A SOCIO-ECONOMIC CHARACTERIZATION OF A SMALL SCALE MORMYRID BASED BAIT FISHERY IN THE KAINJI LAKE BASIN

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ABSTRACT
Small-scale artisanal fisheries that target baitfish have been largely unnoticed and little is known about this fishery in Africa, despite their great importance in the fisheries of many inland water bodies in Africa. This study assessed a bait fishery in the Niger basin in Nigeria based on a small mormyrid, Pollimyrus petricolus (Daget, 1954). The socioeconomic characteristics of the stakeholders, bait-fishers, wholesalers, retailers and bait-users were described based on personal interviews. Most of the stakeholders are above 40 years of age (76.8%) with an average years of experience of 24.2 years in the bait fishery. The fishery is seasonal from November to June and is conducted mainly in the upper reaches of Lake Kainji floodplain while the baitfish is sold and utilized throughout Kainji and Jebba Lakes basin. Four different gears are used for the collection of baitfishes, Malian trap, Cast-net, Dip-net and Double Chambered non-return valve trap (Ndurutu), however the most preferred gears are Malian and Cast-net. Daily catch range from 500-2000 fish per fisher with December to February being the peak fishing period. The baitfish is usually transported in 50 litre jerrican covered with sack. Prices of bait fish were found to fluctuate with season. Analysis of marketing margin shows a market margin of 98,100 per week and marketing efficiency of 1.29. Fish caught with Pollimyrus bait are mainly Lates niloticus, Bagrus species, Heterobranchus species, Synodontis species and Hydrocynus species. The strength of the stakeholders includes high demand for live baitfish in the Kainji and Jebba Lakes' fisheries and availability of P. petricolus in large quantity while the main weakness is the seasonal availability of the baitfish. Over-exploitation and pollution from agricultural activities in the catchment of the P. petricolus fishing ground are the threats identified by the stakeholders.
Keywords: baitfish, small-scale fishery, Mormyridae, *Pollimyrus petricolus*,

INTRODUCTION
Small-scale fisheries include traditional, artisanal and subsistence fisheries. They may be mechanized but tend to use traditional fishing gears such as small nets, traps, lines and spears. Biodiversity of the catch tends to be high. Harvests include a greater variety of species than in large-scale fisheries, and a greater variety of small stocks distributed over numerous management units (Berkes, 2003). An estimated 90 percent of the 38 million people recorded by the Food and Agricultural Organization (FAO) globally as fishers and fish-farmers are classified as small-scale (FAO, 2004). Globally, small-scale fisheries and fisheries-related activities (processing, trading, net-repairing, etc.) make an important contribution to the nutrition (Srinivasan *et al*., 2010), food security (Alder *et al*., 2007), sustainable livelihoods and poverty alleviation of many countries, especially in Africa. Artisanal or small-scale fisheries are critically important both in socio-economic and food security terms, with estimates suggesting that 50 million small-scale fishers operate in developing countries, while up to 250 million people rely directly on the fisheries for food, income and livelihoods, and a further 150 million people work in associated sectors, such as boat building (Berkes *et al*., 2001; FAO, 2004). Yet small-scale fisheries have been marginalized throughout the world through government policies that tend to favour large-scale, commodity-oriented fisheries (Berkes, 2003). In Nigeria, artisanal fisheries contribute the highest percentage of fish consumed by Nigerians, followed by marine and aquaculture. But because artisanal fisheries often supply only the domestic market and contribute little to the export economy of most developing nations, they are often given low priority by national government. Artisanal fisheries are diverse, in terms of participants, fish resources, gears, contexts, and complex in their connectivity to other livelihoods, other ecological systems and across multiple scales (Berkes *et al*., 2001; Berkes, 2003). One of the essential fishing inputs in small scale fisheries is baits which can be live or processed animal, plant products and artificial.

Bait fish are small fish caught for use as bait to attract large predatory fish, particularly game fish and commercial carnivorous species (Wikipedia, 2010). This group of fish is large and diverse schooling species typically common and breeds rapidly, making them easy to catch and in regular supply (Wikipedia, 2010). Common freshwater bait fish include the carps

(Cyprinidae), suckers (Catostomidae), top minnows or killifish (Cyprinodontidae), sardines (Clupeidae), sunfish Centrarchidae), or tilapia (Cichlidae). In the Niger River system of Nigeria, there exists a small but growing bait fishery based on an unusual species, *Pollimyrus petricolus* (Daget, 1954). This is a small mormyrid known only from the Upper and Middle Niger basins, the lower limit of its known distribution range is Lake Kainji lake basin (Paugy, *et al* 2003). In many artisanal fisheries, less attention is given to baitfish as their economic value is overshadowed by the large species they are used in catching. The present study is an assessment of the socio-economic status of the *Pollimyrus petricolus* based bait fishery of Lake Kainji, Nigeria. The specific objectives were to:

i) Describe the individual characteristics of the *Polimyrus petricolus* live baitfish fishery stakeholders in Kainji Lake basin.
ii) Describe the structure of bait fish marketing in the study area
iii) Determine the marketing margin and efficiency
iv) Recommend management measures for the sustainable exploitation of this mormyrid fish

The study will increase our understanding of the contribution of this fishery to livelihood and food security in the basin.

MATERIALS AND METHODS

Study area

The upper Niger River system in Nigeria consist of large tributaries like the Sokoto, Rima, Kontagora, Edu Rivers and two large reservoirs supporting a diverse artisanal fisheries (Figure 1).

Kainji Lake is a shallow tropical man-made lake formed in 1969 by the damming of River Niger at Kainji. It lies in the Savanna region of Nigeria between latitude 9^0 20'N and 10^0 35'N, and between longitude 4^0 20' and 4^0 50'E. The mean depth is between 9-10metres and a surface area of about 1,270km^2. The geology and geography of the Niger valley in the area now covered by Lake Kainji was described by NEDECO (1959) and White (1965). The Lake has been described by many authors: Lelek (1972); Imevbore & Bakare, 1974; Ita (1978) and Sagua & Fregene (1979).

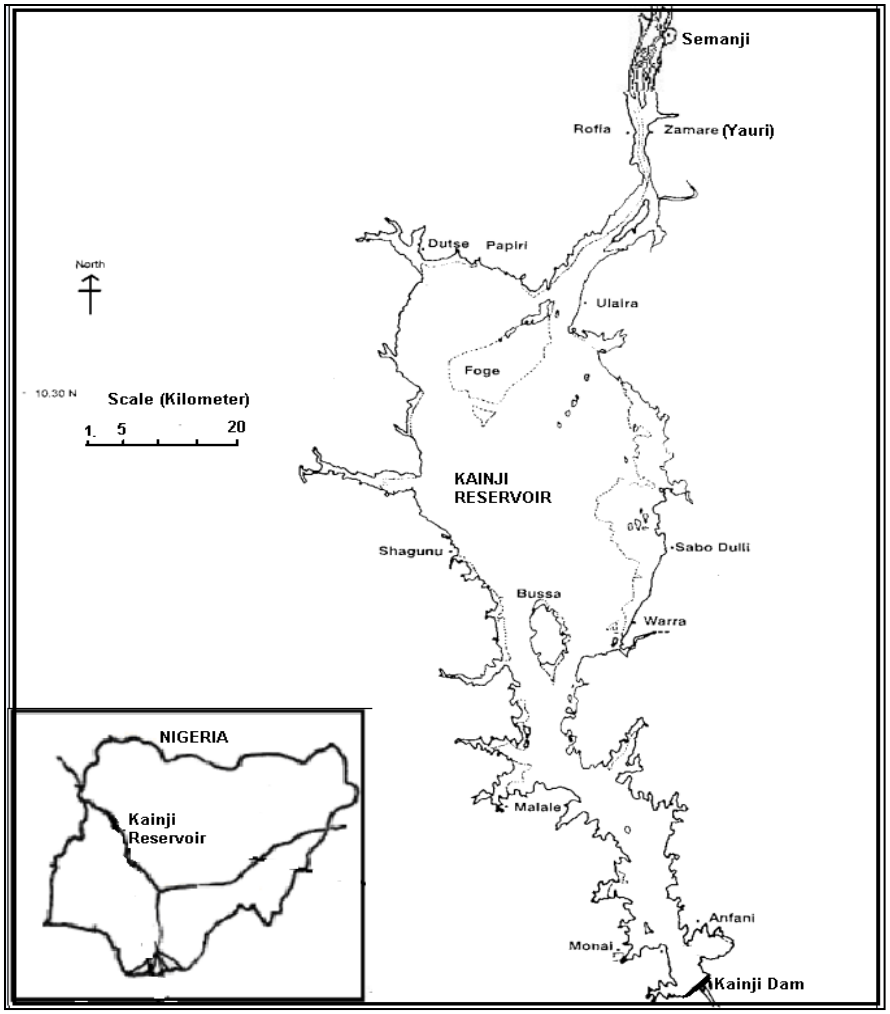

Fig. 1: Kainji Reservoir showing the study area

Survey methodology

The survey took place between March and May 2009 and follows the approach of Neiland *et al.* (1997) which involves a random survey of fishing households (FHH), and other stakeholders along the bait fish value chain. Data for the study were collected from primary and secondary sources. Primary data were collected through semi-structured interview and structured questionnaire administered to stakeholders. Secondary data were obtained from published materials such as journals, textbooks etc.

Study surveys were conducted in four sites, namely:

1. Survey site 1: *Pollimyrus* fishing ground (Palu and Semanaji villages Kebbi State, Nigeria)

Pollimyrus bait fishes were obtained from the floodplains in the Niger River upstream of Kainji Lake. However, information on the fishermen engaging in the collection of this fish was obtained from fishermen in Palu and Semanaji Villages of Shanga Local Government Area, Kebbi State, Nigeria. These villages are on the bank of Palu River which is annually flooded by the Niger River. The interview was conducted on the 17th of May, 2009. A total of twenty one respondents (Fishermen) were randomly selected in these villages.

2. Survey site 2: Baitfish wholesale market, Yauri (Zamare), Kebbi State

Information from the wholesalers was obtained at Yauri, Kebbi State; Nigeria (a large town that lies at the tip of Lake Kainji) on the 16th of May 2009. Due to limited number of wholesalers involved in the marketing of bait fishes, the four wholesalers were purposefully selected for the interview.

3. Survey site 3: Retail market, Sabon Pegi Market, Niger State, Nigeria

The Sabon Pegi market is situated after the Kainji dam on the New Bussa - Mokwa Road. The seven consistent retailers were purposefully selected for interview. Supply and sales data were generated from them for five weeks consecutively from 20th of March, 2009 to 1st of May, 2009.

4. Survey site 4: Retail market and fishing ground, Old Awuru Fishing Village, Niger State.

Old Awuru fishing village is located on north-western shore of Jebba Lake. The market day is Sundays. Data were obtained from the fishermen who make use of the *P. petricolus* as bait for fishing, in two market days on 22nd of March, 2009 and 5th of April, 2009. A total number of thirty six fishermen were randomly interviewed.

Method of Data Analysis

The data analysis was achieved by using descriptive statistics and marketing margin estimates

Descriptive Statistics

Descriptive statistics such as frequency distribution, percentages were used to describe the socio economics characteristics of the respondents.

Marketing margin analysis

Marketing margin is the difference between the price paid for a given commodity at different stages of time, form, place and possession as it moves from the primary producer to ultimate consumer (Olukosi and Isitor, 1990). It is expressed as follows:

Marketing margin = Retail Price-Producer Price x 100

Retail price

It can also be express as

MM = ATR - ATMC

Where MM = Marketing Margin

ATR = Average Total Revenue

ATMC = Average Total Marketing Cost

The marketing efficiency was calculated thus:

ME = ATR/ATMC

Where ME= Marketing efficiency

RESULTS

The Bait Fish (*Pollimyrus petricolus*)

The bait fish, *Pollimyrus petricolus* shown in Plate 1 is the only commercial live baitfish traded in the Kainji Lake and Jebba Lake Basins. It is a small fish with maximum observed standard length of 110mm. The body is covered with minute scale and the fins lacks spine.

Plate 1: *Pollimyrus petricolus* (Daget, 1954)

Socio-economic characteristics of the *Pollimyrus petricolus* live baitfish fishery

The mean age of the stakeholders namely bait fish collectors, wholesalers, retailer and bait users are 44, 56, 43, and 41 years respectively**.** It shows that most of the stakeholders were no longer in their economic active years. The result also reveals that young people are not going into the baitfish fishery even though the number of children per stakeholder is very high (Fig. 2).

In term of education the result shows that most of the stakeholders have no formal education. The highest level of education among the stakeholders is secondary school (Fig. 3). The stakeholders studied have been in the baitfish fishery for quite a long period (Fig. 4).

Other likelihoods that the stakeholders of *P. petricolus* live baitfish fishery engage in include farming, crop produce trading and animal husbandry. The SWOT analysis of the four stakeholders involved in *P. petricolus* live baitfish fishery is given in Table 1. The strength of the stakeholders includes high demand for live baitfish in the fisheries; availability of *P. petricolus* in large quantity, the fishery requires little inexpensive input among others while the main weakness is the seasonal availability of the baitfish. Over-exploitation and pollution from agricultural pesticide use in the catchment of the *P. petricolus* fishing ground are the threats identified by the stakeholders.

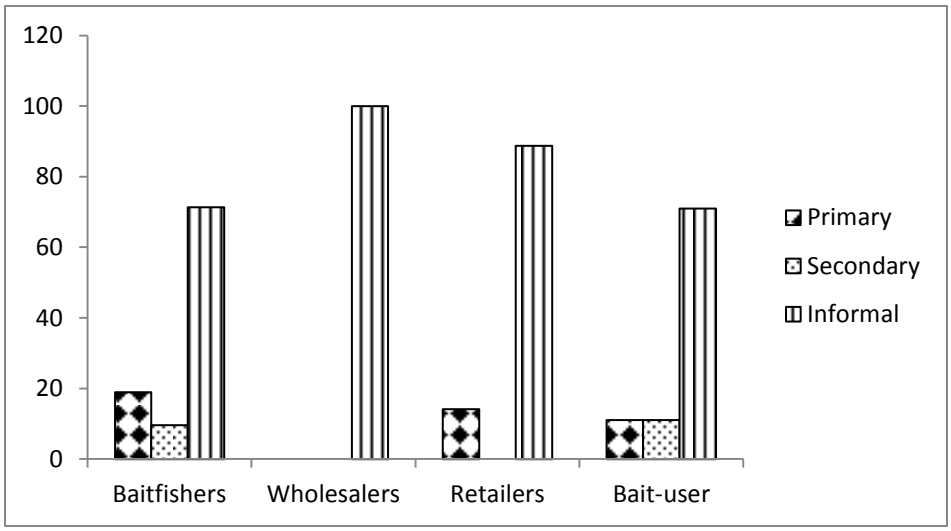

Fig. 2: Educational background of stakeholders in *Pollimyrus petricolus* live baitfish fishery

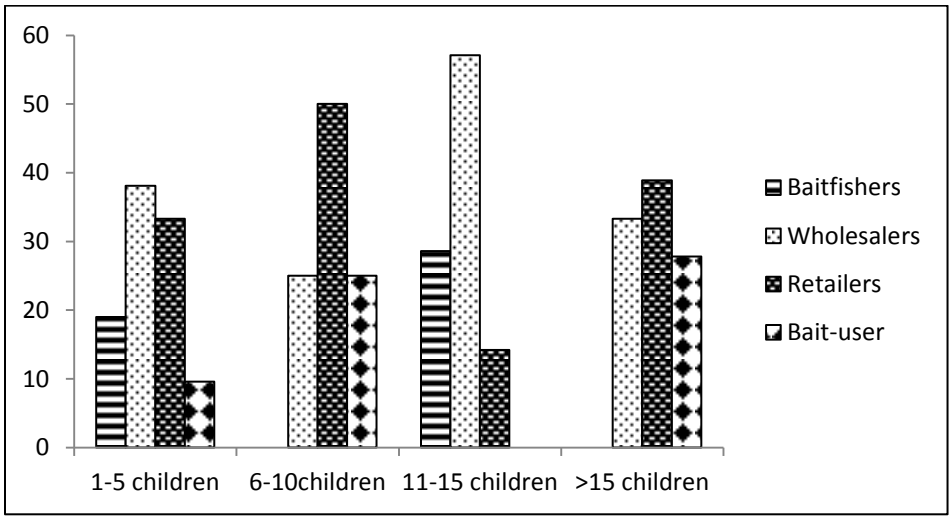

Fig. 3: Number of children per stakeholder of *Pollimyrus petricolus* live baitfish fishery stakeholders

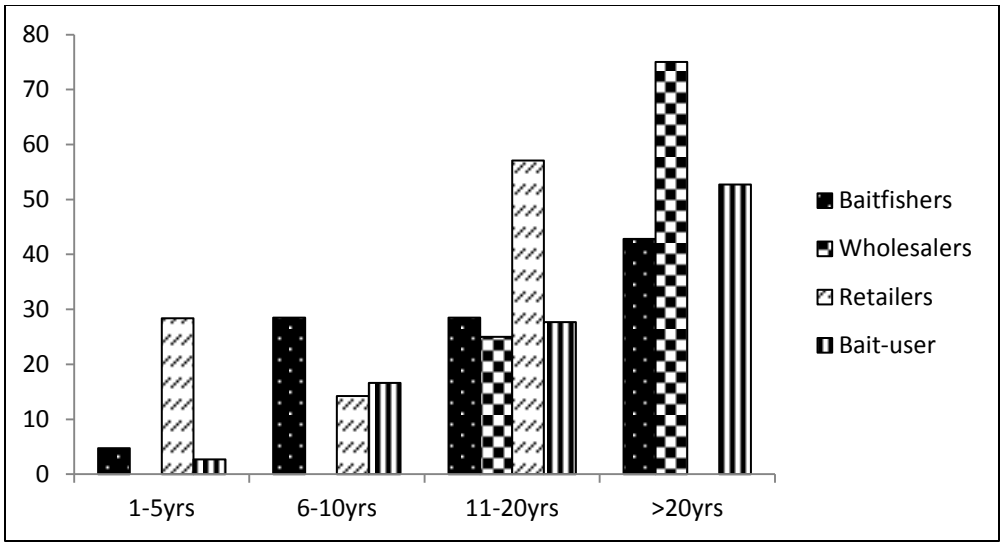

Fig. 4: Years of experience of stakeholders in *Pollimyrus petricolus* live baitfish fishery

Characteristics of the stakeholders

Fishermen (Bait-collectors)

Based on the age of the bait collectors, fewer youth are venturing into the collection of bait fishes as a livelihood. Most of the collectors are above forty years of age. The bait-collectors are concentrated in villages around the fishing grounds. In Semanaji village for instance there are four fishing ground which are mainly floodplains. Bait fishing duration is seasonal and limited to eight months in the year. During the off season of bait fishery many of them are engaged in other fishing activity and farming.

Collection gear: There is no mechanization in term of gear or craft in the collection of this baitfish. The fishers can access their fishing grounds on foot and during high water by wooden canoe. The gears used in harvesting *Pollimyrus* are simple and are made from cheap and locally available materials with the exception of monofilament fishing net. Five different gears are used for the collection of *Pollimyrus*, Malian trap (Plate 2), Cast-net, Dip-net and Double Chambered non-return valve trap (*Ndurutu*). However, the most preferred gears are Malian and Cast-net. According to the fishermen, the Malian traps sometimes catch other food fishes which are either attracted by the baitfish or caught directly. In the construction of Malian trap, monofilament net of ¼ "mesh size is used. Each collector have an average of thirty Malian traps which are set across the river while the remaining stretch of the water is blocked with ¼" mesh sized net as shown in Plate 1 in Palu River. The traps are checked twice daily in the morning and in the evening.

Daily catch range from 500-2000 fish per fisher. According to the bait collectors the months of peak catch which correspond to the abundance of the fish is December to February. This is the period when the flood water is receding with the matured and newly recruited fish moving back into the main river. The period of low catch is March to May, a hot and dry period when the rivers are at low water.

The fishers collect the fish in bowls and later count them into black coloured 50litre jerrican (plate 2). The standard number of fish per jerrican is 2000. The fish are sold to wholesalers from Yauri who buys them from the fishers at the rate of N250 ($1.5)/100fish. According to the fishermen whenever catch is dwindling prize per 100 fish do rise to N260 ($1.6) or N270 ($1.7). According to the fishers they get the best prize in November and poorest prize in May/June. The fishers usually sell to fellow fishers but most of their catches (90%) are sold to the wholesalers. The fishers sometime pull their catch together and transport to the wholesalers at Yauri. On the average baitfish collectors makes an average of N2,500 per day at an average catch of 1000 fish/day.

The dead bait fish is usually sundried and sold as fishmeal at the Yauri Market by the fishermen.

Table 1: SWOT analysis of the *Pollimyrus petricolus* live baitfish fishery

Stakeholder	Strength	Weakness	Opportunities	Threat
Baitfishers	There is high demand for *Pollimyrus* as bait. It is easy to go into the venture –it requires no canoe or other expensive fishing input The fish are easy to catch and less labour is involved The fish is hardy and can withstand stress of overcrowding They have a cooperative group Dead fish can be dried for fishmeal	Seasonal of availability of the baitfish	To develop means of keeping the fish for long period To breed the fish in captivity	Pollution of water where the fish breeds The use of chemical and obnoxious method of fishing Bad road
Wholesalers	There is high demand for *Pollimyrus* as bait. Buyers come to buy directly The return is good The fish is hardy and can withstand stress of overcrowding Dead fish can be dried for fishmeal	Seasonal of availability of the baitfish Mortality during the dry and hot season	To develop means of keeping the fish for longer period	Pollution of water where the fish breeds The use of chemical and obnoxious method of fishing Bad road Fuel Scarcity/high cost of fuel
Retailers	There is high demand for *Pollimyrus* as bait. It is easy to go into the venture The fish is hardy and can withstand stress of overcrowding	Seasonal of availability of the baitfish Mortality during the dry and hot season	To develop means of keeping the fish for long period To develop better means of transporting the baitfish	Pollution of water where the fish breeds The use of chemical and obnoxious method of fishing Bad road Fuel Scarcity/high cost of fuel
Bait-users	*Pollimyrus* is good bait for catching commercial species. The fish can stay for up to 24hours when placed on hook before dying. It is less expensive to buy long-line compare to gillnet. The fish is hardy and can withstand stress of overcrowding	Seasonal of availability of the baitfish Mortality during the dry and hot season. Sellers do not give extra number of fish to compensate for mortality	To develop means of keeping the fish for long period	Destruction of lines by boats and canoes. Bird predators do pick the bait Flood carrying the line away Pollution of water where the fish breeds The use of chemical and obnoxious method of fishing.

Plate 2: Set Malian trap in the floodplain of Palu River

Plate 3: Seine-net used in blocking the floodplain to direct *Pollimyrus petricolus* to the Malian trap

Wholesalers

At Yauri Market, Kebbi State, there are four wholesalers although one of them is the most influential. The main wholesaler has a vehicle with which he travels to the fishing villages to buy the bait from the fishers. According to him a trip cost between N5000 - N6000 because the access roads to these villages are very bad and are not motorable for most of the year.

The other three wholesalers depend on the major wholesaler for their supply although they sometime get supply from the fishers who bring them to the market. The major wholesaler buys the baitfish at N250/100fish from the fishers and sells it at N400 to the other wholesalers while they all sell at N450 on the average to the retailers.

The wholesalers form themselves into a Baitfish marketers association headed by the major wholesaler.

Retailers

Fish retailers are independent dealers with limited buying capacity. Their number on a given day varies.

Two groups of retailers were studied; those retailing at Sabo Pegi market (every Fridays) and move to Old

Awuru market (every Sunday) with the remainder of their fish. The other group only retails at Malale market on Fridays. The first group of retailers leaves early in the morning from Yauri to get to Sabo market at about noon. The fish are transported in jerry cans covered with sack to reflect light radiation away from the black heat absorbing plastic (Plate 4). The sacks are wetted with water so that its evaporation will have cooling effect on the content of the jerrican. An opening is created at top of the plastic container by cutting a flap on side of the handle. Their main mean of transportation is the open pick-up truck through untarred road. Each jerry can is transported at the rate of N500 from Yauri to Sabo market. The market situation for two of the retailers was studied for five weeks in 2009 and the result is shown in table 2. Generally, trade takes place at the market and not at the waterside on a cash and carry basis.

Table 2 shows the marketing margin and efficiency as computed on weekly basis. A market margin value of 98,100 and market efficiency of 1.29 was recorded. When expressed in percentage, the market margin obtained is 22.24%.

Plate 4: Fifty litre plastic containers used in transporting and keeping live *Pollimyrus petricolus*

Table 2: Marketing Margin and Efficiency of bait fish in the Sabo Pegi market, Niger State

Average Marketing Cost	Values (in Naira per week)
Average Total Marketing Cost(ATMC)	342,900
Average Total Revenue(ATR)	441,000
Marketing Margin(ATR-ATMC)	98,100
Marketing Margin %	22.24
Marketing Efficiency	1.29

Bait-users

Most of the bait-users were born into families of fishers. The fishers use *Pollimyrus* as bait with three main gears - Long-line (97.2%) known locally as *Mari-mari*, Hook and line (80%) and Malian trap (50%). The hook size use with long line ranges from hook no 1-9. According to the bait-users hook number 1 is use for baiting Niger perch (*Lates niloticus*) while hook number 7 is use mainly for medium sized fishes.

P. petricolus is placed on the hook by passing the shaft through the fish body below the spinal vertebrae as shown in plate 4. This allow the fish to remain alive for up to 24 hours on the hook. Apart from *Pollimyrus petricolus* other fish species are also use as bait these include small *Clarias*, *Heterobranchus*, Tilapia and Synodontis. However *P.*

petricolus is the preferred baitfish among the bait-users because it has no spine unlike the other bait species that might make predator wary of taking a bite. Beside, *P. petricolus* is very hardy and can remain alive for up to two week in a container with a daily change of water. According to the bait-users the availability of this fish in large quantity make them the best bait for long-line, a gear that can have about 100 baited hooks.

The bait-users studied usually purchase *Pollimyrus* from Awuru market at the rate of N450-700/100fish depending on its abundance.

The fishers use the following methods to keep the baitfish longer in captivity; daily water change and addition of little salt into the water. The highest mortality occurs in the months of April and May during the hot dry period before the rainy season and this is also the time the fish are fecund.

Fish caught with *Pollimyrus* bait are *Lates niloticus*, *Bagrus* species, *Heterobranchus* species, *Synodontis* species and *Hydrocynus* species. Daily catch of fish with *Pollimyrus* baited hook ranges from 4-20 kg with an average of 10.57 kg.

Plate 5: *Pollimyrus petricolus* placement on the hook

DISCUSSION

The Bait Fish (*Pollimyrus petricolus*)

The genus *Pollimyrus* comprises of small species of Mormyrid fishes represented in Nigeria by three species (Olaosebikan and Raji, 2005); *Pollimyrus adspersus* (Gunther, 1866), *Pollimyrus isidori isidori* (Valenciennes, 1846) and *Pollimyrus petricolus* (Daget, 1954). They are characterized by rounded head with the deepest part of the body at the level of pelvic fins. *Pollimyrus petricolus* (Daget, 1954) is endemic to Upper Niger in Guinea to the middle Niger above Lake Kainji (Paugy, *et al* 2003). *Pollimyrus* and indeed Mormyrid generally do not belong to the traditional bait species although this fish has the attributes of a good baitfish. Baitfishes are characterized by high growth rates, high fecundity, and have short generation times. Information on the reproductive biology of *P. adspersus* and *P. isidori* shows that these fishes mature at six months (Kirschbaum, 1987 and Kirschbaum & Schugardt, 2006). They are fractional spawners that shows parental care by building nest and care of the eggs and larvae, the two species are known to produce on the average 120 eggs per spawning at intervals of between 2-20 days during the breeding season (Kirschbaum, 1987). This agrees with the characteristic of most baitfish (Wikipedia, 2010). In addition to the above characteristics, this fish moves in massive school that enables trapping and collection large number relatively easy. They are very hardy, capable of surviving in crowded deoxygenated condition for up to a week.

Socio-economic characteristics of the Pollimyrus fishery

Inland fisheries in Africa provide a major source of subsistence and income to many African countries. Despite the increasing importance of inland fisheries over the last forty years (Geheb and Sarch, 2002), there are few studies that have investigated the role of bait fish fishing in the livelihoods of rural people in Africa. FAO (1995) has identified the characteristics of inland fisheries of central Africa which can be classified into three categories. The category one is based on the environment – fishery production levels are highly dependent on rainfall regimes with fish production from seasonally –inundated areas dominating the catches. The second category according to FAO (1995) is fishing patterns- fishing is carried out using

simple gears; fish stocks exploited are typically large masses of fast growing fish taken from the floodplains or fishing the concentrations in residual rivers and lakes; with changes in the size of landings mainly a reflection of the cycle of rainfall and flood. The third category is socio-economic factors. The bait fishery in this study agrees with the FAO (1995) category two fisheries characteristics. This type of fisheries has been identified by Neiland, *et al* (1997) in the Upper Benue, Lake Chad and Nguru- Gashua wetlands of North East Nigeria. The bait fishery is related to the flood regime of Niger River in Nigeria. Apart from the regular inflow of water, River Niger and Kainji Lake experiences two major annual floods namely the 'white' and 'black' floods. The white flood is formed as a result of rain from Nigeria that enters the Lake as from mid-August with peak flow of 4,000 - 6,000 m^3s^{-1} in September to October. This flood is characterized by high turbidity. The black flood that is derived from the rainfall at the upper catchments of River Niger in Guinea, Mali and Burkina Faso enters the lake in November with a peak flow of about 2,000m^3s^{-1} and it is characterized by high water transparency (Mbagwu *et al*., 2000). The months of peak catch of *P. petricolus* baitfish is December to February corresponding to the period when the Black flood starts to recedes. In this study the fish fence which the baitfish collectors use in congregating the fish towards the trap is made of small mesh size net. Fish fence is a common feature of floodplain fishery in Nigeria (Ita, 1995; Neiland, *et al* 1997). The study showed that bait-collectors do not depend solely on this fishery for livelihood as they derive significant portion of their income from farming and fishing food fish and fishmeal. According to Neiland, et al, (1997) fishing and farming represent complimentary activities which are integrated within the economic activity patterns of the rural households.

This is the first record of bait fishery in the fisheries of Kainji Lake and indeed in the inland fisheries of Nigeria. This study highlight the importance of identifying and characterization of social differentiation among fishers as the fisheries of this lake is one of most studied in Nigeria. This has been recognized by Malvestuto and Meredith (1989), Carmouse et al (1983), Thomas (1995) and Neiland, *et al* (1997). The rules guiding fishing activities of bait fishery are customary with little or no state regulation. The bait-collectors have a cooperative society known as *Masunta* fishermen society. The society serves the interest of the members in term of obtaining credit for buying fishing input and protection from right abuses.

Baitfish Fishery Marketing Structure

The structure and general pattern of distribution and marketing of *Pollimyrus* as observed during the study shows that *Pollimyrus* passes through two intermediaries (wholesalers and retailers) before getting to the end user. According to Adegeye and Dittoh (1983) the characteristics that affect the behaviour and performance of a market is directly related to the set up of the market in terms of degree of connection, number of firms and size constituting the market structure.

CONCLUSION

The present study is an empirical investigation into the socio economic characteristics of a little known small scale bait fishery in the Kainji Lake basin. The study showed that there are small-scale artisanal fisheries that target stocks that are not noticed or largely ignored by fisheries management agencies in many inland fisheries of Africa. The results obtained shows that market volume is small, although the baitfish is important in process of catching bigger food fishes in the lake. There is the absence of women involvement in this fishery while most of the men involved are above 40 years and indicate that younger individuals are not taking to this fishery. The structure of bait fish marketing revealed that bait fish passes through a number of intermediaries before getting to the final consumer. The bait fish is lucrative to the stakeholders involved though the return is seasonal and therefore need to combine this livelihood with other livelihood like farming and catching of food fish. There is need for the application of technology in the transportation and holding of baitfish to reduce mortality. This may involve the use of insulated container and aerating devices. Further research into the biology of this fish in order to encourage the captive breeding in ponds for all year round availability of bait is recommended.

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