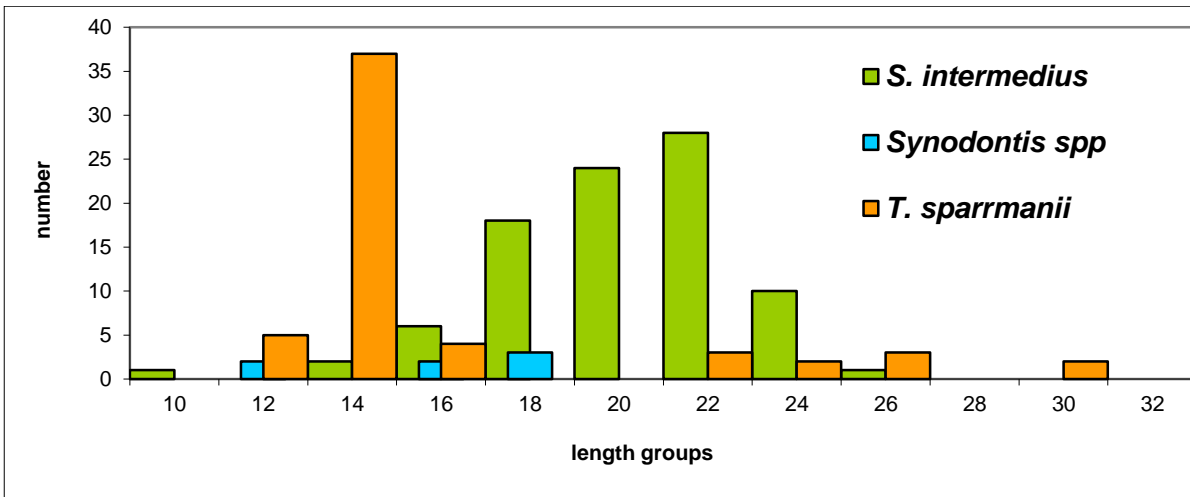
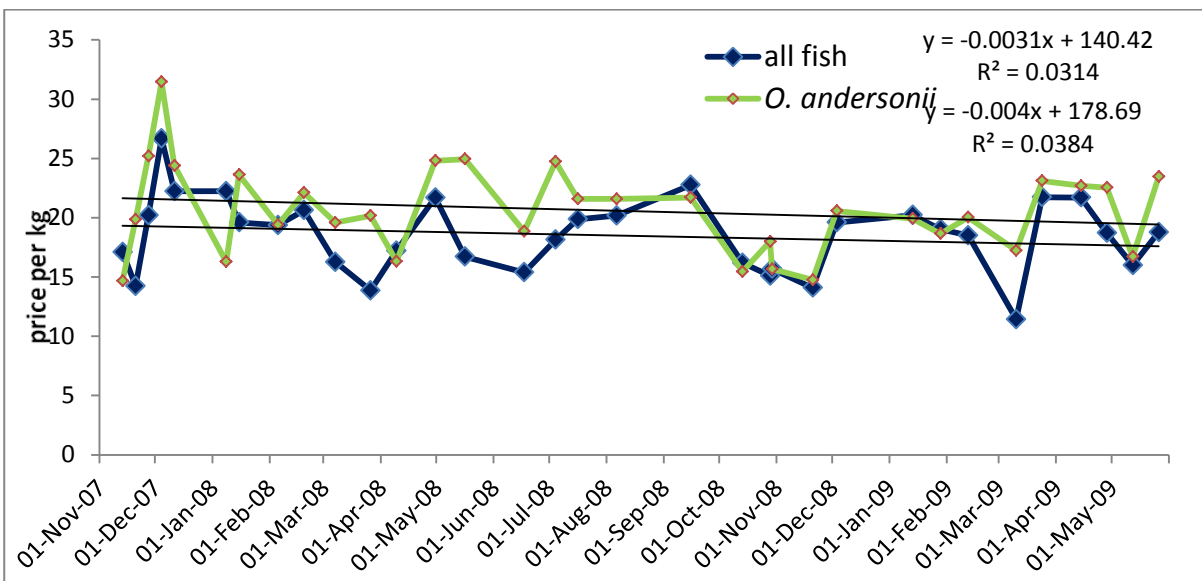


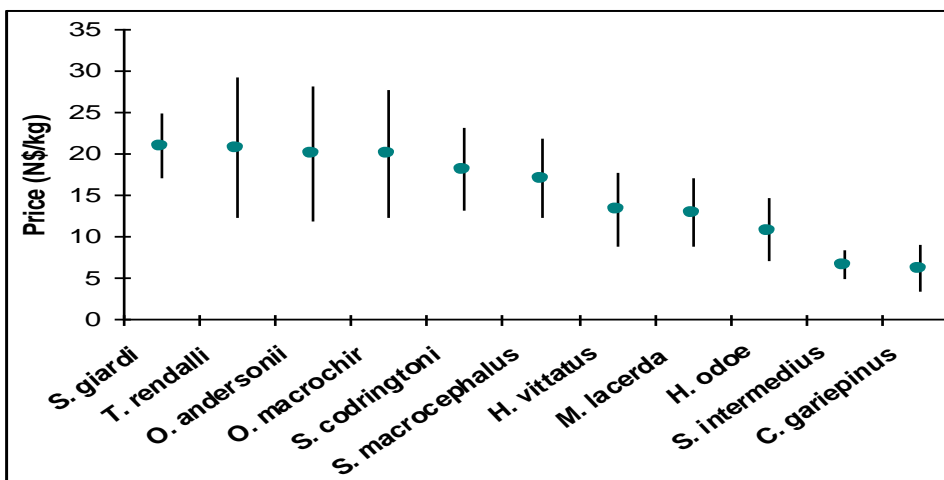
Figure 7. Length frequency distribution for *H. odoe* and *H. vittatus* sampled at the Katima Mulilo Open Market from November 2007 to May 2009.



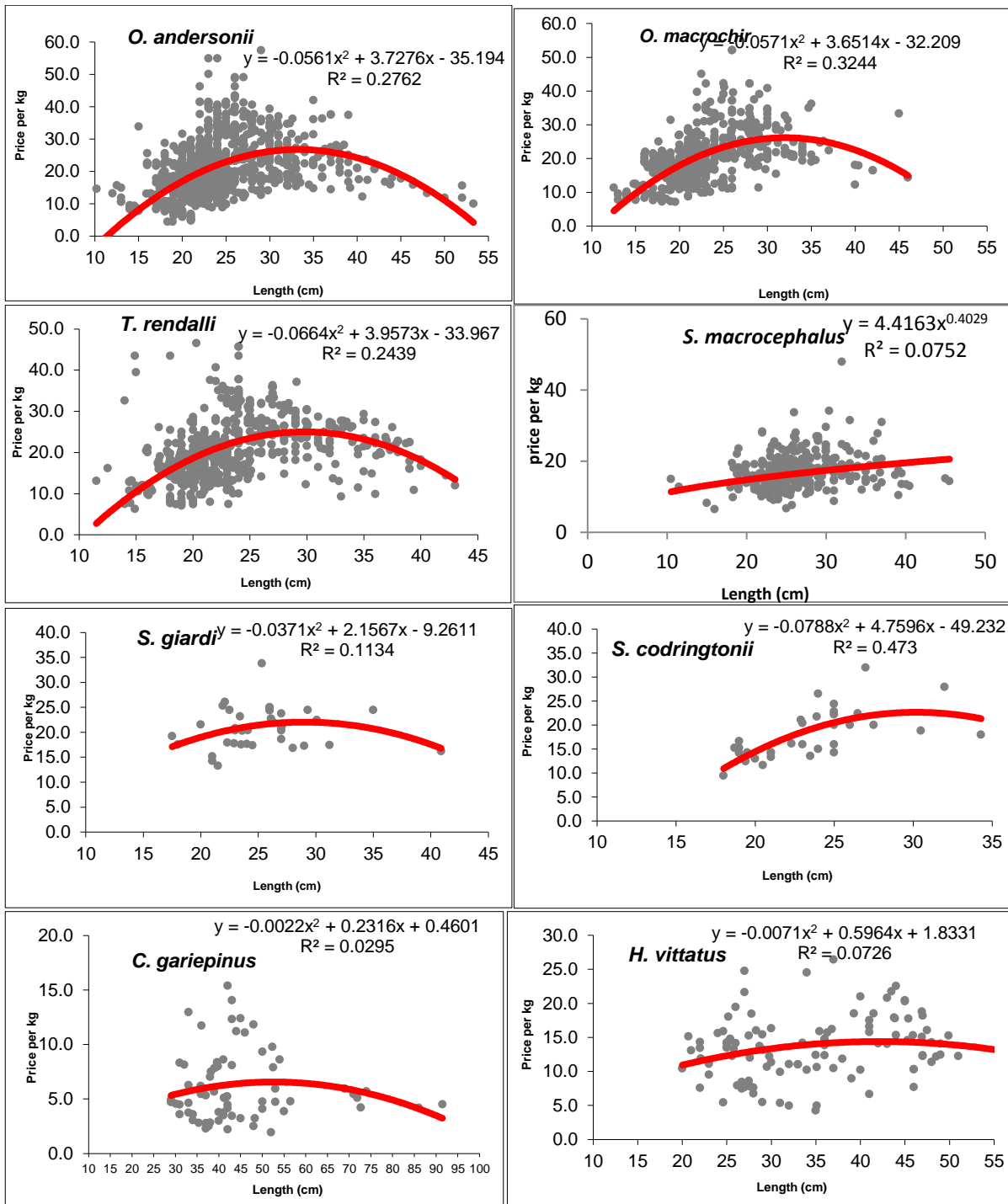
**Figure 8.** Length frequency distribution for the smaller fishes *S. intermedius*, *T. sparrmanii* and *Synodontis* spp. sampled at the Katima Mulilo Open Market from November 2007 to May 2009.



**Figure 9.** Mean fish price of all fish and *O. andersonii* on the Katima Mulilo Open Fish Market from November 2007 to May 2009 with regression lines (SD for all fish = 2.94, for *O. andersonii* = 3.73).



**Figure 10.** Average price for whole fresh fish ( $\pm$  SD) of the most important fish species sold the Katima Mulilo Open Fish Market from November 2007 to May 2009.



**Figure 11.** Recorded prices of various fresh fish species of different length groups at the Katima Mulilo Open Fish Market from November 2007 to May 2009, and the best fit for a regression of the relation, based on best correlation factor.

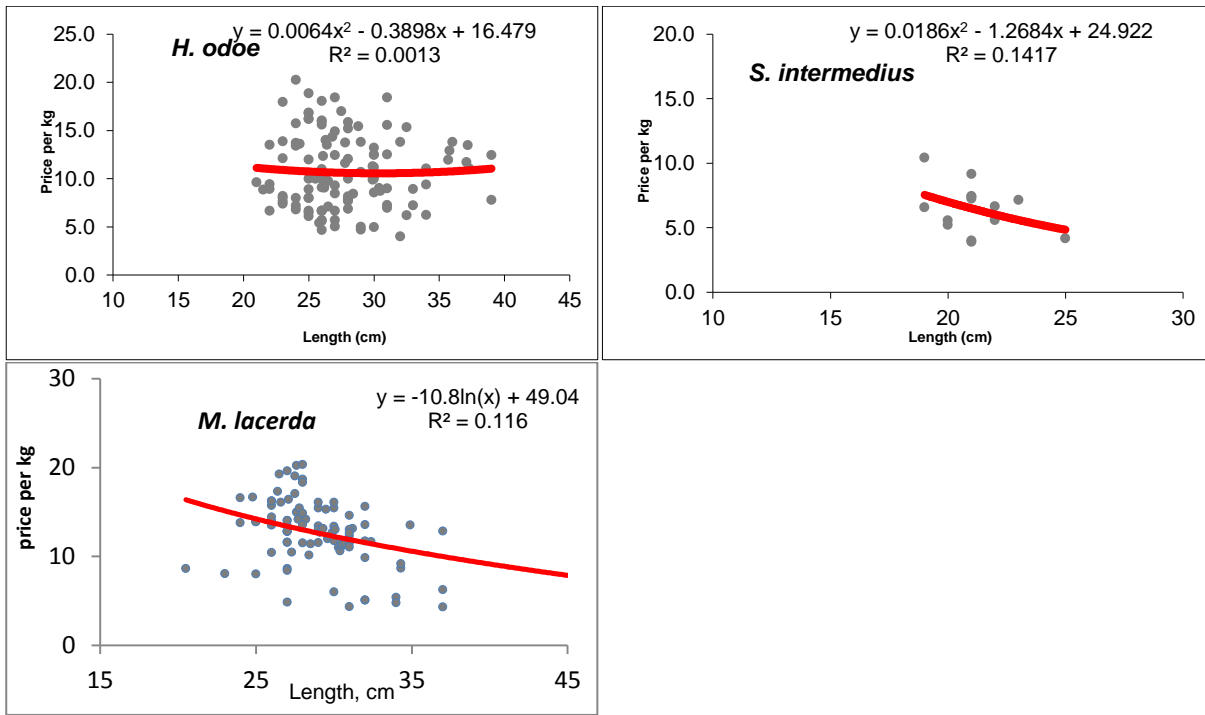


Figure 11. Continued

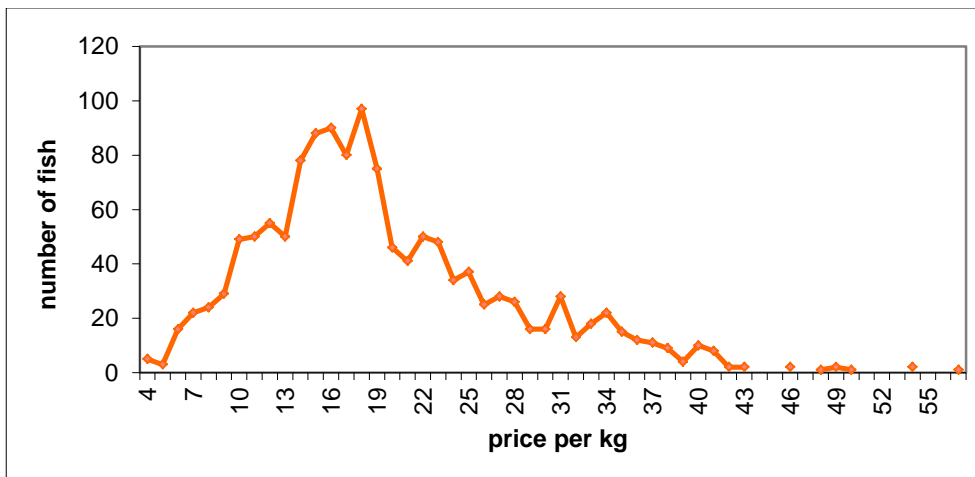
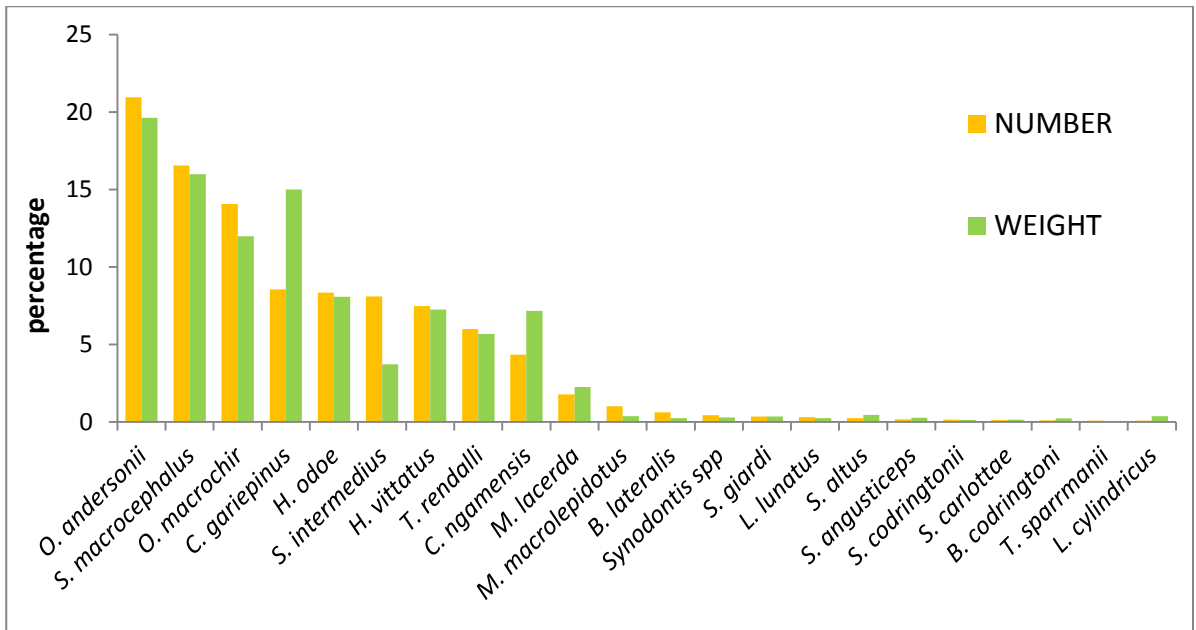
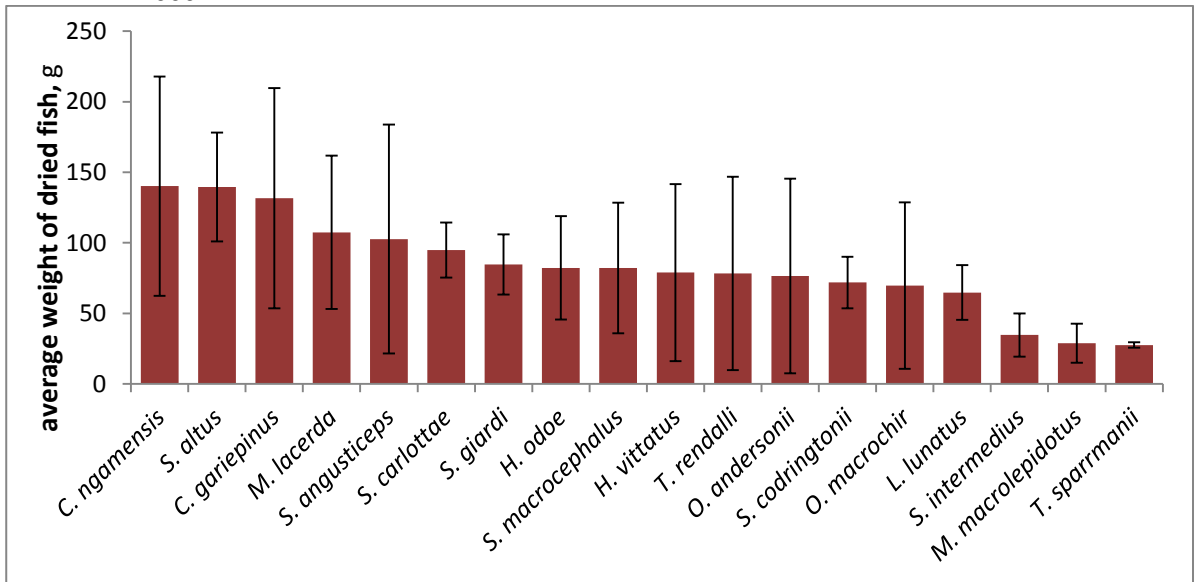


Figure 11b. Frequency distribution of price per kg for fresh *O. andersonii* at the Katima Mulilo Open Fish Market from November 2007 to May 2009.

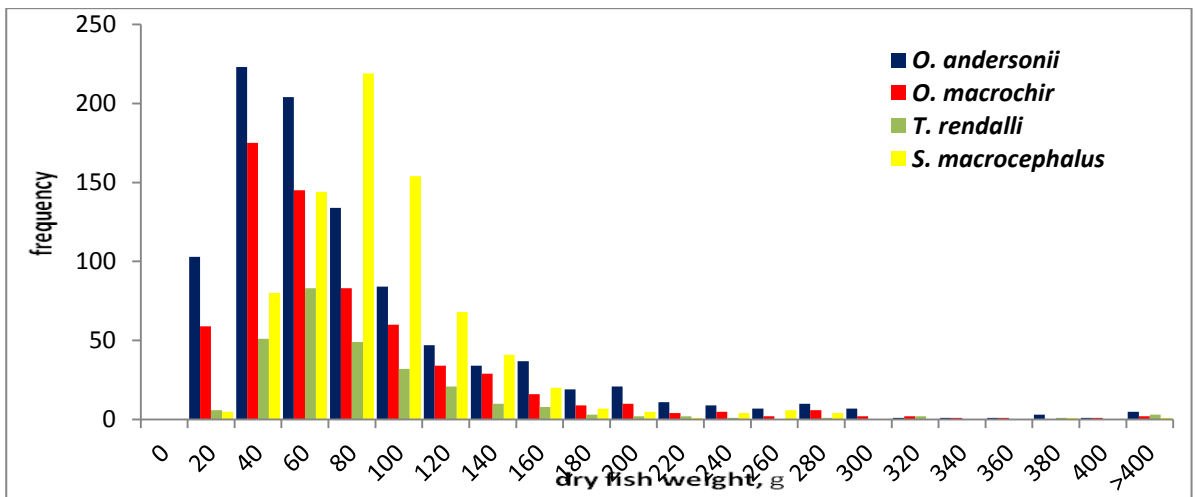




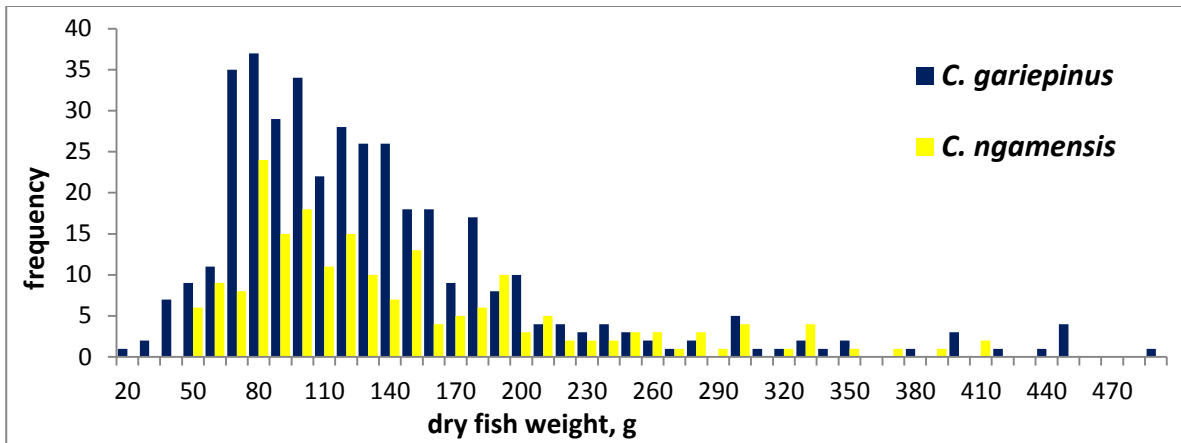
**Figure 12.** Frequency of fish species sold dry at the Katima Mulilo Open Market from November 2007 to May 2009.



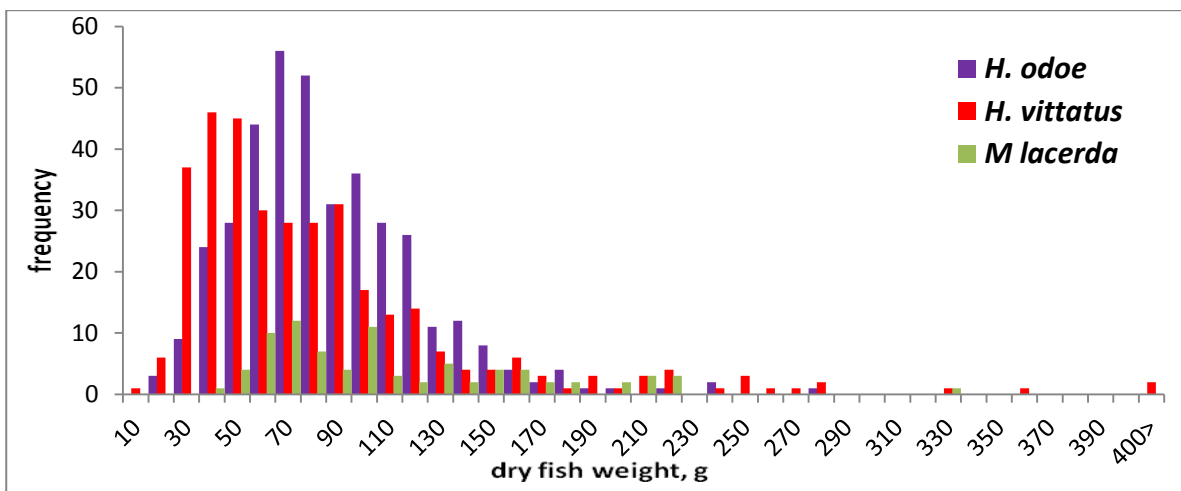
**Figure 13.** Average weight of dried fish ( $\pm$  SD) for sale at the Katima Mulilo Open Market from November 2007 to May 2009.



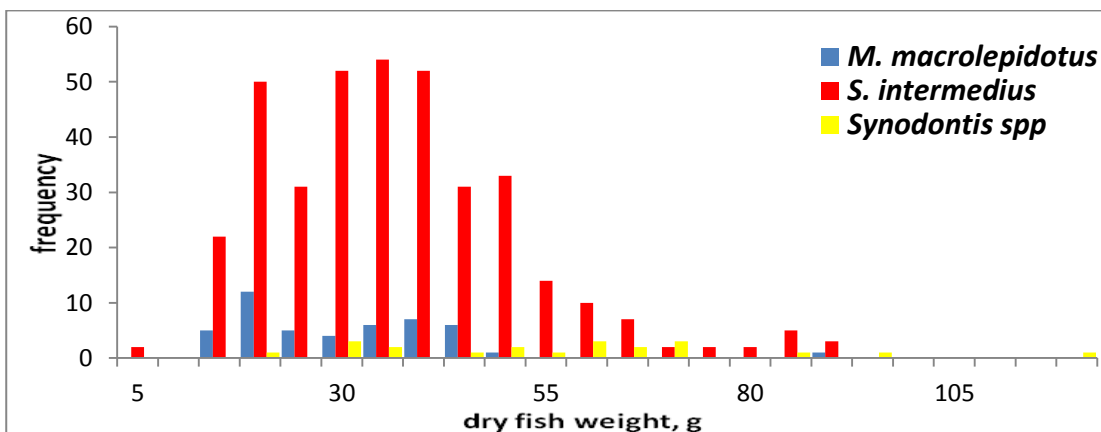
**Figure 14.** Weight distribution of dry fish on the fish market of *O. andersonii*, *O. macrochir*, *T. rendalli* and *S. macrocephalus* at the Katima Mulilo Open Market from November 2007 to May 2009.



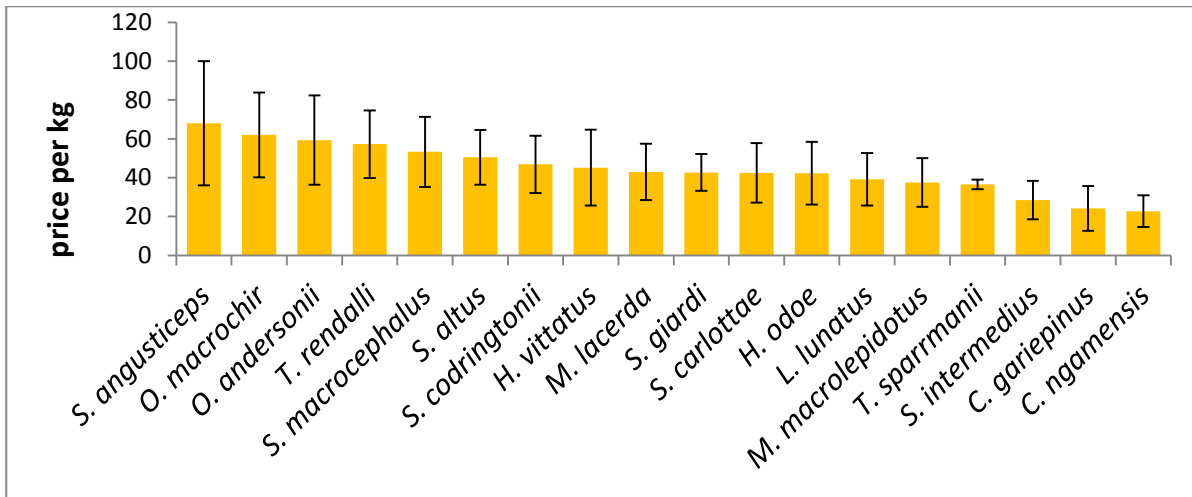
**Figure 15.** Weight distribution of dry *Clarias* spp. at the Katima Mulilo Open Market from November 2007 to May 2009.



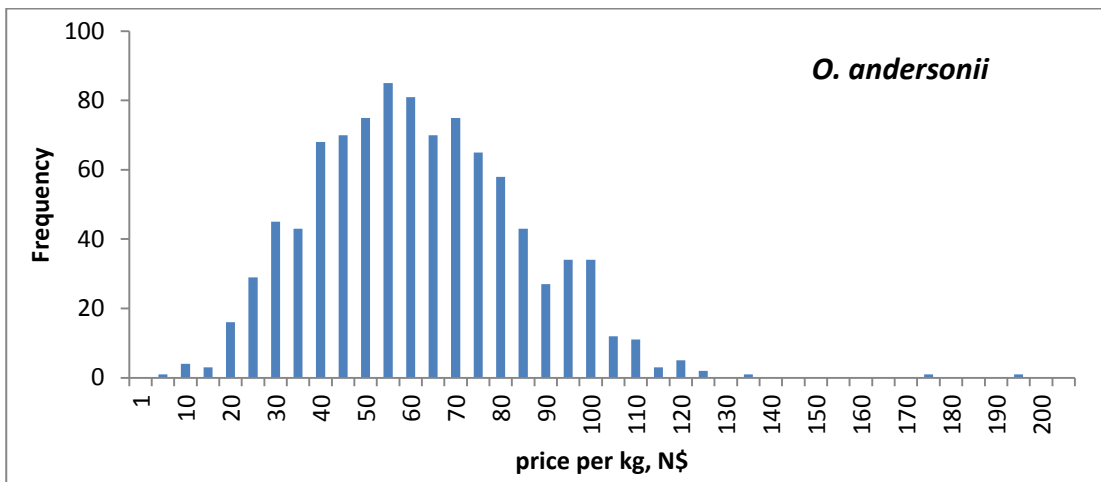
**Figure 16.** Weight distribution of dry *H. odoe*, *H. vittatus* and *M. Lacerda* at the Katima Mulilo Open Market from November 2007 to May 2009.



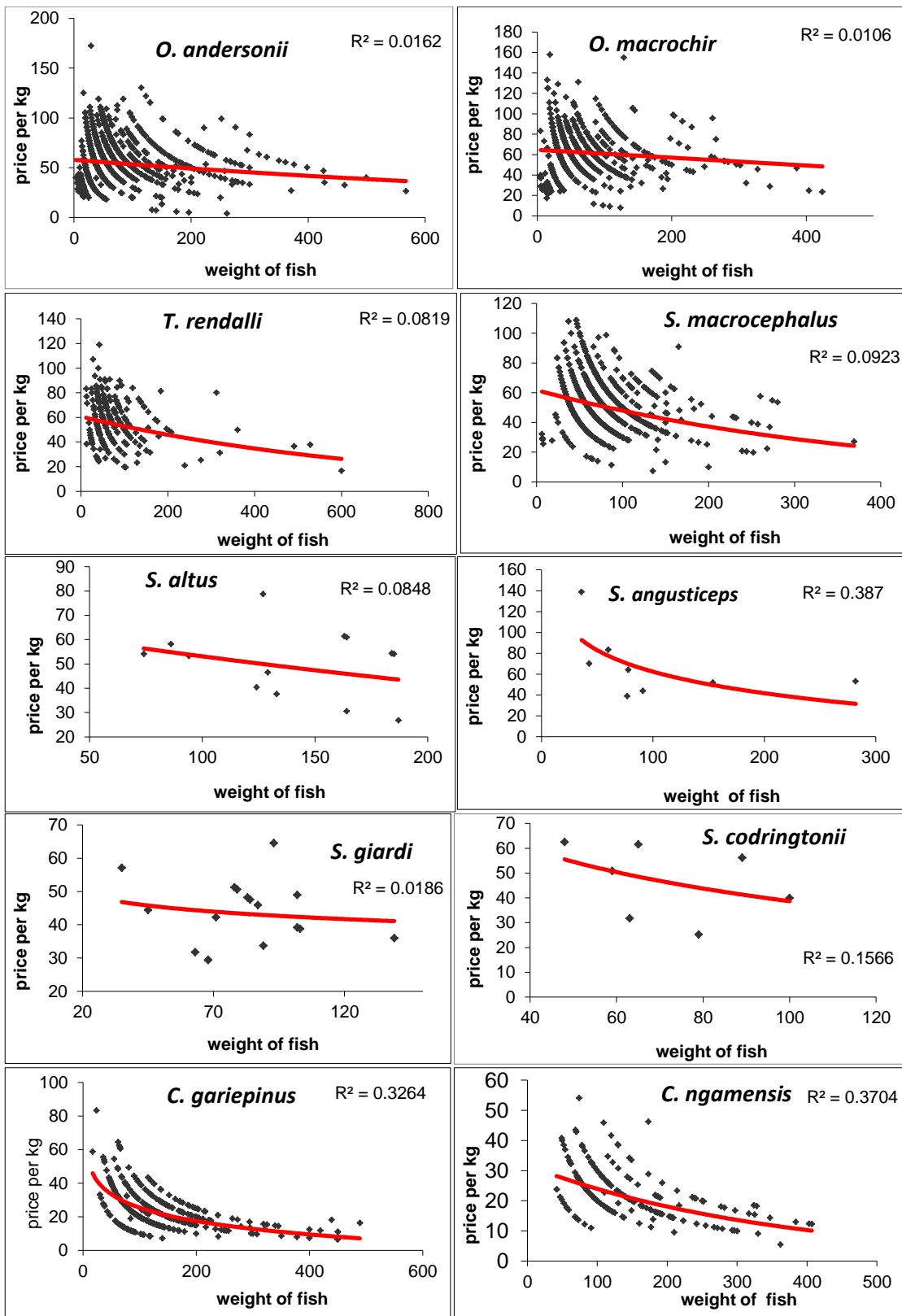
**Figure 17.** Weight distribution of dry *M. altisambesi*, *S. intermedius* and *Synodontis* spp. at the Katima Mulilo Open Market from November 2007 to May 2009.



**Figure 18.** Price per kg ( $\pm$ SD) for the most commonly sold dry fish on the fish market from November 2007 to May 2009.



**Figure 19.** Frequency of price per kg for dried *O. andersonii* at the Katima Mulilo Open Market from November 2007 to May 2009.



**Figure 20.** The change in price per kg with increase in individual weight of dried fish at the Katima Mulilo Open Market from November 2007 to May 2009. Best fit regression lines are added together with correlation ( $R^2$ ) values.

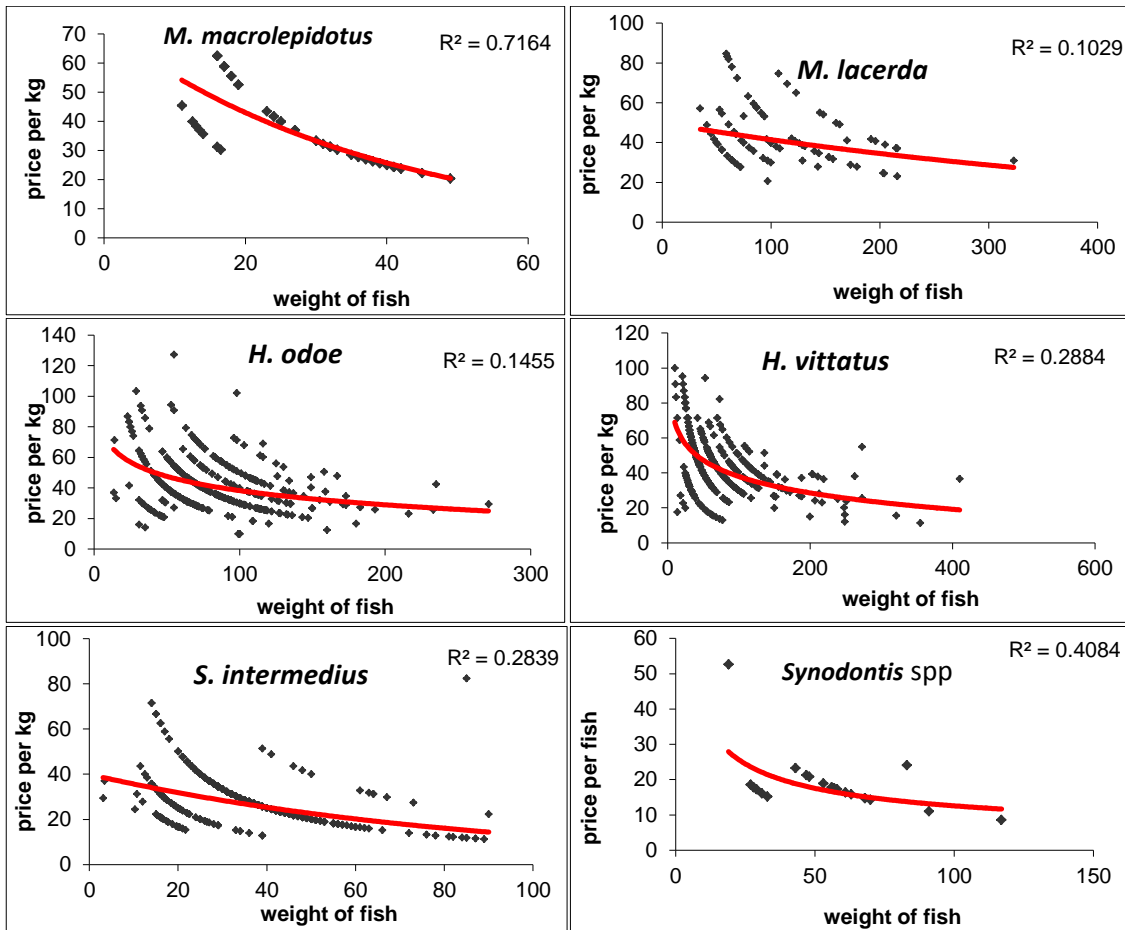


Figure 20 continued.

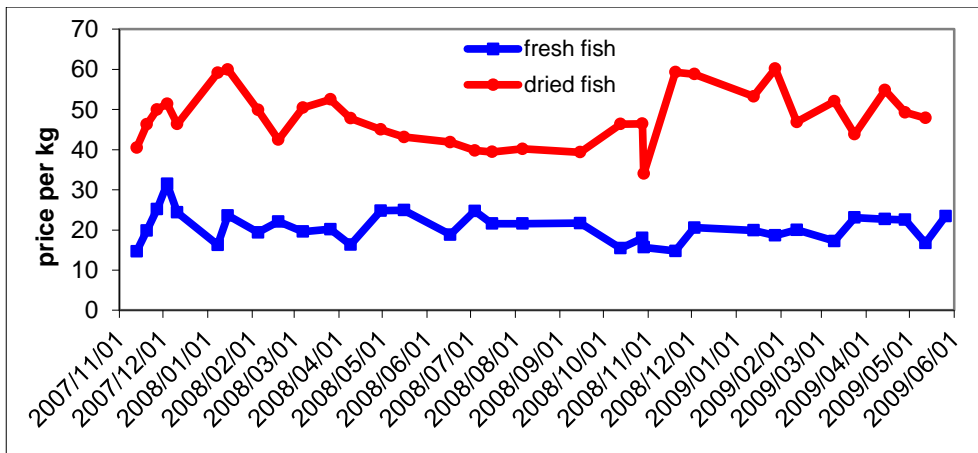
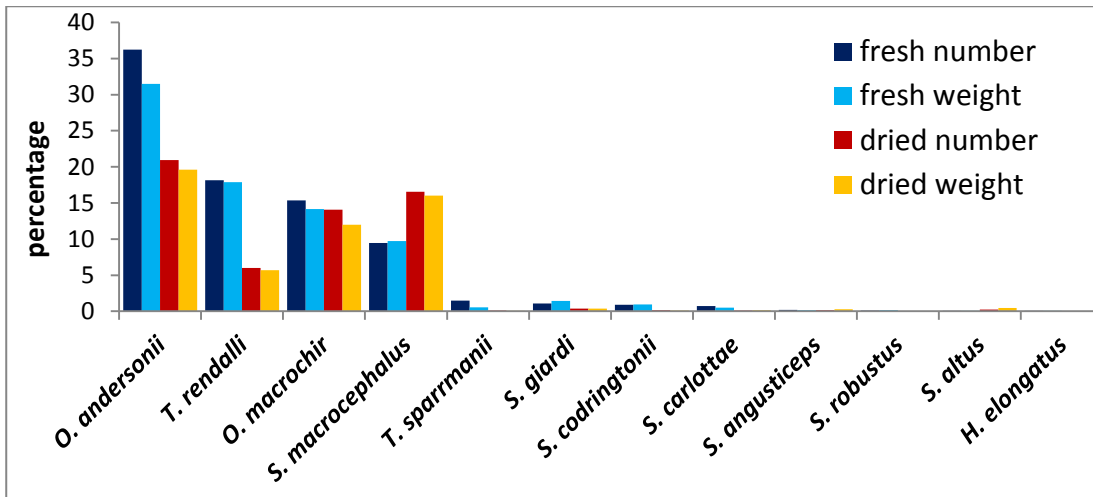
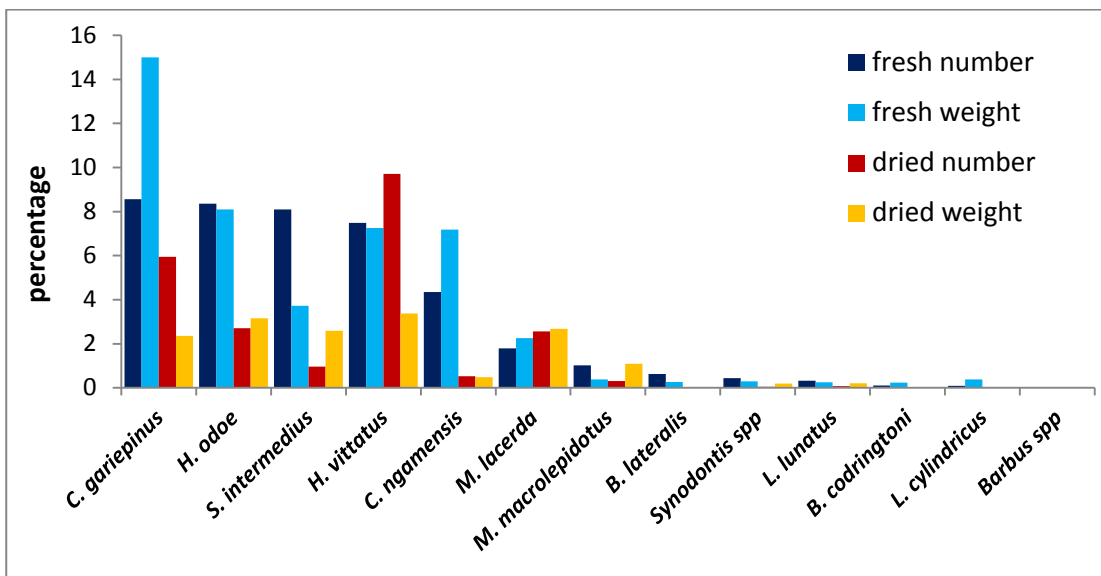


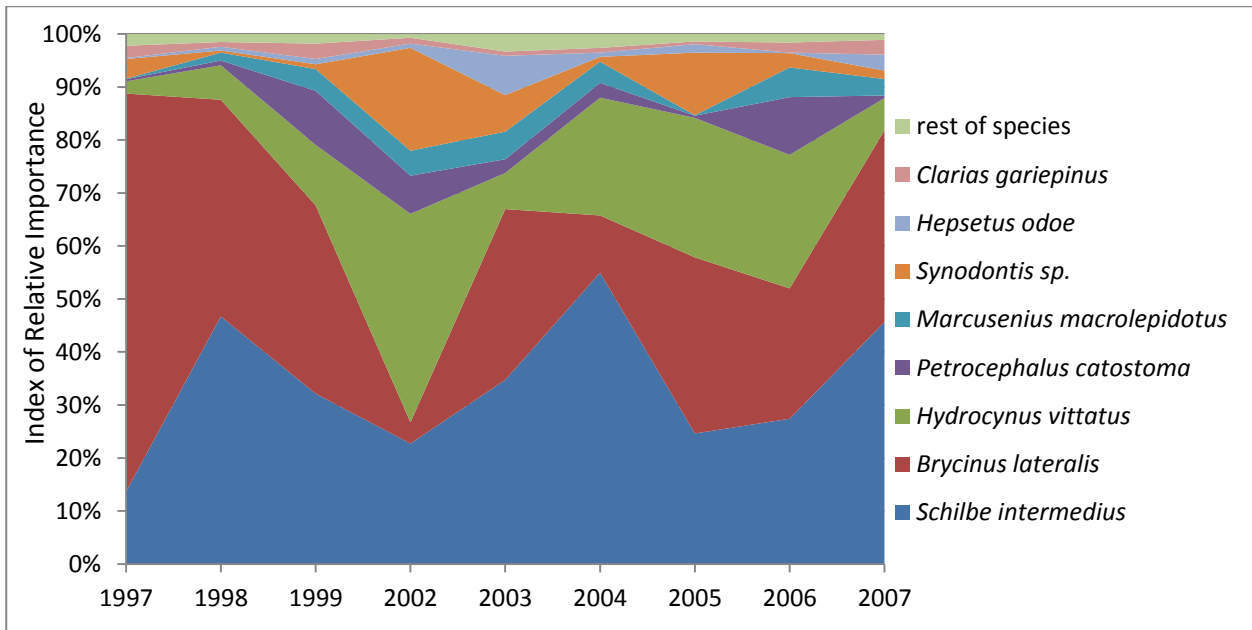
Figure 21. Change in fresh and dried fish price at the Katima Mulilo Open Market from November 2007 to May 2009.



**Figure 22** Percentage composition of cichlids sold fresh and dry at the Katima Mulilo Open Market from November 2007 to May 2009.



**Figure 23.** Percentage composition of non-cichlids sold fresh and dry at the Katima Mulilo Open Market from November 2007 to May 2009.



**Figure 24.** Species composition (Index of Relative Importance) in the rivers as monitored by graded multifilament gill nets (22-150 mm mesh) annually for the study period 1997 to 2007 (winter surveys) combined for the stations Katima, Lisikili, Kalimbeza, Impalila on the Zambezi River and Kabula on the Chobe River, (adapted from Hay, 2009).