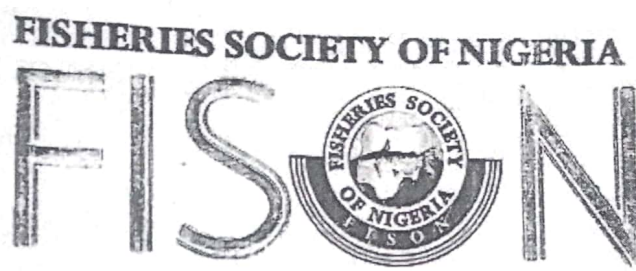


FISON  
PROCEEDINGS  
do not take  
away.



*Conference*  
**PROCEEDINGS**

VOL. II

*Date:*  
26TH - 28TH OCTOBER, 2009.

*Venue:*  
THE FEDERAL UNIVERSITY  
OF TECHNOLOGY, AKURE.

ISSN : 2141-0682

remahmed@yahoo.com

Megbawon Ture  
B. Federal

24<sup>th</sup> ANNUAL CONFERENCE OF  
THE FISHERIES SOCIETY OF NIGERIA (FISON)

Theme:  
SUSTAINABLE FISH PRODUCTION AND FOOD SECURITY  
IN A GLOBAL ECONOMIC RECESSION



Venue:  
THE FEDERAL UNIVERSITY OF TECHNOLOGY, AKURE

OCTOBER 25-28, 2009

CONFERENCE PROCEEDINGS

ISSN : 2141-0682

Edited by:  
Prof. O. A. FAGBENRO, Ffs,  
DR. O.A. BELLO-OLUSOJI,  
Dr. (Mrs.) E.O. ADEPARUSI,  
DR. L.C. NWANNA, DR. O.T. ADEBAYO  
DR. A.A. DADA & DR. (Mrs.) M.O. OLUFAYO

Sponsored by:  
ONDO STATE GOVERNMENT  
FEDERAL UNIVERSITY OF TECHNOLOGY, AKURE  
ONDO STATE OIL PRODUCING AREA DEVELOPMENT  
COMMISSION (OSOPADEC)

OCTOBER 2009

## PREFACE

The Fisheries Society of Nigeria (FISON) held the 24<sup>th</sup> Annual Conference (FISON Akure 2009) hosted by the Ondo State Chapter at the Federal University of Technology, Akure between October 26 and 28, 2009; with the theme, **SUSTAINABLE FISH PRODUCTION AND FOOD SECURITY IN A GLOBAL ECONOMIC RECESSION**. The Conference theme was coined and developed based on the prevailing global economic phenomenon which commenced in 2008.

An appropriately titled keynote address was therefore delivered by Prof. (Mrs.) Esther Ademoji Adesulu, Ffs, a Professor of Fisheries at the Department of Zoology, Obafemi Awolowo University, Ile-Ife during the Opening Ceremony. The address considered and extensively discussed all the various ramifications of the global recession on fisheries in Nigeria for the attention and interest of all stakeholders in the fisheries sub-sector of the national economy.

225 abstracts were received prior to the Conference and were reviewed and edited prior to their publication in the **Conference Book of Abstracts**. During the Conference, 150 scientific papers were presented orally during the technical sessions. All the papers were compiled, peer-reviewed and edited, out of which 92 papers are published in a two-volume **Book of Conference Proceedings**.

We thank all the contributors for their efforts to submit their work in advance for this publication. We also thank our professional colleagues for editorial assistance. This publication will be circulated as widely as possible to FISON members, contributors, participants, government organizations, academic institutions, national associations of fisheries and aquaculture practitioners, regional and international fisheries organizations and other stakeholders in the fisheries industries.

The editorial team apologizes for any mistakes made while editing papers or adjusting the papers to fit the necessary formats. As the editors of this book of proceedings, we express our gratitude to all members of FISON for their contribution to the preparation of this book of proceedings. Deep gratitude goes to Ondo State Government, Federal University of Technology Akure (FUTA), and Ondo State Oil Producing Oil Commission (OSOPADEC), Akure for funding the two-volume of book of proceedings.

**The Editors**  
**October 2009**

Fagbenro, O.A., Bello-Olusoji, O.A., Adeparusi, E.O., Nwanna, L.C., Adebayo, O.T., Dada, A.A. & Olufayo, M.O. (editors) 2009 Sustainable Fish Production and Food Security in a Global Economic Recession. Proceedings of the 24<sup>th</sup> Annual Conference of the Fisheries Society of Nigeria, October 26-28, 2009, Akure, Nigeria. Volume 1. 192pp.

Fagbenro, O.A., Bello-Olusoji, O.A., Adeparusi, E.O., Nwanna, L.C., Adebayo, O.T., Dada, A.A. & Olufayo, M.O. (editors) 2009 Sustainable Fish Production and Food Security in a Global Economic Recession. Proceedings of the 24<sup>th</sup> Annual Conference of the Fisheries Society of Nigeria, October 26-28, 2009, Akure, Nigeria. Volume 2. 192pp.

Printed and published in 2009 by The Fisheries Society of Nigeria

All rights reserved. No part of these publications may be reproduced in any way without acknowledgement of the authors.

**ISSN : 2141-0682**

**© Fisheries Society of Nigeria 2009**

## CONTENTS

No.	PAPER TITLES AND AUTHORS
	PREFACE - The Editors
	OPENING ADDRESS - Governor of Ondo State, Dr. Olusegun Mimiko
	WELCOME ADDRESS - FISON President, Deacones Foluke Areola, Ffs
	KEYNOTE ADDRESS - Prof. Mrs. E.A. Adesulu, Ffs
	CONFERENCE COMMUNIQUE
51	LYSINE REQUIREMENT OF <i>Oreochromis niloticus</i> - Oye, S.O. & Eze, S.
52	BODY-WEIGHT VARIATIONS IN FOUR WEEK OLD <i>Clarias gariepinus</i> - Ebonwu, B.I., Megbowon, I., Ayo-Olajusi, C.I. & Mojekwu, T.O.
53	EFFECTS OF BAIT TYPES ON FISH CONGREGATION AND CATCH EFFICIENCY OF CASTNET IN LAKE KAINJI - Y.B. Ahmed, I.A. Argungu & T.A. Tagago
54	GENETIC IMPROVEMENT OF TILAPIA: CHALLENGES AND PROSPECTS IN NIGERIA - Megbowon, I. & Bombatta-Fashina, I.A.
55	SURVIVAL AND RESPONSE OF <i>Oreochromis niloticus</i> TO DIFFERENT FEEDS - Ogunbona, A.A., Ajiboye, R.O., Onigemo, M.A. & Ishola, O.J.
56	AMINO ACID COMPOSITION OF FOUR TILAPIAS - S.O. Ovie
57	AQUATIC MACROPHYTES ROLES IN NUTRIENT AND HEAVY METAL REGULATION - Uka, U.N., Mohammed, I.A. & Birnin-Yauri, Y.A.
58	AQUACULTURE INVESTMENT IN NIGERIA: CASE STUDY OF NEW BUSSA - R.E. Nyaku, A.A. Tafida, Y.M. Musa & J.M. Rabe
59	EUTROPHICATION AS A CHALLENGE TO SUSTAINABLE CAPTURE FISHERIES: A CASE STUDY OF OYUN RESERVOIR - M.K. Mustapha
60	BY-CATCH THROUGH FISHING GEAR MODIFICATION - Ogunfowora O.O., Ojo, S.O., Uka, U.N. & Yem, I.Y.
61	AN INTEGRATED CHICKEN-FISH SYSTEM IN CONCRETE PONDS - Nnaji, J.C., Madu, C.T., Omeje, V.O., Ogunseye, J.O. & Isah, J.
62	EFFECTS OF SUPPLEMENTAL SELENIUM IN DIETS OF <i>Heterobranchus longifilis</i> - Ibiyo, I.M.O. & Atteh, J.O.
63	DESIGN AND CONSTRUCTION OF 2.14 M LOA (ONE SHEET) FLATBOTTOM CANOE (PUNT) FOR POND ACTIVITIES - Abubakar, S., Musa, I.G. & R. Adamu
64	APPLICATION OF HOLISTIC APPROACH FOR SUSTAINABLE FISHERIES: A CASE STUDY OF KAINJI LAKE BASIN - A.A. Tafida, A.A. Adebayo, M. Galtima, J.O. Ayanda & J.R. Mani
65	CHALLENGES OF FISH FARMERS IN ONDO STATE - Nwabeze, G.O., Ayanda, J.O., Tafida, A.A., Ifejika, P.I., Erie, A.P. & Okeni, A.
66	NUTRITIVE EVALUATION OF ENCLOSED SALTED-SOLAR DRIED <i>Oreochromis niloticus</i> - J.O. Oyero
67	IMPROVED FLOATING DIETS FOR AFRICAN CATFISH AND NILE TILAPIA - Falayi, B.A., Sadiku, S.O.E., S.L. Lamai & S.M. Tsadu
68	CITRIC ACID AS PRESERVATIVE IN SMOKED CATFISH - Omojowo, F.S.
69	DESIGN AND CONSTRUCTION OF 1.5M CORACLE FOR POND ACTIVITIES - Ibrahim, A., Abubakar, S. & I.M. Ayaawei
70	INFORMATION CHANNELS AS TOOLS TO ADOPTION OF AQUACULTURE TECHNOLOGIES FOR FISH FARMERS OF LAKE CHAD BASIN AROUND BAGA AREA - Obetta N.C., Usman, I.M. & Uche, C.P.
71	ATTITUDE OF FISHERFOLKS TOWARDS ADOPTION OF EXTENSION ACTIVITIES IN LOWER KAINJI LAKE BASIN - Bako, W.S. & Balla, G.M.
72	COLLECTION AND MATURATION OF BROODSTOCK OF THE BLACK TIGER SHRIMP, <i>Penaeus monodon</i> - Ayinla, O.A., Anyauwu, P.E., Solarin, B.B., Hamzat, B., Ebonwu, B.I., Ihimekpen, F.A., Ayaabu-Cookey, I.K., Matanmi, M.A. Afolabi, E.S., Adeleke, T.A., Olaluwoye, I.B., D.A. Bolaji & M.R. Ajljo
73	DESIGN AND CONSTRUCTION OF A SHRIMP HATCHERY FOR THE

	BREEDING OF THE BLACK TIGER SHRIMP, <i>Peneaus monodon</i> Ayjula, O.A., Anyanwu, P.E., Atakpu, J.A., Ebonwu, B.I., Hamzat, M.B., Ihimekpen, F.A., Oladosu, G.A., Adeleke, T.A., Matanmi, M.A., Afolabi, E.S., Oguntade, O.R., Ayaobu-Cookey, I.K., Asikhia, G.I., Oseni, A., Olaluwoye, L.B. & M.R. Ajijo	
74	EFFECTS OF PRESERVATIVES ON THE PROXIMATE AND SENSORY ANALYSIS OF SMOKE-DRIED <i>Clarias gariepinus</i> DURING AMBIENT STORAGE - M.M. Salaudeen, G.R. Akande, O.R. Oguntade, O.O. Afolabi, A.O. Olusola & M.O. Ezekiel	100
75	HEAVY METALS AND SENSORY EVALUATION OF CANNED TUNA FISH - A.F. Babalola, A.O. Olusola, G.R. Akande, M.O. Ezekiel & P.A. Ozor	104
76	FOOD BORNE BACTERIAL PATHOGENS IN SMOKE-DRIED FISH IN LAGOS MARKETS - Amusan, E.E., Afolabi, O.O., Babalola, A.F. & Oramadike, C.E.	107
77	CRAB VALUE CHAIN IN LAGOS LAGOON COMPLEX: IMPLICATIONS FOR FOOD SECURITY IN A RECESSION ECONOMY - O.A. Adeogun, B.B. Solarin, E.E. Ambrose, H.K. Ogunbadejo, R.O. Orimogunje, D.A. Bolaji & J. Obienu	110
78	EFFECTS OF SQUARE MESH BUNT ON BY-CATCH REDUCTION IN WHITE SHRIMP, <i>Nematopalaemon hastatus</i> , FISHERY OF NIGERIA - Eyo, E., F.E. Ambrose, D.A. Bolaji, R.O. Orimogunje & J. Obienu	115
79	PURSE SEINE OPERATIONS OFF ORIMEDU FISH PORT, LAGOS STATE - Abass, M.A. & Fakoya, K.A.	125
80	POTENTIALS OF <i>Tarpon (Megalops) atlanticus</i> FOR SPORT FISHERIES AND ECOTOURISM DEVELOPMENT IN NIGERIA - Anyanwu, P.E., Kusemiju, K., Okoro, C.B., Ayo-Olalusi, C.I. & A.O. Ayorinde	130
81	FIELD IDENTIFICATION OF <i>Typha</i> SPECIES IN IHADEJA GASHUA NGURU WETLANDS - Y.A. Birnin-Yauri, B.L. Balarabe, E. Aina & S. Owontunse	134
82	ANAESTHETIC EFFECTS OF POTASSIUM PERMANGANATE ON <i>Heterobranchus bidorsalis</i> - Olufayo, M.O. & Abati, O.H.	139
83	BACTERIA ORGANISMS IN GROW OUT <i>Clarias gariepinus</i> MORTALITY IN JOS AREA - Badmus, O., Jwander, L.D., Agada, G.O.A., Apochi, J.O., Ajibade, A.A., Yacim, S.E. & Kolndadacha, O.D.	143
84	GROWTH OF TWO TILAPIAS IN FLOATING PLASTIC CAGES - Dada, A.A.	146
85	ASSESSMENT OF WATER QUALITY PARAMETERS IN LAKE ALAU - Abubakar Usman, B.M. Modu & Y.U. Paiko	149
86	PROBLEMS AFFECTING FISHERS' LIVELIHOOD AND FISHERIES DEVELOPMENT IN KAINJI LAKE BASIN - A.A. Tafida, A.A. Adebayo, Y.M. Musa, G.O. Nwabeze, R.E. Nyaku & K. Arowolo	153
87	FROZEN AND SMOKE-DRIED FISH MARKETING IN AKURE METROPOLIS - Nwanna, L.C. & O.A. Ogunsuyi	157
88	POTENTIALS OF POULTRY OFFALS IN AFRICAN CATFISH DIETS - A.E. Falaye, A. Omoike Ajani, E.K. & O.T. Kolawole	159
89	CONTROL OF REPRODUCTION IN <i>Oreochromis niloticus</i> USING PAWPAW SEED MEAL AS REPRODUCTION INHIBITOR - T. Jegede, O.A. Fagbenro & L.C. Nwanna	162
90	COMPARISON OF DIPLOID AND TRIPLOID <i>Heterobranchus bidorsalis</i> USING POLYACRYLAMIDE GEL ELECTROPHORESIS (N-PAGE) - Agbebi, O.T., Salami, H.O. & Oguniwin, D.I.	168
91	PRIMARY PRODUCTION AND PHYSICO-CHEMICAL PARAMETERS OF A FRESHWATER FISH FARM IN SOUTH EAST NIGERIA - Ekwu, A.O., Okon, A.O., Ekpo, I.E. & Edet, I.P.	170
92	TOXICITY OF AFRICAN LOCUST BEAN EFFLUENT ON <i>Oreochromis niloticus</i> - O. Ekpo-Jide, O.A. Fagbenro & O.T. Adebayo	178
	Brief Profile of Ondo State, Nigeria	183
	Brief Profile of The Federal University of Technology, Akure	185
	AUTHORS' INDEX - Volume 1	187
	AUTHORS' INDEX - Volume 2	190

## ASSESSMENT OF WATER QUALITY PARAMETERS IN LAKE ALAU

<sup>1</sup>ABUBAKAR USMAN, <sup>1</sup>B.M. MODU & <sup>2</sup>Y.U. PAIKO

<sup>1</sup>Department of Fisheries, University of Maiduguri, PMB 1069, Maiduguri

<sup>2</sup>Department of Water Resources, Aquaculture and Fisheries Technology,  
Federal University of Technology, PMB 65, Minna

### ABSTRACT

The physico-chemical parameters of Lake Alau were monitored for four months to assess the water quality. Parameters such as temperature, transparency, conductivity, dissolved oxygen, biochemical oxygen demand, Ca, P, etc were studied in five stations (A, B, C, D and E). Water samples were collected monthly from 8:00 to 12:00noon, for four months (July - October 2008, wet season) and analysed. The physico-chemical parameters were within the ranges of unpolluted water bodies. Variation occurs in almost all the months of the study. Significant difference ( $P < 0.05$ ) occurred in  $p^H$ , transparency and Ca among the stations, and insignificant difference ( $P > 0.05$ ) in temperature, conductivity, dissolved oxygen, biochemical oxygen demand, Mg and P. These variations may be due to effects of fertilizer application, herbicides and insecticides in irrigated farms around the Lake.

### INTRODUCTION

The quality of water plays a vital role in the productivity of aquatic habitats. The fertility of water is related to its chemical properties and understanding of water chemistry serves as basis for considering whether the water is rich or poor in biological production. The physical and chemical properties of water greatly influence the uses, the distribution and richness of biota (Courtney and Clement 1998). As such, techniques of using physical and chemical properties to assess water bodies are essential. And it will also reveal the concentrations of known environmental contamination which could render such water unfit for human consumption and other purposes. Properties such as high dissolved oxygen in water is an essential pre-requisite for satisfactory aquatic life, while presence of dissolved oxygen and carbon (IV) oxide in water for industrial purposes constitute corrosive agents and threatens the life of most metallic plants (Akpan 1995). The objectives of this study were to assess the physico-chemical parameters of Lake Alau, and compare the water quality parameters with the standard required levels for fish production.

### METHODOLOGY

Lake Alau is one of the largest water bodies in Northeast Nigeria. It was sourced from river Ngadda. It is located about 19km from Maiduguri along Maiduguri-Bama road, between latitude  $10^{\circ}43'N$  and longitudes  $10^{\circ}15'E$  and  $13^{\circ}17'E$  (BSMLS, 2002). It has two distinct wet and dry seasons; a raining season with mean annual rainfall of about 600mm from July to October, and a hot dry season from March to July. The dry season is preceded by a period of dry Harmattan with very low temperature and dry hamatan wind between November and February (Bankole *et al.* 1984). Monthly surface water samples were collected in duplicate for a period of four months (July 2008 to October 2008) with two litre plastic containers. The containers were washed with detergent, rinsed with 0.1M HCL and finally rinsed with distilled water. Collections were made between 8:00am and 12:00noon. Five sampling stations were demarcated from the lake station A, B, C, D and E respectively. Station A serves as the control which is the inlet of the water body. Standard method from APHA(1998) was adopted for this study. Temperatures were measured with mercury in glass thermometer while transparency was measured with a Secchi disk. Conductivity and  $p^H$  were measured using individual meters. DO meter was used to determine the dissolved oxygen and Winkler method was used to determine BOD. The concentration of TDS was determined by evaporation process while that of TSS was by filtration method. Total alkalinity and salinity were analyzed by titrimetric method. Colorimetric method was adopted for Nitrate-nitrogen ( $NO_3N$ ) and Phosphate phosphorus ( $PO_4-O$ ).

### RESULTS AND DISCUSSION

The monthly mean value of the physicochemical parameters of Lake Alau is given in Table 1, while that of monthly mean by sampling station of physicochemical parameters is given in Table 2. Physicochemical analysis showed that temperature was low in September ( $27.42 \pm 0.29^{\circ}C$ ) and high in

July (28.24<sup>±</sup>0.34). However, other low values were recorded in August and October with no significant difference ( $P>0.05$ ). The lowest value was recorded in station C (27.55<sup>±</sup>0.35) and the highest value in station A (28.00<sup>±</sup>0.45). There was no significant difference between all the stations ( $P>0.05$ ). The low temperatures recorded from August to September which is due to the cloudy weather caused the decrease in temperature. This in accordance with the works of Timms (2001), which noted that climatic factors were the determining factor for increase or decrease in temperature in the arid zone and lake Alau shore the climate of the northeast arid zone. The water temperature of the range in this study falls within the normal range (25.0-35<sup>°</sup>) of natural tropical waters (Allabaster and Lyod 1980). The aquatic life of the tropics are adapted to these changes (Wood et al, 2007).

Table 1: Monthly mean of some physicochemical parameters of Lake Alau 2008

Months	Temp (°C)	Conduct (N/cm)	pH	DO (mg/L)	Transp (m)	BOD (mg/L)	Ca	Mg	P
July	28.24 <sup>a</sup>	65.80 <sup>a</sup>	8.476 <sup>a</sup>	3.76 <sup>b</sup>	0.852 <sup>a</sup>	2.38 <sup>a</sup>	0.84 <sup>a</sup>	1.20 <sup>a</sup>	0.09 <sup>a</sup>
August	27.92 <sup>a</sup>	51.04 <sup>b</sup>	7.90 <sup>ab</sup>	4.82 <sup>a</sup>	1.204 <sup>a</sup>	2.68 <sup>a</sup>	0.84 <sup>a</sup>	2.50 <sup>a</sup>	0.1122 <sup>a</sup>
Sept.	27.42 <sup>a</sup>	68.00 <sup>a</sup>	7.468 <sup>ab</sup>	3.34 <sup>b</sup>	1.38 <sup>a</sup>	1.20 <sup>b</sup>	0.36 <sup>a</sup>	0.84 <sup>d</sup>	0.212 <sup>a</sup>
October	27.96 <sup>a</sup>	66.40 <sup>a</sup>	7.124 <sup>a</sup>	3.34 <sup>b</sup>	1.18 <sup>a</sup>	1.40 <sup>b</sup>	0.66 <sup>ab</sup>	1.48 <sup>b</sup>	0.28 <sup>a</sup>

Table 2: Monthly mean of some physicochemical parameters of Lake Alau 2008 by Sampling Stations

Stations	Temp (°C)	Conduct (N/cm)	pH	DO (mg/L)	Transp (m)	BOD (mg/L)	Ca	Mg	P
A	28.00 <sup>a</sup>	61.75 <sup>a</sup>	7.0625 <sup>b</sup>	3.525 <sup>a</sup>	1.5375 <sup>a</sup>	1.925 <sup>a</sup>	0.425 <sup>b</sup>	1.40 <sup>a</sup>	0.3025 <sup>a</sup>
B	28.25 <sup>a</sup>	60.77 <sup>a</sup>	7.99 <sup>ab</sup>	3.675 <sup>a</sup>	1.0375 <sup>bc</sup>	1.85 <sup>a</sup>	0.725 <sup>ab</sup>	1.525 <sup>a</sup>	0.155 <sup>a</sup>
C	27.55 <sup>a</sup>	60.75 <sup>a</sup>	7.915 <sup>ab</sup>	4.30 <sup>a</sup>	1.45 <sup>ab</sup>	2.175 <sup>a</sup>	0.90 <sup>a</sup>	1.45 <sup>a</sup>	0.175 <sup>a</sup>
D	27.95 <sup>a</sup>	66.00 <sup>a</sup>	7.0925 <sup>b</sup>	3.70 <sup>a</sup>	1.015 <sup>bc</sup>	1.925 <sup>a</sup>	0.525 <sup>ab</sup>	1.75 <sup>a</sup>	0.11775 <sup>a</sup>
E	27.679 <sup>a</sup>	64.775 <sup>a</sup>	8.65 <sup>a</sup>	3.875 <sup>a</sup>	0.73 <sup>a</sup>	1.70 <sup>a</sup>	0.80 <sup>ab</sup>	1.40 <sup>a</sup>	0.1275 <sup>a</sup>

Key:

A= Akurari (control), B= Usmanti, C= spillway, D= Abbari, E= Ngawofete  
 ✧ Value with same supper script are no significant different ( $P<0.05$ )

Conductivity was low August (51.04<sup>±</sup>6.52) and high in September (68.00<sup>±</sup>10.56) during the wet season. In terms of stations lowest value was recorded in station C (60.75<sup>±</sup>3.77) and highest in station D (66.0<sup>±</sup>8.68). Also lower values were recorded in station A, B, and E although there was no significant difference between the stations ( $P>0.05$ ). The specific conductance of the lake water was less than 600u/cm recorded from Kiri dam (Ovie et al., 2009). The maximum value of 82u recorded for lake Alau in wet season is another indication of oligotrophy. It implies low level of dissolved salts, a characteristic feature of "soft" water. pH was low in October (7.12<sup>±</sup>0.72) and high in July (8.48<sup>±</sup>1.06) with slight difference compared to the rest of the months. In terms of stations, lowest values were recorded in station A (7.06<sup>±</sup>0.44) and highest value in station E (8.65<sup>±</sup>0.77). Very slight variations occurred between the sample stations. There was significant difference ( $P<0.05$ ) between station A, D and E and no significant difference ( $P>0.05$ ) between station B and C. The values and status in the p<sup>H</sup> of lake Alau agree with the observation of Hanson et al.(1990) in Zambezi river, Elcmi (1990) in Ona river, Atama, (2003) in Rimco reservoir, but contradicted the trend in some African lakes in which pH is lower in wet season, but rises during dry season (Azionu 1983). The pH ranges of lake Alau were comparatively narrow and fall within the recommended range (6.5-9.0) as sustainable for aquatic life (Boyd, 1979).

The DO concentration in the Lake was low in October (3.34<sup>±</sup>0.25) and high in August (4.82<sup>±</sup>1.84). In terms of stations, lowest value was recorded in station A (3.53<sup>±</sup>0.15) and highest in station C(4.30<sup>±</sup>1.21). There was no significant difference between all the stations ( $P>0.05$ ). The pattern of dissolved oxygen varied between stations. Égborge (1979) observe similar pattern of variation in lake Asejire. Oxygen levels in the in the five stations sampled were statistically proved to be significant. Duncan (1975) considered that whereas wind is a major oxygenator in large lakes,



while in smaller lakes, is largely determined by photosynthetic action of phytoplankton. Complete Oxygen depletion was not observed in any of the stations in the lake, apparently because of significant water movement throughout the lake.

Low transparency was recorded in the month of July ( $0.85 \pm 0.20$ ) and high in September ( $1.38 \pm 0.41$ ). In terms of stations, lowest value was recorded in station E ( $0.73 \pm 0.13$ ) while the highest value was in station A ( $1.54 \pm 0.35$ ). There was significant difference between station A, C and E ( $P < 0.05$ ), and no significant difference between station B and D ( $P > 0.05$ ). Water transparency varied from (0.6-1.87) in five stations. This is very low compared to 0.45-2.8m obtain in Kainji lake, (Adeniji, 1975). The remarkable increase in August after the onset of rains indicates that less floods draining into the lake were responsible for high water transparency within that period rather than phytoplankton production. Biwas (1978) observed in lake Volta Ghana, secchi disc transparency decreased with increased in phytoplanktons.

BOD was low in September ( $1.2 \pm 0.61$ ) and high in August ( $2.68 \pm 0.77$ ), other high values were recorded in July. The lowest values were recorded in station E ( $1.70 \pm 1.12$ ) and the highest in station C ( $2.18 \pm 1.46$ ). There was no significant difference between all the stations ( $P > 0.05$ ). Kolo and Yisa (2000) observed that organic matter decomposition from increased human activities can increase BOD variation. Moore and Moore (1976) reported that BOD is a fair measure of cleanliness of any water and classified values of less than 1.2mg/l as clean, while 4-6mg/l as fairly clean, and 8-10mg/l as bad and polluted. Based on these values, lake Alau water may be considered as clean.

Ca was low in September ( $0.36 \pm 0.05$ ) and high in July ( $0.84 \pm 0.29$ ). The value obtained in July, August and September are significantly different compared to the month of October ( $P < 0.05$ ). Station A recorded lowest value of  $0.43 \pm 0.01$  and highest value in Station C ( $0.90 \pm 0.42$ ). The values obtained in Station A and C are significantly different compared to Station B, D and E ( $P < 0.05$ ). This agrees with findings of Amuzu et al., (1990) that heavy metals occur in low concentration in aquatic ecosystem. Hart (1993) classified a surface water with  $< 0.2\text{mg/l}$  of calcium as very low,  $0.2-0.3\text{mg/l}$  as low,  $0.3-0.6\text{mg/l}$  as moderate,  $0.6-1.2\text{mg/l}$  as high polluted and  $> 1.2\text{mg/l}$  very high and heavily polluted. As such lake Alau is unpolluted. Mg was low in September ( $0.84 \pm 0.21$ ) and high in August ( $2.50 \pm 0.22$ ). There was no significant difference among all the months ( $P > 0.05$ ). Station A recorded the lowest value of  $1.40 \pm 0.57$  and highest in station D ( $1.75 \pm 0.76$ ). There was significant difference between all the stations ( $P < 0.05$ ). Odieta (1999) reported that domestic sewage and agricultural effluents has capacity to precipitated manganese salts, which may exert a toxic effect on the aquatic organism. Other sources may be due to localized inputs and sediments transport. Low P was recorded in July ( $0.10 \pm 0.05$ ) and high in October ( $0.28 \pm 0.25$ ). The lowest value was recorded in station D ( $0.12 \pm 0.13$ ) and highest in station A ( $0.30 \pm 0.28$ ). There was no significant difference between all the stations ( $P > 0.05$ ). It has also observed during this study period intensive agricultural activities involve use of fertilizer and pesticides to produce crop vegetables. Some villages where using the water for domestic activities, washing vehicles, which could increase the P level of the lake water. Sandra (2000) observed that P is the most important and limiting substances controlling organic production.

The physicochemical parameters of Lake Alau varied with months and stations, due to their specific properties during the wet season. The limnological features strongly suggest that the water body is maintaining an oligomesotrophic status. The Physio-chemical parameters were within the ranges in unpolluted water bodies. Variation may be due to effect of agricultural activities through fertilizer applications, herbicides and pesticides around the lakes catchments. Furthermore, these findings provide baseline information on some aspects of water quality status as well as the trophic status of the lake. The baseline information will serve as an indicator for ecological problems and action to minimize likely problem with respect to its sustainable management. In order to uphold United Nation Organization standards (UNO, 1992) that all species and habitats should be safeguarded to the extent that is technically, economically, and politically feasible, the following recommendations should be adopted.

1. Settlements around Lake Alau should be encouraged to adopt environmentally friendly initiatives by embracing Low and Non-waste Technologies (LNWT) at all stages of product life.
2. Monitoring of Lake Alau should be encouraged as part of environmental management policy, so as to control the effluents that enter each station, through canals, washing, etc, and hence

- maintain acceptable units of metal concentration, such as nitrate, nitrogen and phosphorus that encourages eutrophication of lake.
- Substantial limnological research information has accrued from a relatively short period of research work, longer period oriented study becomes increasingly vital and desirable. Further prolonged research should be carried in order to provide a broader understanding of this very economically and scientifically important water body in the arid zone. In addition, the knowledge derived should be used as an index for other man-made lakes in the arid zones.

#### REFERENCES

- Adeniji, H.A. (1975). Some aspect of limnology and fishery development of Kainji lake, Nigeria. *Arch Hydrobiol.* 72(2) 253-266.
- Akpan, A.W. (1995). Limnological and Nct plankton, periodicity of a tropical freshwater in Uyo. *Trop. Freshwater Biology* 4: 65-81.
- Alabaster, J.A and Lyod, R(1980). Water quality criteria for freshwater fisheries, 2<sup>nd</sup> Ed. Butternooths, London, 361pp.
- Amuzu, A.T. Calomari, A., Kabe N., Biney A. (1990). Review of heavy metals. In review of pollution in the African aquatic environment. CIFA Technical Paper No.25. FAO, Rome. 33-60.
- American and Public Health Association (APHA), AWWA and WPCF. (1998). Standards Method for Examination of Water and Waste Water, 20<sup>th</sup> ed. Washington DC, USA pp 930-931.
- Atama, C.I. (2003). Studies of physico-chemical characteristics of effluents from RIMCO vegetable oil company Nigerian Brewery Ltd. and their receiving freshwater ecosystem. M Sc thesis University of Nigeria, Nsukka p117.
- Azionu, (1983). Spatial and diel variation in some Hydrological fitness of the shen reservoir Plateau State. M sc thesis. University of Jos. 152pp.
- Bankole, N.O, Sule, O.D., Okwundu, E.C. and Amadi, M. (1984). Preliminary Investigation on the Frame Work and Catch Assessment Surveys of Lake Alau, Maiduguri, *Annual Report NIFFR.* 14.
- Biwas, S. (1978). Observation on phytoplankton and primary productivity in Volta lake, Ghana. *Verh. Internat. Limnol* 20, 1672-1676.
- Boyd, C. E. (1979). Water quality management in fish culture. J. Aurb univ. Alabama. 30p.
- BSMLS (2002). Borno State Ministry of Land and Survey, Topographical Map. Maiduguri, Nigeria.
- Courtney, L.A. and Clements, W.H. (1998). Effect of Acidic P<sup>H</sup> on Benthic Macro Invertebrate Communities Micocosms *Hydrobiologia* 379:145.
- Egborge, A.B.M. (1979). the distribution of phytoplanktons and zoo-planktons in some Ibadan freshwater systems. *Pol. Arch. Hydrobiol.* 26(3)323-335.
- Flemi, B.E. (1990). A limnological assessment of Ona river. Ibadan, Nigeria. MSc thesis University of Ibadan. Nigeria.
- Hanson, J.N., Prepas, E.F. and Mackey, W.C.(1990) Size distribution of the micro invertebrate community in freshwater lake. *Canadian Journal of Fisheries and Aquatic Science* 46: 1510-1519.
- Harts H. I (1993). A national approach to river management. *Search* 24:125-130.
- Kolo, R.J and Yisa, M (2000). Preliminary baseline assessment of water quality of river Suka, Niger State. *J. Fish. Tech.* 91-105pp.
- Moore, W. J. and Moore, E. A. (1976). Envirometal chemistry. Academic press, London. Pp 360-368.
- Odieta, W.O.(1999). Environmental physiology of Animal and pollution. Diversified publ. lmd Lagos.261pp.
- Ovie, S. I. Adepoju, F and Ajayi. O. (2000). Limnological stock assessment, productivity and potential fish yield of Dadin kowa and Kiri reservoir. NIFFR Report.
- Sandra, C. (2000). Alberta agriculture food and rural development. Managing phosphorus to protect water quality. London 315pp.
- Timms, B. V. (2001). A review of limnology and threats to the feature. Lakes reserve resources management. 6:183-196.
- United Nation Organisation. (1992). International Standard for Drinking Water. 3<sup>rd</sup> ed. World Health Organization, Geneva
- Wood, S., Sabastine, K. and Scheria, S. J. (2002). Pilot analysis of global ecosystem. World Resource Institute.