ISSN - 2277 - 2755


Journal of Agricultural Science and Environment

# WATER QUALITY, FISH DIVERSITY AND CATCH ASSESSMENT OF IKERE GORGE OYO STATE, NIGERIA

***F.I. ADEOSUN, Y. AKEGBEJO-SAMSONS AND I.T.OMONIYI**

Department of Aquaculture and Fisheries Management,
University of Agriculture, Abeokuta, Ogun State Nigeria
***Corresponding author**: adeosunfi@yahoo.com, **Tel:** +2348038057564

## ABSTRACT

Study of the physico-chemical parameters of Ikere gorge is one of the recently constructed man-made lake in Oyo state, Nigeria. The need to assess the fish diversity, water quality and catch assessment of this new water body was necessary. Data on fish species were collected on monthly basis using multi-stage gillnet sampling techniques for eighteen months. Four sampling stations were randomly selected from the entire gorge. In each sampling station (fishing villages) were randomly selected for the investigation of the fish composition and abundance. A variety of sampling methods were used at each site in order to reach every fish species. At the river channel and the floodplain sites, traps, cast nets (2.55cm mesh), seine nets (25.5x2m, cm mesh), monofilament nylon gillnets (15.55 cm mesh), and hook and line were employed. Effort were made in order to catch fish species in large abundance. Some sampled fish (dead) were collected and placed in cool boxes and examined within 18h of capture, others were preserved in 15% formalin and stored for later examination. Samples of catches from the commercial fishermen was in addition examined and assessed. A total of 5,736 fish specimens were caught during the study period. These were identified and classified into 34 species belonging to 13 families, and arranged according to Greenwood *et al* (1966). The percentage species composition of the harvest by numbers and weight for all fish species that contributed more than 1% in all the stations combine were computed. Data fish composition and abundance were collected. From field and Laboratory evaluation, Bagridae (25.1%), Cichlidae (37.1%) and Mormyridae (14.5%) were most abundant families contributing 76.7% by number and 75% by weight of the total catch followed by Characidae (9.6%), Cyprinidae (7%) and Centropomidae (3%) constituting (19.6%) by number and 8.7% by weight. Others; Schilbedae (1.1%) Clarridae (0.8%), Hepsetidae (0.7%0, Mochokidae (0.6%), Channidae (0.5%), Icthyoboridae (0.2%) and Malapteruridae (0.1%) were least represented (4% by number and 16.5% by weight of total catch). Study of the physico-chemical parameters such as dissolved oxygen ranged from 2.2 to 9.1mg/l; temperature, 24.2 to $30^0$C; alkalinity, 94 to 118ppm; conductivity, 81 to 86.7ohms/cm; pH, 6.04-8.62; transparency 50cm to 3.9m; nitrate, 258.15-532.6mg/l; total dissolved solids, 0.142-782mg/l; depth, 25-33.60m; pH and water temperature serve as variables since the fluctuation of one affects the values of others. The water quality parameters were favourable for fish production. The gillnet fisheries indicated that different mesh sizes of experimental gillnets were sensitive to different fish species. 78.4mm, 112mm, 67.2mm mesh sizes were efficient in catching *C. nigrodigitatus L. niloticus* and the cichlids respectively. Other gears used were cast net, traps, bamboo stems, spears and gura net. The study has shown that station iv was the most suitable habitat for fish in Ikere gorge. Water level and temperature were observed to guarantee high fish yield in the gorge.

**Key words**: Ikere gorge, Ikere stream, Physico-chemical parameters, water quality.

## INTRODUCTION

Ikere Gorge is a man- made lake constructed on the River Ogun, 8 kilometers east of Ikere village and 30 kilometers North east of Iseyin in Oyo state, Nigeria (Fig. 1). With the impoundment of water in the dam reservoir in 1992, certain villages, namely Alagbon, Olaibi and Alagbede with some 150 farm families upstream of the dam were displaced and resettled. The Authority established two resettlement camps, one each on the left and right banks of the lake. A total of 30 units of residential building were constructed and allocated to the resettles.

The water chemistry of Ikere gorge is influenced principally by the physico-chemical nature of the inflow, the submerged vegetation and soils.

Studies on water quality mostly centred on fish production and aquatic biotic integrity (Boyd, 1979; Abohweyere, 1990; King, 1998). The most notable important physico-chemical parameters are dissolved oxygen, temperature, transparency, suspended solids and dissolved ions (Karr and Dudley, 1981).

## MATERIALS AND METHODS

### *Study area*

The study was carried out in Ikere gorge, 8km east of Ikere village and 30 km North east of Iseyin in Oyo state, Nigeria.

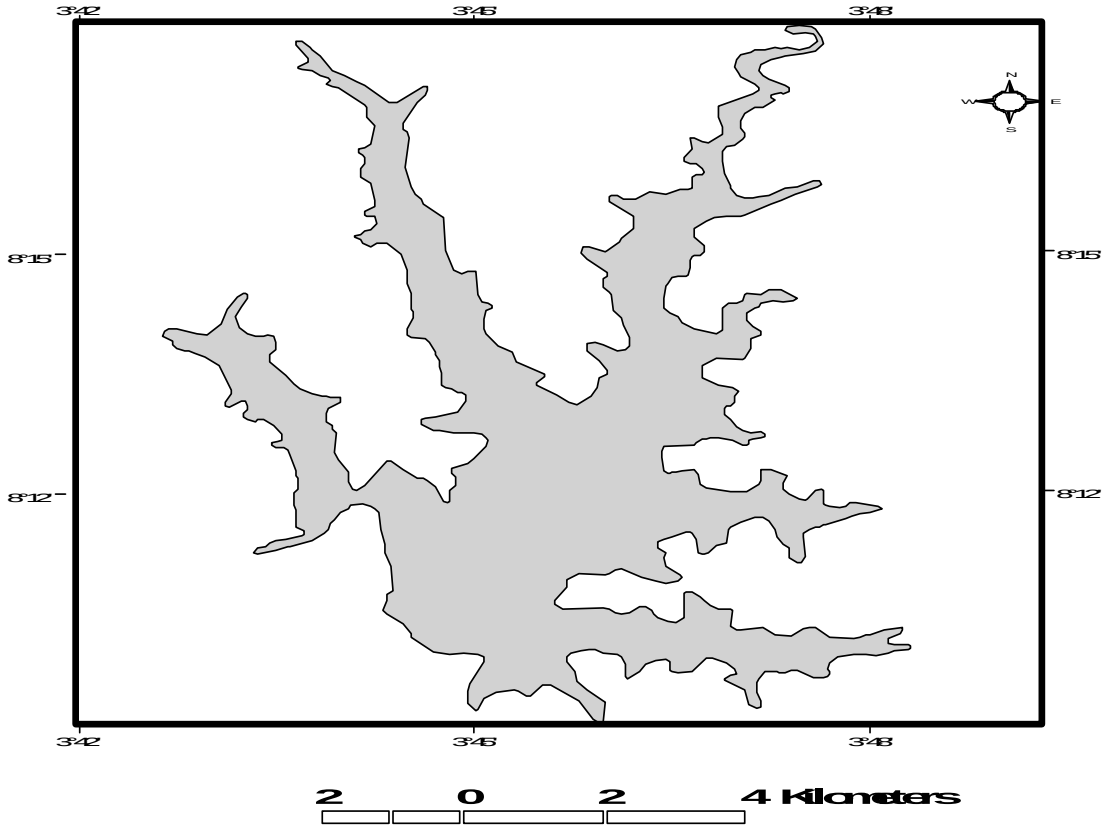


**Fig. 1: Map of Ikere gorge in Oyo State**

The gorge covers all the land between longitude $8^{o}$ $10^{1}$ and $8^{o}$ $20^{1}$E and latitude $3^{o}40^{1}$ and $3^{o}$ $50^{1}$N with total area of 300,000$km^2$.

The depth and width of the river varies slightly at different sampling stations. The minimum and maximum widths are 300 and 600meters respectively. The vegetation presents an interphase between a tropical rainforest and a derived savannah.

### *Sampling procedure*

Data on fish species was collected on monthly basis using multi-stage gillnet sampling techniques. Four sampling zones were randomly selected from the entire gorge. In each zone, at least three sampling stations (fishing villages) were randomly selected for the investigation of the fish composition and abundance. Sampling was done using various available gears, such as a fleet of eight graded experimental gillnets (mesh sizes from 25.4 to 177.8mm) and cast net (50.8mm) of similar surface area, which were done simultaneously in the various sampling station. Samples were taken in the first three days of the first week of every month covering eighteen calendar months of wet and dry season period of the year between July 2004 and December 2005.

A variety of sampling methods were used at each site in order to reach every fish species. At the river channel and the floodplain sites, traps, cast nets (2.55 cm mesh), seine nets (25.5x 2m, 2.55 cm mesh), monofilament nylon gillnets (15.55 cm mesh) and hook and line were employed. In most of the sampling stations, various sampling methods were used in order to catch fish species in large abundance. Some sampled fish (dead) were collected and placed in cool boxes and examined within 18 hrs of capture, others were preserved in 15% formalin and stored for later examination. The commercial fish catch of fishermen was in addition examined as available.

### *Analysis of the Frame Survey Data*

Basic statistics relating to the structure of the fishery were extracted from the Microsoft Excel data spreadsheets, which included total number of gill nets in the fishery by mesh size, total number of fishers in the fishery by sex and tribe, the fishing behavior of the fishers, the total number of fishing craft in the fishery, and the total number of fishing gear in the fishery. The following algorithms have been applied to the data.

### *Mean Standard Catch Per Unit of Effort (CPUE)*

Mean standard catch per unit of effort in PASGEAR (Kolding, 2000) is calculated as:

$$CPUE = \frac{1}{y}\sum_{i=1}^{n} w_i \cdot \frac{SU}{U_i} \cdot \frac{ST}{T_i} \qquad (1)$$

where; y = effort defined as number of settings (nets; or in this case also baskets, hooks, or traps); n= number of samples (observations); $w_i$ = catch (in weight or numbers) in $set_i$ or $sample_i$,; SU = standard relative effort unit (size) of a net panel; $U_i$ = actual effort unit (size) of $net_i$; ST = standard time unit of a setting; $T_i$ = actual time unit of a setting. The standard deviation of the mean CPUE is calculated from,

$$SD(CPUE) = \frac{1}{y}\sqrt{\frac{\sum x^2 - 2\hat{R}\sum xy + \hat{R}^2 \sum y^2}{n-1}} \qquad (2)$$

where, $\hat{R} = CPUE = \frac{\bar{x}}{\bar{y}}$ x is standardized catch, y is effort, n is sample size (i.e., number of observations)

***Catch Composition and Index of Relative Importance***

Total catch composition in numbers and weight (kg) for each of the data sources (except frame survey data) and the frequency of occurrence in the fleet or mesh sizes was calculated. A measure of the relative abundance or commonness of each species (i) in the catch composition was calculated using an index of relative importance, IRI, (Kolding, 1989):

$$\%\,IRI_i = \frac{(\%W_i + \%N_i)\cdot \%F_i}{\sum_{j=1}^{S}(\%W_j + \%N_j)\cdot \%F_j}\cdot 100 \qquad (3)$$

where, $\%\ W_i$ and $\%N_i$ is percentage weight and number of each species of total catch; $\%F_i$ is percentage frequency of occurrence of each species in total number of settings; and S is total number of species.

Shannon's Diversity Index (H') and relative evenness (J')

These are defined in Kolding (2000) as:

$$H' = -\sum_{i=1}^{S} P_i . Ln(P_i) \qquad (4)$$

where, $P_i$ is the relative abundance of individuals found in *i* - the species.

$$J' = H'/H_{\max} \quad \text{where} \quad H_{\max} = Ln(S)$$

Study on physico-chemical parameters of Ikere gorge was assessed for eighteen months (July 2004- December 2005) on a monthly basis and four sample areas were located in the course of the study. The choices of the station location were:

The areas of entry of the water (inlet), the middle of the gorge, shallow area and the outlet area.

The water temperature, pH, turbidity and depth were measured in the field using mercury-in-glass thermometer, pH meter (model 51. Japan), secchi disc (diameter = 12.0) and graduated rope respectively.

Conductivity and dissolved oxygen (DO) were measured with portable electronic conductivity meter (Model Mel.V) and portable digital DO probes (Model Parker,1987) respectively. Other samples such as alkalinity, pH, phosphate, nitrate and total dissolved solid were collected and transported in ice-box to the laboratory for subsequent analysis. These samples were analysed within 24 hours of collection in the laboratory. The total alkalinity nitrate, phosphate, total dissolved solids were determined titrimetrically (APHA, 1980).

The relationship between the physical and chemical parameters was correlated. One-way Analysis of Variance (ANOVA) followed by Duncan Multiple Range Test (DMRT) was also carried out using Statistical Package for Social Science (SPSS).

## RESULTS

The results of the physico-chemical characteristics of Ikere gorge between July 2004 and December 2005 are presented in Table 1. There was no significant difference ($p>0.05$) in the physico-chemical factors of Ikere gorge in the four sampled stations in terms of dissolved oxygen, nitrate, phosphate, temperature, alkalinity and total dissolved solids. However, the mean depth of station 1 value varied significantly ($p<0.05$) from the depth of other three stations.

The range of physico-chemical parameters of Ikere gorge sample showed temperature of 24.2 to $30^0$C, dissolved oxygen of 2.2 to 9.1mg/l, pH of 6.04 to 8.62, alkalinity of 94.2 to 188ppm, conductivity of 81 to

86.7ohms/cm, turbidity of 50cm to 3.9m, nitrate of 258.15 to 532.6mg/l, phosphate of 136 to 351mg/l, total dissolved solids of 0.142-782mg/l and depth of 25cm to 33.60mg/l.

Table 2 shows the fish species composition in Ikere gorge. A total of 5,736 fish specimens were caught between July 2004 to December 2005. These were identified and classified into 34 species belonging to 13 families, and arranged according to Greenwood *et al* (1966). This is presented in Table 2.

**Table 1: The mean values of the Physico-chemical characteristic of Ikere gorge between July 2004 and December 2005**

| Traits | Station 1 | Station 2 | Station 3 | Station 4 |
|---|---|---|---|---|
| PH | 6.15-8.22 | 6.08-8.26 | 6.14-8.62 | 6.04-8.50 |
| Dissolved Oxygen | 7.05±0.22a | 6.84±0.22a | 6.86±0.23a | 6.78±0.30a |
| Transparency | 1.81±0.15a | 1.38±0.10b | 1.87±0.13a | 1.75±0.17ab |
| Nitrate | 0.41±0.04a | 0.47±0.09a | 0.51±0.14a | 0.56±0.19a |
| Phosphate | 0.31±0.04a | 0.36±0.09a | 0.42±0.14a | 0.48±0.20a |
| Temperature | 27.33±0.38a | 27.44±0.45a | 27.55±0.33a | 28.04±0.35a |
| Conductivity | 82.86±0.37ab | 83.39±0.51ab | 82.49±0.36b | 84.24±0.69a |
| Alkalinity | 125.33±6.45a | 139.06±11.06a | 128.50±5.99a | 139.33±12.14a |
| Total Dissolved Solid | 311.88±56.89a | 298.00±58.25a | 310.71±53.12a | 324.83±66.05a |
| Depth | 21.40±2.00a | 1.93±0.28b | 4.05±0.39b | 4.73±0.60b |

*Chrysicthys nigrodigitatus* was in highest biomass (69,198kg) accounting for 34.65% of the total fish caught. *Synodontis nigrita, Malapterurus electricus, Marcusenius psittacus, Gnathonemus sensgalensis* and *Gnathonemus cyprinoides* were the least in number, while *Phago loricatus* was least in biomass (20.00kg) accounting for 0.01% of the total number of fish caught.

## DISCUSSION

This investigation shows that fish species in Ikere gorge are distributed in one of the three ways. There are those species that preferred the shallow areas of the gorge. These includes: *Clarias gariepinus, Tilapia melanopleura, Tilapia zillii, Tilapia marae, Sarotherodon galilaeus, Sarotherodon melanotheron* and *Oreochromis niloticus.*

**Table 2: Fish species caught and their Percentage Composition of fresh water reaches of Ikere gorge**

| Family / Species | No of Fish specimen | % no of specimen | Wt. (kg) of specimen | %Wt. of specimen |
|---|---|---|---|---|
| **CLAROTEIDAE** | | | | |
| *Chrysicthys nigrodigitatus* | 1423 | 24.81 | 69,198.13 | 34.65 |
| **BAGRIDAE** | | | | |
| *Bagrus docmac niger* | 46 | 0.80 | 1,520.21 | 0.76 |
| **LATIDAE** | | | | |
| *Lates niloticus* | 170 | 2.96 | 4,312.31 | 2.16 |
| **ALESTIDAE** | | | | |
| *Brycinus chaperi* | 512 | 8.93 | 6,290.11 | 3.15 |
| *Brycinus macrolepidotus* | 30 | 0.52 | 2,597.01 | 1.30 |
| **CHANNIDAE** | | | | |
| *Parachanna obscura* | 30 | 0.52 | 8,138.22 | 4.08 |
| **CICHLIDAE** | | | | |
| *Hemichromis fasciatus* | 545 | 9.50 | 6,170.14 | 3.09 |
| *Sarotherodon galilaeus* | 432 | 7.53 | 20,720.31 | 10.38 |
| *Tilapia melanopleura* | 596 | 10.39 | 26,864.24 | 13.45 |
| *Tilapia zillii* | 38 | 0.66 | 1,449.10 | 0.73 |
| *Sarotherodon melanotheron* | 444 | 7.74 | 3,893.22 | 1.95 |
| *Tilapia mariae* | 17 | 0.30 | 1,565.14 | 0.78 |
| *Tilapia monody* | 4 | 0.06 | 88.03 | 0.04 |
| *Oreochromis niloticus* | 33 | 0.58 | 7,010.12 | 3.51 |
| **CLARIIDAE** | | | | |
| *Clarias gariepinus* | 39 | 0.68 | 1,2611.21 | 6.32 |
| *Heterobranchus bidorsalis* | 6 | 0.10 | 1,254.10 | 0.63 |
| **CYPRINIDAE** | | | | |
| *Labeo coubie* | 12 | 0.21 | 414.00 | 0.21 |
| *Barbus occidentalis* | 368 | 6.42 | 3,260.11 | 1.63 |
| *Gara water loti* | 3 | 0.05 | 156.00 | 0.08 |
| *Barilius senegalensis* | 4 | 0.07 | 133.33 | 0.07 |
| *Barilius loati* | 12 | 0.21 | 297.14 | 0.15 |
| **HEPSETIDAE** | 41 | 0.71 | 4,777.03 | 2.39 |
| **DISTICHODENTIDAE** | | | | |
| *Phago loricatus* | 2 | 0.03 | 20.00 | 0.01 |
| **MOCHOKIDAE** | | | | |
| *Synodontis membranaceus* | 31 | 0.54 | 4,061.04 | 2.03 |
| *Synodontis nigrita* | 1 | 0.02 | 47.00 | 0.02 |
| **MALAPTERURIDAE** | | | | |
| *Malapterurus electricus* | 1 | 0.02 | 256.00 | 0.13 |
| **MORMYRIDAE** | | | | |
| *Mormyrus rume* | 6 | 0.10 | 1,221.01 | 0.61 |
| *Mormyrus deliciosus* | 23 | 0.40 | 544.00 | 0.27 |
| *Hyperopisus bebe occidentalis* | 21 | 0.37 | 4,551.01 | 0.23 |
| *Marcusenius isidori* | 779 | 13.58 | 8,999.23 | 4.51 |
| *Marcusenius psittacus* | 1 | 0.02 | 30.01 | 0.02 |
| *Gnathonemus senegalensis* | 1 | 0.02 | 30.02 | 0.02 |
| *Gnathonemus cyprinoids* | 1 | 0.02 | 55.00 | 0.03 |
| **SCHILBEDAE** | | | | |
| *Schilbe mystus* | 64 | 1.11 | 3,463.12 | 1.73 |
| **Total** | **5736** | **100** | **199687.65** | **100** |

The second groups are those species that preferred the deep area of the gorge and this includes *Lates niloticus, Synodontis membranaceus, Shilbe mystus, Mormyrus rume,Mormyrus deliciosus* and *Hepsetus odoe*.

The third group consist of those that were evenly distributed all over the gorge. This are *Bagrus docmac niger, Labeo cubie, Chrysichthys nirodigitatus* and *Brycinus macrolepidotus*. A similar pattern of relative species abundance has been observed in other tropical man-made lakes. Cichlid dominated the fisheries of Kainji Lake, Goronyo and Bakolori as reported by Akintunde, 1976 and Ita and Balogun, 1982, respectively. The preponderance of *Cichlids* in Ikere gore could be attributed to their ability to thrive on a wide variety of foods and the provision of suitable breeding and their shelter ground provided by colonization of the banks with green plants.

Observations of the colour of the water thus offer a certain criterion for estimating its productivity, provided that the influence of humic material (which would give a yellow or brown colour due to pigments) can be excluded. The colour of the water varying from tinge of yellow to greenish-yellow was a mark of its productivity. The greenish -yellow colour was deepest between the months of January and December. This study agree with the report of Egborge (1977), that phytoplankton density was highest in the lake during the dry season and lowest during the rainy season in the surface waters in all part of the lake and that total phytoplankton was significantly correlated to temperature and significantly correlated to pH, dissolved oxygen concentration, nitrate nitrogen and water level. Phytoplankton abundance was positively correlated to temperature, pH, dissolved oxygen concentration and negatively related to nitrate nitrogen. Zooplankton was present at all times of the year due to the abundance of rotifers.

This is similar to documentation on the phytoplankton response to artificial enrichment with nitrates and phosphates in an upland and lowland reservoir in Plateau State of Nigeria (Kemdirin and Ejike, 1992).

The high biota production due to high pH values may have been supported by high free carbon dioxide. However no further work has been done to identify these microorganisms. But the work of Singh and Singh (2000) shows that the presence of certain micro- organisms like *Oscillatoria* sp. reflect low water quality. The turbidity value is fairly high at the time of study. This favours even solar heat radiation of the water body and removal of suspended solids which might make the water unfit for drinking. Also, the free floating biota and fish eggs constituting pollutants will be easily exposed to bottom predators (Boyd, 1979).

The physico-chemical parameters documented in this study fall within the minimum permissible limits for aquatic organisms as stated by USEPA (1979).

The abundance of *Chrysicthys nigrodigitatus, Tilapia melanopleura* and *Marcuseinus isidori* in this study could be attributed to their ability to tolerate low levels of oxygen and inability to neither bury themselves nor burrow into the muds.

Low diversity is a function of low productivity which has been a common feature of small fresh water rivers (Welcomme, 1979). The hypothesis states that high diversity would indicate places of unpredictable haz-

ards or places that would be short lived.
The results from the study show that Ikere gorge consisted of fish species that compared favourably with other fresh water bodies. This information can be used for management decisions and formulation of resource development in the area in addition to the provision of a checklist for fisheries study.

## CONCLUSION

The study provided baseline information on the biotic parameter of Ikere gorge in relation to the various physical and chemical environmental factors. Also, it provided firsthand information on the current state of fish production in the gorge. The study also provides good knowledge of the physical and chemical factors of the aquatic environment and the complex biological interactions in the aquatic environment which will help in making good and sound management decisions towards the effective and wise use of the aquatic environment. Regular and periodic study of the physico-chemical parameters and species diversity should be carried out.

## ACKNOWLEDGEMENT

The authors thank Mr. Kayode Bankole of Department of Biological Sciences, University of Agriculture Abeokuta, Ogun State, Nigeria for providing the necessary laboratory facilities to carry out the work.

## REFERENCES

**Abohweyere, P.O.** 1990. Study of limnological parameter and potential fish yield in kigera reservoir (extension system) in Kainji, New Bussa, *Nigeria. J. Aqua.* Sci., 5: 53-58.

**APHA (American Public Health Organisation),** 1980. Standard method for examination of water. APHA, Washington D.C. 15th Ed. p.107.

**Boyd, C.E.** 1979. Water quality in warm water fish pond. Craft Master printers, INC, Opelika Alabama, pp 412.

**Boyd, C.E.** 1982. Water quality management for pond fish culture, Elsevier Science Publisher B.V. p.318

**Karr, J.R., Dudley, D.R.** 1981. Ecological perspective on water quality goals, *Environ. Mangt.* 5: 56-68.

**Kemdrin, E.C. Ejike, C.** 1992. The phytoplankton response to artificial enrichment with nitrates and phosphates in an upland and lowland reservoir in Plateau State. *Nigeria. J. Aqua. Sci.*, 7: 45-57.

**King, R.P.** 1998. Physico-chemical indices of the fisheries potential of a Nigeria rainforest pond. *J. Aqua. Sci.,* 13: 49-54.

**USEPA** 1979. Quality criteria for water, US, Environ. Prot. Agency. E.P.A. 44019-76023, Washington D.C.

**Welcomme, R.L.**1979. Fishery management in large rivers. FAO Fish Tech. Paper, 194: 60.

*(Manuscript received: 5th March, 2009; accepted: 21st May, 2009).*