Wakilis by the project. Presently the *Wakilis* are paid a monthly stipend of N1000 and a bicycle each for easy mobility.

The Project should think of bringing the *Wakilis* and KLFMCU together as one body so as to have coordinated efforts in taking joint decisions for the sustainable management of the Lake fishery resources.

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LIMNOLOGICAL RESEARCH IN NIGERIA: SOME PERSPECTIVES

BY

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INTRODUCTION

The inland waters of Nigeria are numerous and have a total cover of about 15 million hectares. (Ita, 1993). They constitute an important part of the country's natural resources especially as a water source of hydroelectric power generation, irrigation, domestic and industrial water supply and fisheries. As a response to the country's expanding industry and population, long term limnological investigations are urgently needed in most aspects of

limnology, especially in the ecology and management of freshwater resources.

Assessment and constant monitoring of pollution are of urgent priority. Polluted and/or contaminated water pose a serious threat to both man and life in freshwater; thus making the water useless for other purposes. Recent advancement in industrial and technological developments in Nigeria, such as oil and gas explorations and/or

production, agricultural and other land/water use activities are already implicated in some pollution problems around the country's freshwaters. Ita (1996) reported that the productivity of inland water resources of Nigeria has been on the downward trend due severally to the effects of drought, environmental degradation and overexploitation. It has, therefore become very urgent and important to seriously study both the short and long term impacts of these socio-economic and technological developments on our freshwater ecosystems so that regulatory and management policies could be formulated for the preservation of our freshwater resources.

Limnology is defined as the study of the functional relationships and productivity of freshwater ecosystems as they are regulated by the dynamics of their physical, chemical and biotic environments. Understanding of the metabolic responses of our freshwater ecosystems is necessary in order to confront and offset the effects of population, industrial and technological growths so as to achieve maximum meaningful management of the freshwater resources.

2.   FRESHWATER ECOSYSTEMS IN NIGERIA

The vast expanse of inland freshwater ecosystems spread all over the country, from the coastal region to the arid zone of the Lake Chad Basin, is shown in Figure 1. The approximate extent of the major inland water systems is indicated in Tables 1 and 2. The major rivers estimated at about 10,812,400 hectares, making up about 11.5% of the total surface area of Nigeria which is estimated to be approximately 94,185,000 hectares.
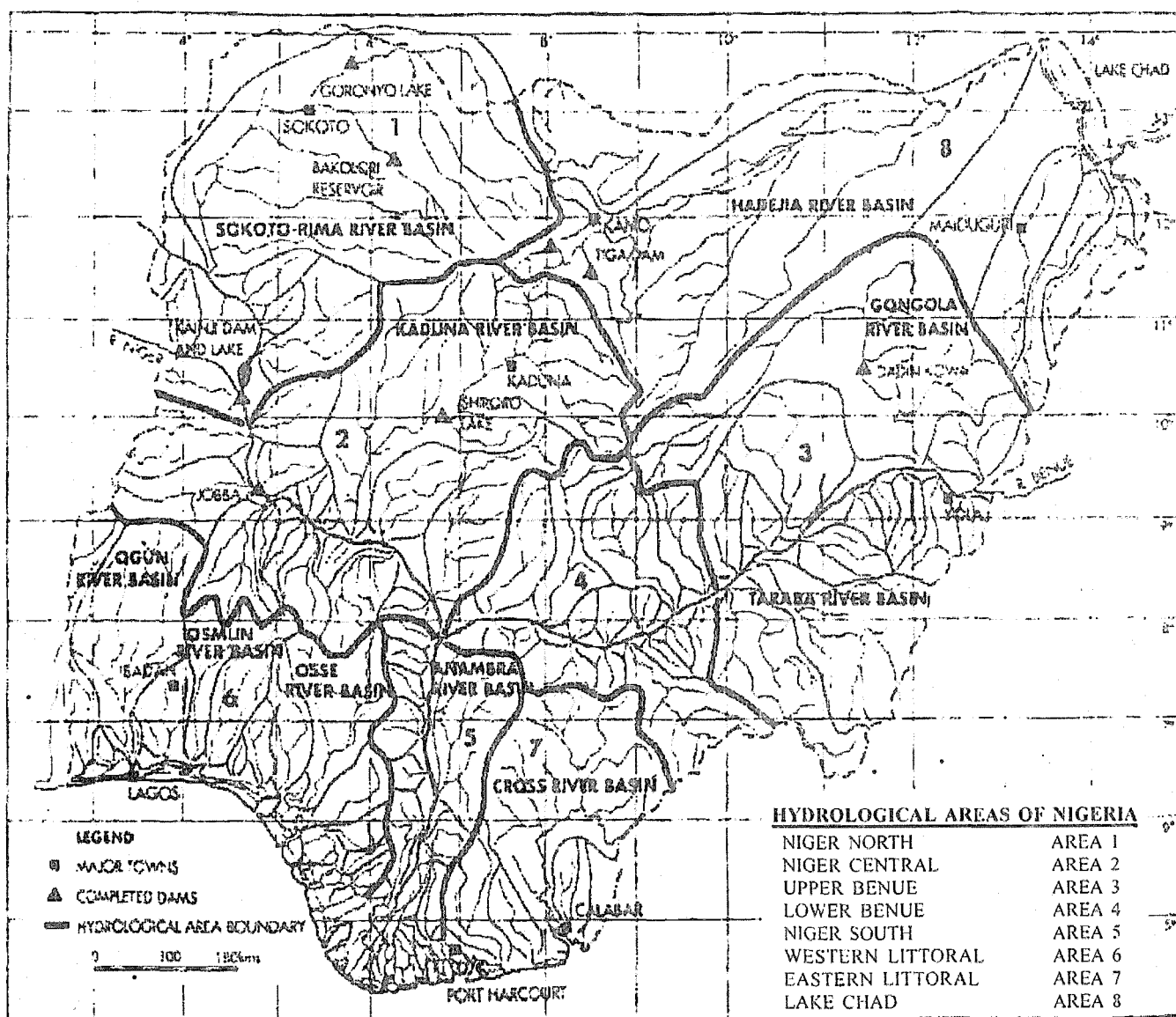

HYDROLOGICAL AREAS OF NIGERIA	
NIGER NORTH	AREA 1
NIGER CENTRAL	AREA 2
UPPER BENUE	AREA 3
LOWER BENUE	AREA 4
NIGER SOUTH	AREA 5
WESTERN LITTORAL	AREA 6
EASTERN LITTORAL	AREA 7
LAKE CHAD	AREA 8

Fig. 1 Hydrological map of Nigeria showing the major inland waters
Source: Courtesy

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Table 1: Major inland water resources of Nigeria

Types of water bodies	Approximate surface area (ha)	References
A: Major River		
i) Anambra River	1,401,000	
ii) Benue River	129,000	Ita and Sado *et al* 1985
iii) Cross River	3,900,000	
iv) Imo River	910,000	
v) Kwa Iboe River	500,000	
vi) Niger River Less Kainji and Jebba Lakes	169,800	
vii) Ogun River	2,237,000	
viii) Oshun River	1,565,400	
Sub Total	10,812,200	
B: Major Lakes and Reservoirs		
i) Lake Chad (natural)·	550,000	Ita and Sado *et al* (1985)
ii) Kainji Lake (Man-made)	127,000	
iii) Jebba Lake (Man-made)	35,000	
iv) Shiroro Lake (Man-made)	31,200	
v) Goronyo Lake (Man-made)	20,000	
vi) Chalawa Gorge (Man-made)	10,100	
vii) Tiga Lake (Man-made)	17,800	
viii) Dadin Kowa (Man-made)	29,000 ·	
ix) Kiri (Man-made)	11,500	
x) Bakolori (Man-made)	8,000	
xi) Lower Anambra (Man-made)	5,000	
xii) Zobe (Man-made)	5,000	
xiii) Oyan (Man-made)	4,000	
Sub Total	853,6000	
Total A + B	11,666,000	

A & B as % of total area of Nigeria (94,185,000 ha). 12.4%

Table 2: Distribution and extent of Nigerian Freshwater bodies

Types of wet land and Distribution	Approximate size (ha)	References
1. Freshwaters		
i) Niger delta Freshwater	362,000	Scott (1966)
ii) Apex of Niger to Lokoja	635,000	Muller (1973)
iii) Niger /Sokoto Basin	470,000	Hughes and Hughes (1991)
iv) Niger/Kaduna Bsin	150,000	Hughes and Hughes (1991)
v) Lower Niger: Jebba to Lokoja	385,500	
vi) Benue River flood plain	312,000	Hughes and Hughes (1991)
vii) Hadejia Komadugu Yobe	624,000	Hughes and Hughes (1991)
viii) Ogun/Oshun flood plains	Not estimated	
ix) Cross River flood plains	250,000	Moses (1981)
x) Imo River flood plains	26,000	ENPLAN (1974a)
xi) Kwa Iboe	7,000	Moses (1981)
Sub Total	3,221,500	
2. Other freshwaters.		
i) Minor reservoirs	98,900	Ita and Sado et al (1985)
ii) Fish ponds	5,500	Ita and Sado et al 1985
	104,400	

3.DEVELOPMENT OF LIMNOLOGY IN NIGERIA

3.1 Historical Background

The study of Limnology in Nigeria started in the early part of the twentieth century. Such pioneer research in Limnology include; diurnal migration and seasonal fluctuations in the numbers of *Thermocyclops nigarians* in a Nigerian pond by Onabamiro (1952); hydrology and plankton of the River Sokoto by Holden and Green (1960); seasonal distribution of zooplankton in the northern basin of Lake Chad by Robinson and Robinson (1971). Second half of the sixties marked the beginning of limnological training in two Nigerian Universities, Obafemi Awolowo University, Ile Ife and University of Ibadan. Imevbore (1967) made a preliminary check list of the planktonic organisms and also studied the hydrology and plankton of the Eleyele reservoir in Ibadan. The work of White (ED. 1965) on the pre-impoundment physico-chemical, biological and fisheries on the lower River Niger before the formation of Lake Kainji in the Niger valley in 1968. Egborge (1970) studied the hydrology and plankton of the River Oshun. Later in Egborge (1977) he described the hydrology and plankton of Asejire Lake which was impounded from the Oshun River.

Extensive Limnological research and training in Nigeria started in 1969 after the formation of Lake Kainji. Scientists and government suddenly became aware of the importance of limnology especially for fish production, public health and other socio-economic and technological developments in the country. As a result, the Kainji Lake Research Project was set up in 1969, by the Federal Government of Nigeria and the Food and Agricultural Organization (FAO) of the United Nations. It was a multidisciplinary project with limnology as one of the disciplines. In 1975, the project was upgraded to full-fledged Federal Government research Institute and renamed Kainji Lake Research Institute. The Limnology Division of the Institute continued to conduct research on man-made lakes, reservoirs, major rivers, fish ponds and floodplains in the country. The name of the Institute was in 1988 changed to National Institute for Freshwater Fisheries Research. Also in 1975, the Federal Government set up Lake Chad Research Institute which had Limnology as a programme within its Fisheries Research Division. The programme conducted research on Lake Chad and other Freshwater bodies of the arid zone. Tobor (1969 and 1970) studied some limnological variables such as temperature, fluctuation in water levels, wind action, plankton and their effects on fishing and feeding of fish in Lake Chad.

2.2 STATUS OF LIMNOLOGICAL RESEARCH AND TRAINING

Limnological research and training in Nigeria are still in their infancy although remarkable growth has been

witnessed in the last two decades. This growth in limnology has occurred inspite of meager funding for research, the paucity of scientists involved in aquatic sciences, the lack of a national body responsible for initiating and coordinating limnological research and paucity of rewards and awards for scientific achievement. Currently limnological research and training are conducted in discipline or sectorial oriented institutions as in

a) departments of zoology in Universities because of their focus on ichthyology, crustaceology and malacology

b) departments of botany in Universities because of their interest in algalogy

c) departments of Fisheries and Wildlife in Universities and colleges of Agriculture because of their concern for fish production and other aquatic resources production.

d) medical and health departments of Universities and research Institutes due to their concern for water borne diseases, sanitation and waste disposal.

e) water works, drainage and irrigation departments due to their concern for water supply, drainage and irrigation.

Limnological research is undertaken by research personnel while training programmes are organised for undergraduate and post-graduate students in the various departments, Presently, the National Institute for Freshwater Fisheries Research (NIFFR) New Bussa is the main centre for limnological research in Nigeria. The limnology Programme of the Institute is as old as the institute itself. The main Limnological research fields include, Limnological water quality-physico-chemical and biotic, phytoplankton ecology and primary productivity; zooplankton ecology and secondary productivity, Benthic ecology and secondary productivitiy, Aquatic microbiology, sanitary bacteriology, physical and chemical pollution, biological pollution, planktonic fish food culture and earth worm and maggot culture.

Limnological research in the Institute is both pure and applied but mostly applied. Most are relevant to fish production, distribution, abundance and catch, including the effects of limnological factors on fish and other aquatic organisms.

Studies on the general limnology and primary production of the Kainji lake were published by Henderson (1973) and Adeniji (1973 and 1978). The primary productivity of many Nigerian man-made lakes has been determined. Such lakes include Kainji, Jebba, Shiroro (Niger State), Goronyo and Bakolori (Sokoto State), Asa (Kwara State) Tiga and Jankora (Kano State), Lower Usman and Jebbi reservoirs in the Federal Capital Territory (FCT) Dadin

Kowa reservoir (Gombe State) and Kiri reservoir (Adamawa State). The Limnological indices from primary productivity and morphonedephic factors have been used in estimating potential fish yield from these water bodies.

Toxic effects of DDT and other toxic compounds on fish, aquatic plants and sediments in Kainji and Jebba lakes have been established. The open drains that enter into river Kaduna were found to contain high pollution indicator organisms beyond the recommended values for effluent discharge. Pollution levels of Jakara reservoir, in Kano, have also been investigated and found to exhibit high conductivity which indicates chemical pollution of the reservoir, Mbagwu (1991).

Limnology programme of the Institute has a remarkable achievement in fish food culture research. *Moina,* an indigenous zooplankton has been successfully isolated from a mixed zooplankton population and mass produced in outdoor concrete tanks for mass rearing of fish larvae to fry stage in the hatchery complex and other hatcheries in the country, Ovie *et al* (1992). Ovie *et al* (1990) also established that local raw materials such as chicken dropping, cow dung and pig manure extracts are effective and good alternatives to inorganic nutrients (which are expensive) in the mass production of natural live fish food.

2.3 *Other centers for Limnological Research and Training*

They include:
University of Jos
Obafemi Awolowo University, Ile-Ife
Ahmadu Bello University, Zaria
University of Calabar
University of Ibadan
University of Nigeria, Nsukka
University of Benin City
University of Ilorin
University of Uyo
Usman Danfodio University, Sokoto
University of Port-Harcourt
Bayeo University, Kano
University of Lagos
Federal University of Technology, Akure
Federal University of Technology, Minna
Federal University of Technology, Owerri
Federal University of Technology, Yola
University of Agriculture, Abeokuta
University of Agriculture, Umudike
University of Agriculture, Makurdi
Abia State University, Uturu, Abia State
Delta State University, Abraka
Imo State University, Owerri
Edo State University, Ekpoma
River State University of Science and Technology, Port-Harcourt

Ondo State University, Ado-Ekiti.

4. PERSPECTIVES FOR FUTURE DEVELOPMENT

Further advance of limnological research and training in Nigeria depends on freshwater resources, the realization of the importance of these resources by society (government authorities, public opinion researchers etc) and the cooperation of external organizations and countries, which have attained greater knowledge in the discipline. The principal reason for initiating limnological research is to preserve and protect freshwater systems. The first step to this achievement is to have a better understanding of the systems and the effects of various perturbations on those ecosystems. It is therefore important to develop a hard core scientific information on the various freshwater communities and their response to pollution so as to increase our ability to predict potential environmental impacts.

Valuable research is already in progress but coordination of current research bodies are very essential. Presently too much of the expertise on limnology is scattered far from where it should be.

Suggested areas of future research include:-

a) Limnological water quality (physical, chemical and biological)
b) Phytoplankton ecology and primary productivity
c) Zooplankton ecology and secondary productivity
d) Benthic ecology and secondary productivity
e) Aquatic microbiology
f) Sanitary bacteriology
   Physical and chemical pollution
h) Biological pollution .
i) Aquatic macrophytes
j) Benthic organisms
k) Planktonic fish food.

It is highly desirable to create an Institute of Limnology in Nigeria, where experts from different disciplines could pool their knowledge together in solving multidisciplinary problems with their students. Long term and integrated research could easily be initiated instead of the current fragmented, short term and individual approaches. A centre for pooling information is highly desirable to maintain high level of awareness through the production of newsletters and journals and by bringing limnologists together through workshops, seminars and conferences. Films and videotapes for television and for general extension use along with extension manuals should be produced so that ordinary people would know the importance of freshwater ecosystems.

Another area of concern is the grossly inadequate provision of infrastructural facilities, equipment and other research materials. Poor funding and late release of research funds are seriously affecting the quality and scope of research. Nigerian limnologists are still very few. More young scientists capable of initiating and undertaking research in the aquatic ecosystems have to be trained. The teaching of freshwater science – a field of study, sadly reglected to a great extent – at the undergraduate and higher levels must be greatly encouraged. With the cooperation between the research institutes and the universities and given the basic facilities, such training could be achieved locally. Most Nigerian universities do not have limnology as part of their curricula. Mass revision of curriculum at all levels of education is required to awaken the citizens to the importance of freshwater environments.

CONCLUSION:

Limnology, indeed, has a future in Nigeria and is vital to the national economic development as it provides necessary background for the effective harnessing of the potentialities of our freshwater resources. It is obvious that as the pace of economic development accelerates in Nigeria, the pressure to make optimum use of our freshwater resources would intensify. Thus, wise planning and management of the resources are necessary in this respect, Nigerian Limnologists can and must come to play an increasing important role not only in the basic and applied research but also in the formulation of national water resource policies.

They have the awesome responsibility for safeguarding the nation's freshwater environments and acting as the conscience of the nation against forces of despoilage, pollution, destruction and degradation. The very great economic value, actual and potential of Nigerian freshwaters, is very obvious; what we require is the necessary scientific background for their development, utilization, management and conservation.

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EMBRYONIC DEVELOPMENT IN *Clarias gariepinus* UNDER LABORATORY CONDITIONS

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ABSTRACT

The embryonic development in *Clarias gariepinus* was studied under laboratory conditions. The stages in the development of eggs starting from first cleavage were examined microscopically. Photomicroscope was used to take important stages of segmentation, blastulation, differentiation of embryo and hatching. The films of the photograph was developed and print of each stage produced. The accurate timing and detailed description of each stage was done.