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ECONOMIC ANALYSIS AND EFFECTS OF WATER HYACINTH (*EICHHORNIA CRASSIPES*) ON ARTISANAL FISHERY OF RIVER NIGER IN NORTH-CENTRAL NIGERIA

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ABSTRACT

The accessibility to water and river plays a crucial role in fishery sector development in North Central Nigeria. The study was carried out to assess the effects of water hyacinth (*Eichhornia crassipes*) on fishery activities in North Central Nigeria. The multistage sampling procedure was employed to obtain 320 fisher folks. Surface water samples were also collected to analyse physicochemical properties of Water Hyacinth Infested (WHI) and Water Hyacinth Free (WHF) settlements. The main tools of analysis were descriptive statistics such as mean, percentage and graph, and inferential statistics (t-value). The result revealed that the bulk (65%) of the fisher folks fell below age of 45 years. About 67% of them had up to 15 years' experience in fishing expedition. Results also revealed that fisher folks in the study area were male dominated (90%); and 64% had adjusted household size of 4-7 persons per household. The average annual income from fishing summed up to ₦120,000. The t-value of fish caught between WHI and WHF were statistically significant at 1% which implies that there were variations in fish caught between both units which could be attributed to the effects of water hyacinth. The result revealed that all the production parameters between WHI and WHF settlements were all statistically significant. Stakeholders should intensify efforts in controlling the water hyacinth through integrated approach, because of inadequacies of one method, which involved physical, biological and chemical methods.

Keywords: Fisher folks, physiochemical parameters, income, water hyacinth

INTRODUCTION

Water is the major component of all living things. It is important both physiologically and ecologically as it plays an essential role in temperature control and also is the medium in which many organisms live (Nagendra and Ram, 2011). Water quality is defined by the physical, chemical and biological characteristics of water which include parameters such as Temperature, Turbidity, Dissolved oxygen content, Biochemical oxygen demand and pH among others (Nnaji *et al.*, 2010). Aquatic habitats found on earth include oceans, seas, rivers, lakes, springs and estuaries, with rivers, oceans and major seas covering nearly three-fourths or about 75% of the earth's surface totalling about 214 billion m^3 of surface water (Food and Agriculture Organisation, FAO, 2013). In spite of recent technological and scientific advancement, weather including water is still the most important variable in agricultural production. Daily, seasonal or annual variations in the values of the climatic

elements such as water are of greater importance in determining the performance of livestock and efficiency of crop growth (Oladimeji and Abdulsalam, 2014).

The aquatic habitats are biologically very productive; hence, people derive various benefits from them for their livelihood. FAO (2009) declared that more than 50 million households consisting of an average of 5 persons per household engaged in the fishery sector in 2008 represented 3.5% of 1.3 billion people economically active in the broad agriculture sector worldwide, compared with 1.8% in 1980. They provide various types of fish on which more than one billion people rely as their main or only source of animal protein (Mujingni, (2012). However, De poorter *et al.* (n. d.) in Mujingni, (2012) opined that aquatic habitats have been under threat for several years from human activities such as alien invasive species of micro-organisms, plants and animals one of which is water hyacinth. Water hyacinth plant is considered by many to be one of the world's worst invasive aquatic species of weed, indigenous to the Amazon Basin of South America (Mujingni, 2012). Water hyacinth (*Eichhornia crassipes)* that infested Nigerian waterways almost one and a half decades ago belongs to the family *Pontederiaeeae* and sub-family *Lilolinaeceae*. It is a large floating tropical aquatic plant with an attractive, pale-violet flower and broad, bright-green leaves. Native plants are able to undergo rapid vegetative propagation by sending out offsets which are connected to the parent plant by brittle stolons (Ogunlade, 2002). Bock (1969) in Ogunlade, (2002) reported that the stolon is easily broken by wave action and the offsets are set free to act as potential colonizers.

Oladimeji (2015) opined that artisanal fishermen in North Central Nigeria regarded infestation by water hyacinth as one of the problem towards fishery development in the study area. The problem of the water hyacinth weed in North Central Nigeria which anchored the two major rivers: Niger, Benue and their tributaries can be understood better when one looks at the benefits that are derived from the Rivers (Rivers Niger and Benue) that might be interfered with through water hyacinth infestation. River Niger and its tributaries cut across 7 seven States viz. Kebbi, Niger, Kwara, Kogi, Edo, Delta and Anambra. Apart from the fact that Kainji and Jebba hydro-electricity power dams derive their water for electricity from River Niger, Kainji Lake are also useful for domestic, industrial and agricultural activities and employment for the people residing around the River as also observed by Lake Victoria Environment management project, (LVEMP), (1999); Noah, (2003) of usefulness of Lake Victoria in Kenya, Uganda and Tanzania or Lake Naivasha found in Kenya and as the case of the Wouri River Basin in Riparian Communities of Cameroon (Mujingni, 2012).

Suffice it to note that River Niger, its tributaries and confluences is the principal source of artisanal or domestic fish production in Nigeria, which ranged between 49.8% to 97.7% with annual average of approximately 86.0% during 1970-2014 decades (Inoni and Oyaide, 2007; FAO, 2015). Therefore, artisanal fishery is very much an integral part of Agriculture sector in Nigeria which maintains a steady contribution of 3.5 to 4% to total GDP in 2008 to 2012. This translates to about 10% of agricultural GDP, which itself contributed between 35 and 40% within the same period (NBS, 2012; FAO, 2013).

A number of possible uses of water hyacinth plant, some of which have been developed and others are still in their infancy have been suggested. The water hyacinth have been found to have potential for use as phytoremediation agent, pulp material for producing grease proof paper, as green manure or compost, in biogas production, human food, fibre, animal/fish feed and for power alcohol and biogas production (Jafari, 2010; Ho, 2015). Other potential uses of the weed include possible utilization of the weed as a bio-asorbent for toxic metals, production of fibreboards for a variety of end uses such as bituminized board for low cost

roofing material, indoor partitioning and formulations of water hyacinth-based medicines to treat certain diseases have been reported in India (Malik, 2007).

However, infestation by hyacinth hindered accessibility to river which made fishing and transport as well as navigation difficult. This result in loss of fishing equipment and reduce fish catches (and subsequent loss of livelihood), especially of tilapia and mud fish which are found mainly along the shores (Mailu in Ndimele, 2011) and river reef (Oladimeji and Abdulsalam, 2014). In addition, it also increases cost of fishing expedition due to labour requirement to remove the weed. Globally, several studies: Alimi and Akinyemiju, 1991; Ogunlade, 1997; Mailu, 2001; Jafari, 2010; Mujingni, 2012 reviewed socio-economic effects of Water Hyacinth (Eichhornia crassipes) on agricultural production including artisanal fishery activities. This study assessed the socio-economic effect associated with water hyacinth among fishery households. The study also analysed differential physicochemical parameters of River water to reflect sampling area with Water Hyacinth Infested (WHI) and Water Hyacinth Free (WHF) vis-à-vis the socio-economic implications of water hyacinth on fishery activities in the study area.

MATERIALS AND METHODS

Description of study areas

The North Central geographical region of Nigeria lies between latitudes 7^0 N to 12^0 N and longitude 2^0 30^1 E to 12^0 E, with temperature ranges between 27 ^{0} C and 37 ^{0} C. The region has six States and FCT Abuja with River Niger flowing along Kwara, Kogi and Niger States and River Benue in Benue State (figure 1). Other States in the region are Nasarawa and Plateau. Therefore, due to its proximity to River Niger and Benue, many farming households in the region also practice artisanal fisheries and fadama cropping. Water hyacinth is much spread in this North Central part of Nigeria as a result of numerous tentacles of inland water and flood plains of the River Niger that stretches from Niger State (Borgu LGA) through Kwara State (Edu LGA) to Lokoja/Idah in Kogi State. River Benue also cut across Benue State with prominence in Markudi and adjacent towns in the State (Oladimeji, 2015).

Sampling procedure, Sample size and Sample analysis

A multi-stage sampling procedure was employed for selecting the representative of fisher folks in the study area. Kwara and Niger States were randomly selected from the list of 3 States in North Central Nigeria (figure 1) that harbours River Niger (Kwara, Kogi and Niger States). The second stage involved random selection of 4 fishing settlements from the list of fishing settlements provided by Fisheries Department of each State Ministry of Agriculture from chosen States. Then, 40 fishing households were randomly selected from each of the village to make a total of 320 respondents. Suffice it to note that the 4 settlements were randomly selected from each State comprising of 2 each of Water Hyacinth Infested (WHI) and Water Hyacinth Free (WHF) areas. The selected villages were: Kungu-Jebba, Lower-Asa Lafiagi, Sunkuso (Kwara State); and Kaya, Garafini kodo, Kokoli, Mago (Niger State).

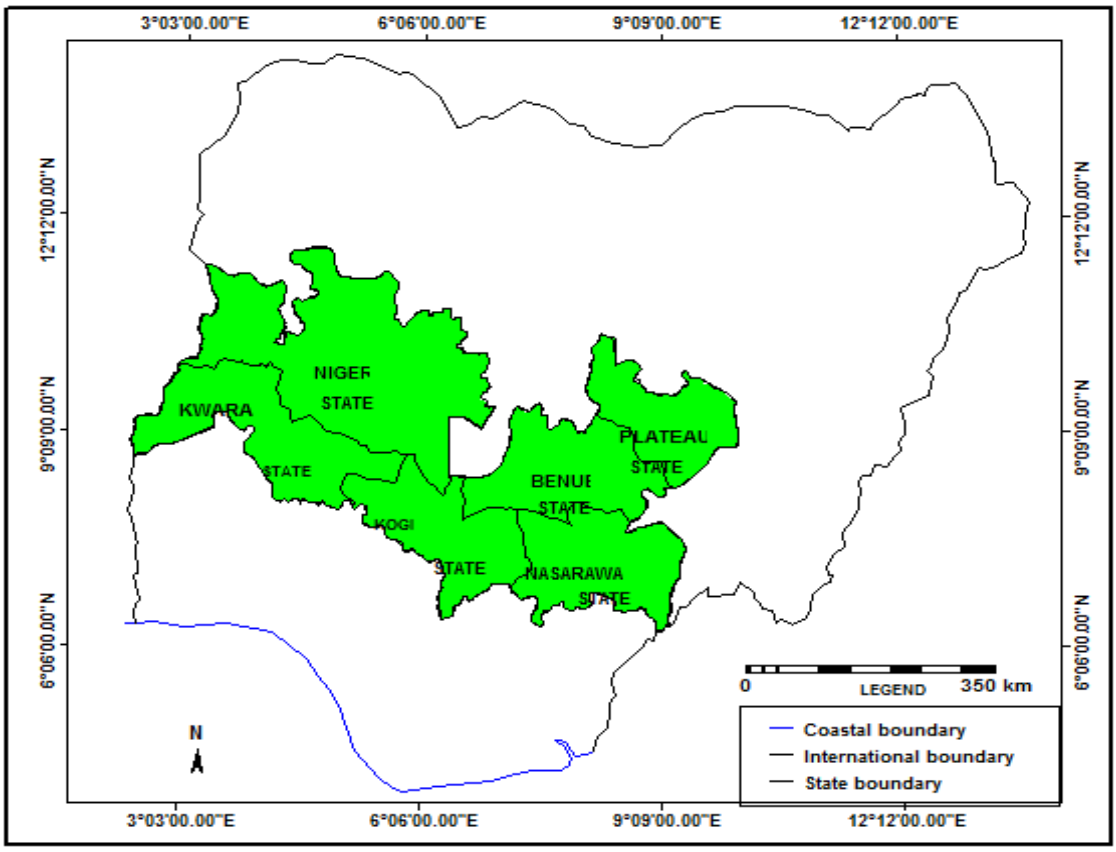


FIGURE 1 : THE NORTH CENTRAL STATE S OF NIGERIA

Source : Adapted and Modified from Administrative Map of Nigeria,

Method of Data Collection

The study employed primary data gathered from field surveys in 2013/2014 farming season through questionnaire and interviews. Surface water samples were also collected between October, 2013 and March, 2014 two times a month during the same period in the study area. Cleaned and sterilized plastic bottles as recommended by (World Health Organization, WHO, 2004) and adopted by (Araoye, 2009; Ahaneku, and Animashaun, (2013) were used for the collection of the samples. The samples were then analyzed and measured for some physicochemical properties. The pH, dissolved oxygen and temperature were measured with their respective meters. Total dissolved solid, Nitrate and Ammonia were determined using standard methods recommended by the American Public Health Association, APHA, 1995. Finally, the heavy metals were determined using atomic absorptions spectrophotometer (AAS). The parameters were determined using standard method recommended by WHO, (2004); Adebayo and Adediran, (2005); Haseen *et al.* (2005); Standard Organization of Nigeria, SON, (2007); United Nations Environment Programme, UNEP, (2012).

Analytical Technique

Both Descriptive and inferential analysis were employed for the collected data. T-statistic was used to find if there is significant difference between physiochemical properties as well as fish caught in water Hyacinth Infested (WHI) and Water Hyacinth Free (WHF) settlements. On each day of sampling, the catches of fish in WHI and WHF settlements selected randomly from targeted landing sites were recorded. Parameters recorded for each sampled fishing canoe were number of crew, gear type, size, time and duration of fishing. Catches were sorted into species and weighed (nearest kg). Weights recorded daily were raised by a function of number of landed canoes to give monthly estimates for a given settlement. Data from sampled settlements were then summed up on a monthly basis and, a

monthly and annual means were then computed following Njiru *et al.* (2000). Estimate of annual total catch was given by equation 1:

AC = CPBD * FD* B…….. (1)

Where AC is the total catch per season (t); CPBD is the mean annual catch per canoe (Kg);

FD =number of fishing days per season, and B = mean number of canoes fishing daily.

The t-statistic is expressed as equation 2 as follows:

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \quad (2)$$

Where t = calculated t-value;
$\overline{X_1}$ = Mean of fish catch or physicochemical parameters of WHF settlements; X_2 = Mean of fish catch or physicochemical parameters of WHI; S_1= Standard deviation of X_1 items; S_2 = Standard deviation of the X_2 items; n_1= Sample size of X_1 and n_2 = Sample size of X_2.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Fisher Folks

Table 1 indicates that the bulk (65%) of the respondents who engage in fishing fell below average age of 45 years with actual mean of 43. Experience in fishery activities also measured in years showed that about 67% had up to 15 years' experience in fishing expedition. The results also showed that fishermen in the study area are males' dominated (90%); and 64% had adjusted household size of 4-7 persons per household. The average annual income from fishing summed up to ₦105,500. The result shows positive contribution to fishery household's welfare. The results are consistent with findings of Adewumi *et al.* (2012): Inoni and Oyaide, (2007) who also observed that fishing is a long time established occupation and a profitable venture among artisanal fisher folks in coastal and riverine settlements of Nigeria.

Table 1: Dominance indicator of the Socio-economic Status of Artisanal Fishermen

Variables	Dominance indicators	Mean	Std dev	CV
Gender (sex)	90% were male	na	na	Na
Marital status	86% were married	na	na	Na
Age (yrs)	65% below 45 years	43	3.9	14.2
Level of Education (years)	31% had primary schooling	5.9	4.5	43.9
Farming experience (years)	67% had up to 15 years	17.5	8.7	32.9
Household size (persons)	64% had 4-7 persons	6.5	3.8	34.9
Extension contact (numbers)	86% had no contact at all	0.92	0.62	43.8
Area devoted to farming	65% had 1-2 ha	0.9	0.3	36
Major occupation	74% engage in fishing	na	na	Na
Ancillary occupation	69% in arable crop farming	na	na	Na
Labour components/year	75% used family labour	83	21.0	65.8
Average fishing income/yr (₦)	54% earned> ₦120, 000	105500	21400	32,9
Off-fishing income/yr (₦)	76% earned< ₦100, 000	87900	19800	42.9

Source: *Field survey, 2014; Note: ₦, Nigeria currency Naira and 1US = ₦169 during field survey*

Majority of the pooled fishermen (69%) had subsidiary occupations with average annual off-farm income of ₦87,900 and this shows that the rural artisanal fishermen have developed capacity to cope with increasing vulnerability associated with fishing such as diversification, intensification and migration.

Level of Severity of Water Hyacinth in the Study Areas

The severity of rating of water hyacinth over time (1986 to 2013) as perceived by fisher folks in Figure 2 hovers between 0.2 to 0.6 in Niger State and zero to 0.5 in Kwara State with an annual average of 0.48 and 0.28 respectively. From the responses, it can be seen that the critical periods of water hyacinth were in the years 1996-1998 and 2008-2010 in Kwara State and years 1990-1992 and 2008-2010 in Niger State. The data shows that the most critical effect was noticed in 1996-2010 in Niger State with 85% of the fishermen reporting the seriousness while 75% of the fishermen reported 2008-2010 in Kwara State as most severe period. Peninah *et al.* (2013) opined that problems associated with aquatic weeds have increased in the last century. Finding on severity of water hyacinth implies that the weed is spreading along the riverine States of Nigeria.

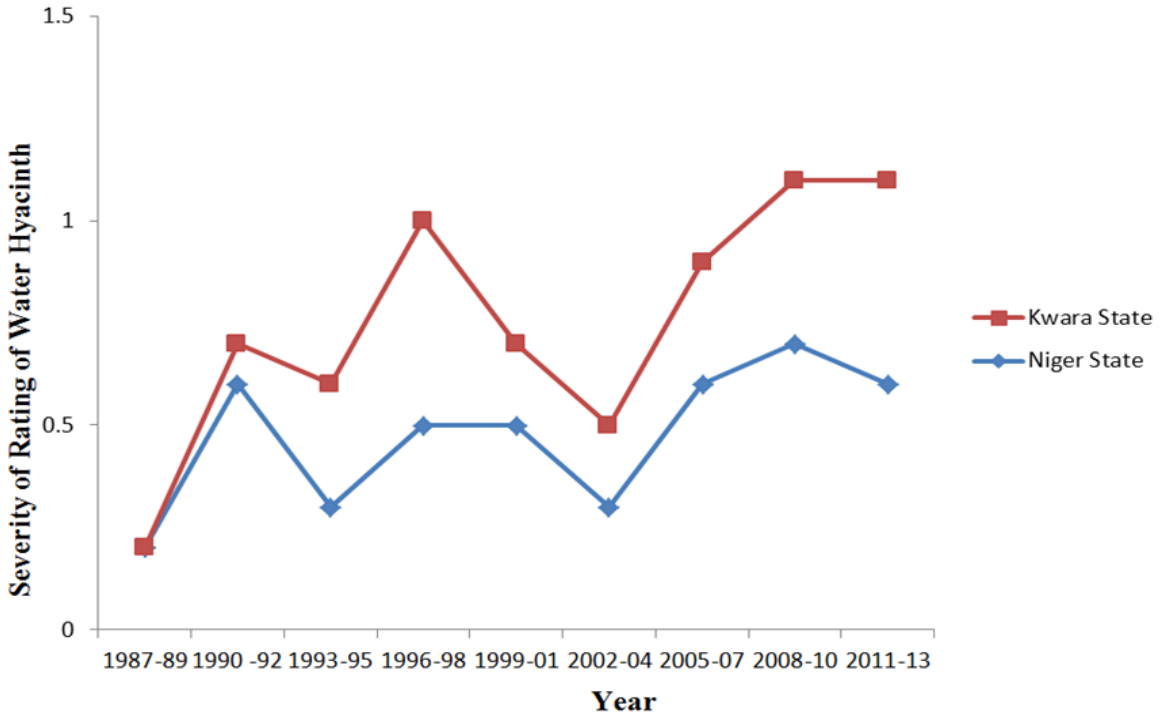


Fig. 2: *Severity of Rating of Water Hyacinth as Perceived by Fisher Folks, 1986-2013*

Monthly Variations in Fish Caught between WHI and WHF

The trend of fish catches in both WHI and WHF areas in both Kwara and Niger States and, pooled data graphically presented in Figure 3 shows that fish catches increase steadily in both WHI and WHF studied areas all through, from October to December, the result also shows that fish catch recorded in January to March exhibit irregular changes. The result further revealed that fish catches were higher in WHF areas compare to WHI settlements throughout the months studies. The findings in this study are in agreement with Noah, (2003); Mironga, (2014); Alimi and Akinyemiju, (1991) who observed that water hyacinth blocks the path for

ht monthly

fishing thereby diminishing catch and profitability; increasing the time used to access the fishing ground and possibly destroy the canoe gears.

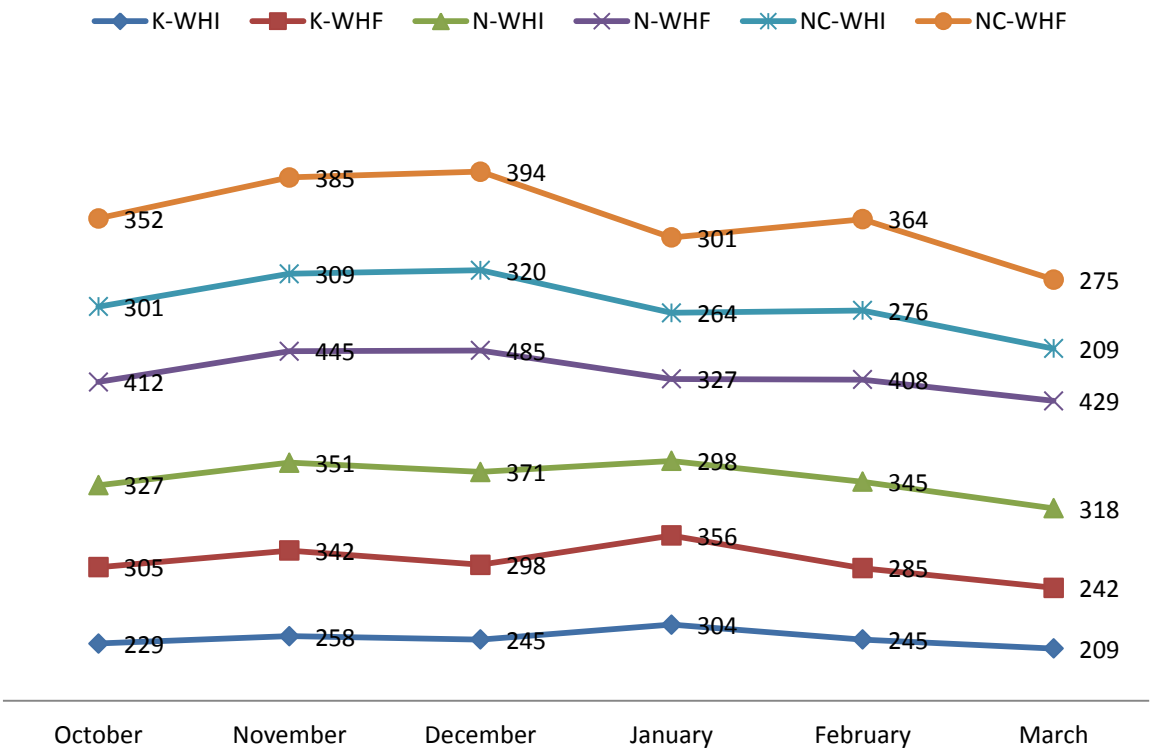


Fig 3: Monthly variations of fish caught in selected settlements of WHI and WHF

Note: K-WHI or F denote Kwara; NWI or F denote Niger and NC-WHI or F stood for North Central studied areas

Effects of water hyacinth on total fish caught

In Table 2, Kwara and Niger States recorded average fish caught per month of 248.3 kg and 335.0 kg in water hyacinth infested area with standard deviation of 32.0 kg and 26.0 kg respectively. However, the 2 States recorded higher values of 304.7 kg and 417.7 kg in water hyacinth free sampled areas with standard deviation of 41.0 kg and 52.5 kg respectively. The t-value between WHI and WHF in both States as well as North Central average were statistically significant at 1% which implies there were variations in fish caught between both units which could be attributed to the effects of water hyacinth.

The findings are in consonance with studies carried out by Mujingni (2012); Noah, (2003) and Ogunlade, (1997) who observed a reduction in fish caught between water hyacinth infested and free settlements and canvassed that water hyacinth played a significant role in the quantity of fish landed in their studied areas. As a result, Alimi and Akinyemiju, (1991), also observed that the monthly total revenue earned was higher than the variable cost in WHF areas, but less than the total cost in WHI areas. This may affect the earning capacity and cash flow in the WHI area.

Table 2: Variations in average fish caught (Kg) by Fishermen in WHI and WHF Areas

Items	Average fish caught (Kg) by fishermen					
	Kwara State		Niger State		North Central	
	WHI	WHF	WHI	WHF	WHI	WHF
Total	1490	1825.0	2010	2506	1679.0	2071.0
Average	248.3	304.7	335.0	417.7	279.8	345.2
STDEV	32.0	41.0	26.0	52.5	40.5	47.3
t-value		**4.08 *****		**2.74** ***		**2.10** ***

Effects of Water Hyacinth on Different Species of Fish Caught

The Effects of Water Hyacinth on fish species caught per season is reported in Table 3, which shows that there was statistically significant difference in total fish caught between WHI and WHF in all the settlements studied although Mago and Kokoli fishing settlements were marginally statistically significant at 10%. It suffices to note that the identified fish species caught were individually and collectively significantly higher in WHF than in the WHI settlements (Table 3). Inter alia, the presence of water hyacinth has marked effect on fish species in the studied areas and fishermen could increase fish catch level if the water hyacinth is control in the settlements where they constitute nuisance. Thus, Noah, (2003) and Mujingni, (2012) confirmed in their studies that water hyacinth played a vital role in composition of fish species in lake Victoria of Kenya and Riparian communities of Cameroon respectively.

Table 3: The Effects of Water Hyacinth on Fish Species caught River Niger, Nigeria

Settlements	Samp area	Variation in fish output along River Niger/fisher /season, kg					
		Clarias	Barilus	hemichromis	Tilapia	Synodontis	t-value
Kungu	WHI	210±19.5	206±14.8	109±12.0	284±20.7	78±7.0	
	WHF	278±16.0	261±14.9	143±10.9	308±23.0	86±6.5	**2.5*****
Lower-Asa	WHI	133±18.0	127±13.5	49±7.9	105±9.5	48±6.7	
	WHF	172±19.8	148±15.4	75±12.2	139±9.9	64±6.3	**2.3****
Lafiagi	WHI	236±32.4	208±24.4	112±16.4	256±17.4	69±5.9	
	WHF	275±30.2	249±26.1	145±19.7	302±27.0	95±9.5	**12.3*****
Sunkuso	WHI	215±17.6	178±9.7	65±5.8	227±29.0	78±7.8	
	WHF	257±23.9	209±12.5	98±6.3	281±30.2	109±12.9	**2.3****
Kaya	WHI	309±20.4	278±21.6	90±11.0	319±31.9	99±8.9	
	WHF	423±30.7	341±22.3	128±5.2	452±26.8	112±7.6	**2.3****
Garafini kodo	WHI	276±26.9	243±8.8	120±5.7	345±24.0	104±6.5	
	WHF	342±29.0	289±11.2	174±11.0	402±28.7	163±17.9	**2.3****
Kokoli	WHI	308±23.7	312±15.8	205±19.0	436±32.4	178±15.6	
	WHF	353±27.0	349±15.7	236±16.8	471±40.4	209±21.9	**1.86***
Mago	WHI	314±28.5	208±9.4	204±8.0	321±20.0	154±24.5	
	WHF	378±35.5	342±15.1	287±22.8	387±20.6	204±14.7	**1.68***
Total(WHI + F		**4479**	**3948**	**2240**	**5035**	**1850**	
Mean		**280±23**	**247**±19	**140**±23	**315**±12.9	**116**±18.4	
Total: WHI		**2001**	**1760**	**954**	**2293**	**808**	
Mean		**250**±17.4	**220**±12.2	**119**±9.8	**287**±14.2	**101**±6.9	
Total: WHF		**2478**	**2188**	**1286**	**2742**	**1042**	
Mean		**310**±11.9	**274**±15.3	**160.8**±8.5	**342.8**±5	**130.3**±4.8	

Source: Field survey, 2014; ***each value is the mean ± S.E recorded at each settlement***

Assessment of Production Characteristics, Output and Water Hyacinth

Table 4 depicts the effects of water hyacinth infestations on production characteristics and average fish caught per season. The result revealed that all the production parameters: number of trips per day; number of fishing hours per day; number of days per month and number of crew per canoe between WHI and WHF were all statistically significant. Furthermore, the average fish caught in all the settlements between WHI and WHF units were also statistically significant. This was consistent with findings of Alimi and Akinyemiju (1991);Noah, (2003); Mujingni, (2012) which reported that the presence of water hyacinth in an area often leads to inefficient use of resources and additional cost of operations with resultant higher total cost.

Table 4: The Effect of Water Hyacinth on Fishing Parameters, River Niger, Nigeria

Settlements	**Sampling area**	**Production/Output characteristics of fisher folks**				
		Av. no of trips /day	**Av. no of hours/day**	**Av. no of days/month**	**No. of crew per canoe**	**Av. catch /season**
Kungu	WHI	1.4±0.7	12.5±2.7	19.4±3.9	4.2±1.2	1780±30.2
	WHF	2.2±0.5	08.5±1.5	16.5±3.0	3.2±0.9	2017±41.6
Lower-	WHI	1.2^{NS} ±0.4	9.4^{NS} ±2.7	20.3±2.9	4.9±1.2	1489 ±11.4
Asa	WHF	1.4±0.6	09.8±1.3	17.5±3.2	3.1±1.0	1630±17.0
Lafiagi	WHI	1.5±0.7	11.6±2.9	22.6±4.6	4.9±1.4	1905±17.6
	WHF	2.3±0.8	09.8±1.9	18.7±2.8	3.5±1.1	2140±22.1
Sunkuso	WHI	1.2±0.5	12.7±1.8	17.8±1.8	4.8±1.7	1978±16.4
	WHF	2.7±1.0	08.6±1.5	15.5±4.1	3.9±1.4	2372±20.3
Kaya	WHI	1.4±0.8	13.7±4.9	21.5±3.7	5.6±2.0	2765±18.7
	WHF	2.0±0.8	09.0±1.1	14.6±2.0	3.3±1.1	3484±19.8
Garafini	WHI	1.5±0.9	12.1±2.9	21.5±5.5	4.4±2.0	2604±22.1
kodo	WHF	2.5±1.3	11.5±3.1	17.9±2.1	3.5±1.6	3245±23.8
Kokoli	WHI	1.5±0.9	12.7±2.9	23.8±4.6	4.9±2.3	2540±19.9
	WHF	2.2±1.8	10.2±1.9	18.7±2.1	3.3±2.1	3205±27.1
Mago	WHI	1.3±0.9	12.9±3.1	23.5±3.1	5.2±2.5	2445±19.8
	WHF	2.3±1.7	08.7±2.0	17.8±3.6	3.7±2.1	3406±26.5
	Av. (WHI)	1.4±0.7	12.3±3.0	21.3±3.8	4.9±1.8	2188.3±20
	Av. (WHF)	2.2±1.1	09.5±1.8	17.2±2.9	3.4±1.4	2687.4±25
	t-Value	0.007***	0.000***	0.03**	0.0004***	0.000***

Source: Field survey, 2014; ***each value is the mean ± S.E recorded at each settlement***

Physicochemical characteristics of WHI and WHF settlements

Table 5 presents the variations of physicochemical parameters of water quality in River Niger fishing settlements. Studies of freshwater have shown that good water for fisheries are supported by water conductivity of 150-500 µs/cm; hydrogen ion concentration of 6.6-8.5 mg/l; temperature of 25^{o}C; total dissolved solids of 500 mg/l; dissolved oxygen of 5.0 mg/l and total nitrate of 50 mg/l (WHO, 2004; Haseenet *et al.* (2005); UNEP, (2010); SON, (2012). The variations of all the physiochemical parameters recorded in Table 5 indicated that the WHF settlement averagely satisfied drinking water, irrigation and fishing quality indices as observed by APHA, (1995) and WHO, (2004). However, the bulk of physiochemical parameters in WHI settlement deviated from established standard of physicochemical parameters of water quality. The results of the study also show that there were statistically significant differences between most physiochemical parameters of WHI and WHF areas. It

is thus obvious that these physiochemical parameters, minerals and heavy metals in WHI areas were manifest factors that reduce fish catch.

Table 5: Physicochemical Characteristics of WHI and WHF Settlements

Settlements	Sampling area	Parameters measured in River Niger Sampled areas								
		PH	**Temp**	**DO_2**	**H_2O**	**TDS**	**NO_3**	**NH_3+**	**Pb^{2+}**	**Fe^{2+}**
Kungu	WHI	8.30	28.04	2.52	160.0	259.0	4.7	0.03	0.02	1.0
	WHF	7.08	25.38	7.20	370.0	410.5	3.6	0.05	0.02	1.5
Lower-Asa	WHI	8.80	28.75	1.85	140.5	198.0	4.4	0.02	0.02	0.4
	WHF	7.85	27.90	5.72	201.5	356.8	3.5	0.04	0.01	0.7
Lafiaji	WHI	7.90	28.90	2.90	180.0	248.5	4.5	0.03	0.01	1.2
	WHF	7.43	25.32	8.80	360.5	401.5	2.9	0.06	0.01	1.7
Sunkuso	WHI	7.75	28.30	1.52	160.5	240.0	5.8	0.03	na	Na
	WHF	7.17	26.50	7.10	370.8	410.8	4.2	0.05	na	Na
Kaya	WHI	8.16	28.41	2.40	157.5	278.9	4.6	0.04	na	Na
	WHF	7.40	26.39	7.40	358.0	417.0	4.8	0.06	na	Na
Garafini kodo	WHI	7.90	28.20	1.80	172.5	209.5	5.1	0.02	na	0.9
	WHF	7.32	26.09	9.96	330.9	423.8	2.7	0.04	na	1.4
Kokoli	WHI	7.95	28.62	1.90	165.0	234.5	4.4	0.03	0.01	1.2
	WHF	7.18	26.40	8.30	358.9	413.5	3.1	0.05	0.01	1.7
Mago	WHI	8.12	28.75	3.10	170.6	209.0	4.3	0.02	na	1.0
	WHF	7.40	26.50	9.95	390.8	398.9	3.2	0.04	na	1.9
	Av. WHI	8.1	28.3	2.3	163.3	234.7	4.7	0.03	0.02	0.95
	STDEV	0.3	0.3	0.6	11.9	27.8	0.5	0.7e-2	0.6e-2	0.30
	Av. WHF	7.3	26.1	8.1	342	404.1	3.5	0.05	0.01	1.5
	STDEV	(0.3)	(0.8)	1.5)	(59.5)	(20.7)	(0.7)	0.8-e3	0.005	0.42
	t-value	***	***	**	***	***	*	ns	na	Na

CONCLUSION AND RECOMMENDATIONS

The study established a differential fish caught and physicochemical characteristics between Water Hyacinth Infested and Free settlements. The result of study revealed that the difference in fish caught between the two settlements were largely due to level of water hyacinth infestation. Therefore, the study suggests that:

i. Fisher folks should collaborate with relevant agencies such as State Ministry of Agriculture and Fisheries Department in the State to intensify efforts in controlling the water hyacinth through integrated approach, because of inadequacies of one method, which involved physical, biological and chemical methods.
ii. Fisher folks and other fresh water stakeholders in collaboration with extension agents should also be educated to mount constant surveillance on spread of the weed.
iii. Fisher folks should also form a formidable group through their cooperative societies to harness the potential of water hyacinth weed into animal or fish feeds and herbivore fodder, leaf protein concentrates in feeds, fertilizer and biogas.
iv. In this way, the present and future artisanal fishery production is enhanced through conservative and sustainability of water resources to support inclusive economic and human development of new Sustainability Development Goals (SDGs).

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