RECOMMENDATIONS FOR MANAGEMENT AND RESEARCH ON THE FISHERY OF LAKE VICTORIA

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(This article was in press with the African Journal of Tropical Hydrobiology and Fisheries for publication in 1976, but that issue of the journal was never printed.)

INTRODUCTION

This report is based on our experience with the Lake Victoria fishery during 1973–1975 while working at the East African Freshwater Fisheries Research Organization substations in Kisumu and Mwanza. We shall first present management recommendations on three major topics:

- the on-going inshore artisanal fishery;
- the proposed offshore trawl fishery;
- the possibility of cage culture.

These will be followed by specific recommendations for research.

INSHORE FISHERY

The greatest sustainable yield from Lake Victoria can be obtained by intense cropping of mature fish. The yield from the inshore fishery can be increased in two ways:

- eliminating fishing gear which crop fish prematurely;
- increasing the intensity of fishing in lightly fished areas of the lake.

Our basic recommendation with respect to fishing gear is that **only long lines and gillnets 4" and larger should be used without regulation**.

Seines should not be used because the seines in common use on Lake Victoria have small meshes which capture all sizes of fish including juveniles without discrimination. Furthermore, seines are particularly harmful because they disrupt *Tilapia* spawning grounds.

Small-mesh gillnets likewise present a problem of premature harvesting of the larger species. Gillnets between 2 1/2" and 4" stretch mesh should never be used because there are no significant fish stocks in Lake Victoria which are harvested most effectively by these nets (WANAJALA and MARTEN 1975; SCULLY 1976). No nets below 1 7/8" should be used. Nets below 1 7/8" are currently used to harvest *Haplochromis*, but they are too small to properly harvest the majority of *Haplochromis* species at maturity (SCULLY 1975).

In summary, for every kilogram of small fish caught in seines and small mesh gillnets, the fishery may be deprived of an even greater harvest of mature individuals of the larger species of fish (MARTEN 1976a). Although fishermen who use seines and small mesh gillnets may individually find them profitable in the short term, their profits are at the expense of other fishermen and the future production of the fishery.

Although we are in complete accord that beach seines should never be allowed on Lake Victoria, we faced a dilemma in arriving at our recommendation of no nets below 4". This policy allows for no harvesting whatsoever of inshore stocks of *Haplochromis* and *Synodontis,* even though *Haplochromis* makes up a significant portion of the present fishery. *Haplochromis* and *Synodontis* are fished most effectively by small mesh gillnets in the range of 1 7/8" to 2 1/2" (SCULLY 1975), nets which incidentally do not remove significant numbers of juvenile *Tilapia* (WANJALA and MARTEN 1975). Nonetheless, these nets prematurely harvest larger species of fish such as *Bagrus, Clarias, Mormyrus, Schilbe* and *Labeo*.

On the one hand, it appears that *Haplochromis* or *Synodontis* could be exploited profitably in some of the more lightly fished areas of Lake Victoria with no significant harm to the rest of the fishery (SCULLY 1975). On the other hand, it would be nearly impossible to keep the small-mesh gillnets out of the parts of Lake Victoria where they are harmful to the fishery, as long as they are permitted in some parts of the lake. We have consequently concluded that no small mesh nets should be allowed on Lake Victoria. This means that the exploitation of *Haplochromis* and *Synodontis* should be left entirely for the offshore trawl fishery until a technique for exploiting inshore *Haplochromis* or *Synodontis* can be demonstrated explicitly not to be detrimental to other species in the inshore fishery.

The only possible exception where seines might be permissible would be mosquito seines to exploit *Engraulicypris*, but only if it is demonstrated beforehand that this can be done without prematurely harvesting a significant number of other kinds of fish.

Because a sudden removal of detrimental gear from the fishery would place an excessive hardship on fishermen who now use such gear for their livelihood, these gear should be phased out over a period of several years. The only effective way we can think to implement this is to control the supply by regulating importation and manufacture.

Turning to more intensive fishing of lightly fished areas, this is primarily a matter of developing the southern portion of Lake Victoria, encouraging transport to lightly fished island areas, and encouraging the exploitation of particular fish stocks which are now underharvested. Transport can be encouraged by means of outboard motors and possibly intermediate-sized boats large enough for an inboard motor.

Examples of particular stocks which are underexploited are:

- *Barbus altianalis* in the West Lake region near Bukoba (SCULLY 1976);
- Lates exceeding 50 kilograms in the vicinity of the mouth of the Kavirondo Gulf, fish which are too large too be captured by gillnets now in use (MARTEN, WANJALA, and GULUKA 1976);
- *Bagrus* which are very numerous in the Kavirondo Gulf (MARTEN, WANJALA, and GULUKA 1976) and might be smoked and exported to Uganda where they have a high value;
- *Protopterus* in lightly fished swampy areas such as the Emin Pasha Gulf (SCULLY 1976).

Another consideration in gear regulation is the removal of fish predators. A statistical study of fish catches in Lake Victoria (MARTEN 1976b) has shown that catches of fish such as *Tilapia* and *Haplochromis* are strongly stimulated by the heavy use of hooks to remove fish-eating predators such as *Clarias* and *Bagrus* from the Lake. A theoretical study by MARTEN (1976a) has shown that at the levels of natural mortality now existing in Lake Victoria, yields are a small fraction of what they would be if natural mortality were substantially less.

Since predation is a major source of natural mortality, it follows that the yields of a fish stock can be influenced as much by fishing predator species as by underfishing or overfishing the stock itself. A level of fishing which is excessive at one natural mortality is not so at a lower natural mortality. A fisherman who catches predators is performing a service for other fishermen. Considering the practical difficulties in reducing the number of fishermen or nets in the fishery, increasing the fishing of predators should be a more feasible strategy for eliminating overfishing than attempting to reduce overall fishing effort.

TRAWLING

There are two major considerations in trawling:

- protection of the existing inshore artisanal fishery;
- the commercial potential of offshore *Haplochromis* stocks.

Considering the inshore fishery, not only would inshore trawling compete directly with artisanal fishermen for fish but it would also destroy fish spawning grounds. Our basic recommendation is **no trawling in gulfs, within 15 kilometers of shore, or in any other waters less than 20 meters deep**. Because the *Tilapia* which can be caught inshore are more valuable than the *Haplochromis* to be caught offshore, trawlers will have strong economic incentives to violate this recommendation. Every trawler should therefore have an enforcement officer stationed permanently on board.

There has been considerable controversy over the intensity of trawling which Lake Victoria can support (FREYER 1974). It is our opinion that the sustained yield trawling potential of *Haplochromis* is not as great as the UNDP/EAFFRO estimate of 200,000 tons per year for potential production of *Haplochromis* in Lake Victoria would at first suggest. The estimate is sound, based on a well executed trawling survey of Lake Victoria (KUDHONGANIA and CORDONE 1974), but it must be interpreted carefully.

- The estimate applies to the entire lake (both inshore and offshore), and nearly 40,000 tons of *Haplochromis* are already being harvested by the inshore fishery (WETHERALL 1973).
- *Haplochromis* catches in water deeper than 60 meters (KUDHONGANIA and CORDONE 1974) are generally not of sufficient quantity to justify commercial operation.
- *Bagrus* consume a large portion of *Haplochromis* production (CHILVERS and GEE 1974), which is consequently unavailable to fishermen.
- The maximum yield can only be realized if fishing is properly distributed over all fishing grounds. If trawling tends to be concentrated near landing points, which is likely in practice, some areas of the lake will be overfished while others are underfished, and the full potential will not be realized.

In other words, economically viable trawling will be restricted to a band between 20 and 60 meters in depth, a region which contains only 55% of the *Haplochromis* stocks responsible for the 200,000 ton estimate (KUNDHONGANIA and CORDONE 1974). Furthermore, the economically-viable band can be expected to contract once trawling commences and offshore stocks are reduced below the virgin levels which prevail today.

Although everyone agrees that trawling in Lake Victoria should be pursued with caution, opinions vary as to what constitutes caution. Assuming a fishing capacity per boat of 1000 tons per year, caution to us means 15 boats initially operating in Lake Victoria.

Because trawlers in Lake Victoria should distribute their fishing effort evenly, they should either be able to land fish at a variety of landings or have cold storage facilities to allow them to move sufficiently far from their home base. They should be large enough to be fully seaworthy under often adverse offshore conditions.

Despite the systematic research that has been done on *Haplochromis* retention by trawl codends of various sizes (CORDONE and KUDHONGANIA 1972) we have not been able to reach any firm conclusions concerning codend size. Nonetheless, judging from our own experience, an initial prohibition of codends below 40 mm seems justified at least from the point of view of stock conservation.

A 20 mm codend is desirable from the point of view of short term commercial returns because there are areas of Lake Victoria where the *Haplochromis* are too small for the 40 mm codend to yield a commercially satisfactory catch (MARTEN, WANJALA and, GULUKA 1976). The 20 mm codend is questionable from the point of view of stock conservation, however, because with full retention of fish down to 6 cm in length, complete elimination of the larger *Haplochromis* species can be expected as a consequence of continuous and heavy trawling. A similar result has been observed in Kenya during the past eight years as a consequence of intense fishing of *Haplochromis* with small mesh gillnets and seines (WANJALA and MARTEN 1975; MARTEN, WANJALA, and GULUKA 1976).

The 40 mm codend can secure a reasonable harvest from virgin stocks which, particularly in offshore areas, contain large numbers of *Haplochromis* in the 15 to 25 cm length range. It may continue to give satisfactory catches under sustained fishing in these areas, particularly if fishing is regulated so as to retain the larger *Haplochromis* in the stocks. If the 40 mm codend does not prove commercially satisfactory, the solution may be a codend intermediate in size between 20 and 40 mm. The use of any codends below 40 mm should proceed with caution.
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The maximum sustainable yield of the fishery, and the size of the fishing fleet which will achieve it, can only be determined by observing the response of the fishery to gradually increased trawling activity. It is therefore important that no trawler is allowed to operate without a reliable record of its catch. The records should be broken down to species where possible — a feasible operation provided there is subsampling of commercial catches. Catch information could be collected by the same officer who is assigned to a trawler to ensure that it obeys the regulations.

We wish to make a final comment concerning the use of *Haplochromis*. Although the domestic demand for fishmeal for animal feed may justify using some *Haplochromis* in this way, we feel the bulk of the *Haplochromis* catch should be available for direct human consumption. There is a substantial reduction in the amount of protein ultimately available for human consumption when fish are converted to meal and fed to animals. It is our opinion, based on personal observations, that the demand for *Haplochromis*, particularly in Kenya, exceeds any quantity that is likely to be harvested from Lake Victoria.

AQUACULTURE

Although improving the catch from Lake Victoria will make a substantial contribution to fish production in East Africa, it cannot by itself provide a long term solution to per capita fish supply in East Africa. Whereas even with the best management, including development of the offshore fishery, the highest yield from Lake Victoria can be expected to at most double over the present level (MARTEN 1976b), the human population of the region can be expected to double in less than twenty five years. The catch from Lake Victoria has a ceiling, but an industry like aquaculture can grow with the population. Although we feel there is an enormous potential for fish culture away from Lake Victoria, we shall restrict our attention here to fish culture in the lake itself.

Cage culture in the lake can be the kind of low capital, labor intensive industry that will provide opportunities for expansion of employment among the growing number of fishermen in the region. It can attract fishermen from the artisanal fishery and reduce the hazards of overfishing in the more heavily fished parts of Lake Victoria.

Studies of *Tilapia* held in cages in Lake Victoria have shown they grow rapidly (RINNE 1975, 1976; IBRAHIM, et.al. 1975). On the basis of the same arguments presented above for predator removal, holding fish safely in cages until they can be harvested at the proper size is the best way to channel the biological productivity of a lake into human consumption. This would be most effective when either the caged fish feed on phytoplankton (as do *Tilapia esculenta* and *Tilapia nilotica*) or when their rations are supplemented with macrophytes or other vegetation, as IBRAHIM et al. (1975) did with *Tilapia zillii*.

RECOMMENDATIONS FOR RESEARCH

1. ***Research on means for implementing the recommendations for gear regulation in the artisanal fishery.*** Such research should include:

- how rapidly detrimental gear can be phased out without excessive hardship to fishermen;
- realistic means of enforcing regulations.

2. ***Research on improving yields by removing fish predators.*** This would include ways to encourage heavier fishing of predators in the artisanal fishery, as well as techniques for selective removal of predators from the offshore fishery.

3. ***Research on Haplochromis.***

- *Identification of the major species in the artisanal and trawl fisheries and development of techniques for their quick identification in the field.* Research and catch records should subsequently be broken down with respect to these main species.
- *Research on codend regulations for the trawl fishery.* Given the large size range of *Haplochromis*, it is still not clear, despite the excellent research that has already been done with experimental trawling on Lake Victoria, which codend size will give a commercially viable catch without excessive harvesting of immature fish of the larger *Haplochromis*

species. The problem has been difficult to resolve because of the difference in size of different *Haplochromis* species and the lack of scientific records in terms of particular species.

- *Research on whether inshore fishing of Haplochromis is justified in any regions of Lake Victoria.* This would include a study of the relationship of the inshore and offshore stocks of *Haplochromis* to each other (including movements between inshore and offshore stocks), in order to determine to what extent the inshore stocks can be exploited by offshore fishing. Also needed is a search for techniques to exploit inshore stocks of *Haplochromis* without prematurely harvesting or disturbing the spawning grounds of other species in the fishery.
- *Continuous monitoring and assessment of the offshore fishery as it develops.*

4. ***Research concerning the impact of Nile perch on the fishery.*** This predator deserves special attention because it is generally blamed by fishermen for the decline in the *Tilapia* fishery. Nile perch does not appear to us to be generally abundant enough to be responsible for the decline in *Tilapia*, particularly considering the prevalence of *Haplochromis* we have observed in the stomach contents of Nile perch. Nonetheless, because the Nile perch is locally abundant and increasing in numbers, present stocks and their food consumption should be assessed in order to determine whether this fish is in fact an undesirable and detrimental predator and whether it should be selectively removed from the lake.

5. ***A continuation of the tagging program already in progress to assess the growth and movements of fish.*** Smaller tags or other marking methods (RINNE 1975, 1976) are needed in order to include *Haplochromis* and younger fish in the program. Of critical importance to the success of the program is an intensive tag recovery system which reaches and motivates every fisherman operating in areas where there might be tagged fish.

6. ***Research on cage culture.*** Research should be coupled with a pilot experiment which includes engineering factors (such as cost, durability, and efficiency of cages), biological factors (such as stocking densities, supplementary feeding, and production), and socio-economic factors.

7. ***Limnology.*** There is a responsibility to keep a limnological record on Lake Victoria because it is one of the world's major lakes. In addition, limnological information can be used to tailor management policies to the diverse environmental conditions which prevail in different regions of the lake (KITAKA 1972). Not only can the different conditions be identified which favor different species of fish in different parts of the lake, but the potential production associated with those conditions can be estimated (RYDER, et al. 1973).

8. ***A Tilapia hatchery.*** When many people think of reversing the decline in *Tilapia* stocks in Lake Victoria, they often think of stocking. Although stocking does not appear to us to be an economically viable proposition, it merits a careful study taking into account the costs and the benefits to be expected.

9. ***River fisheries.*** Rivers are important for many commercial species of fish in Lake Victoria, some of which are in serious decline. These fish are also an important source of food to people away from the lake. A survey should include an assessment of yields and the relation of fishing techniques to declining stocks.

10. ***Research on ways to intensify the fishery.***

- Exploration for unexploited fisheries resources, including an evaluation of the fisheries in marshy areas;
- Infrastructure (e.g., transport) which will encourage heavier fishing in areas now underexploited.

We feel that progress on the research programs listed above will be most satisfactory if research proceeds side by side with management. With the limited resources available and the long list of urgent projects, it is not feasible to carry out the detailed studies necessary to make foolproof management recommendations in advance.

Research initially can only point the direction for management but, once a management recommendation is implemented, research can monitor the results and suggest new directions for improvement. We have in mind a continuing cycle of research and improved management, where in the course of implementing new recommendations, management provides the experiments which in turn allow a progressive refinement of research recommendations.

For example, we cannot say with certainty exactly what regulations will be best for the inshore fishery, particularly in light of the severe practical problems involved in enforcing regulations. We can, however, suggest the elimination of seines and small mesh gillnets, and once this is attempted (perhaps on a pilot scale at first) and the results observed, better recommendations can be developed. The same applies to developing the offshore fishery or manipulating the fishery by removing predators.

This principle applies as well to stocking or aquaculture. In the case of stocking, it might not be possible to predict the survival of small fish placed in the lake without actually doing it in a pilot project. In the case of pond or cage culture, viable procedures cannot be developed at an experiment station working in isolation because economic and social factors which are crucial to the success of any culture technique, or which determine what technical advances are really needed, will only appear in the course of actual development. Furthermore, the limited facilities of any research station allow it to explore only a limited number of culture techniques. If different techniques are tried and monitored in the course of a development program, they provide in effect a large number of experiments from which to develop better techniques.

ACKNOWLEDGEMENTS

We wish to thank Dr. John Okedi and the staff of the East African Freshwater Fisheries Research Organization for their support and encouragement of our work. We also wish to thank Mr. A.W. Kudhongania for his comments on a preliminary draft of the manuscript.

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This article was subsequently published as:
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