REPORT ON THIRD FIDAWOG WORKSHOP HELD AT THE TRIANGLE HOTEL, JINJA, 29 March to 1 April 1999

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Summary of proceedings

The FIDAWOG workshop held from 29 March to 1 April 1999 in Jinja was the third major stock assessment workshop attended by most of the participants during the project. It followed two workshops, each of which lasted three weeks, held in 1998. The first was a data collection and handling workshop supported jointly by FAO/Danida/LVFRP, held in Jinja in January 1998. Data collection methods developed in the LVFRP were successfully field-tested. At the second workshop in Arusha in May 1998 (also supported by FAO/Danida/LVFRP), the project's researchers were given training in key stock assessment techniques and the relevant computer software being used by the project. They used the techniques to explore data they had collected during the preliminary stages of the LVFRP sampling programmes.

The third FIDAWOG workshop brought together all LVFRP participants from the previous two workshops and also new researchers subsequently attached to the project. Also represented were limnologists from each country as the changing limnological conditions in Lake Victoria have been recognised as playing a key role in the fisheries, and the project is now implementing the proposal to link limnological information to data on fish stocks.

In the first two days, all project researchers presented their research findings to date and the PhD candidates presented their project concept notes. Each presentation was followed by a discussion session. Most presentations are included in this project technical document. Those excluded are brief introductions to proposed studies and papers where data analyses were in an early phase. In the latter case, guidance was given for the development of the presentations for the fourth FIDAWOG workshop scheduled to be held in Kenya in August/September 1999. Higher degree research project concept notes are also omitted from this document because they are to be included in a separate project training document.

In the remaining two days, the participants first held discussions in working groups on harmonisation and standardisation of data collection and recording. While the data collection system for the stock assessment activities of the project has been harmonised since the project start, the need was identified for standardised forms in each country, plus the subsequent addition of extra biological and limnological research programmes to the project activities needed harmonisation. Thereafter, a general discussion was held on the overall progress of the project. The LVFRP's objectives were reviewed to identify any gaps in the research programme which need to be filled to obtain all essential data for stock assessment. The programmes in stock assessment, catch assessment, limnology and biological research related to ecological modelling were examined in turn. Recommendations made by the participating researchers arising from the discussions are provided below.

Recommendations

- The purchase of extra computers and relevant software should be expedited. Researchers requiring specific software should make their requests to the project administration, specifying exactly why such software is required.

- Trawl cruises should take place in the middle of each month, between the 8th and 22nd, if at all possible, to help in synchronising data collection in the countries. This does not, however, preclude surveys early or later in the month in the event of circumstances preventing a mid-month cruise.

- Mosquito net-covered/lined cod end experiments should be conducted one day per month, and quarterly the sampling should be conducted over a 24-hr period for feeding studies.

- Extra days should be allocated for catch assessment surveys as specified in each country programme.

- Portable fridges should be purchased for the limnology samples.

- Researchers in related fields of research in the three countries should keep in regular communication by e-mail.

- Researchers working across the lake, particularly those on PhD programmes, should be facilitated to participate in data collection in the other countries' sectors of the lake as and when necessary.

- Existing procurement should be expedited.

- FIDAWOG workshops should be convened approximately every six months, in each country in turn, to review progress.

- In addition to presentation, each FIDAWOG workshop should address a key issue in the development of the project's workplans. Techniques in report writing and presentation were covered briefly during the workshop. Recognising the need for more in-depth training, and following the recommendation included in the STTA report by Dr I.G. Cowx in his November 1998 consultancy report which stated: "it is recommended that personnel are given more exposure in the practice of preparation and publication of scientific papers etc.", the next FIDAWOG workshop should include extensive training in this subject.

- The LTTA Survey Biologist should investigate the possibility of linking the Makerere University Ph.D. student, Ms Namuswe, who will be investigating *Oreochromis niloticus* biology in the Ugandan waters, with the project and coordinating her research with that of Ms Akumu in FIRI and Mr Njiru in Kenya.

- The standardised and harmonised forms for data recording, developed during the workshop, should be introduced in each country with immediate effect.

- The grid system for trawl sampling stations should be standardised in the three countries, with each grid square given a unique identifying code.

- The full workshop report, incorporating the research presentations, should be drafted by the LTTA and circulated for comments before publication as a project technical report.

Brief reviews of the research activities underway in the stock assessment programme of the LVFRP.

Introduction

The presentations made at the workshop covered many different research activities. The introductions made to the various research programmes in this section of the report illustrate how the studies relate to the stock assessment objectives of the project.

1. Bottom trawl surveys

Introduction

Bottom trawling has been the main method of estimating biomass of fish since the 1960s, when the development of a fishery based on the endemic cichlid species flock was planned (Kudhongania & Cordone 1974). The demersal habits of the species to be exploited made bottom trawling a highly effective method of assessing the stocks, as was the case with the cichlid fishery of Lake Malawi (FAO 1976; Banda, Tomasson & Tweddle 1996; Tweddle, Makwinja & Magasa 1995).

Following the major changes in species composition in Lake Victoria, particularly in the 1980s (Okemwa 1981; Ssentongo & Welcomme 1985; Rabuor 1989, 1991; Othina & Osewe 1995, 1996; Rabuor & Polovina 1995), bottom trawling can no longer be used as the sole method for assessing biomass. Nile perch, *Lates niloticus* (L.) is the main species caught both in the artisanal fisheries and in bottom trawling. The species is semi-pelagic and widespread across the lake. Bottom trawling is an effective method of catching Nile perch and providing indices of abundance, but to obtain more accurate biomass estimates additional methods are necessary. These include hydroacoustic surveys and multimesh, multidepth gillnet surveys, which will be discussed later.

Bias is caused by several characteristics of the Nile perch population which were not present in the former cichlid populations of the lake.

1. Nile perch are much larger than cichlids. Banda, Tomasson & Tweddle (1996) demonstrated that for Lake Malawi cichlids, the speed at which the trawl is pulled has a major influence on the size range of fish caught. For cichlids up to 10 cm TL, trawls pulled at 2 knots or 3.5 knots show no difference in selectivity. Above this size, however, higher speeds yield greater numbers of the larger specimens,

thus there is a bias in catches in favour of the smaller specimens of the species at slow speeds. While it may not be accurate to directly extrapolate from cichlid to Nile perch net avoidance behaviour, cichlids and Nile perch have similar morphologies and thus their swimming capabilities are likely to be similar also.

2. Nile perch are semi-pelagic. The bottom trawl has a vertical net opening of 2-3 m. Perch swimming in mid-water will not be caught.

3. Bottom trawling is only possible on non-rocky substrata. Nile perch are more widely distributed and are often closely associated with rocky areas, which are inaccessible to the trawl.

Because of these sources of bias, trawling must be accompanied by other quantitative methods of sampling, discussed later.

Systematic bottom trawl sampling has been undertaken since the start of the project research programme. Until the arrival of standardised trawl gear designed by the STTA Gear Technologist, Mr S. Ridgway, each country used its existing gear. While the data collected by the different gears are not directly comparable, the programme allowed the sampling systems to be developed and harmonised, in preparation for the standardised sampling programme, which began at the end of 1998.

Objectives

- To provide spatial and temporal distributions of major fish species in the demersal zone of Lake Victoria.

- To identify the key environmental factors responsible for the distribution and abundance observed.

- To provide quantitative assessment of the stock dynamics of *Lates niloticus* and *Oreochromis niloticus* in the demersal zone of Lake Victoria.

Methods

Trawl station selection

The sampling design uses a grid-based method (FAO, 1998) to obtain information on distribution and indices of biomass throughout the area. In Uganda and Tanzania, the lake is divided into 5 x 5 n.m. grids, charted using minutes of longitude and latitude. Because the lake straddles the Equator, minutes of longitude and latitude are the same distance, thus the grid dimensions are sufficiently accurate and the sampling grid is reproduced easily. Trawl sampling aims to target every grid square. Within the selection of grid squares, it is also necessary to sample evenly at all depths. This requires selection of different depths in adjacent squares if a similar range of depths is encountered in each square. Some squares are untrawlable because of the rocky lakebed and thus are not fished.

The centre of the lake is logistically difficult to trawl because of the distances involved and time taken to cover the area. However, much of the centre of the lake is affected by de-oxygenated bottom water for most of the year and bottom trawling under such conditions yields no fish. Thus, in each trawl survey, visits are made to deep-water stations for monitoring only. Other sampling methods (hydroacoustics and surface/midwater gillnets) are necessary in deep water and are in use during the project.

Both Tanzania and Uganda have divided their sectors of the lake into three sampling zones, (see workshop presentations). With monthly sampling cruises, each sector is sampled quarterly. In Kenya, the lake has been divided into 2.5 x 2.5 n.m. squares. Alternate grid squares are sampled. The whole Kenyan sector is sampled monthly.

In the longer term, once sufficient data are collected to demonstrate significant differences in catches between different sampling zones, a modification of the sampling regime will be made to improve the statistical significance of the results. This will use stratified sampling to allocate sampling effort in relation to the standard deviation of the density estimates obtained (FAO, 1998).

Sampling and sub-sampling procedures

Identical nets and rigging, designed by the STTA Gear Technologist and constructed in a workshop in Jinja for the three countries' technologists, are used in each country. The three vessels were brought together in Jinja for comparative fishing trials, at which trawling speed was standardised at 3 knots, with revs necessary for maintaining that speed being recorded for each boat. Each trawl haul is scheduled to take 30 minutes. Actual time of starting trawling and hauling is recorded to adjust for the minor differences in time fished. In areas badly affected by bottom debris such as the sunken, decomposing remains of water hyacinth, *Eichhornia crassipes* (Mart.) Sohms, mats, the trawling time is reduced to avoid excessive clogging of the net. The start and finish positions are recorded using a GPS. In the absence of a GPS during the early stages of the project, trawling distance was estimated using the time of fishing and the trawling speed of the vessel.

The treatment of the catch depends on its size. If it is small enough, the entire catch is sorted into species, weighed, and then every fish is measured (TL (cm) and weight (g)). If the catch is too large to handle in this way in the time before the following sample is landed, the larger fish are sorted from the catch and measured individually, while the remaining small fish are sub-sampled as described below.

Initial sampling trials were undertaken using the RV Ibis. Elimination of bias in favour of either large or small fish is essential in any sub-sampling system. Any system of selecting fish by hand and eye will inevitably lead to bias, almost always in favour of larger fish. Failure to thoroughly mix the fish on deck before taking the subsample also leads to bias. When a codend of fish is emptied on to deck, the larger fish slide to the edge of the heap on deck, leaving the smaller specimens in the middle. These forms of bias were demonstrated to the project researchers during the initial trials.

The sub-sampling system used in the Lake Malawi cichlid trawling programme, which was verified as statistically valid by Bazigos (1973), was tested. The system developed was based on taking shovelfuls of fish from the thoroughly-mixed heap of fish. It was established that Nile perch above 35 cm TL are more likely to fall off the shovel when scooped from the heap than smaller fish. Thus, if the full sample contains fish over 35 cm, bias against these larger fish is likely to occur. Three shovelfuls of fish yield a sub-sample of approximately 8 kg of fish. During the first FIDAWOG workshop on data collection and handling held in Jinja under the auspices of FAO/Danida/LVFRP in January 1998, the system was tested statistically. It was demonstrated that the system worked and no bias was found. A key proviso is that the sample must be of about 200 fish, thus the number of shovelfuls of fish to be taken depends on the average size of fish in the sample. Where the sample is mainly of larger fish, more shovelfuls are required to obtain an adequate sample.

This procedure has now been adopted in the three countries. To minimise sub-sampling whenever possible, some modifications are allowed and encouraged. These include making the size cut-off as small as possible, e.g. it is often feasible to fully record all fish above 25 cm TL and sub-sample smaller. On the other hand, large catches may necessitate sub-sampling of fish above 35 cm TL. A possible scenario is that all fish above 45 cm TL are recorded, approximately half the fish from 35 to 45 cm, and the normal sub-sample of fish less than 35 cm. If the larger fish have to be sub-sampled, the sub-sample is taken by thoroughly mixing the full sample on deck, then dividing the catch down the middle using the edge of the shovel and taking one half. The weights of the sub-sample and full sample from which the sub-sample was taken are used to obtain the raising factor.

The relative biomass indices are at present being calculated in terms of kg ha^{-1}. The chart of Lake Victoria presently available has an inadequate number of soundings to obtain realistic estimates of the area of various depth zones. A detailed seismic survey conducted under the IDEAL project is leading to the production of a new bathymetric chart which should enable estimates of biomass in the different depth zones of the lake to be made.

Biological data are collected for assessment of reproductive bionomics and diet from a number of hauls each month.

Limnological parameters

With the arrival of the Seabird profilers, key limnological parameters will be taken at each trawl station to assess the effects of such parameters on catch rates. In all three countries, the profilers will yield measurements of depth and pressure, temperature, conductivity, salinity, and oxygen concentration and saturation. In addition, the Ugandan Seabird includes a fluorometer to measure Chlorophyll-a.

Until the deployment of the Seabirds, Kenya and Uganda will continue limnological sampling using existing equipment. In Kenya, this includes: temperature; dissolved oxygen; conductivity; salinity; turbidity and visibility; alkalinity and total hardness; nitrates; phosphates and silicates. Chlorophyll-a concentrations are also measured.

In Uganda, measurements were made daily at one station in the general trawling area. The following parameters were measured: temperature; dissolved oxygen; conductivity; nitrates; ammonia; soluble reactive phosphorus; total dissolved phosphorus; total dissolved silica and chlorophyll-a.

Results

The results of trawl research so far are presented in this workshop report in the following appendices:

Mkumbo O. Recent trends in the distribution patterns and catch rates from trawl surveys in Lake Victoria, Tanzania.

Okaronon J. Results from the RV Ibis research cruises.

Getabu A. & Nyaundi J. Trawl surveys in Kenyan waters of Lake Victoria.

These reports include detailed methodology, regular sampling stations and data from the surveys conducted from the start of project data collection up to the introduction of the new standardised fishing gears.

2. Multidepth, multimesh, monofilament gillnet surveys

Introduction

In the light of the limitations of bottom trawling as a method to estimate biomass (discussed above), gillnets are being used as a supplementary sampling method. The gillnet data will be used to correct trawl estimates for three sources of bias: (1) ability of larger fish to swim faster and thus escape the trawl; (2) vertical distribution of fish in the water column; and (3) different stock densities in habitats inaccessible to the trawl.

Objectives

- To provide spatial and temporal distribution of major fish species in the inshore waters of Lake Victoria.
- To identify the key environmental factors responsible for the distribution and abundance observed.
- To provide quantitative assessment of the stock dynamics of Nile perch and *Oreochromis niloticus* in open and inshore waters of Lake Victoria.
- To provide a cross check for the biomass and size distribution assessments obtained from trawl surveys.

Size selectivity

Asila (report in this document) conducted extensive experiments on gillnet size selectivity in the Kenyan waters of Lake Victoria. His preliminary results were available for selection of a suitable range of mesh sizes to sample Nile perch with minimal bias for differences in net selectivity with increasing fish size. The methods used for the mesh selection are presented in a separate project document (Tweddle, Ridgway & Asila 1999). This report also includes a description of the overall net design. The net fleets have been mounted to include equal areas of the selected mesh sizes. The document is complete but will be published after inclusion of results of the first net trials.

Vertical distribution of fish in the water column

The nets will be set in four identical fleets, mounted to the anchor ropes to fish at pre-selected depths. The nets have slight negative buoyancy, counteracted by floats attached to head ropes with ropes equal in length to the desired depths. The four fleets are set so that one fleet is at the surface, one at the bottom, and the other two at intermediate depths. Each net is 5 m in depth, thus in 20 m water depth, the entire water column is sampled effectively. In deeper waters, the nets are more widely spaced. Full details are presented in Tweddle *et al.* 1999). The net set on the bottom fishes the same depth zone as the bottom trawl. The ratio of catches in this bottom net to catches in the three nets higher in the water column allows corrections to be made to bottom trawl biomass estimates for the vertical distribution of fish.

A further advantage of fishing nets throughout the water column is that assessment can be made of fish stocks in the centre of the lake and in areas where the presence of an oxycline results in an absence of fish on the bottom.

Habitat selectivity by fish

Trawl catches are biased by bottom type. Trawling on hard rocky ground is not possible, but such grounds may be preferred by fish. Gillnetting is a suitable technique for comparing stock densities over different habitat types. Later in the project, a thorough sampling programme will be undertaken with the gillnet fleets to quantify such differences. Sampling time limitations prevent this survey being undertaken until an adequate time series of trawl data has been collected, allowing trawl surveys to be replaced by intensive gillnet surveys.

3. Hydroacoustic surveys

Introduction

Hydroacoustic surveys are being used to assess biomass throughout the water column on a lakewide basis. Delays in the arrival of equipment resulted in a late start to the programme, but the first complete survey was eventually scheduled for February 1999. When the RV Victoria Explorer was not released for the programme, the RV Ibis was fitted out with the spare transducer and used instead, resulting in further delay. A survey of the Ugandan waters as far as the south west of the Ssese Islands

was undertaken, but bad weather and engine breakdown prevented the survey being extended to Kenyan waters in the time available.

Objectives

- To estimate the spatial and temporal distribution of fish in Lake Victoria.
- To estimate acoustic abundance and biomass indices of fish stocks.
- To examine the species and size composition, and the distribution of fish taxa by area and by depth.
- To determine how limnological parameters influence species distribution and catches in bottom trawl surveys.

Methods and results

Lakewide surveys are planned biannually. The following report on the results of the first survey is presented in this document:

Tumwebaze R. & Getabu A. Results of the first hydroacoustic survey of the Ugandan waters.

A 3.5 x 3.5 m opening frame trawl was used in association with a Furuno netsounder to verify the fish marks seen on the echo traces. It proved very effective, not only in sampling the fish traces, but also in showing that the traces seen on echosounders associated with the thermocline are caused by dense concentrations of *Caridina nilotica* (Roux). This finding has important implications for the Ph.D. study of Mr Y. Budeba on the population dynamics of *Caridina* as the substantial quantities of *Caridina* now known to occur in midwater can be quantified by frame trawling. The results of the frame trawling in the first hydroacoustic survey are presented in this document, as follows:

Tweddle D. & Bassa S. Preliminary observations on the use of a frame trawl in hydroacoustic surveys.

4. Catch assessment and frame surveys

Introduction

Responsibility for fisheries catch statistics on Lake Victoria lies with the Fisheries Departments and not the fisheries research institutes. As the catch information is essential for assessing the status of the fisheries in the lake, this situation is not ideal. Fisheries Department priorities may not be the same as those of stock assessment researchers. They are interested in the size and value of the overall catch, but rarely in accurate details of the species, size structure and CPUE, without which stock assessment is not possible.

The mandate for frame and catch assessment surveys on Lake Victoria falls under the Lake Victoria Environmental Management Programme (LVEMP). Because of the importance of the catch data in the stock assessment programme, the LVFRP is cooperating with the LVEMP in designing and carrying out frame surveys in the three countries.

In Kenya, catch statistics are collected both by Fisheries Department and KMFRI staff. The system used by KMFRI appears to produce consistent results, as shown in the presentation by Mr A. Othina in this report. In Uganda, financial limitations and different priorities in various districts following Government de-centralisation have weakened data collection, and the system needs to be resurrected. The Fisheries Research Institute has, however, started to address the problem by collecting catch data, albeit on a limited scale until now (see Mr L. Muhoozi's contribution in this report). This is now being expanded with the Ph.D. programme of Mr Muhoozi under the LVFRP. Tanzania is handicapped by financial limitations and has few beach recorders in place to collect data. Estimates of catch rates and length frequency distribution of catches of the three important commercial species are being collected under the LVFRP by Mr P. Nsinda as a M.Sc. programme.

Objectives

- To evaluate fully the fishing capacity of the artisanal and commercial subsectors of the fishing industry.
- To assess the fishing mortality of the major commercial species around the lake.
- To assess trends in fish landings from the lake.
- To assist the Fisheries departments and research institutes in setting up a standardised catch assessment survey throughout the lake.

Methods

Frame surveys

A major difficulty in assessment of Lake Victoria fish stocks is the lack of regular frame surveys. The cost of detailed surveys is cited as the main reason for not carrying them out regularly. Alternative methods for obtaining the key information on the number of fishing boats and gears in the fishery have been explored. A two-stage approach has been developed as a result.

Traditionally, a very detailed, several-page questionnaire is used, which covers not only the key data needed for extrapolation of survey catch data to the entire fishing population, but also socio-economic data used to obtain a profile of all aspects of the fishery. These extra data are not needed for stock assessment, where a simpler approach is possible. The disadvantages of the detailed survey are the time and consequent expense needed for fieldwork, and the complicated and time-consuming analysis. It was recognised when planning the present collaboration between projects and institutes that detailed surveys were overdue and should thus be carried out.

In Uganda, it was proposed to sub-sample fishermen in the frame survey conducted under LVEMP. This would not give the necessary information for calculation of catches by extrapolation of catch data as the total number of fishermen would not be available. Kenya considered that it would be possible to fully question all fishermen. Tanzania was in advance of the other two countries and carried out a detailed frame survey before the LVFRP interest was made known to the statistics section of the Fisheries Division. The survey was in the form of a questionnaire, but not as detailed as those proposed for Uganda and Kenya. As the survey was conducted at the peak of an exceptional rainy season, some beaches were missed because of inaccessibility. Thus more data were needed to obtain full counts of boats and fishing gears for catch assessment.

The two-stage process was proposed after intensive discussions with key department and institute staff. The first stage involved accepting the existing plans for detailed questionnaires, while suggesting modifications and simplifications to harmonise data in each country and to eliminate unnecessary questions duplicating those in other surveys, particularly the LVFRP marketing survey which had just been conducted. The key questions related to catch assessment which were included were very full details of the number, type and size of fishing gears owned by fishermen.

The detailed survey would not give a full count of the actual number of fishing craft if either: (a) it was a random sampling survey; or (b) beaches were missed because of either inaccessibility or time and finance constraints. Thus, in addition to the detailed questionnaire, a simple boat count was proposed, which would be conducted on every beach at the same time. The fishing communities would be involved in helping to carry out this survey whenever and wherever possible. The form was designed to be as simple as possible. The details of each boat are recorded in one row on the form. Data were the type and size of craft, and the type of gear carried. If all fishermen could be reached either by community-appointed recorders or Fisheries staff, a full picture of the total number of fishing boats on the lake would be obtained. It was agreed by all three countries that such a procedure was feasible. In both Tanzania and Uganda, a system of local community leaders is in place that enables a count to be made, while Kenya has extensive representation of both Fisheries Department and KMFRI staff in the field. A survey was thus organised which would be conducted, if possible on the same day, in all countries, although it was recognised that two or three days might be needed in some areas.

With detailed knowledge on boat and gear ownership from an adequate sample of fishermen, and a full count of boats and type of gear carried from the "one-day" survey, the total amount of gear in operation on the lake can be estimated with suitable accuracy for catch assessment. The short period of time necessary for the "one-day" count minimises errors caused by fishermen migrating between beaches during the surveys and thus being missed or double-counted.

The great advantage of the "one-day" survey is that it is comparatively inexpensive, both in time and money, and can thus be conducted much more easily than traditional surveys, ideally on an annual basis. Instead of requiring several forms for each fisherman and expenses for several days or weeks of fieldwork, one 2-page form

covers each beach (with space to record 20 boats on each form, larger beaches will require more of the same form). The only other expenses are for two visits to the beach to deliver and collect forms (and possibly a small honorarium for members of the community assisting in the counts). Socio-economic data, and the number and types of gears used by fishermen, remain valid for longer than the number of boats on any beach, and thus more detailed surveys need only be carried out at much longer time intervals.

Catch Assessment Surveys

On interrogation of the catch data collected by KMFRI, a number of sources of potential bias were identified, and the system of data collection has been revised to minimise these sources of bias. The collection of regular species length frequency data has been added to the programme to collect data for length-based stock assessment.

In Mr Muhoozi's PhD programme, he will be collecting catch, effort, and length frequency data and will be developing a sustainable sampling programme for continuation after the current project, in close collaboration with the Fisheries Department.

The initial limited sampling started by Mr Nsinda and described in his report in this document has been greatly expanded to collect data from all three regions of Tanzania bordering the lake to allow the use of length-based stock assessment techniques.

Results

The results of work so far are presented in this workshop report as appendices. These contributions are as follows:-

Muhoozi L. Results of Uganda catch surveys: the relationship of boat size to fish catch in the Lake Victoria gillnet fishery.

Othina A. Catch trends and correction of bias in catch assessment surveys in Lake Victoria, Kenya.

Nsinda P. & Mrosso H. Stock assessment of *Lates niloticus, Oreochromis niloticus* and *Rastrineobola argentea* in Lake Victoria, Tanzania waters.

5. Ecological studies

Introduction

Moreau *et al.* (1993) formulated two Ecopath models of Lake Victoria, one for before and one for after the major changes in the lake ecosystem associated with the Nile perch population explosion. The quantitative data necessary for a viable model were not available and the ecosystem was still in a state of considerable change at the time of the model development. Thus the model is inadequate as a predictive tool. This is being addressed under the LVFRP.

For a realistic functioning model, quantitative data are necessary on the majority of paths in the lake's food web leading to fish production. A number of research programmes have been developed to provide quantitative information. Apart from the quantitative data being collected on fish stock biomass, growth and mortality rates, data are also collected on plankton abundance, macrobenthos and food of the major commercial fish species.

The data collected in the various research programmes will be incorporated into a new Ecopath model under the leadership of Mr M. Njiru of KMFRI. A workshop on Ecopath to be held in Nairobi in August/September 1999 by the developers of this model will be attended by project scientists and used to refine the research programmes if found necessary.

Methods and results

The individual research projects are covered in the reports included in this document (in addition to those listed under other stock assessment research headings above) as follows:-

Agullo C. The diet of juvenile Nile perch in Kenyan waters.

Owili M. The diet of inshore fishes in Kenyan waters.

Njiru M. The feeding ecology of Nile tilapia in Nyanza Gulf.

Njiru M. Feeding ecology and biomass estimation of *Oreochromis niloticus* in Lake Victoria. Ph.D. concept note.

Ojuok J. Reproduction of *Oreochromis niloticus* in Kenyan waters.

Akumu J. Studies on *Oreochromis niloticus* from the trawl surveys in Ugandan waters.

Wandera S. Studies on *Rastrineobola argentea* in Ugandan waters.

Budeba Y. Population ecology of the freshwater shrimp *Caridina nilotica* in Tanzanian waters. Ph.D. concept note.

Omondi R. The distribution and abundance of Copepoda and Cladocera in Lake Victoria, Kenya.

Kenyanya M. Water quality and nutrient dynamics in the Kenyan waters of Lake Victoria.

Ndawula L. Some limnological aspects reflected in the Lake Victoria Fisheries Research project.

Ezekiel C. Limnology in relation to fisheries in Tanzanian waters.

Future FIDAWOG activities

Research activities up to the time of arrival of the new research equipment were covered during this third FIDAWOG workshop. After the meeting, all contributions made at the workshop were thoroughly reviewed with the respective researchers. Training and advice was given in techniques for report writing to improve their presentations. Most contributions are included in Appendix 2 to this report. The publication of others has been deferred to the fourth FIDAWOG workshop report to allow for more detailed analysis and/or incorporation of more data, while other presentations were of an introductory nature and made without intent to publish at this stage. Where contributions are not included, an explanatory note is added in Appendix 2. Students working towards further degrees presented their research programme plans to the workshop. These contributions will be included in a separate project training report.

By the time of the next FIDAWOG workshop in about six months time, a considerable amount of new data will be available from all research programmes. The fourth FIDAWOG workshop will review the progress in new research and revisit the presentations which were given in preliminary form in the third workshop. The workshop will also include an intensive training programme in the preparation of scientific papers, technical reports and presentations at conferences. The outcome of the workshop will be a report including papers by all project researchers. The workshop will also begin the process of coordinating analysis of data from the three countries.

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Okemwa E.N. (1981) Changes in fish species composition of Nyanza Gulf of Lake Victoria. In: Proceedings of the Workshop of Kenya Marine and Fisheries Research Institute on Aquatic Resources of Kenya, 13-19 July 1981. KMFRI, Mombasa, pp. 138-156.

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APPENDIX 1
COMPLETE LIST OF PRESENTATIONS MADE DURING THE WORKSHOP

Mkumbo O. Recent trends in the distribution patterns and catch rates from trawl surveys in Lake Victoria, Tanzania.

Okaronon J. Results from the RV Ibis research cruises.

Omondi R. The distribution and abundance of Copepoda and Cladocera in Lake Victoria, Kenya.

Agullo C. The diet of juvenile Nile perch in Kenyan waters.

Owili M. The diet of inshore fishes in Kenyan waters.

Ojuok J. Reproduction of *Oreochromis niloticus* in Kenyan waters.

Njiru M. The feeding ecology of Nile tilapia in Nyanza Gulf.

Akumu J. Studies on *Oreochromis niloticus* from the trawl surveys in Ugandan waters.

Muhoozi L. Results of Uganda catch surveys: the relationship of boat size to fish catch in the Lake Victoria gillnet fishery.

Othina A. Catch trends and correction of bias in Catch Assessment Surveys in Lake Victoria, Kenya.

Nsinda P. & Mrosso H. Stock assessment of *Lates niloticus, Oreochromis niloticus* and *Rastrineobola argentea* in Lake Victoria, Tanzania waters.

Wandera S. Studies on *Rastrineobola argentea* in Ugandan waters.

Getabu A. & Nyaundi J. Trawl surveys in Kenyan waters of Lake Victoria..

Tumwebaze R. & Getabu A. Results of the first hydroacoustic survey of the Ugandan waters.

Tweddle D. & Bassa S. Preliminary observations on the use of a frame trawl in hydroacoustic surveys.

Mkumbo O. Assessment of Lake Victoria fisheries with emphasis on the ecology of the three commercially important species.

Budeba Y. Population ecology of the freshwater shrimp *Caridina nilotica* in Tanzanian waters.

Tumwebaze R. The distribution and abundance of the pelagic fish *Rastrineobola argentea* using hydroacoustic surveys.

Getabu A. Estimation of fish distribution and abundance of *Lates niloticus* using acoustic and trawl methods.

Okaronon J. Studies on the effects of environmental factors on the distribution and abundance of major commercial fish stocks of Lake Victoria

Njiru M. Feeding ecology and biomass estimation of *Oreochromis niloticus* in Lake Victoria.

Muhoozi L. The structure and functioning of the artisanal fisheries of Lake Victoria.

Mugo J. Preliminary fisheries survey of three rivers in Kenya.

Asila A. Selectivity of gillnets on Nile perch populations in Lake Victoria.

Kenyanya M. Water quality and nutrient dynamics in the Kenyan waters of Lake Victoria.

Ndawula L. Some limnological aspects reflected in the Lake Victoria Fisheries Research project.

Ezekiel C. Limnology in relation to fisheries in Tanzanian waters.

Tweddle D. The selection of mesh sizes for the multimesh, multidepth gillnet surveys.