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Fish Biodiversity and Fishing Activities at Njoboliyo Lake, Adamawa State, Nigeria

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Abstract

This study assesses the fish catches at Njoboliyo lake, Adamawa state. Investigation was carried out from the months of May to August, 2014 to determine the demographic profile of the fishing communities, species of fish harvested, economic impact on the fishing communities and contributions of other livelihoods activities to the overall economy of the fishers. Weight of fish caught was recorded at landing sites using weighing balance and the price of fishes was determined to be four hundred and fifty naira (450) per kilogram. Seventeen (17) species from fifteen (15) families were identified during the period of study. The family Claridae has more species appearance with 54.8%, while the least species appearance with 1.6% was Citharinidae. The fishes were caught with mesh nets and hooks by the fishers. Drag net has highest gear utilization, while gill net lowest. The month of June has highest weight catch of 58 kg valuing ₦26,100; July has lowest catch of 35 kg valuing ₦15,750. Farming after fishing has highest contributing activities to the economy of the fishers with 59.4%, while civil servant has lowest of 3.1%. The traditional co-management system 'Mburkache' is used at Lake Njoboliyo.

Introduction

Tropical freshwater small scale artisanal fisheries provide cash income and animal proteins to many people in rural and urban areas of developing countries [1]. Though fishing is done at large artisanal scale in the ox-bow lakes, flooded plains and wet lands of Upper River Benue, it has in time suffered neglect in terms of development over the years when compares with other sectors of the economy [2], by Government planners whom at times do not release funds or when released will not be enough to run this sector.

However, those fisheries have been increasingly threatened or even disrupted by man-made induced environmental changes, such as pollution: clearance for farmlands and cutting of trees for firewood (deforestation), habitat alteration like river impoundment [3], poor management and over exploitation, these decrease in resources availability, does not only resulted in poor income, but also in well-being of fishing households and the community.

Since fishing communities in Nigeria are generally still far from development the fishers are categorized among the poorest of the poor [4-6]. This important sector has been faced with several constraints, such as fishers having low income, no properties, weak political influences [2,7,8], where these are prominent. Livelihood diversification has been identified as good option that lessens vulnerability, enhance wellbeing and improve rural economy of the fishers [9].

The management of fisheries resources is central in addressing the fishers' vulnerability and improving their livelihoods. This realization necessitated several approaches for resources management over the years by government, donor agencies and non-governmental organizations, with more recent advocacy on concept of livelihood and diversification in order to reduce fishing effort and improve their wellbeing [10]. There is need to look at the contribution of each livelihood activities in the communities and their best combination in order to strengthen the efforts of the fishers in diversifying their livelihood is fundamental to achieve self-sufficiency, improve standard of living and enhance rural community development in those areas.

Upper River Benue being the second largest inland fishery in North Eastern Nigeria after Chad Basin [2] has suffered deflation of fisheries resources which attest to the above facts, considerable literature have agreed with the decline trend over the years [11]. The situation affects the livelihood of thousands of fisheries stakeholders who are directly or indirectly benefit from the marketing chain. This river and its environs are still being exploited by small scale fishers [12,13]. At present the scientific information about Upper River Benue fishery dynamics and fish ecology is relatively scarce; being mainly in form of unpublished thesis or technical reports and this has been preventing the development of its proper management plans [2]. Poor fisheries and non- responsible fishing activities in both traditional and modern systems; have reduced the livelihood of the fishing communities along the region [14]. The poor fishers in trying to meet the demand of domestic needs often over exploit the aquatic resources by the use of destructive fishing gears and adoption of unwanted (obnoxious) fishing methods, thereby destroying the dynamics of that sustain fish population [11,15]. Fishing is the most predominant activities of the communities along most of the riverine areas, the methods they apply to catch those fishes are traditional methods which include hand-searching (*Lalube*), clap net (*Homa*), hand lift nets (*Akauje*), [16]. While the modern fishing gears include cast nets (*Birgi*), drag net (*Taru*), long line hooks (*Mari mari*), return valve traps (*Malin, Gura, Ndurutu*), set gill nets (*kalle-kalle*), by use of canoes, boats or out boat engines. The aim of this research study is to assess variations in fish catches at Njoboliyo lake Adamawa state, Nigeria.

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Materials and Methods

Description of study area

Based on the map of study area (Figure 1); Njoboliyo lake lies within the latitude 9.12 to 16.51°N and longitude 12.28 to 12.43°E on the Eastern part of Yola South Local Government, the major ethnic groups of these area are Bwatiye, Fulbe, Mbula and few migrant fishers that comprises of Hausa and Jukun/Agatu. Some of those migrant fishers have over the years become indigene to those areas [2].

Lake Njoboliyo is awet flooded plain found adjacent River Benue having its course from River Nafari and Chigari as inlets and empties into the River Benue as seen in Figure 1: the lake is perennial. The characteristic formation of the lake is due to the facts that as river Benue, Chigari and Nafari take their courses from the Mandara highlands on entering Nigeria they meet a flat plain basins, which at peak rainfall from July to September they meanders along their ways with continues deposition of alluvia's and sands, leading to formation of many oxbow lakes within the geographical location of the Benue [17].

Methods of data collections

The data were collected from the months of May to August, 2014, on weekly basis in each fishing villages. The main instrument for the data collection for this study was structured questionnaire; the validity and reliability of the items in the questionnaire were tested and found valid and reliable for this type of research study which was used to know.

1)   The demographic profile, socio-economic livelihood of the fishers and their other livelihoods diversity.

2)   The catch assessment survey which was carried out at the landing site through examining the catches, sorting into various species and total weight of the fishes using weighing balance to know the catch of fisher per trip.

3)   Identification of fish species by self-familiarity and use of field guide to Nigerian freshwater fisheries [18] commercially important Freshwater. Fishes of Nigerian designed and produced by National Institute for Freshwater Fisheries, New Bussa, Niger State, Nigeria.

4)   The catch per unit of effort (CPUE) was determine using the relationship between the weight of fish species caught at a fixed time (hour) at lake Njoboliyo as shown below:

$$CPUE = \frac{\text{Weight of fish species caught (Kg)}}{\text{Time (hour)}}$$

5)   The monetary value and economic status of each fisher was determined by valuing 1 kg of fish costing ₦450.00 as its price at landing site.
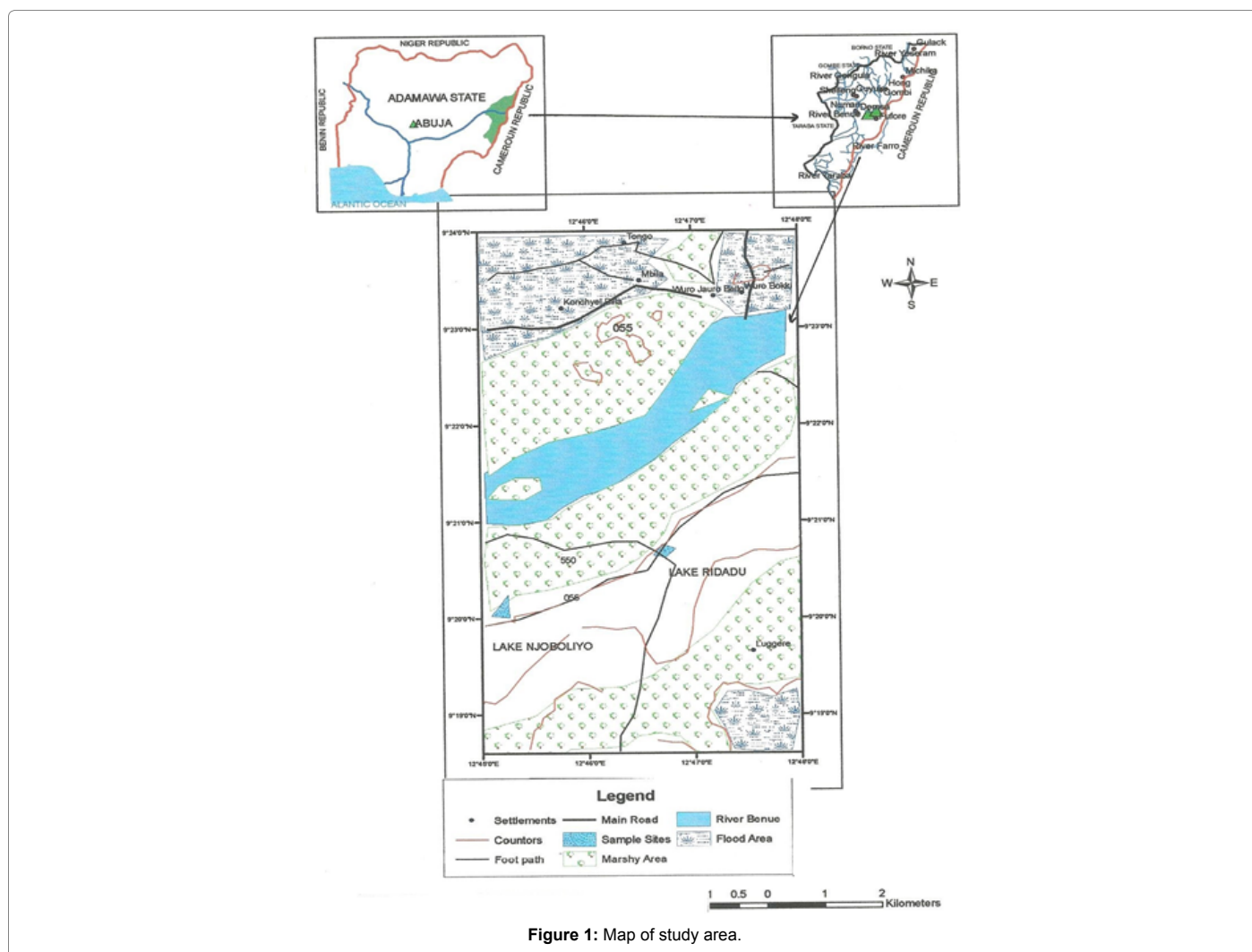

Figure 1: Map of study area.

Population and sampling techniques

The population for this study comprise of Njoboliyo Lake. The major targets were the fishers. A total of Forty (40) fishers were sampled using simple random sampling.

Data analysis: The data collected were analyzed using T-test to correlates, the fish catch, Socio-economic activities of the fishers, Fish species found in the lake, threatened fish species and other contributing livelihoods activities in the fishing villages. While histogram and pie charts is to represent some of the data collected. The field guide to Nigerian freshwater fisheries [18] and commercially important Freshwater Fishes of Nigerian designed and produced by National Institute for Freshwater Fishes New Bussa, Niger State, Nigeria, for the identification of all the fish species seen in the Lake during the study. While the economic status of each fisher was determined by calculating the weight in kilogram(s) of fish X ₦450.00, this was also use to evaluate the impact of fishing on the income of fishers and the population of the fishing community.

Results

The ethnic groups in the fishing villages, Bwatiye having 70%, while Jukun and Hausa have 27.5% and 2.5% respectfully, indicating that this fishing region is located at Bwatiye speaking people (Table 1).

The education level of the fishers at Njoboliyo, with level of uneducated comprising half of the sampled fishers having 50%, while those with General Certificate of Education has 25% followed by First School Leaving Certificate with 20% and the least is those possessing National Certificate of Education having only 2% (Table 2).

The various languages spoken in the fishing village, it was observed that Hausa is the major language spoken in this village with 34% followed by Bwatiye 24%, English 14%, Agatu and Jukun 10% each, the least spoken language at this village is Fulbe with 7% (Table 3).

The fishing gears used in the community, ranging from Set net, Gill net, Cast net, Drag net, Hooks and Traps. Drag net recorded highest utilization value with 29%, followed by Cast net with 25%, while the least utilized gear was Gill net with only 4% (Table 4).

The age group of the fishers at the fishing community, it was observed those in age group 31-40 has the highest value with 50%, while the least was recorded in group with range of 61-70 with 2.5%. Generally those within the active youth age range from 31-50 has total percentage of 72.5% indicating that they are mostly the productive part of every society (Table 5).

The years of experience in fishing of the fishers, with those having 21-40 years in fishing with 65%, followed by those within the range of 1-20 years' experience with 35% (Table 6).

The weight catch and their corresponding monetary value per week. In all the week of study, the highest total catch was recorded at week two with 29% followed slightly by week four. While the least recorded was at week three with 17%. The standard for prize of 1 kg of fish at landing site among the fishers was ₦450.00 (Table 7).

The various fish species in the lake with 15 families with 26 Species, clarias was seen to be highest followed by Tilapia, while the least was *Citharinus* (Table 8).

The monetary value of available fish species observed during the

Types of gears	Number of fishers	Percentage composition
Set Net	7	15
Gill Net	2	4
Cast Net	12	25
Drag Net	14	29
Hooks	4	8
Traps	9	19
Total	**48**	**100**

Table 4: Gear utilization in fishing village.

Age range	Number of fishers	Percentage composition
Nov-20	0	0
21-30	2	5
31-40	20	50
41-50	9	22.5
51-60	8	20
61-70	1	2.5
Total	**40**	**100**

Table 5: Age group of fishers in the fishing village.

Years of experience	Number of fishers	Percentage composition
Jan-20	14	35
21-40	26	65
41-60	0	0
Total	**40**	**100**

Table 6: Years of experience in fishing.

Ethnic groups	Number of fishers	Percentage composition
Hausa	1	2.5
Jukun	11	27.5
Bwatiye	28	70
Total	**40**	**100**

Table 1: Ethnic groups in the fishing village.

Education level	Number of fishers	Percentage composition
GCE	10	25
NCE	2	5
FSLC	8	20
Uneducated	**20**	**50**
Total	**40**	**100**

FSLC: First School Leaving Certificate; GCE: General Certificate of Education; NCE: National Certificate of Education

Table 2: Education qualification of fishers in the fishing village.

Language spoken	Number of fishers	Percentage composition
Agatu	11	10
Bwatiye	28	24
English	17	14
Fulbe	8	7
Hausa	40	34
Jukun	11	10
Total	**115**	**100**

Table 3: Language spoken at the fishing village.

Weeks	Weight (kg)	Monetary value (₦)	Percentage composition
1	50.9	22,905	25
2	58	26,100	29
3	35	15,750	17
4	57.5	25,875	29
Total	**201.4**	**90,630**	**100**

N.B: 1 kg of fish at landing site is N450.00

Table 7: Weight (kg) and monetary value (₦) of fish caught per week.

study, indicating *clarias* with 68% followed by *tilapia* with 27%, while the least was *Stile* with 1% (Table 9).

The frequency of fish species caught in the lake, *Clarias* appear 19 times, followed by tilapia 17 times, with *Synodontis* twice, while *Lates niloticus* and *Schilbe* having 1 each (Table 10).

The economic impact of fishing on the population, indicating that the catch range of 5 above kg was highest with monetary value of ₦57,060.00, followed by range 3-4.9 kg with monetary value of ₦19,530.00 and the least was in range 0-2.9 kg having monetary value of ₦14,040.00 (Table 11).

The activities involved by the fishers at this fishing village, apart from fishing 59.4% of the fishers were engaged in farming, 31.2% in livestock rearing, 6.3 in trading and 3.1 in civil servant being the least (Table 12).

The average monthly fishing efforts value at the fishing village, month of May was highest with CPUE (Catch per Unit Efforts) of 1.01, followed by July with 1.13, June with 1.84 and the least efforts applied in August with 2.61 (Table 13).

Discussion

Ethnic groups

The major ethnic groups identified at the fishing communities include Hausa, Jukun, and Bwatiye. Bwatiye was 70% doubling all the other tribes in terms of number and percentage composition agreed with the work of [2] that all the settlers along upper River Benue are predominantly Bwatiye. The percentage composition of those that attended formal education at Njoboliyo are in the ratio of 50-50%, indicating that education is very poor at the fishing communities [19,20] and that the children of the fishers do not even attend primary schools due to their parent allowing them to assist in fishing. The languages spoken in these fishing lakes are Fulbe, Bwatiye, Jukun, Agatu, Hausa and English, Composition at this village showed Hausa language to be highly spoken, indicating that it's a mother tongue language at this part of the country [2] which is understand by everybody.

Since study area is in the tropics, located in the Sudan Sahel savannah, which is characterized by hot and dry temperatures with short intensive rain fall, in combination of the environmental, climatic and ecological degradation caused by the construction of Lagdo dam upstream the study area which lead to over flooding with floods downstream filling up lakes and pools of water in the flooded plains with silts, giving rise for vegetation to over grown, reduction in depth of water for fishing and irrigation purposes and extinction of some fish species, rendering some fishing gears inactive or out of use, leading to overall reduction in fish catch [16,21,22]. There are six types of gears used on Lake Njoboliyo, include Set nets, Gill nets, Traps, Drag nets, Cast nets and Hooks, The traps include Malin, Ndurtu, Gura of varying shapes and sizes. All these gears are produced based on traditional designs manufactured locally with the use of modern fabricated materials like twines or ropes imported from somewhere.

The 19% use of traps at Njoboliyo may be due to presence of vegetation at the edges which facilitate usage of this type of gear. The 29% and 25% of Drag and Cast nets usage at Njoboliyo is recorded due to the concentrated large surface area of water free from vegetation that allows easy operations of these gears. The low percentages usage of gill net is because of the fact that no enough space to operate it due to disturbances from the fishers throwing Cast Nets and Drag Nets, and mostly the recommended mesh size to be used as promulgated by

S/No	Family	Species	No of species	Percentage composition
1	Citharinidae	*Citharinus citharus*	1	1.6
2	Gymnarchidae	*Gymnarchus niloticus*	1	1.6
3	Mochokidae	*Synodontis filamentous*	2	3.2
		Synodontis violaceus	3	4.8
4	Cichlidae	*Tilapia zilli*	2	3.2
		Oreochromis niloticus	3	4.8
5	Schilbidae	*Schilbe mystus*	2	3.2
		Physailia pellucida	2	3.2
6	Mormyridae	*Mormyrus rume*	2	3.2
		Mormyrops delicious	2	3.2
7	Protopteridae	*Protopterus annectus*	1	1.6
8	Malapteruridae	*Malapterus electricus*	1	1.6
9	Centroponidae	*Lates niloticus*	1	1.6

Table 8: Species composition of fish caught in Njoboliyo fishing village.

Species	Weight (kg)	Monetary value (₦)	Percentage composition
Synodontis	3.3	1,485	2.6
Tilapia	34	15,300	27
Clarias	85.7	38,565	68
Lates niloticus	1.8	810	1.4
Schilbe	1.2	540	1
Total	**126**	**56,700**	**100**

Table 9: Monetary value of commercially available fish species.

Species	Frequency	Percentage composition
Synodontis spp.	2	5
Tilapia spp.	17	42.5
Clarias spp.	19	47.5
Lates niloticus	1	2.5
Schilbe spp.	1	2.5
Total	**40**	**100**

Table 10: Frequency of fish species caught.

Catch range (kg)	Total weight (kg)	Number of fishers	Monetary value (₦)	Monetary performance (₦)	Performance ranking
0-2.9	31.2	15	14,040	936	Below Ave.
3-3.9	43.4	11	19,530	1,775.50	Average
5-Above	126.8	14	57,060	4,075.70	Good
Total	**201.4**	**40**	**80,630**		

Ranking
N1-N1500=Below Average
N1501-N2500=Average
N2501–N3500=Good
N3501-N4500=Very Good
N4501-N5500=Excellent

Table 11: Economic impact of fishing on the population of fishers.

Activities	Number of fishers	Percentage composition
Trading	4	6.3
Farming	38	59.4
Livelihood	20	31.2
Civil servant	2	31.1
Total	**64**	**100**

Table 12: Livelihood activities in the fishing village.

Months	Total weight (kg)	Total time (h)	CPUE
May	50.9	50.5	1.01
June	58	31.5	1.84
July	35	31	1.13
August	57.5	22	2.61
Total	**201.4**	**135**	**6.69**

CPUE-catch per unit effort

Table 13: Average monthly fishing efforts at Njoboliyo village.

Adamawa state edict No 5 of 2003 dated 30/12/2003 [23], should not less than 76 millimeters and thus the fishers cannot adopt the use of the gear since it will give low yield or no catch at all due to presence of smaller fishes at the lakes due to overfishing [4,24,25] thus most fishers react by reducing their fishing net mesh size by moving into other like, Drag net, Set net, Traps, where the fishers use less smaller mesh size to construct [26-28].

The fishers at this community throw most of their fishing gears from boats except very few use foot. Studies revealed that the fishers do not use cutlasses and spear for fishing, due to the absence of fish sizes they use to catch with them as before, but for defense against hippopotamus and pythons in the lake.

Fisheries in the lake are multispecies stock in nature, which demonstrates important dynamic variation in terms of size composition and distribution. There are 15 Families with 26 species of fishes noticed during the study. These lacks of high availability of other commercially valued species may be caused by overfishing or alterations in the environmental conditions of the lakes, like persistence seasonal flooding from Lagdo dam which negatively will affect the reproductive ecology of the various fish species in the lakes [16,22,28,29]. Study also shows that *Hydrocynus*, *L. niloticus*, *Protopterus* and *Heterotis* were seen rarely at Njoboliyo, confirm the characteristics of those fish adaptive to where there are macrophytes acting as shelter and provide available food generated by the decaying vegetation [25].

The highest threatened species as observed during study was *Bagrus* (musku and denko (Hausa), followed by *Polypterus*, *Tetradon*, *Gymmnarchus* with the least threatened are *Latesniloticus*, *Malapterurus*, *Mormyrus*, *Citharinus* and *Hydrocynus*. The conditions responsible for these threatened species may vary either as a result of overfishing due to the demand or affected by macrophytes due to ecosystem degradation cause by the persistent floods from Lagdo dam yearly [16,25,28].

Since the lake are situated on the flooded wetland plains of Upper River Benue with numerous tributaries forming linkages for entrance and exit of new and common fishes such as *Heterotis*, *Citharinus*, *Heterobranchus*, *Mormyrus*, *Hydrocynus*, and *Gymmnarchusniloticus* may be carried away by environmental degradation like floods which has been so common over the years from Lagdo dam upstream these lakes. *Bagrus*, *Citharinus*, and *Mormyrus* and *Mormyrops* bio ecology of inhabiting shallows lakes and rivers and solitary inhabit could be an environmental reasons for finding them newly within the past two, three, or five years during these continuous seasonal flooding [16,29,30].

Based on the result obtained the highest weight of fish catch was recorded at week two with 58 kg. Since financial status of each fisher will depend on his daily average catch, it was shown through study that based on the sampled fishers' number per fishing village; Njoboliyo has average catch of 5 kg per fishers per day, this result to daily amount of ₦2250 per fisher in a day. The low average catch of 5 kg per fisher in Njoboliyo supports the early works of the following, [12,31] that the normal catches per fisher per day in African flood plains hardly exceed 4 kg per fisher per day. Also as a result of the lake at river transit downstream an impoundment of Lagdo dam on the River Benue, its performances is usually also low since the impoundment will reduce the inundated flood plains, alters the natural river flow and retains the nutrients upstream from the barrage and this effect reduces fish production downstream [17,32].

Fishing in combination with other fisheries activities show a dynamic effect on the standard of living of those that are dwelling around the lakes. Some of the other activities that depend on fishery are the fish processor, fish marketers, net menders from already fabricated materials purchased somewhere and the carpenters that construct fishing boats and paddles [10,16]. Though there is no information available on the fish monetary stock account of these lakes generally it has been a belief that fish resources reflect the fundamental economic principles of supply and demand which are affected primarily by abundance, location of fish, environmental conditions and economic factors affecting the fishing industry such as cost of fishing gears, labour and cost of fuel where applicable. While on demand side an increase in population and subsequent demand for food, changing customers' preferences and recognition by nutritionist of the health benefit of fish [33]. Study shows that the number of fishers within each catch range is higher in 0.1 kg-2.9 kg with 15 fishers, followed by 5 above kg with 14 fishers and 3-4.9 kg with 11 fishers, this un progressive increase in monetary based on the total catch range may probably be due to the use of the size, types, selectivity of fishing gears and effort being applied by the fishers [7,10]. Study also revealed that no matter how large the numbers of fishers within a particular group of catch range, their performance grading are the same. The unsuccessful nature of fisheries management in lakes downstream Lagdo dam, and the eventual dwindling of the resources by the fishers have placed more problems to accepting fishing as a viable livelihood option in most of the fishing communities of this lake [2,10,34].

As nature permits response to the continuous reduction returns of fishery production in the lake, the fishers diversified their income source portfolios as a remedy to avoid or alleviate poverty as well as to spread the risks associated with the increasingly vulnerable fishers' livelihood. Since diversification often involves a change in income portfolio either by adding the portfolios or by expanding the existing ones [11,35-37]. Although, the rural fishing economy is a complex one with various activities, however the majority of the fishers diversity more in fishing, crop production, livestock, trading and other services [10,27]. Those economic activities are often inseparable and form a complex web of rural fisher's income.

The overall composition of the activities revealed that farming continuous to feature as a major source of income across the fishing communities of the lake with 59.37%, followed by livestock with 31.25%, while trading has 6.25, Civil servant is the lowest with 3.12%. Water and motor cycle transport, barbing and grain milling were not capture due to the insignificant position they occupied, this agreed with Tafida et al. [10]. Study also identified that the number of activities engaged by the fishers and the size of household are interdependent, that is the larger the family size more livelihood activities they will

undergo. When the demographic profile, socio-economic status and fisheries methods for both the fishing villages were tested by T-test there was no significant difference in all the characters tested. The Fishing effort applied by the fishers at this fishing lake indicates that Njoboliyo have highest fishing efforts in month of May with 1.01 and lowest in August with 2.61[38,39].

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