PRELIMINARY REPORT

Artisanal Fisheries Resources Study Project No.5100.36.47.025 Uganda

T.O. Acere

and

D. Pauly

Manila, June 1988

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Abstract

This preliminary report provides information on the first phases of a small project designed to increase the knowledge of the dynamics of exploited fish communities in Ugandan lakes, with emphasis on the role of Nile perch (Lates niloticus) in Lake Victoria, and implemented by the Uganda Freshwater Fisheries Research Organization working in cooperation with staff of the International Center for Living Aquatic Resources Management.

Introduction

In Uganda, lakes contribute very significantly to food production. They also host a rich fauna, notably endemic fish which have attracted considerable attention from abroad. Thus, a considerable database exists on Ugandan lakes and much of this has been published in various reports of some studies, of which many, conducted during colonial times, are still accessible. This is particularly true with Lake Victoria which has been studied by a large number of scientists and for which a considerable bibliography exists.

In recent years, conflicting assessments of the impact of introduced Nile perch (Lates niloticus) in Lake Victoria have been widely discussed. These assessments have generally reflected two major lines of thought (and of aquatic research) in Uganda and in other East African countries. One of these lines is represented mainly by foreign ichthyologists and emphasized the potential and actual loss of endemic fauna that may

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have resulted from the introduction. The other line of thought, generally represented by African scientists, emphasized the benefits in terms of fish production of this introduction and also emphasized that it was overfishing that had the major impact on the reducing of the stocks of endemic fishes including Haplochromines of Lake Victoria.

The political development in the last decade in Uganda and other related events have prevented these issues from being settled by rigorous studies. Presently, emphasis is on rehabilitation of the fisheries and again, the danger exists that this issue will remain unsettled. The project of which this report is a first account aims at addressing these issues by establishing a computerized database on Uganda Lake Fisheries, and to complement this with Kenyan and Tanzanian data as a second step. The project further aims at analyzing this database using rigorous methods recently developed for the analysis of length frequency and other data typically collected from tropical fisheries.

Specifically, the project aims at using the available database to reproduce and expand on the analyses performed by G. Marten and collaboration in the 1970s which used data for the whole of Lake Victoria and multiple regression techniques to identify the relative impact of different gears and different fisheries intensities around Lake Victoria.

Also, we intend to reassess the available data on the energetics specifically on the food consumption of Nile perch *(L. niloticus)* with the aim of assessing whether this fish is as "voracious" as alleged and whether it can be blamed for the decline of Lake Victoria's Haplochromines and other cichlids.

These abovementioned investigations were initially planned to be performed at least in part during the two- month stay of a staff member of the Uganda Freshwater Fisheries Research Organization (UFFRO) at ICLARM headquarters in Manila, Philippines. It turned out, however, that the fisheries data available from Uganda, plus those collected in Kenya and Tanzania (see below) are too comprehensive to be computerized let alone analyzed during a two-month period. It was therefore decided that ICLARM would continue to support this project beyond the two-month period originally envisioned and contribute to this project staff time and other resources without charges to the project. The reason for this decision is that the project appears to be scientifically challenging and that resolution of the issues mentioned above appear to match ICLARM's mandate to conduct research to assist third-world countries in the management of fishery resources.

Collection of Fisheries Statistics

In addition to field (survey) data collected in the Ugandan waters of Lake Victoria, and to literature (i.e., published) information, to be used extensively in the planned study, a collection of unpublished fishing statistics was undertaken by Mr. T.O. Acere in the three countries adjacent to Lake Victoria. The following gives some details on these data.

Kenyan Fisheries Data

The available fishing data were obtained from 28 February to 6 March 1988 from Kenyan fisheries personnel. They consist of photocopies of records of weights (in metric tonnes) per species per month. These data will be treated as all originating from one area (i.e., Kenyan waters of Lake Victoria). Rainfall data were also photocopied for selected stations close to the shore.

Tanzanian Fisheries Data

The available data obtained during two visits 3-15 March 1988 to Dar es Salaam and 20-26 March 1988 to Mwanza pertain to the Mwanza, Mara and Kagera Regions and are subdivided by stations. The data include fishing effort, number of recorded fishing days by boat and gear types, as well as catch data per species (in weight and monetary values). Rainfall data were obtained for various lake shore stations.

Ugandan Fisheries Data

In Uganda, the catch statistics are for major fish landings along the coast of various lakes, notably Lakes George, Edward, Albert, Wamala and Victoria. The data consist of fishing effort, catch per species by number, weight in tonnes and monetary value per area per month. It is unfortunate that this pattern was not consistently maintained over the years. The information for Lake Victoria dates back to the days of the Lake Victoria Fisheries Service with a gap between 1958 and 1964. There are other gaps as well. The raw and unaggregated data for Lake Kioga were not compiled as the original Regional Fisheries Office for this Lake was inaccessible due to the events that were taking place in Uganda and particularly in that part of the country. As Lake Kioga is the most important and wholly Ugandan lake, the necessary information will be collected when the situation normalizes. Rainfall data for various stations by the lake shores were photocopied.

General Remarks on East African Inland Fisheries Data

The collection of fisheries catch data in East Africa is not very satisfactory, and leaves a lot to be desired. The situation worsened in Uganda from 1976 to date with a few exceptions such as Masese Fish Landing (Jinja). This was the beginning of insecurity coupled with unindexable rate of economic inflation in Uganda. Elsewhere inflation has forced enumerators at various fish landings to partially abandon their duties in search of more lucrative ventures so as to subsidize their official earnings. Since

there is no other alternative measure for fish production the best one can do under the given situation is to cautiously accept the data for their relative value.

Creation of a Computerized Database

About half of the stay of Mr. Acere at ICLARM Headquarters in Manila was spent creating, in conjunction with ICLARM staff, a computerized database upon which future analyses and publications will rely.

This database consists of four elements:

i)   fisheries catch, effort and rainfall data, for Ugandan lakes complemented with data from Kenya and Tanzania as far as Lake Victoria is concerned. The referent file was created using the DBase III software.

ii)   biological data on several thousand Nile perch *(L. niloticus)* sampled by UFFRO staff during trawl surveys from 1982 to 1986. This file was created using the Lotus 1-2-3 program.

iii)   length-frequency data on trawled Nile perch for analysis using the Compleat ELEFAN program package.

iv)   bibliographic references on (1) Uganda and (2) *Lates niloticus*, as extracted from ICLARM's ASFA Compact Disc and other bibliographic sources. These files were created using MICROSOFT WORD.

Diskettes with the contents of these files will be handcarried to UFFRO, Jinja, by the senior author of this report.

The files themselves will be extended and maintained by both UFFRO and ICLARM staff.

The file in (i) will be completed at ICLARM using data based on all the literature and reports brought by Mr. T.O. Acere to ICLARM and once completed will be used to perform the multiple regression and trend analyses.

Analysis of the file in (ii) will be continued (see below for some preliminary results). The file will also be expanded to include data for the 1960s on gill net, trawl fish as well as Nile perch data from other African water bodies.

File (iv) of which Mr. Acere will take hard copies back to Uganda will be used to produce two urgently needed bibliographies, one on Ugandan aquatic resources in general and the other to update only available bibliography of Nile perch now dated, and far too brief.

Preliminary Analysis of Nile Perch Data

The Lotus 1-2-3 file on Nile perch *(L. niloticus)* created during Mr. Acere's stay at ICLARM was used for some preliminary analyses aimed chiefly at assessing whether the data would be suitable for detailed analyses. The results are very encouraging and some initial results may be briefly presented here.

a)   Length-weight relationships

$$W = 0.823 \cdot 10^6 L^{3.123}$$

for females, where W = kg and TL = cm; relationship based on 960 fish ranging from 12 to 185 cm, with r^2 of log transformed data = 0.980, and

$$W = 0.951 \cdot 10^{-6} L^{3.089}$$

for males, based on 1488 fish ranging from 8 to 96 cm with r^2 of log transformed data = 0.970.

b)   The standard length (SL) *vs.* total length (TL) relationship, is expressed by

$$SL = -0.896 + 0.8422\ TL$$

based on 1,491 fish ranging from 10 to 170 cm.

c)   The condition factor of fishes, defined by

$$c.f. = W \cdot 100/L^3$$

usually oscillates seasonally, being higher in the months preceding spawning and lowest outside of the spawning season (Fig. 1).

This allowed identification of two spawning seasons of Nile perch in Ugandan waters of Lake Victoria, a major one lasting from June to August with a peak in July, the other lasting from December to February with a peak in January.

The data also suggest that larger Nile perch spawn earlier and over a longer period than smaller ones, as has also been reported from a number of other fisheries from both temperate and tropical marine and freshwater.

d)   The analyses of condition factor are confirmed by the analyses of the gonadosomatic indices, defined by

$$GSI = \text{weight of gonad/eviscerated fish weight}$$

which were performed here on large female Nile perch only, and which clearly pointed out the occurrence of two spawning seasons each year (Fig. 2).
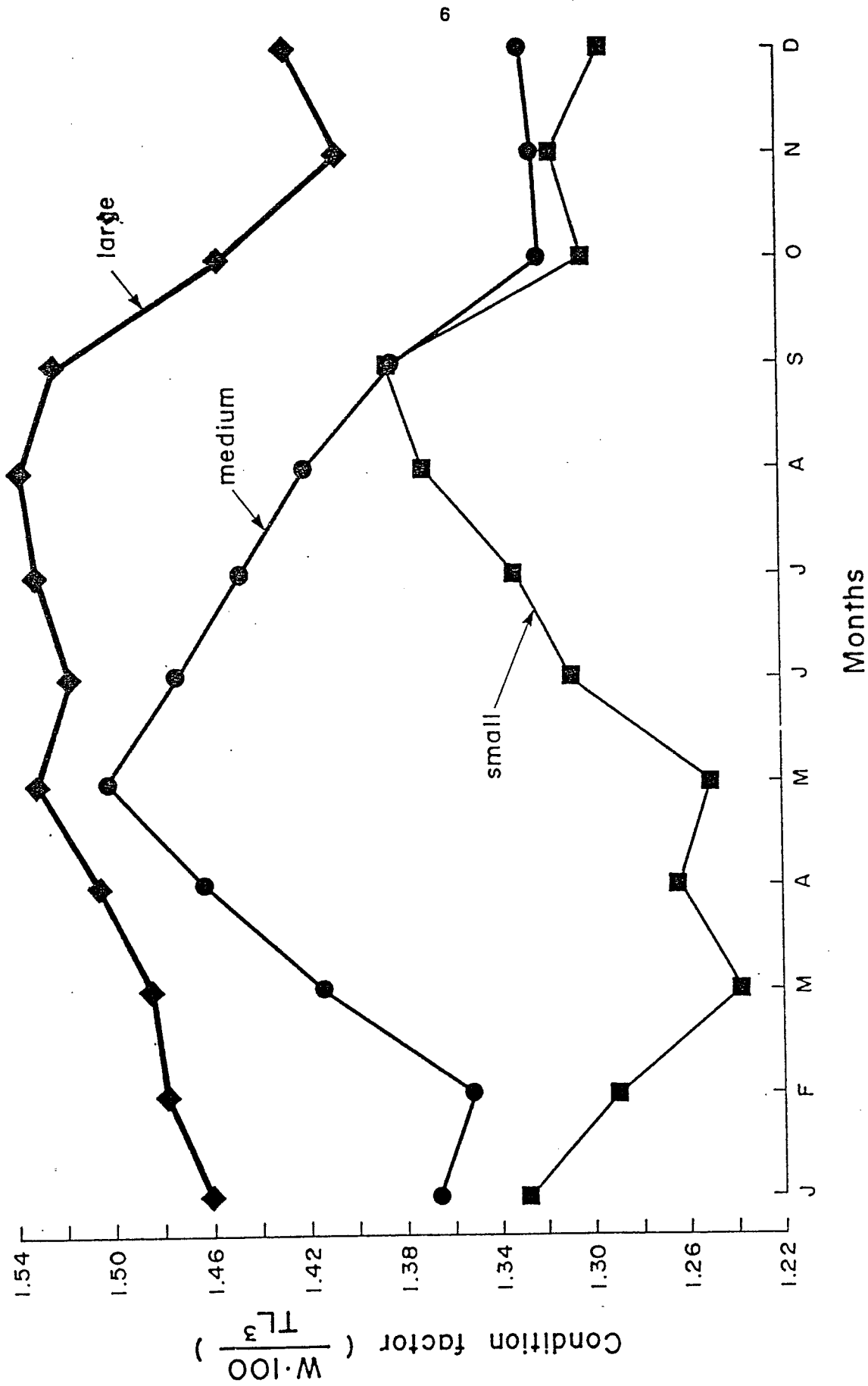
6

Fig. 1. Average monthly condition factors of large, medium and small Nile perch in Ugandan waters of Lake Victoria. Note that these data suggest large Nile perch to start spawning earlier than small ones.
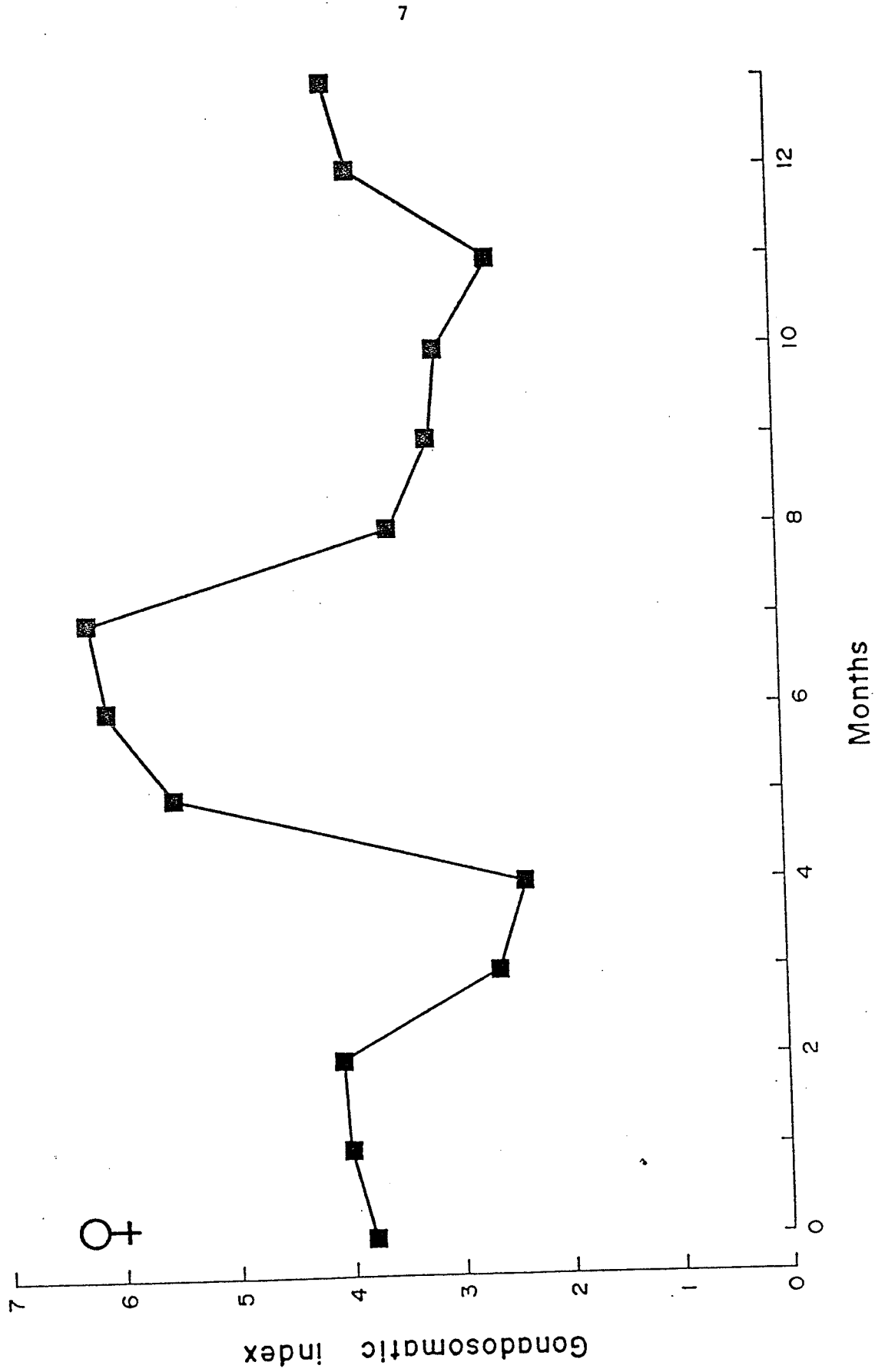
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Fig. 2. Gonadosomatic index of large *L. niloticus* females as used to identify two spawning seasons per year in Ugandan waters of Lake Victoria.

e) Mean gonad stages of Nile perch were also plotted against months (Fig. 3). They confirm the existence of two spawning seasons and the fact that small fish spawn over a shorter period than large fishes.

f) Studies of parasite infestation of Nile perch showed that infestation rates of parasites studied (one lernaeid, one arguilid and mesenteric cysts) increased with size (age). This is illustrated in Fig. 4. Contact has been established with a fish parasitologist to whom parasite specimens will be sent for species identification.

The Lotus 1-2-3 Nile perch file has only begun to be analyzed in terms of the stomach contents data it contains. It is expected, given the straightforwardness of the initial analyses reported below, that the stomach contents dynamics of Nile perch will be elucidated.

The file of Nile perch length-frequency data created with the ELEFAN program, also analysed in preliminary fashion indicated that the data were sufficient for analyses of growth, mortality and elected statistics. We abstain from presenting these preliminary results here because they still need to be put in the context provided by other recent studies of Nile perch growth. It is anticipated, however, that the data at hand will allow a significant improvement in our understanding of population dynamics of Nile perch; and hence to a better understanding of its role as a predator and as well as to improved management of the fishing practices.

Continuation of Study

As mentioned above, the originally planned two-month period of interactions of Mr. Acere with ICLARM staff turned out to be far too short, given the large amount of data brought from Uganda, Kenya and Tanzania.

It became obvious, however, that the data are of considerable scientific interest, so that it would not do justice to these data to use them for a superficial, "consultant-type" report.

It was therefore agreed between Mr. Acere and Dr. Daniel Pauly, Director of ICLARM's Resource Assessment and Management Program, that the initial plan for the project should be modified as follows:

1) The two-month stay of Mr. Acere should be used for initiating the creation of computerized databases to familiarize himself with the software available for interpreting such databases, and to introduce his counterpart (Dr. Pauly) to issues related to Ugandan Fisheries management, and that only a short, very preliminary report should be written during this stay (i.e., this present report).
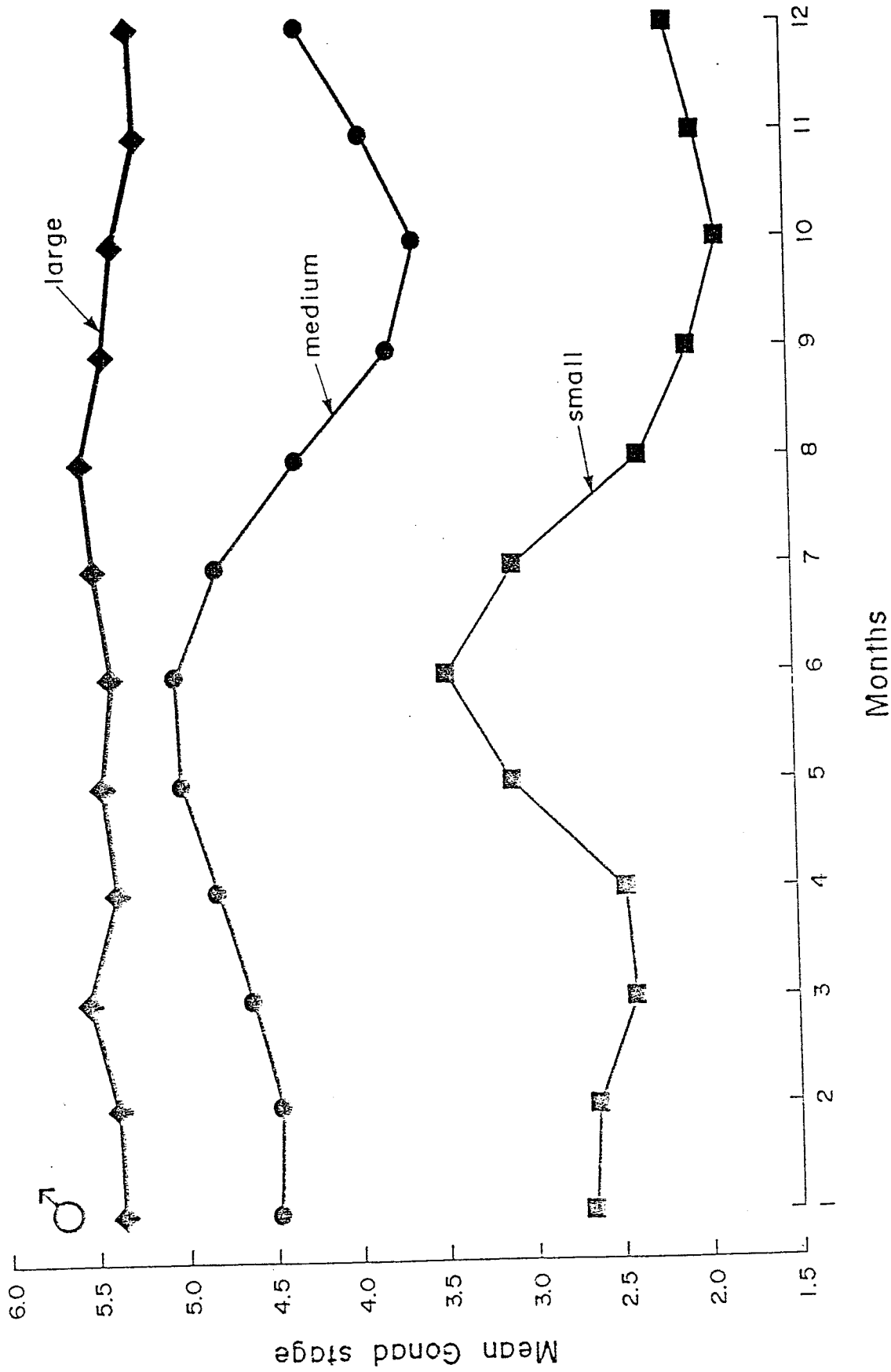
Fig. 3. Mean gonad stages of *L. niloticus* males, with small fish confirming presence of two spawning seasons.
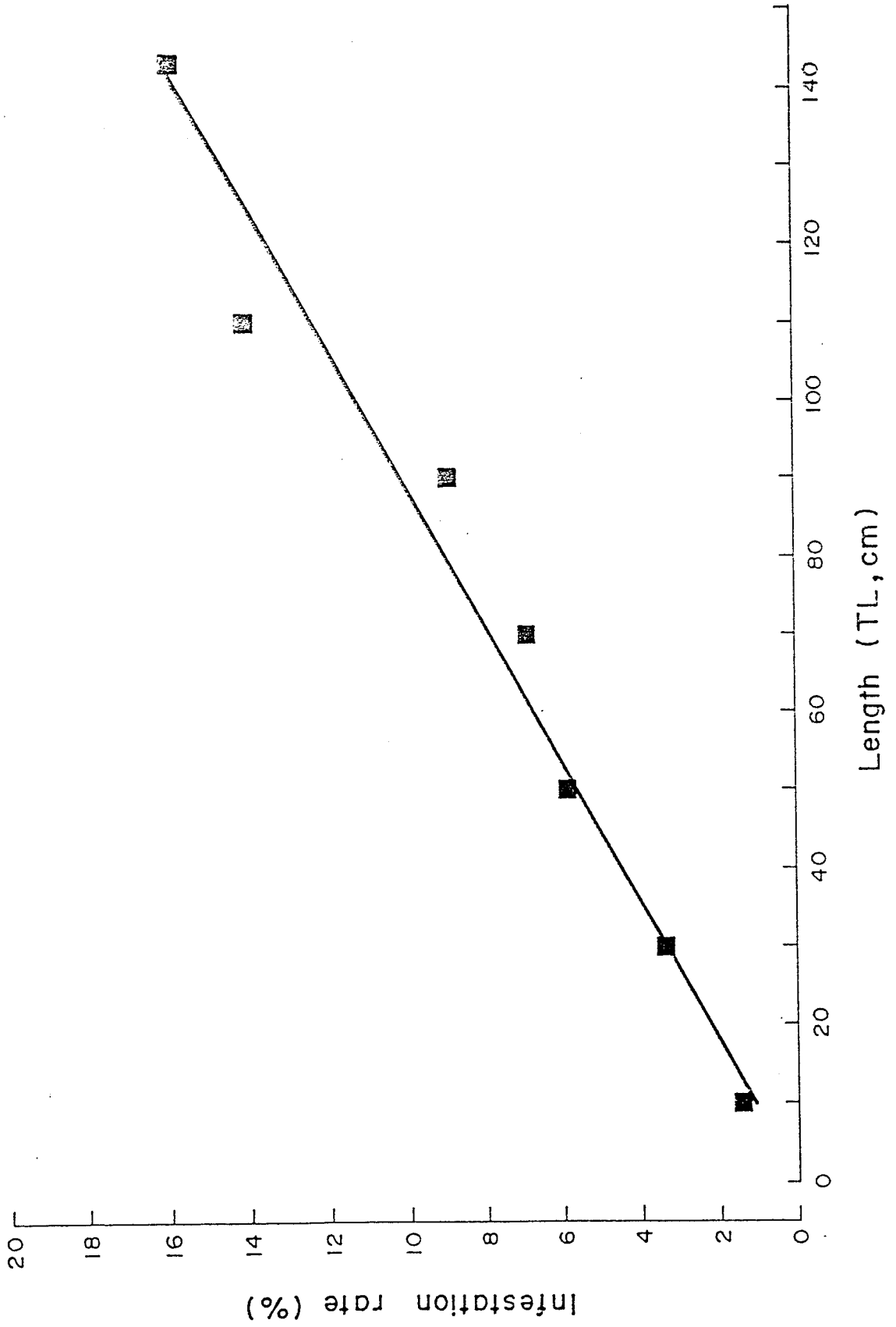
Fig. 4. Relationship between lernaeid parasites and length of Nile perch in Ugandan waters of Lake Victoria.

2) Following Mr. Acere's return to Uganda, he will identify, locate and send to ICLARM new or additional information where they will be incorporated into the databases. At the same time, data reduction and interpretation will continue, both in Jinja, by Mr. Acere and colleagues in Manila, by Dr. Pauly and his staff.
It is expected that this process will last until the end of 1988. This will make it possible for Dr. Pauly to present the project report in February 1989, when he will visit UFFRO in Jinja, in conjunction with his planned trip to East Africa.

3) Mr. Acere (i.e., UFFRO) and Dr. Pauly (i.e., ICLARM) will continue to cooperate beyond February 1989. Notably, they will expand on the report in such a manner that it can be published as a book in one of ICLARM's publication series, as a joint UFFRO-ICLARM publication. This book should be published by the end of 1989 or in early 1990, under the joint authorship (or editorship) of Mr. Acere and Dr. Pauly (see Appendix 3 for budget). ICLARM will contribute staff time to this effort, which shall be considered as the "Ugandan Module" of ICLARM's Network of Management-Oriented Fisheries Research Projects.

Appendix 1
Original Project Objectives and Means of Implementation

Objectives

a. To increase knowledge of the dynamics of exploited fish communities in Uganda Lakes.

b. To consolidate the data already collected on fish population dynamics and to make these available for an overall fisheries stock assessment.

c. To make available to Uganda researchers the data analysis techniques developed for aquatic resources management at ICLARM.

Means of Implementation

The Uganda Freshwater Fisheries Research Organization (UFFRO) will release the fisheries expert who will implement the study for the Ministry of Animal Industry and Fisheries (MAIF), partly in Uganda and the neighboring countries and partly at the International Center for Living Aquatic Resources Management (ICLARM) in Manila, Philippines.

Appendix 2
Original Terms of Reference

The study shall be executed in three phases: a preliminary period in Uganda, a second period in the other Lake Victoria riparian states and a final period for data analysis using the human and material support of ICLARM, to be conducted at the headquarters of ICLARM in the Philippines, (after) which the results of the research shall be published to share the experience provided at ICLARM with the Fisheries Department and with UFFRO.

Phases One and Two: (Article 4.1. Part A)

Literature search with a view to collection and photocopying of all available published and unpublished material on fishes, aquatic invertebrates and plants, and the exploitation of those species in Ugandan waters.

Phase Three, (Article 4.1. Part B)

In cooperation with ICLARM:

a. to collate data with respect to species, area, month; format either length frequency, water temperature (where available), or weight frequency, water temperature.

b. to collate records on mesh selection by gear; catch effort data; biomass estimates and to record any quantitative data on stomach content which may be available.

c. to analyze the data in order to assess stock parameters such as growth, mortality (F+M), recruitment, biomass and production.

d. to draw up and specify, to the extent possible, simple box models of the aquatic ecosystems supporting Ugandan fisheries.

e. to write a report on the findings of this research to be published as a joint Department of Fisheries-UFFRO-ICLARM Report.

Complete any report preparation remaining after return to Uganda, and monitor preparation for publication. In the period following completion of the contract, the UFFRO expert would be able to continue to use the data generated and analyzed in the framework of the contract for further publication. He would be expected to share his experience to the fullest extent possible with his colleagues so that the techniques used in the study may be made available to Uganda.

Annex

UFFRO will assign Mr. T.O. Acere to carry out this study for the MAIF.

Appendix 3
Project Budget (Article 4.1 - Fixing of Price)

This is a reimbursement contract for services rendered to be remunerated to ICLARM as follows:

- Fees 8 weeks at 300 ECU/week	2.400
- Production of 1,000 copies 150 report, all included	10.500
- Air shipment of reports to Kampala	1.000
- Supplies and equipment	2.000
- Contingencies	1.100
- Distribution cost of the study	6.000
Total (ECU)	23.000

Appendix 4
Material and Software Acquired in Manila for Use in Jinja

Computer Material

Projected funds were used to purchase in Manila a portable personal microcomputer (IBM PC Compatible) with specifications as follows:

Memory (RAM)	640 kilobytes
1 disk drive	360 K
1 hard disk	20 Megabytes

This computer will be brought to UFFRO, Jinja, and will be used to continue analysis of the databases described above. The following programs were installed onto the hard disk:

SOFTWARE	USE
MSDOS 3.30	System
NORTON Utilities	Utilities
NORTON Commander	"
Lotus 1-2-3 (release 2.01)	Spreadsheet
Microstat	Statistical analyses
Flowchart	Utilities
Printmaster	"
Copy programs	"
Sideways	Print Utilities
MS WORD	Word Processing
The Compleat ELEFAN	Fish Stock Assessment

Manual for most of these programs were supplied. Also, an EPSON LX-800 printer was purchased, which completes the system.

Calculator Hard- and Software

A Texas Instrument TI-59 programmable calculator, with printer and assorted peripherals and software, previously a property of ICLARM, was donated to UFFRO via Mr. Acere, who will take it to Jinja.

Books and Other Materials

Five ICLARM publication were donated by ICLARM to Mr. Acere, *viz.*

Dwiponggo, A., T. Hariati, S. Banon, M.L. Palomares and D. Pauly. 1986. Growth, mortality and recruitment of commercially important fishes and penaeid shrimps in Indonesian waters. ICLARM Technical Reports 17, 91 p.

Pauly, D., 1979. Theory and management of tropical multispecies stocks: a review, with emphasis on the Southeast Asian demersal fisheries. ICLARM Studies and Reviews 1, 35 p.

Pauly, D. 1984. Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM Studies and Reviews 8, 325 p.

Pauly, D. and G.R. Morgan, editors. 1987. Length-based methods in fisheries research. ICLARM Conference Proceedings 13, 468 p.

Pauly, D. and G.I. Murphy, editors. 1982 Theory and management of tropical fisheries. ICLARM Conference Proceedings 9, 360 p.

Appendix 5
Narrative of Two-Month Stay at ICLARM Headquarters
by T.O. Acere

I left Uganda on 13 April 1988 for Manila via Nairobi, from where I obtained a visa for the Philippines. I left Nairobi on 15 April and arrived in Manila on 16 April 1988. I was collected by an ICLARM driver from Manila International Airport. My subsequent stay at ICLARM from 16 May to 13 June was usefully and fruitfully utilized.

Personnel were assigned to enter the mass of data I brought along into files for both ELEFAN and Lotus 1-2-3 computer programs. The ELEFAN program is a new statistical package for length-based stock assessment methods, developed by Dr. Daniel Pauly of ICLARM. The staff of ICLARM's Information Program assisted with a literature search aimed at assembling a bibliography on Ugandan fisheries and on the different fish species. It is hoped that this approach will assist the scientists in Uganda to know of the advances which have been made with regard to fisheries and aquatic flora and fauna occurring in the country. The ICLARM administration was forthcoming with the supply of materials for my work. I have been supplied with a portable microcomputer, a programmable calculator, software and a comprehensive selection of ICLARM publications.

Nile perch *(Lates niloticus)* data have been analyzed using the ELEFAN computer program and estimates of useful vital statistics have been obtained including growth rates, total natural and fishing mortality rates, length-weight relationship, condition factors, visceral fat contents, spawning seasonality, parasite infestation pattern and food consumption from the different trophic levels. Recruitment pattern as well as probability of capture by length, relative yield per recruit and relative biomass per recruit have also been determined for Nile perch in the Ugandan waters of Lake Victoria. Ecosystem models will be constructed to provide an integrated picture of the different trophic levels in Uganda's lakes. The rest of the data is being analyzed to meet other objectives and terms of reference for this study. I have also received instruction on the MICROSOFT WORD text processing program; and thanks to Mr. Felimon Gaynilo, Jr. for his assistance.

Acknowledgements

My sincere thanks go to the fisheries and meteorological staff of the three Lake Victoria riparian states for their assistance and cooperation in the course of collecting and compiling the necessary information from their offices. It is needless to state that without their cooperation my task would have been impossible. I am most grateful to the staff of ICLARM who made my stay a very enjoyable one; to you dedicated workers I must confess how I envy your set-up. My special thanks go to Dr. Ian R. Smith, Director General of ICLARM, for his hospitality and shining leadership in coordinating the activities of his team. I am greatly indebted to my immediate host, Dr. Habil, Daniel Pauly, Director of ICLARM's Resource Assessment and Management Program, for his

hospitality and the very keen interest he took in my assignment; he provided supporting staff in the persons of Mrs. Susan "Tuttay" M. Luna, who tirelessly strained her eyes to create a database from a voluminous mass of data some of which were in tiny print, and Miss Ma. Lourdes "Deng" Palomares, who assisted with the analyses of Nile perch data. I wish to thank EEC for financing this study, which for long has been overdue. My sincere admiration goes to Dr. Cornelia Nauen, who boldly conceived and convinced her group in Brussels on the idea of hiring local scientists to execute a local program, something which had been of to date, the prerogative of our counterparts in the developed world. By similar terms I thank the Commissioner for Uganda Fisheries Department for accepting my nomination. My mother institution, UFFRO, made it possible for me to undertake the task. I am, therefore, grateful to all my colleagues who have assisted in one way or the other.