Rents Drain in Fisheries: The Case of the Lake Victoria Nile Perch Fishery*

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Abstract

Many fisheries are potentially very valuable. According to a recent report by the World Bank and the FAO (2008), global fisheries rents could be as high as US$ 40-60 billion annually on a sustainable basis. However, according to the report, due to the “common property problem”, most fisheries of the world are severely overexploited and generate no economic rents. The Lake Victoria Nile perch fishery could be among the most valuable fisheries in the world. Unfortunately, also this fishery has fallen prey to the common property problem with excessive fishing effort, dwindling stocks and declining profitability. As a result, there is a large and growing rents loss in this fishery (compared to the optimal) reducing economic welfare and economic growth opportunities in the countries sharing this fishery. As in other fisheries, the biological and economic recovery of this fishery can only come through improved fisheries management.

Key words: Fisheries rents, fisheries rents loss, Nile perch fishery, Lake Victoria, fisheries management, common property problem.

Introduction

The social purpose of fisheries is to utilize naturally occurring fish stocks to improve as much as possible the long run living standards of the population. To achieve this aim usually implies that the fish stock be modestly harvested and maintained at a relatively large size while causing minimal environmental damage. In other words, maximizing the contribution of fisheries to social well-being normally implies sustainable fisheries.

The net economic benefits from fisheries are often referred to as fisheries rents. In developed market economies, fisheries rents may be approximated by the profits accruing from the fishing operations. In less developed market economies, the net economic benefits tend to exceed the profits of fishing as the latter is usually measured.

Many fish stocks are potentially very valuable and on average they may be able to generate net economic benefits (rents) amounting to some 50% of the value of landings (FAO, 1992; Garcia and Newton, 1997; World Bank, 2008). To see this in context, this profit ratio is comparable to those obtainable from fairly typical oil reserves. An added bonus is that fish stocks are renewable, so profits from fisheries can be sustained indefinitely. Oil reserves, by contrast, must eventually run out.

The problem is that because of inappropriate institutional structure, the so-called common property arrangement, the potential net benefits from fisheries are generally not realized. Under the common property (or common pool) arrangement everyone, or at least everyone belonging to a well-defined group, can extract from the fish stocks. This, virtually inevitably, leads to a loss of all the potential profits from the fishery (Gordon, 1954; Hardin, 1968). As a result, although there are individual exceptions, the fisheries of the world are not generating much economic profits. If anything they are losing a good deal of money which is made good by subsidies (World Bank, 2008). The economic waste in global fisheries, i.e. the fisheries rents loss, has recently been estimated to be some US$50 billion per year (2006; World Bank, 2008). To put this amount in context, it is slightly less than the total amount of money given for development assistance in the world (Addison et al., 2005).

The Nile perch fishery in Lake Victoria is one of the world’s more valuable commercial fisheries. It developed after Nile perch were introduced into the lake in the late 1950s and early 1960s and has been producing some 300,000 t annually in recent years; it employs tens of thousands of people and is a major export industry for the three countries involved. Clearly the Nile perch is a very valuable resource. The question is whether the current fisheries management and harvesting policies are maximizing the long run net economic benefits from this fishery.

The fisheries problem

The fisheries problem is fundamentally caused by the common property problem, i.e., the absence of private property rights in the fishery. It is this lack of individual rights to stocks and harvests which basically forces fishers to engage in a wasteful competition with each other for shares in the obtainable catch. This waste appears as:

1. excessive fishing fleets and effort;
2. excessively reduced fish stocks;
3. little or no profitability and unnecessarily low personal incomes;
4. unnecessarily low contribution of the fishing industry to the GDP; and
5. a threat to the sustainability of the fishery.

The essence of the fisheries problem is captured by the diagram in Figure 1. In this diagram the revenue, biomass and cost curves of a typical fishery are drawn as functions of fishing effort. All three curves are sustainable in the sense that they would apply in the long run, if fishing effort was kept constant at the corresponding level.

![Graph of fisheries problem](image)

**Figure 1.** A graphic depiction of the sustainable fisheries model. OSY = optimal sustainable yield, CSY = Competitive Sustainable Yield, which is equivalent to the open access equilibrium.

The lower part of Figure 1 describes what happens to sustainable biomass as fishing effort is increased. Basically sustainable biomass is monotonically reduced as fishing effort is increased (note that the level of biomass is measured in a downward direction) If, as illustrated in the diagram, fishing effort exceeds a certain level, the stock size becomes insufficient for regeneration, the fishery is no longer sustainable at that effort level, and the stock collapses.

The upper part of Figure 1 is the well known sustainable fisheries model initially forwarded by Scott Gordon (1954). As illustrated, sustainable revenues initially increase with fishing effort but at a declining rate as the biomass is reduced. At a certain level of fishing effort, sustainable revenues are maximized. If fishing effort is increased beyond this point, sustainable revenues decline as the biomass level is reduced still further. Finally, at a certain level of fishing effort, the fishery is no longer sustainable. The stock collapses and there will be no sustainable revenues. As drawn in Figure 1, costs, on the other hand, increase monotonically with fishing effort.

Figure 1 reveals that the socially optimal level of the fishery occurs at fishing effort level \( e^* \). At this level of fishing effort, profits and consequently the contribution of the fisheries to GDP is maximized. It should be noted that the optimal fishing effort \( e^* \) is less than the one corresponding to the maximum sustainable yield. Consequently, the optimal sustainable stock level, \( x^\ast \), is comparatively high as can be seen from the lower part of the figure. An optimal fisheries policy is therefore biologically conservative and the risk of a serious stock decline is generally very low.

Under the common property arrangement of the fishery, the fishing industry will find equilibrium at fishing effort level, \( e_c \). At this level of fishing effort, costs equal revenues and there are no net profits or rents in the fishing industry. If, at the same time fishing labour is paid its reservation wage the net contribution of the fishery to the GDP is approximately zero. In other words, the fishery contributes virtually no net benefits to the economy. Notice that this is the equilibrium outcome in any common property fishery irrespective of the size and productivity of the underlying natural resource.

The reason for this unfortunate outcome is not difficult to understand. Assume for instance that fishing effort is below the equilibrium level, \( e_c \). At this level of fishing effort there will be profits. This does two things. It encourages existing fishers to expand their operations in order to increase their profits. It attracts new participants wanting to partake in these profits into the fishery. Thus investment in fishing capital takes place and fishing effort rises. Obviously this process will continue as long as there are any profits to be had in the fishery. Equilibrium in the common property fishery will only be reached when there are no profits, i.e. at effort level \( e_c \).

Compared to the net-benefits obtainable by the optimal fishery, the common property arrangement is highly wasteful. Not only does it generate little or no net economic benefits, it also implies a much smaller biomass level. Indeed, as can easily be verified from inspection of Figure 1, the common property fishery may easily imply the exhaustion of the biomass altogether.

It is important to realize that fishers subject to the common property arrangement can do nothing to avoid this wasteful outcome. When many fishers share ownership in a common fish stock, each one has every reason to grasp as large a share of the potential yield as possible. Prudent harvesting by one fisher in order to maintain the stocks will, for the most part, only benefit the other more aggressive fishers without preventing the ultimate decline of the stocks. Thus, each fisher, acting in isolation, is powerless to alter the course of the fishery. His best strategy is to try to grasp as large a share in the fishery as possible while the biomass is still large enough to yield some profits.

This, in a nutshell, is what Hardin (1968) called ‘the tragedy of commons’. The common property arrangement
in fisheries basically forces the fishers to overexploit the fish resources, even against their own better judgment. As a result, the potential benefits of these resources, no matter how great, become wasted under the onslaught of a multitude of users.

Global fisheries rents loss

In 2006, the World Bank and the FAO organized a major research effort to assess the degree of economic inefficiency in ocean capture fisheries worldwide (World Bank, 2008). A two-pronged approach was adopted. On the one hand, the world’s ocean fisheries were treated as one big fishery and the level of rents and rents loss in this fishery assessed. On the other hand, several case studies of individual fisheries around the world were undertaken with specific models for each particular fishery being constructed and the level of rents and rents loss in each one of them assessed.

According to the results of the World Bank/FAO study, the common property problem in fisheries has been even more devastating than previously thought. The study confirms what the FAO has been saying for years; that the great majority of the world’s commercial fish stocks are seriously overexploited. The global commercial fish stocks are estimated to be less than a quarter of their initial (pre-exploitation) size and between 1/3 and 1/2 of what would be economically optimal. Similarly, global fishing fleets and fishing effort are hugely excessive. Fishing fleets in operation (a large number of fishing vessels are lying idle around the world) are estimated to be two to three times larger than what would be needed for optimal fishing. Perhaps most shockingly, the net economic benefits from the global utilization of the world’s ocean fish stocks are very small. In fact, in terms of profits, it appears that the global fishery is actually operated at an overall loss of some US$ 5 billion annually, a loss made good by subsidies to fishing companies in the developed part of the world. This real operating loss should be compared to the attainable net profits from a well run global marine fishery which according to the World Bank/FAO report is about US$ 46 billion annually. The key results of the World Bank/FAO study are summarized in Table 1.

Table 1. Rents and rents loss in the global fishery. The calculations in this table are based on two different biomass growth functions, the logistic (Clark, 1976) and that proposed by Fox (1970), both of which are theoretically and empirically possible, giving two sets of outcomes. From World Bank (2008).

<table>
<thead>
<tr>
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<th>Units</th>
<th>Current</th>
<th>Optimal</th>
<th>Difference</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Logistic</td>
<td>Fox</td>
<td>Logistic</td>
</tr>
<tr>
<td>Biomass</td>
<td>t x 10^6</td>
<td>148.4</td>
<td>92.3</td>
<td>314.2</td>
</tr>
<tr>
<td>Harvest</td>
<td>t x 10^6</td>
<td>85.7</td>
<td>85.7</td>
<td>80.8</td>
</tr>
<tr>
<td>Fleet/effort</td>
<td>Index</td>
<td>1.00</td>
<td>1.00</td>
<td>0.56</td>
</tr>
<tr>
<td>Profits</td>
<td>USD x 10^6</td>
<td>-5.0</td>
<td>-5.0</td>
<td>39.5</td>
</tr>
<tr>
<td>Rents</td>
<td>USD x 10^6</td>
<td>-5.0</td>
<td>-5.0</td>
<td>39.5</td>
</tr>
</tbody>
</table>

The World Bank/FAO aggregate study employed two different biomass growth functions, the logistic one (Clark 1976) and the one proposed by the biologist Fox (1970), neither of which was preferred by the available empirical data nor basic theory. As a result there are two sets of results, one for the logistic and one for the Fox biomass growth function.

As indicated in Table 1, the global fishery could yield net economic benefits between US$ 39.5 billion and 54.0 billion annually. In the base year, 2004, however, the global fishery was run at a loss (before subsidies) of US$ 5 billion. Thus, the annual rents loss in the global fishery is between US$ 44.5 billion and 59 billion depending on which biomass growth function applies. This rents loss amounts to about 60% of the total revenues of the global ocean fishery in the base year.

Of course these results are subject to considerable uncertainty which is extensively discussed in the report. This uncertainty stems from various sources but most important is the lack of precision in the estimates of parameters of the global fisheries model underlying the results. The uncertainty of the rents loss estimate is illustrated in Figure 2 and the corresponding confidence intervals are reported in Table 2.

Table 2. Estimates of global rents loss according to confidence intervals (from World Bank, 2008).

<table>
<thead>
<tr>
<th>Confidence</th>
<th>Estimated rents loss (billion US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>95%</td>
<td>26-73</td>
</tr>
<tr>
<td>90%</td>
<td>31-70</td>
</tr>
<tr>
<td>80%</td>
<td>37-67</td>
</tr>
</tbody>
</table>
Figure 2. Uncertainty of the global rents loss estimate: density and distribution functions (from World Bank, 2008)

The results from the aggregate global ocean fishery were supported by the individual case studies. About 20 such studies of different fisheries were carried out and a considerable range in the rents loss in individual fisheries was observed but, taken together, the results were similar to the ones from the aggregate global study.

The inescapable conclusion is that, far from benefiting the people of the world, the global ocean fishery is actually an economic burden. Having decimated most of the fish stocks by excessive harvesting, the world’s global fishing fleets are contributing next to nothing the world’s economy and a significant part of the fishing fleets are being kept afloat by subsidies in various forms.

The global marine fishery provides a striking example of how much economic damage can be caused by the common property problem. The common property problem not only affects the global fishery but operates in any fishery which doesn’t have enforceable property rights. Neither is it restricted to ocean fisheries, or even large scale fisheries, because small scale inland fisheries fall just as easily prey to the common property problem as large scale ocean ones.

Rents loss in the Lake Victoria Nile perch fishery

Nile perch were introduced into Lake Victoria in the early 1950’s. By 1980, the Nile perch fishery had attained major commercial significance. Helped by successful international marketing campaigns, foreign and domestic investors installed fish processing plants specializing in Nile perch products. As a result, demand for Nile perch landings expanded greatly attracting a dramatically increased number of fishers to the fishery. In 2006, the Nile perch fishery contributed over 24% of the total volume of fish harvest and 66% of income generated from fisheries in the three East African countries of Kenya, Uganda and Tanzania (LVFO, 2007).

In terms of commercial value the Nile perch fishery dominates the Lake Victoria basin fisheries; in Kenya alone, which has a 6% share of the lake’s area, the income derived from Nile perch fishery in 2006 was estimated to be US$134 million (landed value). Nile perch fish products processed by fish processing plants based in Kenya earned a further US $43.0 million in international trade. Thus, it may be estimated that the Nile perch fishery generated income of over US$ 177.0 million in Kenya alone.

Unfortunately, there are strong indications that the Nile perch catches have for some time exceeded the biological productivity of the resource. As a result, the stock is now severely overexploited and incapable of sustaining catch level unless a stock rebuilding program is initiated. At the same time, the number of fishers in Lake Victoria has continued to increase, further increasing the pressure on Nile perch and other fish species in the lake. The data are not readily available but it seems inevitable that this decline will be accompanied by substantially diminished profits to the fish processors and severely reduced incomes to individual fishers and their households.

Thus it seems that the Nile perch fishery has now fallen victim to the same common property problem that has devastated so many fisheries around the world. This outcome is no surprise. The fact that this fishery has, by and large, been operated as a common pool fishery without an appropriate rights-based fisheries management regime made this outcome virtually inevitable. The longer the current inefficient fisheries management regime persists, the greater will be the devastation of the Nile perch and other fish stocks in the lake and the more difficult it will be to return to a healthy sustainable fishery.

During the winter of 2006/7, Mr. Simon Warui of the Ministry of Livestock and Fisheries Development in Kenya investigated of the Lake Victoria Nile perch fishery as a part of his studies at the United Nations University Fisheries Training Programme in Iceland (Warui, 2007). This study, of course, is not the final word on the matter. It was and remains a student dissertation based on three months of research work. Nevertheless, at this point of time, it is the most complete study of the rents and rents loss in this fishery. Moreover, it tells a story that fits both with theory and the experience from a multitude of similar common property fisheries around the world.

In his work, Warui adopted the World Bank/FAO methodology (World Bank, 2008) His model of the Nile
perch fishery may be summarized in three equations as follows:

\[ \dot{x} = G(x) - y \]  
(Biomass growth function) \hspace{1cm} (1)

\[ y = Y(e, x) \]  
(Harvesting function) \hspace{1cm} (2)

\[ \pi = p \cdot Y(e, x) - C(e) \]  
(Profit function) \hspace{1cm} (3)

The five variables of this model, i.e., \( x, y, e, \pi \) and \( p \) represent biomass, harvest, fishing effort, profits and landings price, respectively. The first four are endogenous, i.e. determined within the fishery, while the fifth (price) is exogenous, i.e. determined by market conditions outside the fishery. The derivative, \( \dot{x} \equiv \frac{\partial x}{\partial t} \) measures the change in biomass at a point of time.

The model comprises three elementary functions basic to any bio-economic fisheries model; (i) the natural growth function, \( G(x) \), (ii) the harvesting function \( Y(e, x) \), and (iii) the cost function, \( C(e) \). The form adopted for these functions is specified below. As in the World Bank/FAO global study there are two options for the biomass growth function.

\[ G(x) = \begin{cases}  \frac{a \cdot x - \beta \cdot x^2}{a \cdot x - b \cdot \ln(x) \cdot x} & \text{(logistic)} \\ a \cdot x - b \cdot \ln(x) \cdot x & \text{(Fox)} \end{cases} \]  
(4)

The harvesting function is specified as:

\[ Y(e, x) = q \cdot e \cdot x^d, \]  
(5)

This is an extended version of the Schaefer (1954) harvesting function with \( q \) as the catchability coefficient and \( d \) as the schooling parameter. Normally \( d \in [0, 1] \). A value of \( d \) close to one would indicate little schooling and a lower \( d \) suggests increasing tendency toward schooling. For species such as Nile perch, \( b \) is thought to be between 0.75 and 0.95.

Finally, the cost function is specified as

\[ C(e) = c \cdot e + fk, \]  
(6)

where \( c \) is a parameter and \( fk \) represents fixed costs.

The parameters of the model represented by equations (4)-(6) were estimated partly on the basis of the available data and partly by using the data-poor estimation techniques explained in the World Bank/FAO (2008) study. The key data used in the estimation are summarized in Table 3.

On the basis of the fisheries model expressed by equations (4)-(6) and the estimates of its parameters it is possible to derive a the traditional sustainable fisheries model for the Nile perch fishery corresponding to the upper panel of Figure 1.

The results of the rents and rents loss drain according to both the logistic and Fox biomass growth functions are summarized in Table 3.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Assumed value</th>
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</thead>
<tbody>
<tr>
<td>Maximum sustainable yield (t x 10^3)</td>
<td>300.0</td>
</tr>
<tr>
<td>Virgin stock biomass (t x 10^3)</td>
<td>1427.0</td>
</tr>
<tr>
<td>Landings in base year 2006 (t x 10^3)</td>
<td>255.0</td>
</tr>
<tr>
<td>Landings price in base year 2006 (US$ kg^-1)</td>
<td>1.50</td>
</tr>
<tr>
<td>Net biomass growth in base year 2006 (t x 10^3)</td>
<td>0.00</td>
</tr>
<tr>
<td>Profits in base year 2006 (US$ x 10^3)</td>
<td>53.0</td>
</tr>
</tbody>
</table>

As illustrated in Figure 3, the model, employing the logistic biomass growth function, indicates that the current fishing effort (measured in non-motorized boat units) is well above the one corresponding to the maximum sustainable yield and way beyond the optimal level. As a result, the sustainable yield with the current effort is only about 250,000 t compared to the assumed maximum sustainable yield of 300,000 t. Even more worrying is that effort is currently just below that where the biomass ceases to be sustainable, i.e. where the sustainable revenue curve becomes vertical. The fishery appears to be in serious danger of a collapse if the present level of fishing effort is maintained.

![Figure 3](image-url)

**Figure 3.** A sustainable fisheries model for Nile perch derived from the logistic biomass growth model. • = yield, ○ = costs, \( e^p \) = optimal level of fishing effort, \( e^f \) = present level of fishing effort.

According to Figure 3 the fishery in 2006 was operated at slight profits, some US$50 million. This should be compared to the potential profits of more than US$200 million which could be attained on a sustainable basis if a more appropriate fisheries policy was adopted. This more appropriate fisheries policy reduces fishing effort by some 40 and would be attained at a biomass level about double the current one and sustainable harvests of some 280,000 t annually. The results of the rents and rents loss drain according to both the logistic and Fox biomass growth functions are summarized in Table 4.
Table 4. A summary of the main results, using the logistic and Fox model to compare the current situation in the Nile perch fishery with predicted optimal values.

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th></th>
<th>Optimal</th>
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<td>Logistic</td>
<td>Fox</td>
<td>Logistic</td>
<td>Fox</td>
<td>Logistic</td>
</tr>
<tr>
<td>Biomass (t x 10^3)</td>
<td>436.3</td>
<td>264.3</td>
<td>892.9</td>
<td>717.0</td>
<td>456.6</td>
</tr>
<tr>
<td>Harvest (t x 10^3)</td>
<td>254.7</td>
<td>254.7</td>
<td>281.1</td>
<td>282.1</td>
<td>26.4</td>
</tr>
<tr>
<td>Effort (boats x 10^3)</td>
<td>94.7</td>
<td>94.7</td>
<td>56.9</td>
<td>44.9</td>
<td>-37.8</td>
</tr>
<tr>
<td>Profits (US$ x 10^6)</td>
<td>52.9</td>
<td>52.9</td>
<td>216.4</td>
<td>257.0</td>
<td>163.5</td>
</tr>
<tr>
<td>Rents (US$ x 10^6)</td>
<td>72.0</td>
<td>72.0</td>
<td>235.5</td>
<td>276.1</td>
<td>163.5</td>
</tr>
</tbody>
</table>

Notable information in Table 4, in addition to what has already been discussed, is that it doesn’t make any material difference to the optimal policy whether the logistic biomass growth function or the Fox one applies. In both cases fishing effort should be reduced by some 40-50%. However, if the Fox biomass growth function applies, the actual rents loss of the current policy and the maximum attainable rents are substantially (some US$ 40 million) greater than if the logistic biomass growth function applies. The reason is that the Fox biomass growth function is more resilient (generates more biomass growth) at low stock sizes than the logistic. So, if it actually applies the calculated base year Nile perch biomass level in Lake Victoria is substantially less and the gains from a stock rebuilding policy correspondingly greater than if the Fox biomass growth function applies.

As in any study of this kind, there is a substantial uncertainty regarding the model and its parameters. Stochastic analysis based on Monte Carlo simulations indicates that with 90% confidence the current fishing effort should be reduced by some 25-60% to achieve the optimal sustainable yield. With the same 90% probability this would yield net economic gains of between US$ 90 million and 260 million annually.

It is one thing to identify the optimal sustainable yield and quite another to describe the best way to get there. Simple dynamic analysis suggests that to maximize the present value of the net profits from the fishery it would be necessary to close it immediately for one year, followed by a small amount of fishing in the following year and increase fishing effort in the third and fourth years until it reaches its long-term sustainable level. This would be characterized by a fishing effort of roughly 2/3 of the current level and a catch of around 280,000 t per year.

This optimal path of fishing effort is illustrated in Figure 4. The first year in the diagram represents the base year fishing effort; subsequent years represent the approximately optimal dynamic policy. The stock rebuilding policy depicted in Figure 4 is qualitatively the same as predicted by optimal dynamic theory and the actual ones that have been much more carefully worked out for other overexploited fisheries. One can therefore be reasonably confident in the broad structure of this policy.

The rent maximizing dynamic policy involves somewhat dramatic reduction in fishing effort and harvests at the outset. This may be socially difficult to endure. Therefore, a more moderate stock rebuilding policy may be more appropriate. This will lead to a longer adjustment period until the optimal sustainable equilibrium is attained. Given the current depressed state of the Nile perch stock, any sensible policy would nevertheless imply a substantial reduction in fishing effort right away.

![Figure 4](image_url)  
**Figure 4.** The evolution of fishing effort following the establishment of an optimum fishing effort policy. The first year in the diagram represents the base year fishing effort; subsequent years represent the approximately optimal dynamic policy.

There are some indications that the natural productivity of the Lake Victoria basin may be declining, possibly reflecting the impact of pollution or long term environmental cycles (Awange and Ong’an’ga, 2007). If this is the case, the total benefits of the stock rebuilding policies outlined above might be too optimistic. It is important to realize, however, that even in this case the gains from these policies would still outweigh the losses that will occur if the current policies are allowed to continue. Moreover, the best fishing effort policy in an environment where productivity is declining would still be roughly the same. It would still be optimal to reduce fishing effort drastically.

**Discussion**

Common property fisheries virtually without exception lead to overexploitation and loss of economic fisheries rents. In the global fishery, the resulting loss in economic rents is huge (World Bank 2008). It is by now...
well established (see e.g. Shotton, 2000; Arnason, 2007) that the best way to overcome the common property problem is to introduce a fisheries management regime based on property rights. For this purpose ITQs (individual transferable quotas), TURFs (territorial user rights) and community fishing rights have been introduced in many fisheries around the world (Shotton, 2000). The first two systems have clearly demonstrated their ability for recovering economic rents in fisheries and, in addition, introducing various kinds of new efficiencies in fisheries. The performance of ITQs, which are applicable to a much wider range of fisheries than TURFS, has been particularly impressive. Encouraged by the observed benefits of ITQs in other nations, over 15 major fishing nations have now adopted the ITQ-system in their fisheries management regimes and well over 20% of the global ocean fish catch is now taken under this form of fisheries management. In all these cases, increases in economic efficiency and profitability have been dramatic. In most cases previously declining fish stocks stabilized and in some cases recovered (Costello et al., 2008).

The Lake Victoria Nile perch fisheries management regime has essentially been a common property fishery. This is the fundamental cause of the inexorable decline in the biological foundation and the economic return of this fishery. To halt this trend and embark on a socially responsible fisheries policy as outlined in section 4 above, it is necessary to develop and implement a new fisheries management regime. Theory and experience of other fishing nations shows that this management regime has to be based on high quality property rights. Apart from this, not much can be asserted without a careful study of the social situation.

An ITQ-system seems attractive but may be difficult to enforce on an individual fisher basis. Organizing fishers into communities holding community ITQs and with some TURF rights may be a practical as well as an efficient way to go. The ITQs would be enforced on the community level and, provided that enforcement is effectively conducted, the communities would be induced to control their own members. This system of community ITQs has been tried for instance in England and Holland with encouraging results (MRAG et al., 2008). It goes without saying that under this system, each of the nations involved would have their own national Nile perch quota for which they are responsible and could allocate to their community units. These national quotas could be transferable and any overages by individual nations would be subject to the appropriate payment to the other nations plus the appropriate penalty. It is clear that for these national constraints to hold, each of the nations would have to exhibit a high degree of national responsibility.

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References
Managing Nile perch Using Slot Size: is it Possible?

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Abstract

The fishery of Lake Victoria became a major commercial fishery with the introduction of Nile perch in 1950s and 1960s. Biological and population characteristics point to a fishery under intense fishing pressure attributed to increased capacity and use of illegal fishing gears. Studies conducted between 1998 to 2000 suggested capture of fish between slot size of 50 to 85 cm TL to sustain the fishery. Samples from Kenya and Uganda factories in 2008 showed that 50% and 71% of individuals processed were below the slot size respectively. This study revealed that fish below and above the slot has continued being caught and processed. This confirms that the slot size is hardly adhered to by both the fishers and the processors. The paper explores why the slot size has not been a successful tool in management of Nile perch and suggests strategies to sustain the fishery.

Key words: Lake Victoria, Nile perch, exploitation, management, slot size.

Introduction

The Nile perch, Lates niloticus (L.), is a predatory fish highly valued in both commercial and recreational fisheries which can grow to 2 m in length and weigh over 200 kg (Ogutu-Ohwayo, 2004). It is widely distributed in Africa, occurring in the Congo, Niger, Volta and Senegal rivers, and in Lakes Chad and Turkana, and throughout the Nile system as far as Lake Albert but was prevented from reaching Lake Victoria by the Murchison Falls. It was introduced into Lake Victoria from Lake Albert during the 1950’s and early 1960’s (Pringle, 2005) in order to convert the small and bony but abundant haplochromine cichlids to suitable table fish (Anderson, 1961). Opponents of the introduction feared that Nile perch might deplete the stocks of native fish species as well as its own numbers, through cannibalism, which would cause the fisheries to collapse (Fryer, 1960). It took about two decades for Nile perch to establish itself in the lake but its numbers increased rapidly in the late 1970s, leading to a dramatic increase in fisheries productivity (Ogutu-Ohwayo, 1990). At the same time, predation by Nile perch brought about a reduction in the numbers of many native species with haplochromines falling from >80% of the biomass during the 1970’s to <1% by the mid-1980’s, and it was feared that many species had become extinct (Ogutu-Ohwayo, 1990; Njiru et al., 2008).

The growth of the fishery and increasing fishing intensity led to a decline in catches of Nile perch creating fears that the fishery might not be sustainable without appropriate management measures (Matsuishi et al., 2006; Njiru et al., 2007). Studies carried out between 1998 and 2000 suggested that the capture of fish between 50 and 85 cm TL could be permitted and slot sizes of 50 to 85 cm TL were gazetted by the countries around the lake with enforcement starting in mid-2000s. This paper examines the extent to which fishermen and the processing factories adhere to the slot sizes, using information collected at landing beaches, processing factories, as well as published and unpublished literature. Factors that could have led to the decline in Nile perch in Lake Victoria are discussed and possible management strategies suggested.

Genesis of the slot size

Catches

Annual catches of Nile perch in Lake Victoria increased from 30,000 t in the late 1970s to a peak of 560,000 t in 1999. In Kenya, for example, the Nile perch catch increased
from 146 t in 1973 to 115,000 t in 1999 but then declined to 30,000 t in 2007 (Figure 1). The Ugandan catch increased from 11,000 t in 1977 to 120,000 t in the early 1990s but fragmentary data from the 1990s makes it difficult to determine trends, except that by 2000 the catch was around 175,000 t. In Tanzania, the catch increased from 72,000 t in 1983 to 231,000 t in 1990 but the poor catch assessment data in that country means that trends cannot be identified (Matsuishi et al., 2006; Njiru et al., 2007). Recent data suggest that the monthly catches of Nile perch have not declined significantly over the short term, except in Kenya (Figure 2) where the total catch fell from 290,000 t in 2005 to 260,000 t in 2006 and 230,000 t in 2007 (Lake Victoria Fisheries Organization, unpublished data).

**Figure 1.** Fish catches from the Kenyan sector of Lake Victoria, 1973-2007. ♦ = *Lates niloticus*, ○ = *Rastrineobola argentea*, ● = tilapias (mostly *Oreochromis niloticus*). Source: unpublished data from Kenya Marine and Fisheries Research Institute, Kisumu.

**Figure 2.** Estimated monthly catches of Nile perch in Lake Victoria, 2005-2008. ● = total catch, ○ = Kenyan catch, △ = Tanzanian catch, ○ = Ugandan catch. The only significant trend was for the Kenyan catch (y = 4465.5 - 284.6x, r = 0.810, p < 0.01). Source: LVFO unpublished data.

**Population and biological characteristics**

The slot size is based on the premise that Nile perch ≤ 50 cm TL feed predominantly on the shrimp *Caridina nilotica* (Roux), thus converting invertebrates into fish flesh while larger fish are predominantly piscivorous, feeding mainly on the cyprinid *Rastrineobola argentea* (Pellegrin), juvenile Nile perch, Nile tilapia, *Oreochromis niloticus* (L.) and haplochromines (Figure 3), which is both destructive to the lake’s biodiversity and energetically wasteful. Harvesting Nile perch ≥ 50 cm TL could also lead to the recovery of the haplochromines, thus enhancing the productivity of the fisheries, especially in deep waters where only the pelagic *R. argentea* occurs at present. Female Nile perch grow to a larger size and mature later than males and up to 2006 males and females reached 50% maturity at 54-64 and 62-85 cm TL respectively (Table 1). The sex ratio changed with size because males were smaller than females and most fish > 80 cm were females (Hughes, 1992) but the removal of large fish by the fishery has resulted in a more or less equal sex ratio in the 40-60 size class (LVFO, unpublished data). Thus, the slot size of 50 to 85 cm TL sought to protect immature fish, harvest mature individuals and at the same time protect the larger females which would be expected to replenish the stocks.
Table 1. Changes in the length at 50% maturity (cm TL) in male and female Nile perch from Lake Victoria. Adapted from Njiru et al. (2007, 2008)

<table>
<thead>
<tr>
<th>Area</th>
<th>Year</th>
<th>L_50 (males)</th>
<th>L_50 (females)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya</td>
<td>1988</td>
<td>74</td>
<td>102</td>
</tr>
<tr>
<td></td>
<td>2002</td>
<td>55</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>55</td>
<td>62</td>
</tr>
<tr>
<td>Tanzania</td>
<td>1985</td>
<td>54</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>2002</td>
<td>64</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>2003</td>
<td>57</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>58</td>
<td>70</td>
</tr>
<tr>
<td>Uganda</td>
<td>1990</td>
<td>60</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>2002</td>
<td>54</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>60</td>
<td>85</td>
</tr>
</tbody>
</table>

Factors that may be hindering the effectiveness of the slot size

Factories and markets

The continued capture of immature Nile perch may be a consequence of the increased demand for fish. The number of factories processing Nile perch increased from 32 in 2000 to 35 in 2005 before falling to 27 in 2008 (Table 2) and their capacity exceeds the quantity of fish they are able to obtain (SEDAWO, 1999; Abila, 2000). The factories once processed Nile perch with a minimum weight of 2 to 3 kg but as a result of increased competition for fish and the reduced numbers of large ones they now accept smaller fish, sometimes only weighing 1 kg. Some export markets prefer fillets from 0.5-kg fish (or smaller) owing to their low fat content while the local and regional markets accept fish of any size (Muhoozi, 2002). This market demand has encouraged use of small gillnets (<127 mm mesh), beach seines and small hooks which target small Nile perch. A recent survey showed that most Nile perch landed at beaches were below the length at first maturity (L_50) while most fish sent to the factories and filleted were also below the slot size (Figure 4).

Table 2. Changes in the number of Nile perch processing factories around Lake Victoria (LVFO, unpublished data).

<table>
<thead>
<tr>
<th>Area</th>
<th>2000</th>
<th>2005</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya</td>
<td>31</td>
<td>35</td>
<td>27</td>
</tr>
<tr>
<td>Tanzania</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Uganda</td>
<td>9</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
<td>53</td>
<td>47</td>
</tr>
</tbody>
</table>

Ownership

Fish processing factories control the Nile perch fishing industry and have marginalized local fishers because there is intense competition for fish to meet the demand of the processing plants (SEDAWO, 1999). The prominent fishers also compete to harvest more, factories to buy more than a nearby factory or in another country. The fish processing factories or prominent fishers can register any number of canoes without limit, and pay a fishing license (~$US 5 per boat) while there is no limit to the numbers of nets being used as long as the vessel can carry them. There is no system of ensuring that fishers use legal gear apart from what is reported during registration. The factory processors have an association where they strategise and dictate terms in the industry, whereas fishers do not have such a forum and are therefore unable to take a common stand. Fishers are totally at the mercy of the fish processing factories and with the loss of control to “foreign investors”, local fishers have been deprived of ownership, which traditionally has been in the community (Geheb and Crean 2000), leading them to resort to irresponsible fishing practices (Yongo et al., 2005).
Open access

The Lake Victoria fishery is an open-access without any limitation on the total number of fishers, boats and gears used. The demand for fish from Lake Victoria has continued to increase over the years (Abila, 2000) and so fishing effort has also increased (Cowx et al., 2003; Njiru et al., 2008). Fishers are using more efficient illegal fishing gears and methods to get more fish irrespective of their sizes (Cowx et al., 2003). The recommended gill mesh size for the lake fishery is 5 inches (127 mm), but gill nets <5 inches are still prevalent while banned gears such as beach seines, cast nets and monofilaments are still being used (Njiru et al., 2008) and when used in shallow areas all of them capture immature Nile perch.

The declining catch per unit effort (CPUE) has made fishing with legal fishing gears unprofitable without costly investments such as larger boats, outboard motors, or large quantities of gillnets (Muhoozi, 2002). The majority of fishers in lake cannot afford such investments and consequently resort to illegal fishing practices such as joining small-meshed gillnets (< 5 inches) together so a fleet of 80 nominal nets in one canoe is actually 240 nets, which may extend spread up to 3 km and are drifted by boats with outboard engines. This fishing method is more efficient but is also a source of conflict between fishers because it destroys passively set nets (SEDAWOG, 1999; Muhoozi, 2002). Although, the active operation of gillnets is illegal in Uganda 85% of boats fishing in the inshore areas operated gillnets actively (Muhoozi, 2002). These fishing methods probably enable fishers to maintain reasonably high catches of Nile perch, many of them undersized, at a time when the stocks are declining.

Security

Theft of gears and piracy has become a problem on Lake Victoria and has influenced the way fishers conduct their fishing activities (SEDAWOG, 1999). In addition, the high cost of the legal fishing gears has led to the use illegal fishing gears and methods (Muhoozi, 2002) such as cast nets and beach seines which are less easily stolen as they are under the control of fishers at all times. It has been argued that the Kenyan part of the lake is highly productive because it is shallow, has numerous river mouths and high nutrient loads, and is therefore the major breeding and nursery area of Nile perch and so fishing should be restricted to deeper waters (Njiru et al., 2007). This has led to conflicts with Kenyan fishers being imprisoned in Uganda and Tanzania in pursuit of “their adult fish” but this view is unverified and it will remain so until investigations into fish migration have been carried out. Fishers who do not venture into the deeper waters of the lake and run the risk of being detained remain in the shallow waters where they target juvenile perch with illegal fishing methods.

Fishing for Rastrineobola and Cardina

The decline of Nile perch stocks in Lake Victoria, has led a shift towards the more abundant Rastrineobola which could have some adverse effects on the Nile perch stock because of its mode of fishing. Fishing for Rastrineobola is supposed to be carried out in deeper waters during dark nights by light attraction using 10-mm mesh nets. This is not the case in shallow areas < 5 m deep, where fishing goes throughout the year without light attraction and with 5-mm mesh nets (Muhoozi, 2002). Fishers sometimes join several of these nets vertically and horizontally so that they are up...
to 500 m in length. They are then used as beach seines, and this method is unselective, capturing juvenile fish of all species and so endangering recruitment.

The shrimp *Caridina* is harvested for poultry meal production in Nairobi and Dar es Salaam, and as it is the most important prey item for smaller Nile perch (Figure 2) this could result in a scarcity of food for fish < 60 cm TL (Budeba, 2003). This might eventually have an adverse effect on the Nile perch stock but, despite the importance of *Caridina* little is known about its ecology in Lake Victoria. In Tanzania, *Caridina* is neglected during recording of catches (Budeba, 2003) and there is a need for more information on this fishery.

**Policies and enforcement**

Policies and regulations governing Lake Victoria’s resources which are different in each country (Ndiba et al., 2001), but substantial efforts towards harmonisation have been made by the Lake Victoria Fisheries Organisation (LVFO, 2007b). For example, the use of monofilaments was banned in Tanzania and Kenya and allowed in Uganda, but during the LVFO Council of Ministers Session in February 2009, a joint communiqué was signed to ban monofilament in the three Partner States. The same session set the minimum mesh size for *R. argentea* at 10 mm instead of 5 mm nets. However, fishing for *R. argentea* is prohibited only in Kenya between 1 April and 31 August. Where some regulations are similar, the penalties are different. There is therefore an urgent need to harmonise all the regulations and penalties in the Lake Victoria fishery and treat the lake as one system.

**Management strategies**

**Capacity and enforcement**

The Nile perch population is dominated by small individuals (<40 cm TL) which suggests successful recruitment (Figure 4). These small fish occur mostly in water < 10 m deep which appears to be the most heavily fished area (Litvjeo et al., 1995; Njiri et al., 2008). Illegal fishing gears and methods in the shallow zones of the lake can lead to growth over-fishing resulting in depletion of the stock as few mature individuals are given a chance to replenishment it (Mkumbo, 2002). To sustain the fishery, the recommended slot sizes should be enforced, entry into the fishery should be limited through licensing, and illegal fishing gears and methods eradicated.

**Funding**

Lake Victoria’s fisheries generate up to US $500 million annually mostly from Nile perch export (Yongo et al., 2005) but no substantial funds are ploughed back for research and management. Instead, fishery management agencies rely heavily on donor funds and donors whose objectives might not be of immediate concern to management of the lake. Consequently, there is a need to source money locally, perhaps from taxes levied on the fishing industry to support research and management needed to maintain the fishery resources. In such a situation, research would have to be demand-driven and aim to answer specific issues raised by stakeholders.

**Alternative livelihoods**

Even with the best management systems in place, the supply of fish from the lake will be insufficient to meet the ever growing demand (Abila, 2000; Yonge et al., 2005) because with a population growing at 3% the demand for fish outstrips the catch. Aquaculture, which is poorly developed around Lake Victoria, could be a viable option but much needs to be done since the combined production from, Kenya, Uganda and Tanzania is less than 10 000 t (< 0.02% of global production) (Mushi et al., 2005). The contribution from aquaculture should be greater because East Africa region has an adequate year-round photoperiod, extensive water bodies and wetlands, and suitable native species aquaculture suitable for fish farming Development of aquaculture, and other activities like ecotourism or horticulture might reduce pressure on the Victoria fisheries provided they could provide adequate livelihoods to a sufficiently large number of people.

**Co-management**

Properly implemented monitoring, control and surveillance schemes should be linked to community-based management approaches because government enforcement has been successful up to now (Ndiba et al., 2002). The study by SEDAWOG (1999) found that beach communities formed for patrol and monitoring of their fishing grounds to deter thieves and control illegal gears were very effective. Since Beach Management units (BMUs), of which all fishermen must be members, have been established to coordinate fishing activities at all landing beaches around the lake. Co-management will transfer responsibilities and privileges to the stakeholders giving them a sense of ownership of the resource and if this approach succeeds illegal gears and the capture of undersized fish will be much reduced or, hopefully, eliminated. Security is a major problem but this could be strengthened by integrating communities into the management of the fishery resource through the BMUs, but their success will depend on local commitment the one hand and strong political support on the other.

**References**


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Status of the Major Commercial Fish Stocks and Proposed Species-specific Management Plans for Lake Victoria*

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Abstract
The fishery of Lake Victoria is dominated by four species, the introduced Nile perch (Lates niloticus) and Nile tilapia, (Oreochromis niloticus), the native dagaa, (Rastrineobola argentea) and haplochromines. Recently, there has been a concern about the state of these fish stocks and their current status is reviewed by examining trends in biomass, catch, catch per unit efforts and biological indicators. The Cadima model was used to predict the MSY of Nile perch and dagaa and the Nile perch was shown to be under intense fishing pressure. The biomass has considerably reduced with catches being higher than the predicted MSY. In contrast, the dagaa fishery was well below the predicted MSY and there is still scope for expansion. The fishery for Nile tilapia is also under pressure as a result of increased fishing effort and illegality, but little is known about the haplochromines. The current status of the fisheries threatens the benefits which the lake has been providing for decades and it is recommended that management options outlined in this paper are implemented to avoid the collapse of the fisheries.

Keywords: Lake Victoria, biomass, Nile perch, Rastrineobola, recovery plan, species specific management plan

Introduction
Lake Victoria, with a surface area of 68,800 km² is the world’s second largest freshwater body and it supports one of the world’s most productive inland fisheries with a total catch of around one million tonnes per annum. It supports about 200,000 fishermen and the catch is valued at more than US$ 400 million which includes some US$ 250 million in exports which is 3-5% of the total GDP of the three countries around the lake (Ogutu-Ohwayo and Balirwa, 2006).

The fish stocks in the lake have changed dramatically since the introduction of Nile perch Lates niloticus (L.) during the late 1950s and early 1960s. These changes included the apparent destruction of the endemic haplochromine species flock, which made up about 80% of the fish biomass in the lake in the 1970s (Kudhongania and Cordone, 1974), but less than 4% by the early 1990s while Nile perch became the dominant species (Okaronon, 2004). Currently, the fishery is dominated by two introduced species, Nile perch and Nile tilapia Oreochromis niloticus (L.), and the native pelagic cyprinid Rastrineobola argentea (Pellegrin), commonly referred to as ‘dagaa’ (also ‘omena’ or ‘mukene’), and haplochromines. The recovery of the haplochromines is a striking feature of recent catches but it is not clear which species are involved and how many may have been lost. The Nile perch fishery is the most valuable since it provides most of the export earnings, but concerns about over-exploitation have been expressed (Matsuishi et al., 2006) and signs of overfishing, such as a decline in the biomass and a decrease in the age of first maturity, are now evident (LVFO, 2007, 2008a).

This paper summarises current knowledge about the status of the fish stocks and reviews the need for species-specific management plans for the major commercial fish species of Lake Victoria. It also outlines a recovery plan for the Nile perch fishery where fishing effort may now be almost twice the optimal level needed for a sustainable yield (Arnason, 2009).

Methods
Data for this assessment were obtained from biennial frame surveys carried out from 2000 to 2008, catch assessment surveys from 2005-2008, acoustic surveys carried out from 1999-2001 (Getabu et al., 2003; Tumwebaze et al., 2007) and again from 2005-2008, and bottom trawl surveys undertaken from 2005-2008. These
surveys were carried out concurrently in all three countries, using standardised methods, and are among the first to provide information on a lake-wide basis.

A wide variety of stock assessment models are available (Sparre and Venema, 1992; Jennings et al., 2001) but many of these require data which are not readily available from Lake Victoria. In particular, adequate long-term data are lacking while inconsistency in datasets and fragmentation of data as a result of interruptions in sampling are a major problem. Two projects funded by the European Union, the Lake Victoria Fisheries Research Project (LVFRP) which ran from 1997 to 2001 and the Implementation of Fisheries Management Plan Project (IFMP) which began in 2003 and will be completed in 2010 have provided consistent lake-wide data.

The current assessment is based on a simple but robust form of surplus production model, the Cadima equation, in which

$$\text{MSY} = 0.5 \times (Y + M \overline{B})$$

where $\text{MSY} =$ maximum sustainable yield, $Y =$ yield, $M =$ natural mortality and $\overline{B} =$ mean biomass. This model was chosen because models that rely on catch and effort are difficult to use owing to problems in estimating a standardised measure of effort since a wide variety of fishing methods are used in Lake Victoria.

**Results**

*Biomass and relative abundance*

The average biomass of fish in the lake was estimated to be 2.1 million tonnes (range 1.6 million to 2.6 million tonnes) over the period from August 1999 to August 2008 (Figure 1a). The Nile perch biomass declined from 1.9 million t in August 1999 (82% of the total biomass) to 227,000 t (15%) in August 2008. On average, it accounted for 59% of the total biomass in 1999-2001 but only 26% in 2005-2008. It made up only 37% and 15% of the stock in August 2005 and August 2008. The biomass of *Rastrineobola argentea* has risen considerably over the last decade (Figure 1b). In 1999 its biomass was only about 245,000 t (10% of the total) although this rose to an average of 477,000 t (23%) during 1999-2001. Its biomass continued to rise throughout 2005-2008 with an average of just over 1 million tonnes or 50% of the total. Its population fluctuated quite considerably, however, with the lowest estimate during this period being recorded in August 2005 (500,000 t or 34%) and the highest in February 2008 (1.5 million tonnes or 57%).

The Nile tilapia is the most important tilapia in the lake (Ojuok et al., 2007) but its biomass could not be determined as it mostly lives in water < 10 m deep where it cannot be adequately sampled by acoustic methods. Similarly, there are no direct data available on haplochromine biomass although their populations are evidently increasing (Table 1). Stock assessment of this group will be very difficult because the stock consists of a number of species, not all of which can be easily distinguished and treating it as a single unit could mask significant changes within the community.

**Biological indicators**

The mean length of Nile perch in trawl catches did not change much between 1994 and 1999 although there was a marked increase from around 18 cm in 1999 to about 32 cm in 2002 (Figure 2). This may be a result of the export bans that were imposed at various times between 1997 and 2000, which led to a reduction in the total catch and, presumably, a decrease in fishing effort. This increase in mean length was not sustained and it fell back to about 18 cm by 2007. The mean maximum length of Nile perch detected by single target detection during the acoustic surveys carried out during the IFMP was around 50 cm between August 2005 and February 2007. Thereafter, it fell sharply to about 27 cm by August 2008 and this corresponded significantly with a reduction in its biomass (Figure 3).

**Table 1.** The proportion (%) of major inshore species collected in trawls during the acoustic surveys, 2005-08. Dagaa are not effectively sampled with bottom trawls.

<table>
<thead>
<tr>
<th></th>
<th>Nile Perch</th>
<th>Tilapia</th>
<th>Haplochromines</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 05</td>
<td>81.4</td>
<td>4.8</td>
<td>7.2</td>
<td>6.6</td>
</tr>
<tr>
<td>Feb 06</td>
<td>86.2</td>
<td>6.7</td>
<td>3.4</td>
<td>3.7</td>
</tr>
<tr>
<td>Aug 06</td>
<td>66.8</td>
<td>12.6</td>
<td>12.9</td>
<td>7.7</td>
</tr>
<tr>
<td>Aug 07</td>
<td>83.6</td>
<td>0.7</td>
<td>12.7</td>
<td>3.0</td>
</tr>
<tr>
<td>Feb 08</td>
<td>75.0</td>
<td>3.5</td>
<td>14.0</td>
<td>7.5</td>
</tr>
<tr>
<td>Aug 08</td>
<td>71.1</td>
<td>1.7</td>
<td>21.9</td>
<td>5.3</td>
</tr>
</tbody>
</table>

**Figure 1.** Changes in the biomass of (a) Nile perch and (b) *Rastrineobola argentea* (dagaa) in Lake Victoria, 1999-2008, in relation to the total fish biomass. Grey shading = total biomass, points = biomass (± standard deviation). No surveys were carried out between August 2001 and August 2005. Data from Getabu et al. (2003), Tumwebaze et al. (2007) and IFMP surveys, 2005-08.
The size at first maturity of Nile perch has fluctuated over time (Table 2). These data suggest that it matures relatively early when its population is small, i.e. in the 1960s and 1970s when it was still expanding, and again more recently when its biomass has fallen as a result of overfishing. The length at first maturity was greatest in females, at about 93 cm in the period from 1982-92 when Nile perch were probably most abundant in the lake.

The decrease in size of dagaa is reflected by changes in the size at first maturity. In the pre-Nile perch era dagaa matured at around 60 mm TL but by the 1990s this had fallen to around 35-40 mm (Table 3). In the Kenyan waters of Lake Victoria the mean length at first maturity of Oreochromis niloticus was reported to be 35 cm TL (Getabu, 1992) while Ojuok et al. (2007) reported that it was 35.0 cm TL for males and 31 cm TL for females. By 2004-05 their length at first maturity had decreased further to 22.0 cm TL in females and 25.0 cm TL in males (Njiru et al., 2006).

Fishery indicators
A decline in the catch per unit effort (CPUE) of Nile perch was noted in paddled sesse boats using gillnets in Tanzania, and in sesse boats with motors/sails and gillnets in Kenya, and amongst paddled sesse boats with longlines in both Kenya and Tanzania (Figure 4). The number of fishermen and the number of fishing boats rose by 54% and 63% respectively between 2000 and 2008, but the relative number of boats remained more or less constant at 0.3 per fisherman. Fishing gear increased considerably, however, and in each case the numbers per fisherman also increased. This was especially evident in long lines, which target Nile perch almost exclusively, where the number of hooks rose from 27 per fisherman in 2000 to 56 in 2008 with the total number increasing by 322% over the same period. The most significant increase was in the number of small hooks (i.e. size 10 or above) which increased by 77% from 2006 to 2008, reflecting the decrease in the average size of Nile perch.

Table 2. Size at first maturity (total length, cm) in male and female Nile perch in Lake Victoria, 1964-2007.

<table>
<thead>
<tr>
<th>Year</th>
<th>Females</th>
<th>Males</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964-67</td>
<td>45.3</td>
<td>32.2</td>
<td>Okedi (1970)</td>
</tr>
<tr>
<td>1968-77</td>
<td>54.7</td>
<td>41.9</td>
<td>Ogutu-Ohwayo (2004)</td>
</tr>
<tr>
<td>1982</td>
<td>93.3</td>
<td>46.8</td>
<td>Ogutu-Ohwayo (2004)</td>
</tr>
<tr>
<td>2001</td>
<td>75.8</td>
<td>57.7</td>
<td>UNECIA (2001)</td>
</tr>
<tr>
<td>2007</td>
<td>58.0</td>
<td>52.5</td>
<td>LVFO (2007a)</td>
</tr>
</tbody>
</table>

Table 3. Estimates of length at first maturity (standard length, cm) in Rastrineobola argentea. The data for 1973 have been converted from total length using the relationship SL = (TL – 0.33)/1.22 (Wanink, 1994).

<table>
<thead>
<tr>
<th>Females</th>
<th>Males</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>51.4</td>
<td>44.0</td>
<td>Okedi (1973)</td>
</tr>
<tr>
<td>40.0</td>
<td>41.0</td>
<td>Wandera (1992)</td>
</tr>
<tr>
<td>34.0</td>
<td>36.0</td>
<td>Manyala et al. (1992)</td>
</tr>
<tr>
<td>33.0</td>
<td>46.0</td>
<td>Wanink (1998)</td>
</tr>
<tr>
<td>40.0</td>
<td>40.0</td>
<td>Wandera et al. (2005)</td>
</tr>
<tr>
<td>41.6</td>
<td>40.2</td>
<td>Wandera et al. (2005)</td>
</tr>
</tbody>
</table>

Figure 2. Mean length of Nile perch in trawl samples, 1993-2007 (points) The grey shading denotes the annual catch while the cross-hatched area indicates the period when export bans were in force at various times. Data from Yongo et al. (2005), Payne et al. (2006) and IFMP surveys.

Figure 3. The relationship between the mean maximum length (points) and biomass (grey shading) of Nile perch during IFMP acoustic surveys, August 2005-August 2008. There was a significant correlation ($r = 0.94, p < 0.01$) between the two variables.
The catch rates of dagaa in all vessel-gear types fluctuated to a considerable extent with no clear pattern (Fig. 5). The mean catch rate for paddled sesse boats averaged about 220 kg boat\(^{-1}\) night\(^{-1}\) in all three countries but catches lowest from Kenya (122 kg boat\(^{-1}\) night\(^{-1}\)) and highest in Tanzania (282 kg boat\(^{-1}\) night\(^{-1}\)). Catch rates from sesse boats propelled by sails or motors were only reported from two countries and again, those from Kenya were much lower (mean = 106 kg boat\(^{-1}\) night\(^{-1}\)) than those from Tanzania (523 kg boat\(^{-1}\) night\(^{-1}\)).

The catch rates of *Oreochromis niloticus* made by sesse boats with hand lines decreased significantly \((p < 0.05)\) in Tanzania while the reduction in catch by sesse boats with gillnets in Uganda was nearly significant \((p < 0.10)\). There was no clear pattern in the catch rates from parachute boats with gillnets and hand lines (Figure 6).

**Figure 4.** Catch per unit effort (kg boat\(^{-1}\) day\(^{-1}\)) of Nile perch in the main vessel-gear combinations. ● = Kenya, ▲ = Tanzania, □ = Uganda. Only significant \((p < 0.05)\) relationships are indicated by a regression line. Data from IFMP catch assessment surveys.

**Figure 5.** Catch per unit effort (kg boat\(^{-1}\) night\(^{-1}\)) of dagaa in the two main gear-vessel combinations: (a) Sesse boats with paddles and small seines, and (b) sesse boats with a motor or sail and small seines. ● = Kenya, ▲ = Tanzania, □ = Uganda. Data from IFMP catch assessment surveys.

**Figure 6.** Catch per unit effort (kg boat\(^{-1}\) day\(^{-1}\)) of *Oreochromis niloticus* fishery of Lake Victoria in relation to the principal gear-vessel combinations. ● = Kenya, ▲ = Tanzania, □ = Uganda. Data from IFMP catch assessment surveys.

**Stock assessment and reference points**

During the period 1999-2001 the yield of Nile perch ranged from 58-86% of the predicted maximum sustainable yield \((MSY)\) and from 12-23% of the mean biomass \((B)\) recorded during the surveys at that time (Table 4). This had changed dramatically a few years later and by 2005-07 the proportion of MSY taken by the fishery was over 100% while the yield exceeded 40% of the mean biomass which was considered to be the maximum for a species with the characteristics of Nile perch (LVFO, 2008b).
Table 4. The mean performance of the Nile perch fishery in relation to predicted MSY and biomass in 1999-2001 and in 2005-07. \( \bar{B} \) = biomass (t), \( Y \) = yield (t), \( MSY \) = predicted maximum sustainable yield (t) using data from LVFRP and IFMP. In all cases natural mortality (\( M \)) was taken to be 0.3.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bar{B} ) (x 1000)</td>
<td>1,390</td>
<td>579</td>
</tr>
<tr>
<td>( Y ) (x 1000)</td>
<td>229</td>
<td>249</td>
</tr>
<tr>
<td>( MSY ) (x 1000)</td>
<td>323</td>
<td>212</td>
</tr>
<tr>
<td>( Y/MSY )</td>
<td>0.73</td>
<td>1.18</td>
</tr>
<tr>
<td>( Y/\bar{B} )</td>
<td>0.18</td>
<td>0.44</td>
</tr>
</tbody>
</table>

Table 5. The effects of reducing yield by on the \( MSY \) and \( Y/B \) ratio in the Nile perch fishery, 2005-07. Symbols and units are given in Table 4.

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass ( \bar{B} )</td>
<td>544</td>
<td>676</td>
<td>518</td>
</tr>
<tr>
<td>Effort -10% ( Y )</td>
<td>259</td>
<td>208</td>
<td>205</td>
</tr>
<tr>
<td>( MSY )</td>
<td>211</td>
<td>205</td>
<td>180</td>
</tr>
<tr>
<td>( Y/\bar{B} )</td>
<td>0.4</td>
<td>0.31</td>
<td>0.4</td>
</tr>
<tr>
<td>Effort -20% ( Y )</td>
<td>230</td>
<td>185</td>
<td>182</td>
</tr>
<tr>
<td>( MSY )</td>
<td>197</td>
<td>194</td>
<td>169</td>
</tr>
<tr>
<td>( Y/\bar{B} )</td>
<td>0.42</td>
<td>0.27</td>
<td>0.35</td>
</tr>
<tr>
<td>Effort -30% ( Y )</td>
<td>202</td>
<td>162</td>
<td>160</td>
</tr>
<tr>
<td>( MSY )</td>
<td>183</td>
<td>182</td>
<td>158</td>
</tr>
<tr>
<td>( Y/\bar{B} )</td>
<td>0.37</td>
<td>0.24</td>
<td>0.31</td>
</tr>
</tbody>
</table>

An assessment of the dagaa fishery suggests that the yield is lower than maximum sustainable yield (Table 6). Therefore, the current fishing effort could be increased to bring the \( Y/\bar{B} \) ratio to 100% which should be sustainable in a short-lived species like dagaa (LVFO, 2008b).

Table 6. The mean performance of the dagaa fishery in relation to predicted MSY and biomass in 1999-2001 and in 2005-07. Symbols and units as in Table 4. In all cases natural mortality (\( M \)) was taken to be 2.0

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bar{B} ) (x 1000)</td>
<td>468</td>
<td>856</td>
</tr>
<tr>
<td>( Y ) (x 1000)</td>
<td>194</td>
<td>395</td>
</tr>
<tr>
<td>( MSY ) (x 1000)</td>
<td>565</td>
<td>1,054</td>
</tr>
<tr>
<td>( Y/MSY )</td>
<td>0.34</td>
<td>0.37</td>
</tr>
<tr>
<td>( Y/\bar{B} )</td>
<td>0.41</td>
<td>0.46</td>
</tr>
</tbody>
</table>

Of the three variables in the Cadima model, only the yield (\( Y \)) can be influenced directly by management through increasing or decreasing the fishing effort. Given the present state of the Nile perch stocks, the only management measure available is to reduce fishing effort, which would also reduce the yield. If the effort reduction was adequate a decrease in the \( Y/\bar{B} \) ratio would be expected and the stock could begin to recover. An indication of how yield reduction could affect the fishery can be obtained by changing \( Y \) in the 2005-07 data by varying amounts (Table 5). It would require a 30% reduction of effort to bring the yield to below 40% of the mean biomass as recommended by LVFO (2008b).

**Discussion**

The fisheries of Lake Victoria directly support around three million people (EAC, 2006) and make a significant contribution to the GDP of the countries around the lake (Ogutu-Ohwayo and Balirwa, 2006). The reduction in the biomass of Nile perch is therefore of concern as a potential threat to the local economy. Some benefits that have already shown signs of being affected include incomes and employment owing to the closure of some fish processing factories, while those currently operating are working at reduced capacity (Onyango, 2006).

While the total biomass of Nile perch has decreased, the catch is higher than the predicted \( MSY \) in most years. This is the result of increased fishing effort which has led to reduced numbers of larger fish in the population. The reduction of the spawning stock could impair the ability of the stock to replenish itself, although this has been offset by a reduction in the size of first maturity. Nevertheless bioeconomic models suggest that fishing effort is too high for a sustainable fishery (Arnason, 2009) and draw attention to the need to reduce effort and a regional plan of action has been drawn up to accomplish this (LVFO, 2007b).

If an \( MSY \) of 225,000 t is to be maintained then, assuming that 30% of the biomass can be removed, then the target biomass would come to 750,000 t. This can be achieved by a 30% reduction of effort and for practical purposes the allowable catch should therefore not exceed 30% of the mean biomass in the previous year. Various options exist for reducing effort and these have been set out in the Regional Plans of Action for (a) Capacity and (b) Illegal, Undocumented and Unlicensed Fisheries, and the full implementation of these plans should have an impact on the stocks. Other possible actions include the establishment of closed areas to protect stocks in key habitats or even closed seasons for as long as 3 months per year to allow for the stocks to recover.

The dagaa fishery seems to be capable of further expansion with yield being substantially lower than maximum sustainable yield and a relatively small proportion of the biomass. As a small, rapidly-growing species it has a high P/B ratio (probably > 2.0) and the catch can exceed the mean biomass. At present there is no obvious need to set limits for this fishery but if the Nile perch stock recovers this it may reduce the dagaa stock and the need to control fishing may have to be re-examined.

The development of specific management plans for other species is hampered by a lack of data. Little is known of the biomass of Nile tilapia because they inhabit shallow water where they cannot be sampled adequately by trawl or acoustic surveys. Some declines in catch per unit effort have been noted in Uganda (sese boats with gillnets), Tanzania (sese boats with long lines) but more data are needed. The reduction in their since the late
1980s suggests a degree of overfishing and highlights the need to manage this species using mesh size regulations, the protection of breeding areas, and the control of illegal regulating gears that disrupt nests and destroy nests and young fish.

The management of haplochromines has been hampered by a lack of taxonomic knowledge and therefore an inability to separate the stocks. Haplochromines are taken as a by-catch in the dagaa fishery so, possible management measures for that fishery should take haplochromines into account. Fishing in littoral waters can affect specialised species, such as those restricted to rocky habitats, which are heavily fished for bait for long lines targeting Nile perch (Mkumbo and Mlaponi, 2007). There may be a need to control these activities.

The development of fishery-specific management plans is a new concept in Lake Victoria which aims at managing fish species individually, but taking into consideration their biology and ecological interactions. The major focus is on the promotion of sustainable exploitation to achieve effective fisheries management for sustainable development. Therefore, we recommend that species-specific management options outlined above be implemented to reverse the current trend in the Nile perch stocks, the most immediate management issue in the lake.

Acknowledgements

We thank the scientists and managers from the Lake Victoria Fisheries Organisation’s institutes for their advice and provision of data. Special thanks to Prof. Brian Marshall for his assistance in data analysis. In addition, we thank the Lake Victoria Fisheries Organisation, and the EU for funding the surveys through Lake Victoria Fisheries Research Project and Implementation of Fisheries Management Plan project.

References


Lake Victoria’s Water Budget and the Potential Effects of Climate Change in the 21st Century*

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Abstract
This paper presents the Lake Victoria water budget for the period 1950-2004 and findings of a study on potential climate change impact on the lake’s Hydrology through the 21st Century. The mass balance components are computed from measured and simulated data. A2 and B2 emission scenarios of the Special Report on Emissions Scenarios are considered in the climate change assessment. Results show that rainfall and Evaporation by far exceed catchment inflow and outflow. Rainfall over the lake exceeds evaporation by a factor of 0.1 whereas outflow exceeds inflow by a factor of 0.27. Due to climate change, increase in temperature of 4-5°C and 2.3°C are expected by the end of the 21st century under the A2 and B2 emission scenarios respectively. There is very significant downward trend in the lake Net Basin Supply reducing by up to 50% by the end of the Century. Towards the end of the 21st century, the lake is likely to experience more frequent and prolonged droughts implying lower lake levels

Key words: Lake Victoria, Water budget, climate change, emission scenarios.

Introduction
Lake Victoria provides various resources and economic opportunities to about 33 million people living in its basin (in 2004). Over the past four decades or so, the lake has come under increasing pressure from a variety of interlinked human activities such as industrial pollution, eutrophication and sedimentation (Hecky et al. 1993; Muyodi et al. 2005). These pressures have led to a deterioration of the lake’s water quality which is threatening its capacity to provide the benefits enjoyed by the communities. Efforts have been made to reverse this situation through the Lake Victoria Environmental Management Programme (LVEMP) among others. It was realized that any strategy aimed at effective management of pollution to the lake would require a quantitative understanding of the relationship between sources, types, concentration, transportation and effects of pollutants on the lake’s ecosystem. The water budget of Lake Victoria was therefore determined primarily to estimate the loading rates of major pollutants from key sources such as tributaries to Lake Victoria, atmospheric deposition, and contaminated sediments to establish baseline loading rates. It would also be used to evaluate the success of future interventions aimed at reducing pollution of the lake.

Relatively little work has been undertaken to establish the water balance of Lake Victoria. Piper et al. (1986) and Krishnamurthy and Ibrahim (1973) have attempted to determine this balance while other workers have only inferred it from historical records of water levels. These investigations have not benefited from a wealth of recently measured flow fluxes, a factor that could be responsible for a large margin of uncertainties.

This paper presents an updated water balance for Lake Victoria for the period 1950-2004 and is a continuation of the quantification of the lake’s water budget as part of a limnological study of Lake Victoria (LVEMP 2002).

Water resources are very vulnerable to the adverse effects of climate change and variability, and that relatively small climate changes could produce significant impact on water resources (Lins et al. 1991). This paper assesses the impact of climate change on the water balance of the lake and examines the evidence that the climate of the region might change significantly in the 21st century. The way these changes affect the lake’s hydrology and the potential consequences are also discussed. The work of Georgakakos, et al. (2005), on which most of this review was based, is acknowledged.

Methods
Water Balance fluxes

Current knowledge of the Lake Victoria hydrologic system and ground measurements allow for a reasonable estimate of the water budget but there were shortcomings with the measurements from some stations in and around the lake. These included an insufficient length of data, missing data, and fragmented and erroneous records. The computed water balance would be expected to have a large number of uncertainties but these uncertainties have

been greatly reduced by using systematic checks and comparisons with the relatively long time sequences of water levels.

In view of these limitations the objective of this work was to quantify as accurately as possible the components of the water budget for Lake Victoria, particularly the flux terms involving input processes. This work sought to acquire all information relevant to the quantification of each component, develop a method for calculating it and identify the assumptions that must be made to estimate particular components. It is recognised that water budget terms vary temporarily as a result of natural precipitation patterns and variability.

The principle of conservation of mass was used in the development of the water budget and five components of the water balance were identified: (1) rainfall over the lake; (2) inflow from the catchment; (3) evaporation; (4) outflow through the Nile at Jinja and (5) storage. There is an interaction between groundwater and surface water of Lake Victoria but its influence in relation to other water balance fluxes is insignificant (Krishnamurthy and Ibrahim, 1973) and it was therefore assumed to be negligible. Catchment inflow was estimated through rainfall-runoff modelling using the Nedbor Afdronning Modele (NAM) model for the Kenyan and Ugandan catchments and the Soil Moisture Accounting Procedure (SMAP) Model was applied for the Tanzanian Catchment.

Rainfall

Continuous rainfall time series for the period 1950-2004 from selected stations in the catchment and on islands were generated using measurements, correlations with neighbouring stations and the insertion of a ‘typical year’. The selected stations were representative in that they covered the geographical area of the catchments as well as areas with different rainfall characteristics. On average, 2 to 6 stations were selected in each catchment (see Figure 1 for the catchments and rainfall stations used for the computation of areal rainfall). Rainfall records were subjected to vigorous quality control checks including visual examination of raw and plotted data, computed statistical properties, comparison with records at adjacent stations, and examinations of double mass curves.

Figure 1. Catchments and rainfall stations used for computing areal rainfall over Lake Victoria.

A reference station was identified in each catchment and used to fill gaps in the records from other stations in that catchment; the reference station was usually the one with the longest continuous high quality records. A
double mass curve was plotted and a trend line fitted for the subject stations and the equation for that trend line was then used to fill the gaps. For periods when records were missing from both the reference station and the other stations, a ‘typical rainfall year’ method was used, a method that was developed for this work and proved to be successful.

The idea was to fill the rainfall record gaps with data from a ‘wet’ ‘average’ or ‘dry’ hydrological year, running from 1 October to 30 September. The typical years were determined from the rise in lake level during that year with a ‘wet year’ being arbitrarily defined as one in which the lake level rose by 0.2 m or more while a ‘dry year’ was one in which the lake level fell by 0.2 m or more and in an ‘average’ year it fluctuated by ± 0.2 m. Having defined the type of year, the next step was to determine the total annual rainfall for each station during the typical year.

The rainfall over the lake was computed as a weighted sum of records from stations around the lake and on islands. The lake was divided into boxes (Figure 1), with each having a reference station and the mean annual rainfall in each box was estimated from isohyetal curves. The daily/monthly rainfall in each box was then estimated as

\[ R_{\text{box}} = \frac{R_{\text{ref}} \times MAR_{\text{box}}}{MAR_{\text{ref}}} \]

where \( R_{\text{box}} \) = daily rainfall in box; \( R_{\text{ref}} \) = daily rainfall at reference station; \( MAR_{\text{box}} \) = mean annual rainfall in box and \( MAR_{\text{ref}} \) = mean annual rainfall at reference station.

The average daily rainfall for the lake was then calculated as the sum of the areal weighted means of the daily rainfall in the boxes (\( \sum R_{\text{box}} \)) as

\[ R_{\text{lake}} = \sum (R_{\text{box}} \times W) \]

where \( R_{\text{lake}} \) = rainfall over the lake and \( W \) is a weighting factor.

---

**Figure 2.** The location of evaporation stations used for computing evaporation over Lake Victoria.
Evaporation
Continuous evaporation time series were generated using the same methods like that for rainfall records, but with some minor changes. However, the idea of using a reference station was not applied because evaporation is determined only at full meteorological stations, which may be a considerable distance apart. The concept of a wet, average or dry year was also not used but instead the mean estimate for a particular day was used to infill records; for example, a missing station value for say 1st of October of a particular year was in-filled by using mean measurement for 1st October for other years where records were available. Figure 2 shows the evaporation stations used in the computation of evaporation on Lake Victoria. Evaporation over the lake was computed as a weighted sum of records from around the lake and islands within the lake.

Catchment Runoff
River discharges were computed on the basis of rating curves, visually inspected to remove outliers, and measured gauge heights. There are several river-gauging stations, usually located at the confluence of larger rivers, in each catchment in the Lake Victoria Basin. Since the objective was to quantify the inflow to the lake, river discharges at the closest station to the mouth of the river were used wherever possible.

Because the river gauging stations had varying length of records, rainfall runoff modelling was done to extend the flow series to cover the period 1950-2004. The NAM model a, lumped conceptual model from the Danish Technical University was employed on the Uganda and Kenyan catchments. In this model the entire catchment was considered to be a single unit with uniform properties and the flow of water through the system was conceptualized into a number of reservoirs with the parameters partly reflecting the physical characteristics of the system. The SAM model was used for the Tanzanian catchments, because it is best suited for use with monthly data and it, too, is a conceptual model but with simpler structures. Both models were calibrated by adjusting the model parameters by trial and error until the modelled and observed accumulated discharges, peak flows, recession curves and low flows were in agreement. Given that the objective of this study was to quantify the inflow into the lake, emphasis was then placed on the correct simulation of total inflow into the lake rather than the correct simulation of flow peaks.

There are a number of ungaged catchments around the lake, most of which consisting of small rivers and swamps fringing the lake. Other catchments are gauged but their records could not be used either because the period they covered was too short, or they were erroneous or did not represent the entire catchment. Two methods were used to estimate the flows from these catchments: (1) by using one of the two models with the same parameter values from an adjacent and similar catchment, and (2) by using a modified form of the Rational Formula, a standard empirical formula for computing peak flow rates.

Most discharge stations were not at the river mouth and some corrections were necessary to obtain the total discharge from the basin. This was done by (1) increasing the basin discharge by a proportion of the areas i.e. basin discharge = station discharge * (basin area/gauging station area) or (2) applying rainfall runoff modelling to the entire basin. The first method was chosen to compute the final discharge for each river basin since it deals directly with the measured station discharge and the second was only used in cases where several rain gauges were required to cover the ungaged catchment.

Computation of the Water balance
The water balance was then computed as the sum of the inflows (rainfall + river discharges) minus the sum of the outflows (evaporation + discharge to Victoria Nile) and the budget was assumed to be balanced when the difference between inflows and outflows was equal to the net storage of the system. This assumption proved to be effective in reducing uncertainties in the computed flows. The storage term was translated into lake levels and then compared with the measured lake levels at the Entebbe station and correction factors were applied to the various flow components until the predicted lake levels agreed with the observed ones.

Climate Change
Two emission scenarios in the Special Report on Emissions Scenarios (IPCC, 2000) were selected for the assessment of potential impacts of future climate change on the water balance of the lake, on the basis that they represented a wide range of potential emissions in the future. The B2 scenario assumes moderate economic and population growth resulting in moderate cumulative emissions between 1990 and 2100 amounting to 1,164 Gt of carbon. The A2 scenario also assumes moderate economic growth but more rapid population growth and much higher emissions (1,862 Gt C). The final temperature and precipitation sequences for both scenarios were produced for both the lake and the watershed.

This assessment of the impact of climate change on the hydrology of Lake Victoria adopted an integrated approach using global climate models, hydrologic models for the lake and its watershed, and water resources models. The HadCM3 General Circulation Model, a coupled atmosphere-ocean model with a spatial resolution of 2.5 x 3.75 degrees, was used to simulate the response with respect to temperature and precipitation over the lake. Several bias-adjustments were employed before downscaling the model’s monthly temperature and precipitation predictions for use in assessing the implications of future climate change on the lake’s hydrology. The model was calibrated against observed temperature and precipitation over the lake for the period 1961 to 1980 using the Climate Research Unit TS2.0 monthly temperature and precipitation data sets at a resolution of 0.5 x 0.5 degrees. Evaporation over the lake was assumed to take place at climatic potential rate and was estimated using the Malmstrom potential
evapotranspiration rate described by Dingman (2004, cited in (Georgakakos et al. 2005), which was

\[ PET(k) = 40.90611 \exp \left( \frac{17.3(T_{\text{mean}}(k) - 273.16)}{T_{\text{mean}}(k) - 273.16 + 237.3} \right) \]

where \( PET(k) \) is the monthly potential evapotranspiration rate (mm) and \( T_{\text{mean}}(k) \) is the mean monthly air temperature over the lake in degrees Kelvin. The watershed evapotranspiration was computed with the Pike evapotranspiration equation using the precipitation and temperature sequences from the HadCM3 regional model, where

\[ ET = \frac{P}{\sqrt{1 + \left( \frac{P}{PET_0} \right)^2}} \]

where \( ET = \) annual evaporation (mm), \( P = \) annual precipitation (mm), and \( PET_0 \) is the annual potential evapotranspiration (mm).

To facilitate prediction of potential future changes in the water balance, the assessment considered two lake regulation policies: (a) the agreed curve (AC) release policy, where water is released through the Owen Falls Dam according to the natural lake outflow and (b) the energy demand-driven policy (ED) where the quantity of water released is determined by demand for energy.

**Results and discussion**

**The water balance**

The estimated inflows to and outflows from the lake are liable to errors and these were corrected by balancing all the fluxes and comparing the results with the measured lake level during the period 1950-2004. Correction factors were then applied for periods where major discrepancies were discovered. The need for correction could explain the various physical changes – land use change- within the catchment over the last fifty-five years. After these corrections were made there was a reasonably good agreement between the predicted lake level (from the computation of the water balance) and measured level (Figure 3).

![Figure 3. Predicted and measured lake levels at Entebbe, January 1950 to December 2004.](image)

**Table 1.** Average annual water balance of Lake Victoria 1950-2004 (infilled data from LVEMP Database).

<table>
<thead>
<tr>
<th></th>
<th>Flow (m³ s⁻¹)</th>
<th>Volume (km³ yr⁻¹)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gains</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfall</td>
<td>3,719</td>
<td>117</td>
<td>82.0</td>
</tr>
<tr>
<td>Basin discharge</td>
<td>814</td>
<td>26</td>
<td>18.0</td>
</tr>
<tr>
<td><strong>Losses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaporation</td>
<td>3,330</td>
<td>105</td>
<td>76</td>
</tr>
<tr>
<td>River Nile</td>
<td>1,058</td>
<td>33</td>
<td>24</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td></td>
<td>145</td>
<td>5</td>
</tr>
</tbody>
</table>

Evaporation and direct rainfall are the most important factors in the Lake Victoria water budget (Table 1). Rainfall contributes about 117 km³ (82%) of the total inflow and evaporation accounts for 105 km³ (76%) of the losses from the lake. Rainfall outweighs evaporation by a factor of 0.1, but the outflow from the Nile exceeds the inflow from the other rivers by a factor of 0.27. Over time, the annual rainfall nearly equals evaporation implying that the outflow into the Nile was mainly sustained by the watershed runoff. This assertion is further explained by the comparison of the computed water balance components and those earlier estimated by Krishnamurthy and Ibrahim (1973).

**Table 2.** A comparison of the computed water balance from this study (km³ yr⁻¹) compared to that estimated by Krishnamurthy and Ibrahim (1973), abbreviated as “K and I (1973).”

<table>
<thead>
<tr>
<th></th>
<th>K and I (1973)</th>
<th>This study</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inflow</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfall</td>
<td>100</td>
<td>117</td>
<td>17</td>
</tr>
<tr>
<td>Basin discharge</td>
<td>18</td>
<td>26</td>
<td>44</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>118</td>
<td>143</td>
</tr>
<tr>
<td><strong>Outflow</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaporation</td>
<td>100</td>
<td>105</td>
<td>5</td>
</tr>
<tr>
<td>River Nile</td>
<td>23</td>
<td>33</td>
<td>43</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>123</td>
<td>138</td>
</tr>
</tbody>
</table>

Table 2 shows the percentage difference between the computed water balance and earlier estimates. The basin
discharges increased by 44% while Nile outflow increased by 43%, and the total gains and losses only differ by only 3.6% which is within experimental error. The significant discrepancy between the basin discharge and Nile outflow can be explained by (i) a 17% increase in rainfall; (ii) the impact of deforestation in the 30 years between the two studies, which leads to an increase in runoff because there is no vegetation to retain water, thereby affecting the quantity and timing of runoff to the lake; and (iii) changes in the lake release policy in the last decade of the assessment period.

Long-term fluctuations (1950-2004) exhibit a 5-6 year cycle of water level maxima (Figure 4) which agrees with the conclusions in Temple (1969) but a review of Net Basin Supply (NBS) revealed a 10 year cycle of maxima for the period 1900-2003 (Songa and Sewagudde, 2007). The NBS (rainfall + runoff - evaporation) is a critical determinant of the lake’s level and ideally it maintains a relatively stable level and volume of water. The most variable annual precipitation over the period 1950-2004 occurred in 1961-1964 and again in 1997-1998, with elevated rainfall totals attributed to the El Niño Southern Oscillation. In 1961-64 the average rainfall reached 130 km³ (1900 mm) which is 11% above average and this led to a significantly greater discharge (about 68% above average) from the rivers. As a result the lake level rose by 2.4 m over a period of four years, an enormous increase given the size of Lake Victoria (68,800 km³). Similarly in 1997/98 the rainfall increased by only 10% but river discharges increased by about 80%. The higher river discharges in 1997/98 despite the same rainfall increase as in 1961-64 further confirms the effect of deforestation in the watershed as earlier explained.

![Figure 4](image_url)  
**Figure 4.** Historical variations in the mass balance components for Lake Victoria, 1950-2004. Data from LVEMP

![Figure 5](image_url)  
**Figure 5.** A comparison of the monthly discharge (m³ s⁻¹) from the Kagera River and some major rivers flowing from Kenya.

The Kagera River is the largest river flowing into Lake Victoria and it normally contributes about 37% of the total inflow to the lake, although it was reported to have contributed about 63% in 1969 (WMO, 1974). There is some seasonal variation in the inflow from the catchment with the rivers flowing from the Kenyan highlands having their peak flows from about May to August while the Kagera, which rises on the Rwandan highlands reaches its peak flow in May, although its base flow remains above that of the other river flows (Figure 5). The Uganda catchments contribute insignificantly to the lake inflow.

The outflow from the lake through the Victoria Nile and the level of the lake are linked through a mathematical equation known as the agreed curve. It was first developed from the flow over the then Lake Victoria control (Ripon falls) before the construction of the Owen Falls dam. The outflow is presently being controlled by the Naalbale-Kiira hydropower complex. The agreed curve was followed consistently until 1998 when there was a deviation (Figure 6) caused by heavy rains in 1997/98 which were a result of the El Niño southern...
oscillation. At this time the release of water through the Owen Falls Dam was reduced in order to ease flooding downstream in the Lake Kyoga region and, as a result, there was excess storage with the lake elevation being 0.1m above the expected water level.

From June 2000 onwards the water released at Owen Falls exceeded the agreed curve to meet the demand for hydropower and for a few months this water was drawn from storage attained during the heavy rains in 1997/98. This storage was depleted by July 2001 and the water was then being drawn from the ‘natural’ lake storage leading to a slight decline in water levels. The situation was exacerbated by persistent droughts in the region between 2003 and 2006, which meant that the actual net input to the lake was reduced by about 50% (Songa and Sewagudde, 2007).

![Figure 6. The relationship between the Nile discharge (m$^3$ s$^{-1}$) and the elevation of Lake Victoria (m above sea level). From the Directorate of Water Resources Management database.](image)

**Potential impact of climate change on the water balance**

Temperature plays an important role in the water balance because it drives evaporation and both the A2 and B2 climate models suggest that temperatures in the region will rise in the 21st century (Figure 7). The temperature trend between A2 and B2 scenarios increases with the same slope up to 2040 when they start to diverge conspicuously. Both trends continue to increase but temperature under A2 increases at a greater rate. In the last two decades of the 21st century, the trend in B2 tends to taper off. According to the A2 climate change scenario, the average air temperature over the lake and its watersheds is expected to increase by 4 to 5 degrees Celsius by the end of the 21st century compared to present conditions. The corresponding temperature increase for the B2 climate scenario is about half.

![Figure 7. Predicted temperature variation over the lake in the 21st century (from Georgakakos et al., 2005).](image)
Figure 8. Changes in rainfall, evaporation, runoff and net basin supply (NBS) in Lake Victoria under the Future Climate Assessment A2 Scenario (lines are annual moving averages). NBS = net basin storage. From Georgakakos et al. (2005).

As a direct consequence of the increase in temperature, evaporation over the lake will increase steadily (Figure 8) but up to 2025 evaporation and rainfall balance out just as they did in the historic past. Beyond 2025 evaporation is predicted to increase steadily and by the end of the century it could exceed rainfall by 20 billion m$^3$ yr$^{-1}$ (20 km$^3$). The mean annual lake rainfall over the lake will oscillate about the historical long-term mean throughout the century with neither a positive nor a negative trend (Figure 8). This assertion is valid for the first six months of the year where the HadCM3 exhibits commendable rainfall prediction skills but a rainfall trend could still develop as a result of rainfall variability during the last six months of the year in which the model shows weak prediction and some climate predictions have forecast increased rainfall over the region (Tate et al. 2004). Runoff from the catchment also exhibits a mild downward trend as a consequence of evaporative losses resulting from increased temperatures. Mean runoff reduction is not expected to exceed 5 to 10% of the present catchment discharge by the end of the century.

Figure 9. Current and predicted levels of Lake Victoria under the Agreed curve policy up to the end of the 21st century. Adopted from Georgakakos et al. (2005). The broken horizontal lines indicate the historical maximum and minimum values.
Net basin supply is a critical indicator as it maintains lake levels and supports all other water uses, and predictions suggest that there will be a significant downward trend in the net basin supply over the next century. The NBS is expected to fall by about 50% (20 billion m$^3$ yr$^{-1}$) by then and this will have severe consequences for the lake and its ability to meet the region’s water needs. The NBS series indicates a significant increase in the frequency of extreme droughts and so, towards the end of the 21st century, NBS will be negligible or even negative from time to time as a result (Georgakakos et al., 2005). Thank Mr. Agey Keye for is effort in reorganising the data into a standard format.

References

Conclusion
Rainfall and evaporation are the major players in the water balance of Lake Victoria. The large size of the lake acts as a buffer to abrupt sharp changes in water levels on an annual basis as long as the agreed curve policy is followed. However, the lake level changes significantly when rainfall over the lake is consistently above or below normal for a couple of consecutive years.

Climate change is likely to cause increase in both lake evaporation and catchment evaporation as a direct response to temperature increase. Consequently catchment runoff will reduce as a direct response to increased evaporation. However, lake rainfall is likely to fluctuate about the historical mean level. Increased evaporation and constant rainfall will imply reduced net basin supply, leading to more prolonged droughts and reduced wetland area. If the agreed curve water release policy is followed throughout the 21st century, the lake level is likely to fluctuate about the historical optimum fluctuation band under the B2 emission scenario, but reduce below the lowest optimum level under the A2 scenario. With reduced net basin supply, the ability of the lake to meet its regional water needs such as hydropower supply, irrigation needs, fisheries water requirements, etc. will be greatly hampered.

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Climate Change and Fishery Sustainability in Lake Victoria*

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Abstract
The fisheries of Lake Victoria have recently undergone rapid ecological and social change. Loss of diversity in terms of species richness and economic opportunity has increased the system’s vulnerability to additional economic, ecological, and social stressors predicted with future climate change. This paper discusses the fisheries of Lake Victoria as a complex adaptive social-ecological system and summarises the recent literature on the impacts of climate change on the Lake Victoria Basin. Possibilities for reducing vulnerability and enhancing adaptive capacity in the basin are discussed. The paper concludes that the Lake Victoria Fisheries Organization is uniquely able to address present and future sustainability challenges, but that a re-examination of the sustainability goals of fishery may be appropriate.

Key words: Social-ecological systems, resilience, adaptive capacity, vulnerability, localisation

Introduction
The fisheries of Lake Victoria have undergone rapid ecological and social change in recent decades. Climate change, the still rapid growth of the human population and continued dependence on Nile perch for export, regional and local markets all threaten to exacerbate the ongoing depletion of the Nile perch fishery. In this paper the fisheries of Lake Victoria are discussed as a social-ecological system, the predicted impacts of climate change on the basin are reviewed, and the concept of localisation as strategy to reorient societies around the sustainable local production of food, energy, goods, and governance is introduced.

Lake Victoria as a social-ecological system
The future of Lake Victoria is uncertain. Will current management regimes be able to avoid the collapse of Nile perch stocks? How will shifting climate patterns impact the ecosystem functioning of the basin? Will the presently high rates of human populations continue into the future? What is clear is that the future health of Lake Victoria and the more than 30 million people who live around the lake is determined by virtually innumerable social and ecological forces at local, national, regional and international scales. The Nile perch export trade itself is influenced by socio-cultural, economic, political and ecological forces at multiple scales, such as fishing practices, the demand for fish, concerns for fish quality, the need for foreign exchange, the effectiveness of management regimes, the health of the ecosystem and the potential impacts of climate change. Still, the Nile perch fishery, while the most important export fishery, is but one component of the Lake Victoria Basin system as a whole.

Conceptualizing Lake Victoria as a social-ecological system (SES) that is complex and adaptable is a useful framework for analysing the many complex social and ecological dynamics determining the health of the basin as a whole. SESs are complex adaptive systems in which social-ecological factors interact at multiple scales across both time and space (Janssen and Fawange, 2006). Change in an ecological dimension of the basin can invoke subsequent change in one or more social dimensions of the system and vice versa. For example, ecological conditions such as stratification, rising water temperature, and shifting species composition interact with social factors such as fishing effort (which is in turn influenced by the demand for fish, the availability of alternative livelihood strategies, and the effectiveness of management efforts) to influence the quantity, quality and value of fish landings. At the same time, the lake and its watershed are central to the survival of tens of millions of people, hundreds of species of aquatic life and provide renewable forest, wetland, and aquatic resources. These complex social-ecological interactions influence the health of the Lake Victoria Basin and are simultaneously

a source of opportunity and growing concern for sustainability at multiple temporal and spatial scales.

Conceptualizing the fisheries of Lake Victoria complex adaptive SES is a step towards a more holistic, ecosystem-based approach to fisheries management in the basin that considers humans to be a part of “the environment.” It also provides a framework for identifying and prioritizing the components of a sustainable future for Lake Victoria, given the potential negative and uncertain impacts of climate change.

Climate change and the Lake Victoria basin

The negative impacts of climate change will increasingly be felt in the waters and on the shores of Lake Victoria. Inter-annual and inter-seasonal variability in rainfall and temperature could affect the survival of aquatic life, increasing the variability of fish catches, while uncertain agricultural yields inland may bring new entrants into the fishery each year. The ongoing influx of political and environmental refugees into the basin and the fishery are likely to increase under all climate change scenarios (Myers, 2002; Awange and On’Gan’ga, 2006).

Detailed studies integrating potential biophysical, ecological and social impacts of climate change have yet to be undertaken, but climate scientists have identified general trends and made predictions about the basin-wide impacts of climate change. The recent application of climate change models to the basin by Sabiiti (2008) suggests that rainfall and temperatures could increase up to 2030, but some microclimates will experience decreasing rainfall and night-time temperatures. Hydrologists applying climate change scenarios to the water balance of the lake predict a fall in lake levels by 2030 and a subsequent rise by 2080 (Tate et al., 2004). Recent falls in lake levels illustrate these predictions, suggesting that some models may be too conservative. These fluctuations will not only affect ecological and biophysical processes in the lake, but will also have serious implications for human health with respect to disease outbreaks and the availability of adequate quantities of potable water.

In addition to the declining availability of freshwater, climate change will increase waterborne and vector-borne diseases such as cholera and malaria. A 2006 report coupled climate parameters (precipitation and temperature) from 1978-2002 with hydrological characteristics of the Yala River and related them to outbreaks of cholera. The analysis showed that high peak river flows, occurring predominately in El Niño years, coincided with cholera epidemics resulting in rates of mortality and morbidity several orders of magnitude higher than hygienic cholera episodes (Wandiga, 2006). Additionally, as the severity of storm events increase as predicted under future climate change scenarios, it is likely that the influx of phosphorus-rich sediments into the lake will also increase. This increased nutrient loading will likely exacerbate ongoing eutrophication and decreasing oxygen availability in the lake, providing additional stressors to social-ecological life in the basin (Hecky et al., 1994; Stone and Bohannon, 2006).

While climate change science and modelling in the basin are still conducted at relatively coarse scales, it is clear that the basin is vulnerable to the impacts of climate change. More frequent extreme weather events and unpredictable rainfall patterns will continue to threaten human security in already vulnerable basin communities. Such considerations must be brought into natural resource policy and management, especially in fisheries, to ensure a sustainable future for the Lake Victoria Basin.

Conceptualising change in social-ecological systems

Scholars and professionals addressing climate change in SESs have developed useful heuristics to guide the sustainable management of these systems. Two of the most relevant to Lake Victoria's fisheries include vulnerability and adaptive capacity. When faced with uncertainty minimising vulnerability and enhancing adaptive capacity are essential for fostering sustainability in these systems.

Vulnerability, according to the Intergovernmental Panel on Climate Change, is the “degree to which a system is susceptible to injury, damage, or harm.” (Ahmad et al., 2001). Vulnerability to climate change is context specific (Adger and Kelly, 2005), with some groups of people, places and species more vulnerable to change than others (Adger et al. 2003). In the Lake Victoria Basin vulnerability has both ecological and social dimensions. Ecologically, declines in the production of ecosystem services, including the availability of potable water and species diversity, makes the system more vulnerable to changing climatic conditions. Socially, the lack of adequate educational and social services, gender discrimination and lost bargaining power in the fish trade exacerbate vulnerability. Additionally, technological factors form a subset of the social dimensions of vulnerability. For example, the reliance on fossil fuels in the Nile perch fishery and the lack of adequate sanitation and transportation infrastructures combine with other social factors to potentially compromise future sustainability.

According to Young et al. (2006) globalisation may also increase vulnerability to climate change. Communities highly dependent on income generated from a single export commodity, such as Nile perch, are more vulnerable to change than more economically diversified communities. The latter are better able to alternate production and livelihood strategies in response to social or environmental change. These forms of vulnerability combine to increase sensitivity to climate change as well as changes in the global fish trade such as fluctuating market and transportation costs. Understanding how and to what degree SESs adapt to minimize or increase vulnerability is key to managing the system towards sustainability.

Adaptive capacity is another concept used to understand change in SESs. It refers to the ability of SESs to adjust to actual or anticipated climate-driven threats to enhance the integrity of the system. According to Folke et al. (2005) “systems with high adaptive capacity are able to reconfigure themselves when subject to change without significant declines in crucial functions of the social ecological system”. This does not imply that it is always desirable for a system to maintain its current state when
presented with change, but rather that the ecological and social components of a system with high adaptive capacity are able to adjust to experienced changes without severely reducing the services the system provides. SESs with high adaptive capacity are thought to be characterised by high levels of genetic and biological diversity and are managed by formal and informal social institutions that learn and store knowledge, are flexible and balance power among interest groups (Peterson et al., 1998; Scheffer et al., 2001; Brooks et al., 2005). It follows that the ability to diversify livelihoods, as well as species composition, is vital for local welfare and for increasing adaptive capacity.

Defining what these crucial social-ecological functions are is an important step towards conceptualising and managing towards sustainability. Should the primary function of Lake Victoria be defined as consistent exports of Nile perch? Should another be the promotion of vibrant local and regional markets for fish? Are these two incommensurable? The answers to these questions must come from the system’s stakeholders. Those analysing stakeholder input must also remember that stakeholder opinions may be as diverse as the options available, while also recognising that all stakeholders do not have the same ability to influence policy and management outcomes to meet their needs. Less powerful stakeholders are no less important than more influential ones to the long term sustainability of the fisheries of Lake Victoria.

**Conceptualising change in Lake Victoria’s fisheries**

Much of the effort in understanding how social-ecological systems adapt to change has focused on identifying thresholds or tipping points that, once crossed, can change the system from one type to another for better or worse. Holling (2001) provides a visual representation of this cycle with respect to what he calls potential and connectivity (Figure 1). Potential represents the number of “alternative options for the future,” while connectivity determines the “degree to which a system can control its own destiny”. The movement of the cycle alternates between “long periods of slow accumulation and transformation of resources (from exploitation to conservation, or r to K)” and “with shorter periods that create opportunities for innovation (from release to reorganization, or Ω to α)”.

![Figure 1. Conceptualizing Change in Lake Victoria as a Social Ecological System 1950’s-2000. Adapted from Holling (2001).](image)

In the case of the fisheries of Lake Victoria the introduction of Nile perch in the 1950s and 1960s moved the once multi-species fishery from a long period of conservation (K) to a period of rapid release (Ω) (Figure 1). As a result of Nile perch predation on the haplochromine cichlids, the system moved through a period of reorganisation (α) into the primarily three-species fishery of today. Throughout the 1980s and mid-1990s the system was able to sustain fishing pressure up to 500,000 tons per year and the development of the
Nile perch export industry, while moving from (r) to (K). The reorganisation of the fisheries of the Lake Victoria Basin from a local and regional fishery to the largest source of exported freshwater fish in Africa shortly after the Nile perch began to dominate catches is testament to the past adaptive capacity of this system. Today, management of the fishery is focused largely on maintaining Nile perch exports, keeping the fishery in the conservation (K) phase and avoiding a complete transformation of the fishery at (Ω) and subsequent reorganisation at (α). While sensible, given the need for foreign exchange, income-generating activities in the basin and the priorities of international donors, it is possible that even recent efforts to reduce illegal fishing in the lake will be not enough to sustain a fishery dominated by Nile perch into the future.

The Nile perch fishery of today is unsustainable at (K) for a variety of ecological and social reasons, and is likely moving towards a release phase. If recent increases in fishing effort continue, the system will likely reach a new tipping point, moving the cycle back into the release (Ω) and reorganisation phases (α), creating a very different fishery. The threshold will likely be reached in the near term if demand for and harvest of adult and juvenile Nile perch continues at current levels. Presuming that fishing effort is effectively controlled, a long term transformation may still be likely in response to the additional multiple environmental stressors such as as silitation and eutrophication, an increasing human population, and rising and falling lake levels and, temperature increases resulting from climate change.

Predictions of change in biomass made by an ECOPATH/ECOSIM model reflect similar future conditions (Matsuishi et al., 2006). They show that adult and juvenile Nile perch populations will continue to fall substantially, while haplochromine and Nile tilapia populations are likely to rise. At the same time, they showed that catch per unit effort declined from over 140 kg of Nile perch per boat per day in 1989 to under 40 kg per boat per day in 2000. While these transformations will negatively impact the export-oriented Nile perch fishery, they may have substantial benefits for fish consumers within the basin as new species emerge for local markets.

Reducing vulnerability and enhancing adaptive capacity in the Lake Victoria basin

Reducing vulnerability and enhancing the adaptive capacity of Lake Victoria as a SES is essential for coping with future climate change. Potential strategies to do so include: protecting and enhancing biological and occupational diversity, reducing pollution, reducing gender disparities, accounting for the social and environmental externalities of Nile perch exports, re-examining the focus on Nile perch exports as an indicator of SES health, and even reducing dependency on Nile perch exports. One strategy alone will not adequately address the future problems of climate change. Approaches to reduce vulnerability and enhance adaptive capacity must be implemented holistically as part of a suite of adaptation strategies. The Lake Victoria Fisheries Organisation, with a history of basin wide collaboration and commitment to co-management is well suited to plan for and implement adaptation strategies in the basin.

Scholars studying adaptation to climate change in Kenya and Tanzania believe that occupational and biological diversity is essential if adaptive capacity is to be increased (Eriksen et al., 2005). Strengthening the value of biodiversity through promotion of a multi-species fishery, valuing other species for their economic value and their ecological and local nutritional value may reduce vulnerability by increasing local food sources and reducing dependency on Nile perch exports. Contrary to present management strategies, allowing the continued harvest of juvenile Nile perch may be the best way to accomplish this goal. Another is to reduce inputs of pollution into the lake, given that untreated effluent from industry and municipal sanitation is a potential driver of ecological change in the fishery and may have significant human and ecological health impacts. Effluents from mining and other industrial activities such as the fabrication of batteries, metals, corrugated iron sheets, and pharmaceutical, beverage and tannery production can also have substantial impacts on the health of wetlands in the basin (Muwanga and Barifijo 2006). Recent calls for an “Environmental Police” around the basin is a promising sign that toxic pollution is beginning to garner the attention it deserves.

Recognising and working to reduce gender disparities in the fishery is another component of a multifaceted adaptation strategy. While there are some inspiring examples of women profiting from the Nile perch export fishery, many women in fishing dependent communities have been marginalised by the industrialisation of the fishery as they have also been through the industrialisation of other resource bases. As artisanal processing and trade in the pre-Nile perch multi-species fishery was replaced partly by industrial processing and export of Nile perch women were excluded from the monetary benefits of the fishery (Geheb et al., 2008). Encouraging profitable alternative livelihoods for women, as well as men, is one way to reduce these gender disparities, as is increasing female representation in governance institutions. In my fieldwork I have observed that fishing communities with local female and male leadership appear to have lower rates of domestic abuse and prostitution than fishing communities with only male leadership. Enabling women to become local economic and political leaders alongside men should be an integral part of any strategy to address climate change in the basin.

Increasing the per kilo value of Nile perch exports by accessing duties on exports and pursuing fair trade and/or sustainability certification are additional strategies to manage towards sustainability in the fishery. Despite the increasing global demand for seafood and decreasing supply of Nile perch, consumers in Europe, Asia and the Middle East receive Nile perch at artificially low prices, in part because Nile perch is easily replaced by other whitefish, such as farmed basa (Pangasius bocourti) and tilapia from Asia. Foreign consumers do not pay for the externalities associated with consumption of Lake Victoria Nile perch, including the social-ecological impacts of an already depleted fishery and the transfer of
nutritional value from potential basin-based consumers to comparatively wealthy consumers of exported fish. At the same time, most Nile perch-exporting nations, due to the African and Caribbean Free Trade Agreement, are unable to access duties on Nile perch exports to fund fisheries science and management in the basin, as well as other economic development priorities. Actively pursuing the assessment of duties on Nile perch exports and a “fair trade” fishery (as GTZ is experimentally implementing in several beach management units in Tanzania) are two ways to internalise some of these externalities in the prices consumers pay for Nile perch abroad.

These externalities can also be addressed by reconceptualising the way the fishery is valued and oriented. The Nile perch export fishery has indeed contributed to economic development in the basin, but has been accompanied by many well-documented negative ecological and social impacts (Ogutu-Ohwayo, 1990; Witte et al., 1992, 1999; Abila and Jansen, 1997). According to many fishermen around the lake, these negative impacts outweigh the positive benefits of the Nile perch export fishery. With the looming problems of climate change, population growth and continued illegal overfishing, it may be time to re-examine the focus on Nile perch exports as the primary indicator and driver of social, ecological, economic health in the basin. Local access to the nutritional and economic benefits from a multi-species fishery may actually better meet the sustainability goals of a larger number of stakeholders in the basin than the maintenance of a three species fishery dominated by the exported Nile perch.

Food systems around the world are beginning to reorient themselves away from global food sources towards local production, processing and consumption in response to concerns over the long term unsustainability of the global food trade. As transportation costs and awareness of the links between the global food trade and climate change rise, production and consumption of local food has also increased. This shift, while in its nascent stages, is accompanied by steps towards sustainable local food, energy, goods, and governance sources - what some scholars are calling localisation (Hines, 2000). A “localised” Lake Victoria would not mean completely halting the Nile perch export trade, but would bolster already active local and regional markets to ensure that the lake’s fisheries are meeting the needs of East Africans first and global consumers second. The Lake Victoria Fisheries Organisation and Lake Victoria itself with its recent shift towards co-management are well suited to promote localisation, prioritise local economies and support sustainable livelihoods in the basin, in turn reducing vulnerability and enhancing adaptive capacity in the basin.

While the global demand for seafood continues to rise, with the UN predicting a 40 million metric ton global seafood deficit by 2030, so does local demand for fish (FAO, 2009). Household surveys (n = 130) administered in Mwanza, Tanzania in the summer of 2007 show that 79% of all households consumed less fish in 2007 compared with 2002, with 70% of those 79% consuming much less fish in 2007 than 2002. Most respondents gave the rising price of fish as the reason for this decrease in consumption, and stated that they were unable to substitute fish for other animal protein sources such as beef or chicken. A recent study conducted in Western Kenya found that almost 50% of all children under five suffered from stunted growth, yet another impact of the fish deficit (Bloss et al., 2004). While the Nile perch export trade is certainly not the only cause of this deficit, it does play a role in limiting local availability of fish.

Recently, the illegal trade in undersized juvenile Nile perch has emerged to meet this local demand with clear consequences for the sustainability of the Nile perch export trade as it is known today. Despite recent efforts to control illegal fishing, the unmet demand for fish protein and the lack of alternative livelihood strategies in the basin are likely to continue to drive illegal fishing efforts and so reducing already dwindling Nile perch stocks (as suggested in Figure 1). At the same time, species once thought to be extinct are re-emerging (Baliwra et al., 2003), providing an opportunity to strengthen the local fish trade and improve human health in the basin.

Localisation is one promising and proactive strategy to increase adaptive capacity and reduce the vulnerability of this system to climate change by fostering ecological and economic diversity. Allowing local and regional markets to flourish legally may help empower women, the primary processors and traders of locally consumed fish, while providing substantial nutritional benefits for many of the 30 million residents of the basin. Increased local processing, trade and consumption of the fish harvested from Lake Victoria will have local economic multiplier effects that may outweigh short-term reductions in foreign exchange earnings. With the commitments made by Uganda, Kenya and Tanzania to collaboration, cooperation and co-management and the scientific and policy expertise of the Lake Victoria Fisheries Organisation, a more basin-based fishery can be fostered in order to reduce vulnerability and increase adaptive capacity to ongoing climate change.

References


Re-configuring Poverty: The Wickedness Perspective*

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Abstract

Alleviating poverty in small-scale fisheries requires a clear understanding of what poverty means. On the whole, different perspectives and strategies have been used to understand and address poverty. These strategies have been grounded in an understanding of poverty as a straightforward economic problem. Moreover, a number of these strategies and perspectives have one way or another been grounded in the understanding that poverty has to do with low incomes and expenditure. However in reality, poverty presents itself as a more complex problem. This paper, therefore, explores an understanding of poverty that goes beyond the income-expenditure nexus. Based on empirical information from Lake Victoria Tanzania, the paper discusses two issues, first, that poverty should be understood from an ecological, social and institutional context and secondly, that poverty alleviation involves a dilemma and a wicked problem.

Key words: Poverty, small-scale fisheries, poverty, wicked problems, happiness, value pluralism, Lake Victoria

Introduction

Poverty is multifaceted and multidisciplinary (Béné, 2003; Hulme and Toye, 2006) but incomes and expenditure have been used with increasing precision as the measure of global poverty. Fundamentally, these perspectives dominate research and leading institutions that focus on poverty, such as the World Bank and the IMF (Maxwell, 2001; FAO, 2005; Hulme and Toye, 2006). Incomes and expenditure have provided a simple categorization of people into one of three groups: poor, middle-class, or rich and governments of poor countries have been drawn into the income-expenditure paradigm as a fundamental way of thinking about poverty (URT, 2005; Research and analysis Working group, 2005; Rwanda, 2007).

The problem of poverty reaches way beyond just incomes and expenditure, a reality that has gained more recognition in recent years and changed the perspectives of several global institutions. For instance, the United Nations Development Program identifies poverty with the lack of opportunities and choices most basic to human development will lead to a healthy and creative life where people can enjoy a decent standard of living, freedom, dignity, respect, and self-respect (UNDP, 1997). The Organization of Economic Cooperation Development recognizes poverty as encompassing different dimensions of deprivation that relate to human needs, among them food consumption and food security, health, education, rights, voice, security, dignity, and decent work (OECD, 2001). The International Labour Organization (ILO) perceives poverty as a basic needs issue; UNICEF perceives it as a rights-based issue; and Medicins du Monde of France (MDM) perceives it as a social exclusion issue. Additionally, some authors have argued that poverty is a gender (Agarwal, 1985), environmental (Leach, Mearns & Scoones, 1995) or livelihoods and human development issue (UNDP, 2000). These diverse interpretations illustrate the point that poverty is a complex concept and daunting problem.

The complexity of the poverty problem is evident in certain societies, such as small-scale fishing communities, which utilise marine or freshwater natural resources of high value that generate incomes above the poverty line (1.25 US$ per day) and provide employment and food to the people in these communities (FAO, 2005). A deeper analysis reveals, however, that these people remain among the poorest and most vulnerable sections of the population. The problem, therefore, is to understand the reasons behind this reality and what poverty means in such communities. That is, if incomes alone cannot be used to understand poverty among small-scale fishers then poverty must be analyzed from a different angle. Why are

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people poor in a situation when they have natural resources that can potentially provide a decent standard of living? This paper aims to move the discussion beyond the income-expenditure nexus and provide a broader perspective on poverty. It begins by examining how images (Kooiman et al., 2005) have shaped understanding of the poverty problem and notes that people writing about poverty were influenced by those images. Indeed, the understanding of poverty seems to have been influenced by what was going on in the so-called developed nations where the poor could be readily identified by measures such as income, employment and or work, exclusion, and dependency, among others. But in some underdeveloped nations, especially at the community level, these measures of poverty have different meanings and identification of the poor remains problematic; in these nations, poverty alleviation presents itself as a dilemma which can best be thought of as a “wicked problem” (Rittel and Webber, 1973; Jentoft and Chuenpagdee, 2009). Using data from the Lake Victoria fisheries in Tanzania, this paper explores the wicked problem perspective, and argues that income does not provide an adequate measure of poverty in the fishing communities around the lake. In this case, the poverty problem begs for a re-configured analysis and solution and the discussion of poverty alleviation should not be focused on simplification and a universal application of the definition of problem.

Understanding poverty

The need to alleviate poverty, which has long been a concern among scholars, policy-makers, governments, and others, depends on a clear understanding of what poverty is. Those responsible for dealing with it must first have a clear understanding of what they are dealing with, which is easier said than done, especially when it comes to problems as complex as poverty. Poverty has been of concern since the nineteenth century (Katz, 1990; Hyatt, 2001) but understanding it has been challenging. Discussions of what poverty is and its causes have been largely shaped by the images dominating at different periods of time and the ways people involved in the poverty problem debate have been influenced by them.

This paper does not provide a chronology of when these images appeared but focuses on how some of them have shaped the understanding of poverty. Such images are built on ideas such as liberalism, free markets, the welfare state, progressive reform, structural adjustment programs, and empowerment, among others. As a consequence, two distinct lines of argument can be drawn in the understanding of poverty. First, there was the argument that the poor were themselves responsible for their “pathological habits and lifeways” (Hyatt 2001), a line of thinking that led to what Lewis (1963) called the “culture of poverty”. The second line of argument contested this notion and argued that the poor were led into such a life by external factors and therefore poverty alleviation required intervention by the government or some other external agent (Hyatt 2001).

The individualistic perspective

The argument that the poor are responsible for their life ways is based in liberalism which has become a radical ideology since the 17th century. The ideology of liberalism was intended to create self-reliant, “free” individuals (individual liberty) released from the grip of traditional political constraints. Liberalism, with its origin in both Europe and North America, was founded on the belief that individuals possessed a natural rationality and inclination for self-governance. This focus on self-reliance expected that social progress would manifest itself in a higher form of morality in individuals who practiced self-sufficiency and goodwill, as opposed to competitiveness and self-interest, and the poor would be morally rehabilitated into sober, law abiding, socially responsible, and self-reliant citizens (Bracking, 2005).

Lewis’s “culture of poverty” appears to accept this fundamental principle of liberalism. Indeed, when writing about peasants in a Mexican city and the Negroes of the United States, he appears to have been convinced that “one of the most disabling features of poverty was the predominance of a social or anti-social behaviour” (Hyatt 2001). To him, the poor demonstrated behaviours and attitudes that assured a continuation of their poverty or, in other words, they remained poor because of their adaptations to the burdens of poverty (Lewis 1998).

This presented the poor as having a distinct culture in their way of life but Katz (1990) argued that this culture did not focus on the poor as such, but rather categorized them as belonging to “a class of people whose behaviours and values converted their poverty into an enclosed and self-perpetuating world of dependence”. This culture, as it appeared, “could persist even without the immediate deprivations caused by modernization, class and race” (O’Connor, 2002). The poor were, therefore, considered to be free individuals who chose how to live their lives, independent of any outside influence. In this way they were held responsible for their poor condition and way of life.

By focusing the study of poverty on the poor themselves, rather than the systems that created conditions of poverty, social researchers developed an interest in understanding the culture of the lower class. In fact, the debate on lower-class culture reflected in the post-World War II attitude to human rights now enshrined in a new global order greatly influenced thinking in the social sciences about the poor. The distinctions were observed in the following: the political economy of affluence, which led to the notion of America becoming a classless society with a small group of the poor; post-war institutionalisation of behavioural sciences which encouraged the psychological emphasis in research on class and race; the resurgence of the middle-class and the rise of poverty as a global political issue (O’Connor, 2002). These changes disturbed social scientists of the time, including Oscar Lewis, who introduced the idea of the culture of poverty into their thinking. These arguments led some anthropologists to conclude that he took the view that the poor were responsible for their own predicament and deficiencies but ethnographers contested this perspective (Hyatt 2001).

The structural perspective

Arguing against the notion that poor societies presented themselves as having low levels of social
organization, some social scientists believed that they actually had a very complex social organization (Hyatt 2001). This conclusion was based on studies of a number of groups (which they considered poor) such as “street corner men” (Anderson, 1976, Hamner, 1969, Suttles, 1968 and Whyte, 1943 quoted by Hyatt 2001), gangs (Keiser 1969 cited by Hyatt 2001) and the role of extended kinship and friendship networks among women (Aschenbrenner 1975; Stack 1974; Susser 1982, 1986, 1988 quoted by Hyatt 2001). The complex social systems found among these poor groups indicated that they were not victims of their own deficiencies and the cause and sustenance of their poverty was thought to be externally driven. It was argued that government programmes of providing aid to the poor stripped them of their abilities and capacities for self-reliance, leaving them incapable of taking responsibility for their actions (Hyatt 2001).

To these social scientists, government welfare programs such as the Action Program and Model Cities Program in the United States of America that guaranteed direct assistance and cash benefits to the poor left them dependent and were not truly helpful in addressing the poverty problem (O’Connor, 2002). They argued that poverty alleviation required social programmes that encouraged self-reliance, managerial and entrepreneurial skills, and an environment that fostered dependence on innate abilities rather than government support (Hyatt 2001).

Another view of government interference can be seen in its establishing an environment for vibrant institutions, specifically in the institutionalisation of the world economy, which has shaped societies and lives more deeply and radically than people realized. Barth (1997) argued that the world economy had become institutionalised to such an extent that anthropologists would find it difficult to use anthropological insights to analyse any situation. He gave an example from the Lake Victoria fisheries which, at the time of writing, was an economic success story as far as the Nile perch export fishery was concerned, but this economic success was not matched when it came to the welfare of the lakeside populations. His argument was that the pursuit of an ‘economistic’ idea of progress and development by the governments around the lake led to poverty among the local populations through eliminating life-sustaining practices, arrangements and balances.

This perspective approached poverty from the assumption that poverty is reduced as incomes and expenditure rise. This proved not the case in the Lake Victoria fisheries where there was increasing poverty together with increasing wealth which meant that the government’s role in the globalised Nile perch market had the effect of perpetuating poverty rather than reducing it (Barth 1997). External interference can also be seen through the advocacy of empowerment, which revolves around creating room for the less privileged in society (the poor) to have a voice in decision-making that affects their lives. A notable theme in these efforts is the idea that the poor have not been organised because they are unable to organise themselves so they have to be assisted in doing so. In some instances, empowerment has been implemented through management regimes or mechanisms that do not take local conditions into consideration (Onyango and Jentoft, 2007). Examples of empowerment mechanisms in fisheries include—co-management regimes, community-based management, precautionary approaches to ecosystem management, and the concept of Marine Protected Areas.

Some level of assistance could be given to these poor populations (taking into account the nestedness of social relations and interdependence within the society), but they are not devoid of abilities or capabilities and probably have many skills that are not obvious. One problem is that opinion leaders may be driving perceptions of the poor; society is made to think they are helpless and hopeless people who must be shown how to get out of their poverty and that they are simply lacking in everything they need to accomplish this. Whether this is true or not may vary from one place to another but experience with Lake Victoria fishers, suggests that this is not the case. Indeed, fishers here have great abilities and capabilities, many of which they may not be aware of themselves. These capabilities can be referred to as invisible presences, or those abilities that poor fishers have taken for granted such as cooperation, respect, wisdom, education, trust and competition.

The resulting poverty notion

Based on these two perspectives, poverty has been understood in a certain way focused on the individual, which is what eventually led to a culture of poverty that saw poverty as an individual condition needing individual reform. The poverty problem therefore has a multifaceted dimension (Henderson, 1971; Jensen, 2000) which includes things like: (a) infection by chronic treatable diseases; (b) saving money to buy items only to find that the price increased while doing so; (c) looking old when one is actually very young; (d) the problem of insects in food and on the body; (e) an inability to keep food fresh or to maintain personal hygiene; (f) an inability to obtain proper education or health; (g) a pessimistic view of life and a dream of obtaining money.

Thus poverty is a deficit with poor people being deprived of life’s basic needs; it is a broken relationship that leads to exclusion, fear that makes one vulnerable, and misused power that leads to exclusion, an induced inability that increases a deficit, powerlessness and lack of freedom. Additionally, poverty is a problem of inequality, unemployment, low wages, labour exploitation, and political disfranchisement and has no single cause or explanation.

It could be argued that poverty results from structural weaknesses or failures in the governance system; the so-called interactive governance coined by Kooiman et al. (2005). This view emphasises that an integrated, communicative, and politically informed approach is needed if societal problems such as poverty are to be addressed (Jentoft et al., 2007). Since poverty is complex, multidimensional and multidisciplinary it requires the participation of public and private stakeholders. This participation should be realised through a strong and a vibrant relations of interactive governance components—system-to-be-governed, governing system and governing
interactions. In the absence of such a relationship
governability of societal problems such as poverty may be
low (Jentoft et al., 2007).

Poverty in Lake Victoria, Tanzania: mixture of
individualistic and structural

This investigation of poverty around Lake Victoria
was conducted in Chabula village of Magu district, in
Mwanza region, Tanzania. It is among the 124 villages in
the district and a fishing village along the shore of lake,
with a population of 5,399 people (Magu District Council,
District Development Plan 2008/09, unpublished report),
most of whom live by fishing and agriculture forms. The
study was specifically based at Nyakasenge beach, one of
the beaches in Chabula village, located 7 km from the
Mwanza-Musoma road at Nyangunge trading centre.

Driving towards the beach from the main road, one is
humbled by what meets the eye: old and run-down grass
thatched houses, a people highly dependent on rain for
their agricultural activities, people walking or using
bicycles, women carried on a bicycle’s back seat or they
themselves cycling, no electricity and no running water,
children walking barefoot, girls and women carrying pails
to fetch water, sometimes from the small ponds that form
after rains have fallen, young boys or men herding cattle,
shades made of grass which protecting sugarcane sellers
by the roadside, and moving shops – individuals carrying
clothes for sale known locally as machinga.

On reaching the beach, one notices the houses,
almost all of unburnt soil or mud; the houses are very low
and one cannot easily distinguish between a shop and a
residence. Fishing activities take place on the beach,
women are busy sorting and selling dagaa (Rasirinebola
argentea), men who have been fishing through the night
work on their long lines, some sleep under shades, others
sit and chat, or play cards, pool or checkers. Some young
children help to fetch water, while others play, there is
very loud music, and fish trucks wait by the beach for fish
to be taken to the processing factory.

My research assistants and I interviewed women and
men fish traders, fishermen, crew members, and gear and
boat owners, supervisors of agents collecting fish for the
processors. Our interviews focused on who is poor or
what poverty is in this village, among other topics and
although I and one of my research assistants had
interacted with this community over ten years of working
around Lake Victoria, we lived with them for over six
weeks and participated in a number of their daily activities
for this particular study.

Our question and subsequent discussion on what
poverty is taught us how people in the community thought
and acted and what their values, norms and customs were.
We found that poverty could not be reduced to an
individual phenomenon but rather that the individual
reflected his or her community and that the community
was the sum of its individuals. Our respondents suggested
that a poor person could not do anything, could not use his
head, hands or legs to do anything, was a disabled person;
was someone with less than four cows and a plough, has a
grass thatched house which is leaking and he cannot get
the grass to repair it because there was none in the
surroundings, a person who cannot confront an
emergency, for example, if they were called to go
somewhere 100km or so away and lacks the means to
leave immediately if necessary. We examined the
perception of disability more closely because of the fact
that our image of poverty, based on incomes dependency,
and exclusion among other factors, was far from what we
heard and observed in the village.

We came to understand the disability point of view
from the case a young boy we will call “Jed” who appeared
to be more than ten years old and came from a
nearby village. Both of his parents had died, but his father
had been a fish trader and was known among the people
with whom we interacted. Jed went to school in his village
and claimed to have reached standard three (Grade 3) but
could not write his name, the letter B, or the number 100
which he wrote as 11 while the number 11 was written as
01. It was clear that either he had not reached standard
three, as he claimed, or he had forgotten what he learnt in
school. He claimed that he left school because there was
no one to buy him a school uniform and shoes. His father
died before his mother but his father had many wives and
his mother died long before the woman he came to know
as his mother. This stepmother did not provide him with
the requirements for school after his father died. Jed had
lived in Nyakasenge for more than one and a half years
although he stayed on the nearby Shoka Island for three
months. On the island he watched young boys washing
boats in between fishing trips so he decided to start
washing them himself. He did this but also fished using a
single hook and line known locally as Ndoano. He lived
with a fisherwoman on the island who welcomed him, on
the condition that he washed her boats. He moved
between the island and Nyakasenge, but finally decided
to settle at Nyakasenge to avoid a crocodile that had been
killing Ndoano fishers. [They are vulnerable to crocodiles
here because they fish from rocks that are in the middle of
water some distance from the beach.]

As we were interviewing him, a boat landed and he
ran to compete with other boys of his age for a chance to
wash it. We discovered that there were over ten young
boys like him involved in this activity but the group he
belonged to called themselves the G7. Boat activity is an
activity that has attracted other boys from the village who
come to the beach after school. Our interview went on for
another day and part of his group joined him for the
discussion. They revealed that for each boat they wash,
they get either one piece of fish or 500 Tanzanian shillings
(equivalent to USD 0.39). Washing at least two to three
boats was guaranteed on days that fishermen went fishing
and on a lucky day a boy can wash up to five boats
earning him well over 1 USD per day. Some of the boys
doing this had become breadwinners back home with the
fish they earn being taken home for the day’s meal. On the
face of it Jed was an outright poverty case, but in this
community he was viewed as a hardworking boy who
used his hands, legs and head to make a living. He was not
disabled and therefore the community did not consider
him to be poor and although he had few material
possessions, he was not dependent on anybody for his
daily needs. Indeed, he was self-employed and earned a
living doing work that the community considered essential
to the fishing activities. His security rested not only on his
individual capabilities but also on the community and his relations he has with others, which given his young age, was essential for his well-being in the short as well as in the long run.

One striking observation we made concerned mealtimes; if we were interviewing someone, or just near somebody’s house at mealtimes, we would be welcomed in to eat with them. We found it difficult to agree because each time we thought that they had prepared just enough food for themselves but later learnt that this was not the case. In this community, they have a tradition in which, people expect you to join them for meals when you find them eating. In any case you refuse to eat with them, and then they would be disappointed; others may even consider you an enemy. In this manner the community ensured that everybody, including those who could not afford food, got to eat and access to food only required one to have legs and hands. It was a moral obligation for those who had food to accept an additional mouth at their table and it was wrong to refuse food, even if satisfied. Although this practice has now diminished, the principle behind it, that is “being your brother’s keeper,” is still cherished. No one will be allowed to go hungry, have nowhere to sleep, or no clothes to wear, for lack of money; in this situation, the community shares what little they have.

Our interview with Jed, together with his G7, concluded with a question about what they want to be in the future. Four of the G7 hoped to be kupanda dolo, crew members on fishing boats, one wanted to become the president while two wanted to join either the police or armed forces. We learnt that Jed did not have a place to call home and he slept anywhere he could find a space, but mostly on the driver’s seats in the fish trucks that parked at the beach. At times, he would stay at the local place until it closed down at around four or five in the morning. He planned to go and find his father’s home someday, but he did not know when. Jed’s case made us inquire more closely into the lives of the crew members and discovered that a number of them came from either broken families, or they were children who ran away from home to avoid responsibilities or to reduce their burden on their parents, or simply to look for opportunities to enable them to support their parents and siblings. Jed, therefore, was on his way to becoming a crew member who represented a significant category of fishers.

We discussed Jed’s case with the local leadership, who knew him and his situation; they informed us that he had a stepfather and relatives who knew exactly what he was doing and no one had ever reported his case to the village government office to take action. In their view, all was well with Jed until such time that his case was reported and it seemed that there was no concern about his situation because he has relatives who should care for him. Moreover, he was well integrated into the community and was experiencing no problems with them. That he had relatives to care for him does not constitute dependency, but is simply a case of fulfilling social responsibilities. Dependency, in this case, is not what Fraser and Gordon (1994) allude to as being a matter of gaining one’s livelihood by either involuntarily working for someone, or by relying on charity or welfare for support. According to this community, the fact that Jed can make a living without becoming a thief, beggar or deviant, implies that he is not poor, not excluded from livelihood opportunities, and not helpless, hopeless, passive, incapacitated, desolate or unemployed. Jed has strengths, he can use his hands, legs and head and he is part of a community that knows and supports him.

A further discussion of Jed’s case with the community leaders led us to conclude that in this region poverty is an issue concerning responsibility and care for relatives and members of the community. Thus, Jed needs to be taken care of by his remaining relatives or members of the community where he lives. Another form of responsibility is evident in parents transferring their responsibilities to their children, regardless of the child’s age and regardless of whether parents cannot look after themselves. Poverty is not just an issue of going without food or housing when you can eat or find a place to sleep from relatives or other members of the village and, indeed, individual life in this village is embedded in their community. Life in the community is defined in terms of the various activities that it carries out and life is not complete so long as your neighbours and relatives do not have their basic needs. What one possesses is valuable only so long as it is useful to others too. Thus, individuals like Jed live lives that reflect community values; the washing of boats, for instance, is part and parcel of this community and whoever is involved in it is fulfilling a community need. Thus, understanding the community means understanding poverty, and issues such as dependency, inequality, wealth distribution, work and income will be better understood if viewed from a community perspective.

This led me to question my preconceived ideas of what poverty is and the longer we lived there, the more we could see inclusion, rather than exclusion. We saw social cohesion, rather than marginalisation and we did not see deprivation, helplessness, hopelessness, passiveness, inability, and despair. Was the conventional image of poverty, based on incomes, the standard measure of poverty? Relying only on this image (poverty as we know it) may be inappropriate for developing strategies for poverty alleviation in this area. We concluded, therefore, that understanding poverty should not only be based on individual and or structural perspectives independently, but should encompass a mixture of both as was the case in this village. Most of all, we need to regard poverty in relation to governance because poverty as a reflection of governance failure is a systemic, not isolated, issue. This also has implications for poverty alleviation strategies since poor people are not “outliers” in the community who need special treatment and care. Poverty involves the whole community and an individual’s life simply reflects the nature of the community.

Poverty clearly needs to be understood through a different branch of sociological theory that can shed light on the existing conflicts of values such as persistent child labour in a country that has signed child protection conventions, or young boys under eighteen years taking responsibilities as breadwinners, despite the reality that their parents do not have any disabilities or health problems, even though this may be against the law. The
theory of value pluralism seems relevant in this context. The idea behind the theory is that there are several values which may be equally correct and fundamental—for instance being a nun and being a mother—and yet in conflict with each other. In addition, the theory postulates that in many cases, such incompatible values may be incommensurable, in the sense that there is no objective ordering of them in terms of importance. Among Jed’s community leaders, there seem to be no prioritization of national and local community obligations with regards to child labour. Whereas the local community obligations should be achieved through the stipulated national laws, this is not the case with child labour in this community. Child labour is a practice that local community does not seem to have problems with. There is nothing wrong by having it as law at the national level similarly there is nothing wrong with talking against it at the local community level. However there is a conflict when it is practiced. This theory therefore helps in understanding decision-making when faced with a value conflict. It argues that in such a situation, decisions will be greatly influenced by the need for accountability that strengthens or weakens three observational trade-off reasoning: the desire to conserve cognitive effort; to protect self-esteem; and to avoid blame (Tetlock et al., 1996). In other words, there is a need to understand how Jed’s community leaders will make decisions and act with accountability towards their community as well as national and international obligations.

Rethinking the poverty problem
The dilemma

The questions - what is a problem and is poverty a problem? - seem to be simple ones but, without being clear about it, we may not be able to see poverty as a problem. According to Rittel and Webber (1973) a problem can be conceptualized as an obstacle that makes it difficult to achieve a desired goal, objective or purpose, or a situation, condition, or issue that is unresolved. In a broad sense, a problem exists when one becomes aware of a significant difference between what actually exists and what is desired and one can do little if anything to change the existing situation into the desired one. The word “problem,” from the Greek word problema, means that something has been presented to be solved which implies that something is a problem if it can be solved. But are all problems solvable and can there be problems without solutions or whose solutions are never an end in themselves? When a problem presents itself, there is either a known solution (which means there is no problem) or there is not. But if the solution is not known, then you also do not have a problem because you do not know what the problem is, because by definition a problem must be solvable.

This is the first dilemma. In the case of Lake Victoria, is poverty really not being able to use your hands, legs and head? Is poverty really a disability? If it is, then the solution would be to deal with disability and then we would have eradicated poverty from the lake region. But poverty is still prevalent in this region, meaning that the disability argument is either insufficient and we do not know what poverty is or we simply cannot deal with disability because it has no solution. One can also know the solution to a problem without being able to implement it, but one should not overlook the important part, which is how to arrive at the solution. It is one thing to know what the problem is, but solving it is another. The second dilemma arises with regard to the need to change, which involves three things: the present situation which one needs to move out of, the state of affairs that one wants to be in, and how to move between the two states (Figure 1). Which of these states of being, the current state of affairs or the desired state constitutes a higher level of satisfaction? Why would one not prefer the status quo? Or do both states yield the same level of satisfaction? It is important to note that being aware of one’s condition is important in understanding a problem as it might be easier at times to know where one wants to be rather than where one is. Moving or changing may not necessarily bring about much change in one’s level of satisfaction because these states of being are determined by a fundamental issue—happiness, used here to mean evidence of a good life or well-being. Philosophers and religions have defined happiness in terms of living a good life; to Aristotle, for instance, happiness is the only emotion that humans desire for its own sake. Wealth, honour, or health is not sought for its own sake but in order to be happy.

![Figure 1: Diagrammatic conceptualisation of a problem](image)

Figure 1: Diagrammatic conceptualisation of a problem

Happiness, then, is the same wherever one might be but differences come about because of differences in what leads one to the state of happiness, i.e. happiness is brought about by different things in different areas. As Rojas (2005) puts it: “A person’s judgment about her happiness is contingent on her conceptual referent for a happy life”. A relevant question to ask, therefore, is what constitutes or brings about happiness? Does happiness necessarily involve material or social possession? The answer to this question depends on several things, including social, economic, and some may even argue, biological factors (Veenhoven, 1991; Kenny, 2005; Rojas, 2005; Böhnke, 2008; Ball and Chernova, 2008). Kingdom and Knight (2007), reviewing literature from generally advanced economies, concluded that in these economies “happiness increases with absolute income, ceteris paribus, but not proportionately and at a diminishing rate”. Echoing this point, Heady et al. (2008) argue from their research in Australia, Britain, Germany, Hungary and The Netherlands that, contrary to the previous belief about the relationship between money and happiness, they found that happiness was considerably affected by income. But happiness is found equally in poor countries where incomes are low and living conditions are difficult among certain unfortunate groups (Veenhoven, 1991; Easterlin, 1995). In other words, income can either make one happy or not, depending on the circumstances.
Jed and his G7 group and crew (who could represent a larger group) on Lake Victoria, neither complain about what they do nor about what life has offered them, and neither does the community as a whole. To them their life is what life is and it has to be enjoyed and happiness is embedded in their community values and way of life. Would poverty alleviation, in the form of greater material wealth, bring them more happiness? If it led to the breakdown of their community values and its social support structures then it might not. This, then, is the dilemma faced by all those involved in poverty alleviation. Is material wealth the only measure of poverty and is the social cost of acquiring such wealth too high?

Poverty is a wicked problem

The concept of wicked problems emerged from public administration and policy research (Weber and Khademian, 2008a) and stemmed from a realisation that many problems defy established systems of defining problems and finding solutions. Wicked problems show characteristics which best fit any description of poverty, which is more likely to benefit from a wicked problem-management approach rather than a traditional problem-management one. Broadly, wicked problems can be described as unstructured, cross-cutting and relentless (Weber and Khademian, 2008a; Rittel and Webber (1973) used the word wicked to mean thorny or tricky, or “wicked in a meaning akin to that of malignant (in contrast to benign) or vicious (like a circle) or tricky (like a leprechaun) or aggressive (like a lion, in contrast to the docility of a lamb”).

Our experience in Lake Victoria fishing communities reveals that, by focusing concerns about poverty on individual situations, such as Jed’s, poverty is being deconstructed and transformed into a “tame problem.” Rittel and Webber (1973) contrasted “tame” from “wicked” problems by arguing that in tame problems all the information that would be required to solve them is available. Deconstructing Jed’s problems means that the solutions will not have been addressed as the problem, but only as the symptoms of the problem, and it is these that will have been addressed rather than the problem itself. Jed’s problems are both what he experiences daily (individual perspective) and the forces that have created these conditions (the structural forces at both national and global levels). The characteristics of wicked problems, therefore, bring out these structural issues (Table 1).

Table 1. A summary of the characteristics of “wicked problems” (from Rittel and Webber, 1973; Weber and Khademian, 2008b).

<table>
<thead>
<tr>
<th>On</th>
<th>Wicked problems are/have ……</th>
<th>Aspect of characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>Unclear, problematic, tricky or thorny; causes that are difficult to identify; contradictory, incomplete; little consensus on what the problem is.</td>
<td>Unstructured</td>
</tr>
<tr>
<td>Solutions</td>
<td>No stopping rule - problem never solved once and for all; neither true or false but better or worse; no one shot operation; no set of potential solutions; requires large set of stakeholders to change their mindset.</td>
<td>Cross-cutting</td>
</tr>
<tr>
<td>Nature of problem</td>
<td>Unique; can be symptoms of other problems; can be explained in numerous ways; very complex; involves several trade-offs among competing values; socially embedded; public.</td>
<td>Persistent</td>
</tr>
</tbody>
</table>

First, wicked problems are not clear, but they are contradictory and they depend on who is defining them (Rittel and Webber, 1973). In our Lake Victoria case, poverty was viewed in different ways ranging from disability to ownership of wealth and to responses to emergency and we left this fishing village without any consensus from the fishers of what poverty meant to them. Their perceptions were highly varied and there was no general agreement as to what causes poverty, which makes poverty problems unstructured.

Second, because there are many different causes of poverty, there have to be many different solutions. Wicked problems do not have true-or-false, or right or wrong, solutions but tend to have solutions that are either better or worse. There is no single person who is an expert on wicked problems and so they cannot be domesticated into any discipline, or managed by policy-makers or managers (Narayan et al. 2000). Moreover, any one solution may require a large set of stakeholders to change their mindset, something which is difficult if not impossible. Solutions to the problems of disability, wealth or dealing with emergencies in Nyakasenge village were perceived differently by different groups. To some, fishers needed to organise themselves and stop their persistent use of illegal gears, while to others there was a need for accessibility to credit facilities, provision of infrastructural facilities, and a reduction in the stringent government fishery regulations.

Third, the nature of wicked problems makes them quite unique to a particular area. For example, the Lake Victoria fishing communities face difficulties that may resemble those faced by fishers elsewhere such as a lack of adequate, safe water. But solutions to the problems are unique to a particular place and solutions to the provision of clean water cannot be the same in two different places. Wicked problems such as poverty are very complex as they involve trade-offs among competing values and may be symptoms of other problems. The final characteristic of a wicked problem is that it is difficult to tell whether or not the problem is solved as there is no finish line or
“stopping rule.” The problem cannot be solved once and for all.

Conclusion

Poverty is a problem and not merely a concept but its definition depends on who is defining it and how they are defining what it means. It is experienced differently in different places and there is no universal definition; the description may be the same at first but the impacts and possible solutions will differ from situation to situation. It is therefore a problem with value judgments and moral issues rather than being a simple measurable inadequacy. Realistic judgements must consider the values and interests of those affected by poverty.

The complexity and context of poverty makes it a wicked problem whose meaning depends on the values and relationships within society. It is a composite problem, process and an experience that is not easily reducible to a single property. Although poverty cannot be isolated from the poor, its alleviation cannot similarly be focused entirely on the poor. There is a need to broaden our knowledge of this problem by focusing not only on the conditions of the poor, but also on the whole process of cultural dynamism and social valuation. The broad concept of culture, not the narrow concept of the culture of poverty, therefore plays an important role in understanding the poverty problem.

Poverty should therefore not be treated as a straightforward problem because this is a recipe for failure. It is encouraging though to note that poverty is increasingly being understood as a wicked problem calling for an all-inclusive approach. The interactive governance theory provides a new perspective in understanding this problem; for this reason poverty, as a governance issue needs to rely on the collective judgement of stakeholders through a process that is participatory, communicative, and transparent (Jentoft and Chuenpagdee 2009).

Furthermore, the theory presents an opportunity to assess governability of poverty. In this case, governability and its limitations can be examined with respect to the components of interactive governance, namely, systems-to-be-governed, governing system, and governing interactions (Kooiman et al., 2005; Chuenpagdee and Jentoft, 2009). Assessment of governability of these components would be focused on the systems properties including diversity, complexity, dynamics, and scale.

Since poverty presents itself as a wicked problem, it would be prudent for those engaged in the study and alleviation of poverty to approach it with flexibility. The images that people hold of certain things may prove to be different when subjected to closer scrutiny because images can be powerful and judgmental. For instance, Hardin’s (1969) “tragedy of the commons,” (TOC) the foundation for many ecosystem management proposals, assumes that freedom of choice will be exercised to such an extent that resources are destroyed and therefore impoverish the communities that depend on those resources. The TOC assumes an absence of relationships among resource users whereas in reality individuals within a community do not live as if they are isolated from others, they are constantly connected to one another. Thus, around Lake Victoria, the situation is more complex and individuals such as Jed live a life that is highly connected to others within the community and defined by multiple values. Such relationships are so crucial that they become the defining and driving force of activities. Such relationships can only be appreciated with methodological and conceptual flexibility, a view of poverty as a set of qualities that need to be experienced on the ground through an interaction with those who would conventionally be defined as poor.

Finally, the dilemmas that the poverty problem presents require careful thought about the need to change people’s conceptual referents. Research should focus on people’s social context, culture, life experiences and exposure to social influences, in order to understand why they see life as they do. Policy-makers, on the other hand, might focus on whether it is ethical to change a person’s social and cultural context in order to increase his or her happiness. These dilemmas are a means of broadening the debate on what Kooiman and Chuenpagdee (2005) call “orders of governance”; (1) focusing on problem-solving and opportunity creation; (2) focusing on building coherent governance institutions; and (3) a meta-governance order that focuses on values, and principles for the first and second orders. All three orders are crucial if poverty is to be effectively and legitimately governed. The first order would solve Jed’s problems by, for instance, providing him with shelter, among other things. The second order would ensure that the solutions to Jed’s problems are embedded in the institutional settings of his community, for instance, establishing a mechanism which strengthens community welfare system. These two governance orders can be addressed directly but in this paper I argue that Jed’s condition needs to be looked at from a broader (meta-governance) perspective, involving more than simply fixing problems wherever possible. We need to change the conceptual image of poverty and recognise that it is a wicked problem, the solution to which largely depends on how we look at it.

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References


The Contribution of Lake Victoria Fisheries to National Economies*

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Abstract
The paper discusses the contribution of the Lake Victoria fisheries resources to the riparian states as well as the communities. The paper has used data from studies conducted simultaneously and by reviewing documents from government and other studies reports. Results indicate that in addition to GDP, fisheries have also generated income and revenue, provided employment and brought in substantial foreign exchange. Other findings also reveal direct and indirect contribution of the fishing industries in the improvement of services and quality of life among the dependant community. However, the lake is still faced with the challenges of poor business environment, inadequate technologies for value addition and poor local markets for fish among others. In conclusion, Lake Victoria is an important resource among the partner states as well as the riparian communities. Control of fishing illegalities and promotion of economic value of other fish species especially dagaa will increase benefits to the riparian communities.

Key words: Lake Victoria, Nile perch, economic contribution, employment, exports.

Introduction
The Partner States of the East African Community (EAC) have designated the Lake Victoria Basin as an economic growth zone, which implies that the resources of the basin should contribute to their development goals. These include poverty alleviation, self-sufficiency in food, employment creation, increased foreign exchange earnings, and improved public services, among others. Managing the fisheries of Lake Victoria so that they make an effective contribution towards the achievement of these goals is a major challenge facing the Partner States.

One of the constraints on the implementation of fisheries management on Lake Victoria is the lack of reliable and sustainable sources of financing for the fisheries institutions. This compromises their ability to discharge their mandate effectively, which is a situation that needs urgent redress. The next Fisheries Management Plan for Lake Victoria, 2009-2014 (FMP2) includes plans to establish sustainable financing mechanisms for these institutions, incorporating the user-pays principle at all levels of fisheries (LVFO, 2008).

This principle is embedded within the Code of Conduct for Responsible Fisheries (CCRF) and in the EAC Protocol for the Sustainable Development of the Lake Victoria Basin. Through its application, the wider community not directly involved in fisheries activities is able to derive benefits from the fisheries, which are shared common pool resources. The Lake Victoria fishery contributes significantly to the economy of the riparian countries bordering the lake and has been managed since 1950’s according to different management regimes. In the pre-colonial period the fishery was purely community managed. During and after the colonial period up to and including the 1990’s fisheries management was the responsibility of the central governments. Now a partnership arrangement is being developed where the lake resources are managed by the governments in collaboration with communities within a co-management framework.

In recent years, Lake Victoria has been faced by over fishing. This has been evident by the declining trends in catches. Stock assessment surveys reports a declining trend on the Nile perch biomass since 2000, while at the same period CAS reports an increased total catches for Nile perch. Other indication of over fishing is the common use of small and illegal nets that has reduced the average size of the fish caught. Declining fisheries have far reaching socio-economic consequences, including a loss of incomes and livelihoods, unemployment, food and nutritional insecurity,
and conflicts over resources at community, national and regional levels.

Methods
This paper is based on a study carried out simultaneously in the three Partner States to establish the contribution of Lake Victoria’s fisheries to national and household economies. In each country, the literature was reviewed and secondary data and information collated by reviewing published and unpublished manuscripts, official government records and publications, including statistical abstracts and bulletins from the national Bureaus of Statistics, economic survey reports, national development policy documents, trade reports, and sectoral strategy documents produced by relevant ministries. Information was also obtained from previous studies undertaken during the Implementation of a Fisheries Management Plan (IFMP) project (Abila et al, 2006; Abila et al 2007, LVFO 2007, 2008, Odongkara 2006a, 2006b and 2006c). The study also made use of data and reports from other IFMP components such as the Catch Assessment and the Frame Surveys, while some statistical information was also obtained from the Trans-boundary Diagnostic Analysis of the Lake Victoria Basin report recently produced by the Lake Victoria Basin Commission (EAC).

National institutions were also visited to fill information gaps and address key questions arising from the literature review. These institutions included Fisheries Departments and other Government Ministries and Departments, especially those responsible for statistical, planning and financial portfolios, and other institutions with information and data, such as the national associations of fish processors and exporters.

Results and Discussion
Contribution of fisheries to poverty alleviation
Poverty in fishing communities is multi-dimensional, concerned not only with low or declining catches and the consequent fall in income and food supply, but is also reflected in the inadequate access to social services, poor levels of education, remote and isolated locations of fishing communities, poor organisation, political voiceless and the high exposure of fishers to accidents and natural disasters (FAO, 2009). Fisheries contribute to poverty alleviation by providing food for the poor and supporting local livelihoods in different ways (Figure 1).

Although many of the fisheries activities are still carried out on artisanal basis, they are focussed on the market, continuing to generate earnings from the sale of the fish products and creating wealth. It is also an engine of growth for rural development and can promote economic growth at national level. Many households and communities within the Partner States depend on fisheries to ensure their food security.

The fisheries on the lake have provided opportunities for people to work as crew members, boat owners, processors, traders, input suppliers and service providers. Much of the occupation is poverty focussed because of its low-capital, low-skill requirements, suitable for the poor and semi-educated communities along the lakeshore. Fortunately, Lake Victoria has species, apart from the Nile perch, that can be targeted by poor people such as tilapia, dagaa and the haplochromines, which enables them to earn some money, although the income of crew members is lower than that of boat owners (Table 1). Furthermore, some of these species, notably dagaa and the haplochromines, are becoming increasingly abundant in the lake as a result of the decline in Nile perch biomass. Other fish products utilised by poor people include the factory by-products such as fish heads and frames, off-cuts, skins and oils.

<table>
<thead>
<tr>
<th></th>
<th>Boat owner</th>
<th>Crew</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya</td>
<td>9.1</td>
<td>3.5</td>
</tr>
<tr>
<td>Tanzania</td>
<td>22.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Uganda</td>
<td>42.0</td>
<td>14.6</td>
</tr>
</tbody>
</table>

The co-management strategy has been introduced in the fisheries with the overall objective of improving the livelihoods of the fishing communities. The establishment of Beach Management Units (BMUs) has contributed to the fight against poverty through improved planning and resource management for sustainable livelihoods; good governance with particular emphasis on the rights of all, with democratic participation by disadvantaged and vulnerable groups like the crew and women and promoted self reliance as a necessary basis for working out of poverty. The fishing industry has indirectly contributed to improvements in the services and quality of life among the poor. Access roads to beaches have been improved, leading to better market for fish and improved supply of goods and services while schools, health and recreational facilities have been built in the vicinity of fishing villages, thus providing them with social services.

There has been some concern that the export trade in fish products, notably Nile perch, has reduced the supply of important food source to the communities and reduced
opportunities for those traditionally involved in processing and marketing, particularly women (Abila et al., 2007). As a result the riparian communities have resorted to catching of immature fish thus contributing too much to fishing with illegal gears.

The per capita consumption of fish in the Partner States; 4.0 kg yr⁻¹ in Kenya, 6.0 kg in Tanzania, and 7.0 kg in Uganda (FAO, 2009) is relatively compared to the world and Africa consumption which stood at 16.4 and 8.3 kgs respectively in 2005 (FAO, 2008). It is determined by human population, fish production, fish export and import, purchasing power, tastes and preferences, cultural influences and availability of other substitute foods that the population can consume.

*Fisheries production as a contribution to GDP*

Fisheries have made substantial contributions to the regional economies through monetary as well as non-monetary values (Table 2). On the monetary side, the fisheries sector has to a large extent been integrated into the formal economic sector in the region through the international fish trade. Values are generated in the production component, which involves the processing sector including both artisanal and industrial activities, and distribution through domestic, regional and international trade. Values are also generated through such support services as the manufacture and repair of boats and nets, the cleaning, grading and icing of fish, packaging and transportation. Non-monetary values include fishing for personal consumption as well as the use of personal or family labour in fisheries activities. While attempts have been made to capture both monetary and non-monetary values in the national income accounts of the Partner States, the problem of poor records makes it difficult to obtain accurate estimates of these values.


<table>
<thead>
<tr>
<th>Year</th>
<th>Kenya Fisheries GDP</th>
<th>% of Total GDP</th>
<th>Tanzania Fisheries GDP</th>
<th>% of Total GDP</th>
<th>Uganda Fisheries GDP</th>
<th>% of Total GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>101.1</td>
<td>0.7</td>
<td>139.6</td>
<td>2.7</td>
<td>118.1</td>
<td>2.2</td>
</tr>
<tr>
<td>2001</td>
<td>100.5</td>
<td>0.6</td>
<td>151.8</td>
<td>2.6</td>
<td>160.0</td>
<td>2.6</td>
</tr>
<tr>
<td>2002</td>
<td>97.3</td>
<td>0.6</td>
<td>173.0</td>
<td>2.6</td>
<td>166.3</td>
<td>2.6</td>
</tr>
<tr>
<td>2003</td>
<td>88.3</td>
<td>0.5</td>
<td>198.1</td>
<td>2.6</td>
<td>180.6</td>
<td>2.4</td>
</tr>
<tr>
<td>2004</td>
<td>98.5</td>
<td>0.5</td>
<td>220.2</td>
<td>2.5</td>
<td>230.6</td>
<td>2.6</td>
</tr>
<tr>
<td>2005</td>
<td>98.9</td>
<td>0.5</td>
<td>249.3</td>
<td>2.5</td>
<td>289.4</td>
<td>2.6</td>
</tr>
<tr>
<td>2006</td>
<td>94.2</td>
<td>0.4</td>
<td>241.4</td>
<td>1.6</td>
<td>338.8</td>
<td>2.7</td>
</tr>
<tr>
<td>2007</td>
<td>95.9</td>
<td>0.4</td>
<td>277.4</td>
<td>1.6</td>
<td>390.6</td>
<td>2.7</td>
</tr>
</tbody>
</table>

*Fisheries contribution to employment*

Unemployment is one of the challenges facing the regional economy. Fisheries contributes to employment within its production, processing, marketing and industrial processing components (Figure 2).

**Figure 2.** Some of the ways in which fisheries on Lake Victoria contribute to employment

<table>
<thead>
<tr>
<th>Work opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Making and repairing boats and nets</td>
</tr>
<tr>
<td>Cleaning, grading and icing of fish</td>
</tr>
<tr>
<td>Owning boat and gear</td>
</tr>
<tr>
<td>Providing fishing labour as crew</td>
</tr>
<tr>
<td>Processing and trading in fish</td>
</tr>
<tr>
<td>Packaging, transporting, loading and unloading fish</td>
</tr>
</tbody>
</table>

**Table 3. Direct employment in fishing (thousands). From LVFO (2009)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Kenya</th>
<th>Tanzania</th>
<th>Uganda</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>38.4</td>
<td>56.0</td>
<td>34.9</td>
<td>129.3</td>
</tr>
<tr>
<td>2002</td>
<td>54.1</td>
<td>80.1</td>
<td>41.7</td>
<td>175.9</td>
</tr>
<tr>
<td>2004</td>
<td>37.3</td>
<td>78.0</td>
<td>37.7</td>
<td>153.0</td>
</tr>
<tr>
<td>2006</td>
<td>44.2</td>
<td>98.0</td>
<td>54.1</td>
<td>196.3</td>
</tr>
<tr>
<td>2008</td>
<td>42.3</td>
<td>105.0</td>
<td>51.9</td>
<td>199.2</td>
</tr>
</tbody>
</table>

*Fisheries contribution to foreign exchange earnings*

Fisheries contribute to the region’s foreign exchange earnings through the regional and international fish exports. Tanzania and Uganda were the main fish exporting countries to the region, while Kenya was an importer (Lwenya et al., 2006; Odongkara et al., 2006; Onyango et al., 2006) while other countries that imported fish were the DRC, Rwanda and Burundi. All the major commercial fish species were traded within the region, with sun-dried dagaa
and smoked tilapia being the leading products. The main constraints in regional fish marketing were inadequate marketing inputs, insufficient fish, a lack of infrastructure and technological facilities, inadequate information and an unclear regulatory and policy framework governing the trade. Furthermore, the informal organisation of the trade meant that it was not adequately documented and its value to the regional economy is not fully appreciated.

The international trade in Nile perch has attracted most attention. Around 152,000 tonnes of Nile perch were processed by the region’s 32 operating factories to produce about 86,000 tonnes of various Nile perch products for export in 2006 (Table 4). The fish export markets are diversified to include at least 26 countries in all five continents, although the European Union is the dominant market. Fish is among the most important exports from the region, earning substantial foreign exchange in countries that currently run serious trade deficits.

**Table 4.** Nile perch fish exports (chilled and frozen fillets, gutted and beheaded) from Lake Victoria, 2000-2007. The quantity is expressed as thousands metric tonnes while the value is in millions of US dollars. From LVFO (unpublished).

<table>
<thead>
<tr>
<th></th>
<th>Kenya</th>
<th></th>
<th>Tanzania</th>
<th></th>
<th>Uganda</th>
<th></th>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quantity</td>
<td>Value</td>
<td>Quantity</td>
<td>Value</td>
<td>Quantity</td>
<td>Value</td>
<td>Quantity</td>
<td>Value</td>
</tr>
<tr>
<td>2000</td>
<td>15.8</td>
<td>34.3</td>
<td>30.8</td>
<td>49.8</td>
<td>15.9</td>
<td>34.4</td>
<td>62.5</td>
<td>118.4</td>
</tr>
<tr>
<td>2001</td>
<td>17.9</td>
<td>50.4</td>
<td>31.4</td>
<td>79.5</td>
<td>28.2</td>
<td>79.0</td>
<td>77.5</td>
<td>209.0</td>
</tr>
<tr>
<td>2002</td>
<td>16.5</td>
<td>52.2</td>
<td>24.7</td>
<td>82.5</td>
<td>25.2</td>
<td>87.6</td>
<td>66.4</td>
<td>222.3</td>
</tr>
<tr>
<td>2003</td>
<td>16.5</td>
<td>50.9</td>
<td>32.4</td>
<td>104.5</td>
<td>25.1</td>
<td>86.3</td>
<td>74.1</td>
<td>241.7</td>
</tr>
<tr>
<td>2004</td>
<td>15.7</td>
<td>52.1</td>
<td>30.3</td>
<td>87.5</td>
<td>30.1</td>
<td>102.9</td>
<td>76.1</td>
<td>242.5</td>
</tr>
<tr>
<td>2005</td>
<td>13.7</td>
<td>46.7</td>
<td>40.8</td>
<td>123.2</td>
<td>36.6</td>
<td>143.6</td>
<td>91.1</td>
<td>313.5</td>
</tr>
<tr>
<td>2006</td>
<td>12.7</td>
<td>48.6</td>
<td>40.9</td>
<td>143.0</td>
<td>32.0</td>
<td>137.0</td>
<td>85.6</td>
<td>328.6</td>
</tr>
<tr>
<td>2007</td>
<td>12.4</td>
<td>43.5</td>
<td>44.7</td>
<td>127.5</td>
<td>28.4</td>
<td>117.4</td>
<td>85.5</td>
<td>288.4</td>
</tr>
<tr>
<td>2008</td>
<td>13.0</td>
<td>45.6</td>
<td>46.0</td>
<td>131.2</td>
<td>23.4</td>
<td>96.7</td>
<td>82.4</td>
<td>277.9</td>
</tr>
</tbody>
</table>

*Revenues from the fisheries*

The contribution of fisheries to public revenues is usually provided for through the various statutory instruments. On Lake Victoria, these include vessel license fees, fishing fees, fish trading fees, fish transport fees, market dues, fines and permits of various sorts, although the specific rates vary from one country to another. At present, the governments, with the support of development partners, provide the funding for fisheries management but the lack of resources remains a major constraint. There is a need to strengthen statutory provisions for revenue collection to ensure that fishery management can be self-financing and sharing public revenues with the different fisheries institutions and BMUs.

*Conclusions*

The paper examined the contribution of fisheries in the national economies of the riparian states of Lake Victoria. Areas of contribution identified included poverty alleviation, contribution to household and national incomes, employment, foreign exchange earnings and public revenues. While considerable information exists on the significance of fishers, details of the information are often lacking and data gaps have been identified, notably in the areas of poverty and livelihoods, consumption and marketing.

Apart from data limitations, the role of fisheries in the riparian economics is also hindered by the role of the fisheries in the riparian countries is also hindered by poor distribution of the fisheries values, conflicting values, particularly export versus consumption values, poor business environment for fisheries investments, inadequate technologies for value addition, and poor local markets for fish, negative socio-cultural practices and poor revenue collection by the institutions concerned.

*References*


Implementing Co-management of Lake Victoria’s Fisheries: Achievements and Challenges

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Abstract
For a long time governments made decisions on the management of fisheries resources in Lake Victoria with little or no input from the resource users and other stakeholders. This approach has been ineffective and these resources have continued to decline over the years. Legislation has therefore been enacted to facilitate the involvement of the resource users in fisheries management through the creation of a local co-management unit the Beach Management Units (BMU). Harmonised BMU guidelines were developed for the establishment and operations of these institutions with a total of 1069 having been formed along the entire shoreline. In addition, BMU networks have been formed for the development of management plans, to prevent and address conflicts, and to represent BMUs at higher levels of governance. The communities now take an active role in the elimination of illegal fishing methods, are involved in revenue collection on behalf of the governments, and in the decision making processes on fisheries related issues. There are still many challenges facing the sustainable management of Lake Victoria fisheries, including; lack of compliance with regulations and rapid increase in fishing effort, environmental degradation, inadequate service provision and the high prevalence of HIV/AIDS amongst the fishing communities.

Key words: Lake Victoria, co-management, beach management units, management plans, illegal fishing, regulations.

Introduction
Lake Victoria, the largest freshwater lake in Africa with an area of 68,800 km², is shared between the three East African states of Kenya, Uganda and Tanzania. It supports one of the world’s largest inland fisheries, based primarily on three species, the Nile perch Lates niloticus (L.) and Nile tilapia Oreochromis niloticus (L.) both of which were introduced, and the endemic cyprinid Rastrineobola argentea (Pellegrin) known locally as dagaa, omena or mukene. Some native species, such as the haplochromines, which were thought to be close to extinction are beginning to recover and becoming increasingly important in the fisheries.

Nile perch is by far the most valuable species since it supports an export industry that provides the three countries with about US$350 million in export earnings per year. Evidence that the Nile perch stocks are declining is causing concern and has forced the three countries sharing the lake to rethink their management strategies. In each country the fisheries departments are entrusted with the management fish stocks and traditionally made management decisions with little or no input from resource users and other stakeholders. It is now accepted that without the involvement of the stakeholders, especially those whose livelihoods depend on the resource, in management it may not be possible to reverse this trend. Consequently, in order to involve stakeholders, legislation has been enacted in each country to lay down structures make possible a shift from the command and control approach previously adopted by the Governments to a co-management approach that involves stakeholders at all levels. Consequently, all members of the fishing community, including boat owners, boat crew, managers, fish processors, fishmongers, local gear makers, and dealers in fishing equipment, are being brought into the co-management through membership of local institutions called Beach Management Units (BMUs). The Lake Victoria Fisheries Organization, which was set up to coordinate fishery management across the lake, developed harmonized BMU guidelines to help govern the operations of these newly created institutions.

The creation of these community-based beach administrative units required actions to raise awareness amongst the different categories of stakeholders, after which they were registered, BMU committees were elected, and registration certificates issued by the respective departments of fisheries. A total of 1,069 BMUs have now been formed around the entire lake and have become involved in the co-management of the fisheries. While successes have been recorded in all the
three countries there are also challenges that must be addressed as the new institutions grow and appreciate each other. Lake Victoria now has the world’s largest co-
management system and its progress is of significance within and beyond the African continent.

For BMUs to be effective in fisheries co-
management, they must collaborate with other BMUs, as well as with government agencies and other stakeholder groups. This can be achieved through the formation of BMU Networks and Fisheries Co-management Committees at local, national and regional levels. The co-
management guidelines that have been drawn up (LVFO, 2007) give the procedures for the formation of BMU Networks and Fisheries Co-management Committees at each level as well as a clear outline of the functions of these structures and of each stakeholder group. The guidelines also explain what co-management means for Lake Victoria fisheries and how the meetings and activities of the BMU Networks and Fisheries Co-
management Committees will be funded. They will therefore strengthen the understanding and implementation of co-management, including the further development of institutions, and contribute significantly to sustainable fisheries management.

Fishing communities as partners in co-
management
An essential first step in the formation of BMUs around the lake was the development of regionally agreed harmonized BMU Guidelines, which were approved by the LVFO Fisheries Management Committee in May 2005 and used to guide the development of national guidelines. Legislation to provide legal status for BMUs was passed in Uganda in 2003, in Tanzania in 2005 and in Kenya in 2008. The key innovations in BMUs formed during the implementation of a Fisheries Management Plan (IFMP) project were the inclusion of everyone working in fisheries, reforms to the composition of committees and the election process, and legal empowerment. In the earlier BMUs in Tanzania, for example, there were only around 20 members with women and boat crew being poorly represented, with the result that not everyone knew what the BMU was doing or could influence decision-making. Now, everyone working in fisheries at a beach must belong to a BMU and the BMU committee is required to include women and crew members. With the new structures in place, everyone gets a chance to speak, either through their representatives on the committee or during BMU assembly meetings. Monitoring surveys carried out in 2007 and 2008 indicated that 49% of women believe that they have a greater say in the BMU affairs, a significant improvement over the previous situation.

The international experience of fisheries co-
management clearly demonstrates that it should be concerned with developing the fisheries communities, as well as about managing the fisheries. Co-management takes time to evolve, as it requires policies, institutions and systems to be developed first and a general agreement on the nature and direction of co-management. Roles, functions and relationships will change over time, as the capacity of stakeholders is improved, trust between stakeholder groups is gained, relationships are strengthened and lessons are learnt from experience.

Pre-BMU management approaches
Until the late 1990s, the fisheries of Lake Victoria were managed in each country by regulations developed and enforced by central government, with out-posted fisheries staff. There was very little, or no, participation by fisheries communities in resource planning, management and development but the need to involve fishing communities in management grew from the recognition that:
(a) The top-down government-only approach to management was not succeeding in managing the fisheries;
(b) Fishing capacity in the lake, particularly for Nile perch, driven by high catch rates difficult for the fisheries departments to manage the fisheries alone;
(c) Illegal fishing had increased and could not be controlled by the fisheries departments because of the size of the lake;
(d) International trends in natural resource management which involved cooperation between governments and communities, and
(e) Involving stakeholder groups in management would promote a sense of ownership and a greater willingness to comply with regulations.

In the late 1990s Tanzania began the process of implementing co-management with the formation of community-based Beach Management Units (BMUs), with generally positive results. More BMUs were formed in Tanzania and Kenya in the late 1990s and early 2000s with a few in Uganda. Because there were no harmonized guidelines at the time, they differed in the way that they were formed, and their membership and operations. In 2004, the IFMP project brought the Partner States together to agree on regional guidelines for BMUs which were then used to produce national guidelines in Tanzania and Kenya; Uganda already had compatible guidelines.

Current challenges
The sustainable management of the fisheries on Lake Victoria faces a number of challenges. These include a lack of compliance with regulations and the rapid increase in fishing effort, which is threatening fish stocks, as well as environmental degradation, inadequate service provision to the fishing communities and the high prevalence of HIV/AIDS in these communities.

Regulations to protect young and breeding fish and to ensure that the fisheries are sustainably managed have been promulgated but their enforcement remains a key challenge. Many fishing illegalities still exist on the lake, including the use of small meshed nets, small hooks and active fishing methods. Undersized fish are regularly caught and sold, thus damaging the fish stocks and the future livelihoods of the fishing communities. Improving compliance with fisheries regulations is therefore a key goal of fisheries co-management. It is envisaged that the participation of fishing communities in the management of the fisheries at all levels, from policy to data collection, will lead to greater awareness and compliance.
The numbers of fishers and gears have been steadily increasing thereby increasing the fishing effort. For this reason, Regional Plans of Action have been drawn up for the Management of Fishing Capacity (RPOA-Capacity) and for dealing with Illegal, Unregulated and Unreported Fisheries activities (RPOA-IUU) and are in the process of implementation.

Environmental pollution and degradation within the catchments are further challenges, and include deforestation, siltation, low standards of hygiene and sanitization at the landing sites, effluent from factories and urban areas, and chemical run-off from agriculture. Action is needed at all levels to address these challenges and to improve the health of the lake and of the communities living on the lake shores. Similarly, the inadequate provision of services to fishing communities has a detrimental impact on livelihoods. Inadequate drinking water, sanitation, access roads, health care, education and access to savings and credit facilities are all common features of life at fish landing sites. Despite the fact that there is regular income within these communities, the quality of life in the fishing communities is not at the level it should be.

Furthermore, the prevalence of HIV/AIDS in fishing communities is substantially higher than the national averages in the Partner States and a concerted effort is needed to address this major challenge around the lake. Co-management should significantly improve livelihoods by empowering and organising the communities, strengthening linkages with government, including in development planning, and by enabling agencies to work with, and through, the BMUs and BMU Networks.

The concept of co-management

Governments have worked in partnership arrangements with fishing communities for many years but co-management is seen as taking this further by giving communities (and other stakeholders) the rights and responsibilities that will give them a real say in management decision-making. Co-management must be well designed and implemented, with sufficient resources to support the development of the process, otherwise it will not succeed in its objectives. It is defined as “a fisheries management approach where responsibility is shared between the government, fishing communities and other stakeholders”. It must be emphasised that it is a learning process, as almost all situations differ and require different arrangements, systems and processes. Co-management is based on the principles of:

(a) Democracy, transparency, accountability and sustainability in systems, processes and objectives;
(b) Power sharing between government, communities and other stakeholders;
(c) partnership between government, fisheries communities and other stakeholder groups, and
(d) Subsidiarity, with management authority being delegated to the lowest possible organisation.

International experience in co-management has led to an understanding that there is a ‘spectrum’ of co-management, ranging from government management to management completely given over to user groups. This implies that with government management, there is minimal exchange between users and government, whereas with community-based management, interactions are based on communities informing government, not working with government. True co-management lies somewhere between these two extremes.

The importance and objectives of co-management

Fisheries co-management was borne from the realisation that central governments working alone were unable to manage fisheries and enforce regulations and was therefore a response to the desire to empower fishing communities. The objectives of fisheries co-management are to enable all stakeholders to work together in a collaborative and cooperative partnership for sustainable fisheries management and improved livelihoods of fishing communities. Effective fisheries co-management should lead to increased fisheries productivity and therefore make a significant contribution to the development of low-income countries as well as to sustaining the natural resource base.

Expected benefits of co-management

The primary advantage of co-management is that with the right institutional and legislative framework, it allows the knowledge and understanding of all stakeholders to be reflected in making and implementing decisions. Those who use resources directly tend to have a greater knowledge of their local environment and the fishing practices employed in it than do the distant administrators of a top-down system. Once suitably organised and motivated by a sense of ownership, and funded through revenue-sharing they are then in a position to respond to signs of local overexploitation or to damaging fishing activities and to lobby for appropriate changes in policy.

Seeking and incorporating the views of fishing communities on the design and implementation of management interventions also boosts the legitimacy of any actions that are subsequently taken. This increases the community’s willingness to adhere to them and to assist in ensuring that others do likewise. This increases both the level of resources devoted to this activity and the efficiency of the government’s own activities. Increasing the exchange of information between resource users and government agencies also reduces costs and further improves the decision making process.

Co-management can enhance the position of disadvantaged groups by giving them direct representation in decision making and allow them to benefit from collective action. They can also benefit from increased security by reducing thefts, piracy and inter-group conflicts, improved sustainability of fishing, while adding to the value of the catch through the provision of better handling facilities and collective bargaining with traders. Furthermore, by acting as a focal point, community organisations also enable service providers to build awareness and capacity across a wide variety of issues, such as HIV/AIDS, alternative income-generating activities and savings mobilisation.
Adoption of co-management on Lake Victoria

Fisheries co-management on Lake Victoria is moving strongly from consultation between fishing communities and the government, with limited exchange, to collaboration or cooperation between resource users and government. Collaboration implies power sharing and the delegation of certain management functions to user-organisations, supported by existing policy and guidelines. This means that (1) fishing communities are equal partners with government and other stakeholders and (2) BMUs are community-based fisheries management organisations, registered with the Fisheries Departments of each Partner State. The relationship between government, BMUs and other stakeholders must be one of mutual cooperation and responsibility for the achievement of agreed objectives and goals. In the case of sustainably managed fisheries, this means that all parties should work together and trust each other to deliver on agreed tasks.

Policy and legislative framework

The implementation of fisheries co-management on Lake Victoria is supported and directed by a number of policy documents, legislation and guidelines. The existing policy and legal framework includes:

(a) The Convention for the Establishment of the Lake Victoria Fisheries Organisation (1996) supports co-management by providing for the private sector to be represented on the National Committees for Lake Victoria Fisheries.

(b) National Fisheries Policies in each of the three countries commit them to a co-management strategy by encouraging community participation in resource management and development and working with all stakeholder groups in resource management, and the decentralisation of management functions to local governments.

(c) Legislation gave BMUs legal status in Uganda (2003), Tanzania (2005) and Kenya (2007). The policy and legal basis of co-management on Lake Victoria is therefore well established, but will be further strengthened as required, particularly in relation to its financial sustainability.

Stakeholders in Lake Victoria fisheries

A wide variety of stakeholder groups are involved in fisheries co-management on Lake Victoria. The BMUs, represented by their BMU Committee and Assembly, are perhaps the most important as they include all members of fishing communities at the beaches. The BMU Network committees formed at the respective administrative levels of governance according to local/central governments, the Fisheries Departmental staff at different these levels. Likewise, local authorities, from the village to district levels, play an important part as do other government departments. Away from the beach, fish traders, fish processors and exporters, and the manufacturers and suppliers of fishing gear and boats all have a significant stake in the fisheries.

The police and judiciary also play a crucial role in effective fisheries management. They should be trained in fisheries laws and regulations and should be made fully aware of the meaning and importance of co-management, and understand the roles of the BMUs.

Institutional arrangements

Whilst each group has its own role and functions within fisheries co-management, they must work together for co-management to be implemented effectively. This can only work well through co-management structures, which should fit into existing systems of governance in the Partner States. The institutional arrangements and linkages for fisheries co-management on Lake Victoria are set out in Figure 1 (see page 57).

<table>
<thead>
<tr>
<th>Level of BMU Network</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Village (Tanzania)</td>
<td>2-4 representatives from each BMU</td>
</tr>
<tr>
<td>Parish (Uganda)</td>
<td>Only where there are many BMUs in a sub-county is a parish BMU needed; 2-4 representatives from each BMU.</td>
</tr>
<tr>
<td>Ward/location/sub-county</td>
<td>2-4 representatives from each BMU/parish.</td>
</tr>
<tr>
<td>Division (Kenya)</td>
<td>2-4 representatives from each ward/locational BMU network.</td>
</tr>
<tr>
<td>District</td>
<td>1-4 representatives from each ward/division/sub-county</td>
</tr>
<tr>
<td>Provincial (Tanzania)</td>
<td>2 elected representatives from each district</td>
</tr>
<tr>
<td>National</td>
<td>All district BMU network chairpersons</td>
</tr>
<tr>
<td>Regional</td>
<td>2 elected representatives from each Partner State (national chair and one other)</td>
</tr>
</tbody>
</table>

Co-management begins with the establishment of BMUs around the lake, after which members of the elected BMU Committees come together at higher levels to form Sub-County, Ward, Location, District, National and Regional BMU Networks. Nominated members of these Networks will join a Fisheries Co-management Committee at the same levels, as in Table 1. The function of these networks is to harmonise plans and management measures, to prevent and address conflicts, and to promote equity and justice between BMUs for all members. The formation of networks also facilitates the representation of BMUs at higher levels of governance, as representatives of co-management committees.

The following points should be noted in the formation and operation of BMU Networks:

(a) The levels at which BMU networks are formed relate to the planning levels of government. These networks were also formed to facilitate the election or
nominated of representatives at higher level administrative structures such as at parish level in Uganda where there may be many BMUs in one sub-county and at village level in Tanzania, when there may be more than one BMU in a village.

(b) The two to four representatives of the BMU networks at village, parish, sub-county, ward, or location levels from the BMUs should include the Chair.

(c) The representatives should come from the four main stakeholder groups; boat owners, boat crew, fishmongers, and ‘others’.

(d) BMUs are encouraged to ensure gender parity in their nominations for representation at all levels.

(e) Each BMU Network will elect its own Chair, Secretary and Treasurer.

Table 2. The composition of Fisheries Co-management Committees at different levels. FO = fisheries officer, NGO = non-governmental organisation, CBO = community based organization DoF = Director of Fisheries.

<table>
<thead>
<tr>
<th>Level</th>
<th>Composition</th>
<th>Frequency of meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ward, location, sub-county</td>
<td>1 sub-county, location, ward or division FO; and 1-3 sub-county, location, ward or division BMU network representatives. Optional: sub-county chief, ward executive officer, location chief or division officer; focal environment officer; community development assistant; and 1 district-based (or lower) fisheries NGO/CBO.</td>
<td>At least quarterly</td>
</tr>
<tr>
<td>Division (Kenya only)</td>
<td>1 division FO; and 1-3 division BMU network reps Optional: division officer; focal environment officer; community development assistant; and 1 division-based (or lower) fisheries NGO/CBO.</td>
<td>At least quarterly</td>
</tr>
<tr>
<td>District</td>
<td>1 district FO; 2 FOs; and 3 district BMU committee representatives. Optional: district planner; district environment officer; community or social development officer; and 1 district-based fisheries NGO (if present).</td>
<td>At least quarterly</td>
</tr>
<tr>
<td>Provincial</td>
<td>1 regional FO or fisheries advisor, 2 district FOs, and district BMU committee chairs. Optional: regional planner; regional secretariat (natural resources); regional community development officer; and regional fisheries-based NGO.</td>
<td>At least twice yearly</td>
</tr>
<tr>
<td>National</td>
<td>Director/Commissioner of Fisheries (Chairman); 1 DoFs; 3 regional or district fisheries officers; 3 BMU representatives; 1 processor representative; 1 from fisheries NGO working on Lake Victoria; 1 from fish marketing association; 1 local authorities representative; 1 fisheries research representative.</td>
<td>At least once a year</td>
</tr>
<tr>
<td>Regional</td>
<td>Expansion of the Fisheries Management and Scientific Committees to include: chair of the Regional BMU Network; 1 regional fish processors representative; 1 regional fish marketing representative; local authority representative; 1 from regional fisheries NGO on Lake Victoria.</td>
<td>At least twice a year</td>
</tr>
</tbody>
</table>

**Fisheries co-management committees**

Fisheries co-management committees bring together BMUs, government and other stakeholders to plan management measures and to monitor the implementation of these plans mobilising whatever resources may be available to them. The composition of the fisheries co-management committees at the different levels is given in Table 2 (see p. 59). Co-management committees may be formed at village levels at a later date, but the formation of these structures should begin with the levels set out in the Table 2. Representatives from each stakeholder group should be nominated or elected by the members of that group while BMU representatives should include the Chair and others from different stakeholder groups, with women represented where possible. The fisheries co-management committees will be chaired by the Fisheries Department.
**Process of forming BMU networks and fisheries co-management committees**

BMU Networks and Fisheries Co-management Committees will be formed according to the following procedure:

(a) The Fisheries Officer advises the BMU Assemblies on the purpose, structure and functions of the BMU Networks, with guidance on the number of BMU Committee members needed to represent each BMU at a higher level.

(b) At sub-County, ward/ or location level, each BMU Assembly elects between two and four committee members, including the Chair, to represent it in the BMU Network. In Tanzania, villages with more than one BMU will form a network before the ward level.

(c) At district level, each sub-district BMU network will send 2-4 representatives to the district BMU network, including the Chair. In Kenya, the district level will be preceded by the division.

(d) At national level, each district BMU Network will send their chairpersons to form the national BMU network. In Tanzania, the national BMU network will be preceded by a network at provincial level.

(e) At regional level, two representatives of the national BMU networks are elected from each Partner State as the national representatives.

At the first meeting of the BMU networks, the members will elect a chairperson, secretary and treasurer. The Fisheries Departments will provide technical guidance to BMUs to support the formation of the BMU Networks. The election of representatives at all levels should ensure different stakeholder representation and at least 30% of the places on each BMU Network should be women.

The Fisheries Co-management Committees will include BMU representatives elected by the BMU Networks at the same level of the Fisheries Co-management Committees. Government representatives will be nominated by the Fisheries Departments while other sectors will nominate their own representatives at the various levels.

**Conclusions**

The BMU formation process has come along way and the achievements are enormous and noble as have already been expressed. It is however important to find a sustainable source of funding for these organizations. The three partner states should also ensure that the employs of the respective fisheries institutions complement the good work done by the BMUs towards eradication of fisheries illegalities rather than being accomplishers of such vices. The trainings and sensitization sessions that were conducted to the BMUs should be done regularly to ensure that new recruits in the fisheries understand and appreciate the importance of sustainable fisheries resource exploitation and management for posterity.

**Acknowledgements**

The Authors of this paper express their gratitude to individuals and the respective fisheries institutions of the partner states for their role in the production of this paper and in the BMU reformation process. The European Union is acknowledged for providing funds through IFMP programme, without which the BMU reformation process could not have been undertaken while the Lake Victoria Fisheries Organization and the MRAG team of consultants made it possible to complete the BMU reformation process along the whole shoreline of Lake Victoria. National co-management working groups have worked against very tight schedules and limited resources yet always met deadlines. Last but not least, the fishing communities, NGOs and other stakeholders contributed to the success of the BMU formation process and their support is acknowledged.

**References**

Figure 1. The institutional structure of fisheries co-management on Lake Victoria. Adapted from “An Overview of the Lake Victoria Fisheries Organisation”, LVFO Secretariat, July 2004.
Gender Integration in the Management of the Lake Victoria Fisheries*

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2 National Fisheries Resource Research Institute, P.O Box 343 Jinja, Uganda
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* Author for correspondence: cgichuki@yahoo.com

Abstract
The riparian governments of Lake Victoria have adopted co-management approach in fisheries management. This paper discusses gender mainstreaming in fisheries management of Lake Victoria, user rights, successes and challenges of the process. This paper has used gender-disaggregated data from several studies carried out around Lake Victoria using quantitative and qualitative methods. Results revealed an increase in female-headed households in the fisher communities. Men earned an average of $17.8 per landing while females earned about $7.72 per day, signifying unequal distributions of benefits by gender related activities. There has been an increase in registration of both men and women in the BMU, but women were lowly positioned in committees. In conclusion, the representation of women in decision making has improved, but not significantly translated into increased benefits, access to and control of assets and resources. There is a need to achieve an equitable gender responsive fisheries management regime.

Key words: Lake Victoria, gender, user rights, resource access, fish marketing, incomes co-management.

Introduction
Lake Victoria is the second largest freshwater lake in the world, with an area of 68,000km² and about 30 million people living in its catchment, many of whom depend on it for employment, food, water for domestic and industrial use, transportation, recreation and hydro-electric power. It also earns foreign exchange for the three riparian countries (Kenya, Tanzania and Uganda). Most of these export earnings come from the Nile perch Lates niloticus fishery, although other species are involved in the regional trade.

Despite the fact that the fisheries of Lake Victoria play a crucial role in the livelihood of many people, the resources are under pressure from the increasing human population around the lake, most of whom are poverty-stricken and lack of alternative livelihoods. The number of boats and gears has increased as illegal gears and methods in order to meet the rising demand for fish. Although Lake Victoria being a shared resource each country has been managing its portion separately but this situation has changed following the establishment of the Lake Victoria Fisheries Organization, which is charged with coordinating research and management of the lake. Fisheries management was previously the responsibility of the central government using a command and control system with the users making little contribution to decision-making. The recognition that government agencies acting alone could not ensure sustainable practices has provided an argument for greater involvement of communities and civil society in the management of natural resources (Ostrom, 1990; IED, 1994; Mearns, 1996). The devolution of natural resource management is usually based on three arguments, (i) the inability of the government agencies to manage natural resources, especially at grass roots level; (ii) the ability of local institutions to formulate rules and regulations that enable them to manage their resources effectively; and (iii) the cost-effectiveness of devolution following a reduction in the transaction costs associated with managing common resources (Berkes, 1989; Vedeld, 1992).

Resource user and access rights
Access to the Lake Victoria fisheries has up to now been unrestricted and anyone is free to enter the fishery after purchasing a fishing license, a situation that is a serious threat to the fishery and the income that it provides. The only restriction is the national boundaries, although passage between these boundaries occurs in the open waters of the lake, especially between Kenya and Uganda. It has been argued that the Lake Victoria fisheries cannot be managed effectively without well-defined user rights and access regime policies (Abila et al., 2000).

The devolution of management natural resources is perceived to be beneficial as the resources are often locally specific, diverse and with multiple uses and can be improved by using local knowledge. Diverse uses will give rise to conflicts which the local resource users might be better able to resolve because of their shared interests. In fisheries, co-management is seen as a means of achieving equity and social justice through power-sharing by government, fishers and other stakeholders. There are often thorny issues in co-management that may involve social and economic divides in a community, including gender roles that interlink ethnicity, economic status and age besides sex identities.

Group members of a common property regime face the problem of organising themselves in order to change from a situation of independent action to one of collective action and coordinated strategies that maximise benefits for the group while reducing adverse effects. For institutional arrangements to be maintained over time, workable procedures must be developed for monitoring the behaviour of fishers, sanctioning non-conforming behaviour and settling conflicts. The cost-effectiveness of rules to organize fishing activities depends upon the physical nature of the resource, the rules-in-use and the level of conformance to the rules (Ostrom, 1990).

**Co-management on Lake Victoria**

Since 1998 the governments of Kenya, Tanzania and Uganda have been in the process of developing co-management of Lake Victoria’s fisheries. In 2003 the Lake Victoria Fisheries Organization received funding from the European Development Fund for the implementation of co-management as part of the Fisheries Management Plan. This aimed to promote community participation in fisheries management through formation of Beach Management Units (BMU). This project has organised a total of 1069 BMUs (307 in Kenya, 433 in Tanzania and 355 in Uganda) which include all the people engaged in fishery activities at officially gazetted landing sites who were registered and became BMU members after meeting all the conditions set out in the BMU guidelines. Their participation in fisheries management entails control and access to fisheries resources through licensing and taxation and BMU executives are involved in the selection of applicants for fishing and boat licenses. Access to the lake depends on long-term residence in the local community, high family dependency on fishery, compliance to fisheries regulations and fishing skill.

Since communities are not homogeneous not all stakeholders have the same adaptive capacity because of individual variations in ability, a desegregated approach needs to be taken. This paper examines desegregation by gender which plays a defining role in the fisheries on the lake. Gender defines the socio-cultural roles, functions and characteristics of men and women as they relate to each other within a specific social and cultural context and shapes people’s access to, use of and control over natural resources. Therefore, gender issues cut across resource management activities in several ways. First, men and women do not have equal or the same rights over natural resources. Second, division of labour based on gender gives men and women different priorities and they benefit differently from the resource. Third, men and women have different realities and therefore use natural resources in different ways and at different rates. The knowledge, skills and practices of both men and women must play a part in the conservation and management of natural resources and so it is necessary to define the roles of men and women and their knowledge, needs and contributions to resource management. This paper is based on information sourced from four studies carried out by the Research Institutes in each country through the Lake Victoria Fisheries Organization (LVFO, 2007, 2008; Nunan et al., 2007; Odongkara et al., 2006), and some of the findings of these investigations are discussed in the sections that follow.

**Stakeholder characteristics by gender**

The average age of fishers was 36.0 years for men and 35.6 for female while crew members are relatively young (about 80% being less than 35 years old) and most were school dropouts entering the fishery for the first time. Most were either in monogamous or polygamous marriages. A relatively high proportion (26%) of households were headed by women as the open-access fisheries on the lake enable widowed women, as well as unemployed youth make a living from it. This was evident in the fact that 25% of widows were not permanent residents at the beach where they were currently located, while 19% of married women were not with their spouses and therefore headed their households single-handedly for most of the year. These data draw attention to the importance of including women in all aspects of governance of the fishery.

Both men and women in each country tended to be poorly-educated, with a high proportion being primary school drop outs, especially amongst women (Table 1). The lack of education will limit their chances of finding alternative employment outside the fishery but poorly-educated males are more likely to be employed as a crew member and be absorbed into the fishery while the women had to get married first. In 2005 it was noted that more boys than girls were involved in the fishery: in Kenya an average of 2.2 male and 1.4 female children per household: and Uganda male 0.13 and 0.03 female (LVFO, 2007) Over 80% of men and women indicated that they reside permanently on the landing sites, which is one of the qualifications for joining a BMU.
Table 1. Socio-economic profile of fishers (% of respondents) on Lake Victoria (from Nunan et al., 2007).

<table>
<thead>
<tr>
<th></th>
<th>Kenya</th>
<th></th>
<th>Uganda</th>
<th></th>
<th>Tanzania</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Age</td>
<td>38</td>
<td>39</td>
<td>37</td>
<td>34</td>
<td>36</td>
<td>35</td>
</tr>
<tr>
<td>Permanent residence at the landing</td>
<td>78</td>
<td>76</td>
<td>90</td>
<td>83</td>
<td>92</td>
<td>88</td>
</tr>
<tr>
<td>Household heads</td>
<td>71</td>
<td>29</td>
<td>75</td>
<td>25</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>Education: No schooling</td>
<td>5</td>
<td>16</td>
<td>8</td>
<td>15</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>Incomplete primary</td>
<td>26</td>
<td>34</td>
<td>19</td>
<td>17</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>Complete primary</td>
<td>33</td>
<td>37</td>
<td>19</td>
<td>17</td>
<td>82</td>
<td>63</td>
</tr>
<tr>
<td>Incomplete Secondary</td>
<td>17</td>
<td>11</td>
<td>24</td>
<td>16</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Complete Secondary</td>
<td>18</td>
<td>2.5</td>
<td>3</td>
<td>2</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Post-secondary</td>
<td>2</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Access to banks</td>
<td>26</td>
<td>10</td>
<td>42</td>
<td>18</td>
<td>22</td>
<td>7</td>
</tr>
</tbody>
</table>

Gender Roles in the fishery

The fisheries of Lake Victoria are highly characterized by gender with men catching the fish while women dominate post-harvest activities such as fish processing and trade (Table 2). Males are also dominantly employed as boat crew and fish factory agents and transporters of fish. Many (40.5%) of the boat owners' wives were involved in farming while only 23.6% of them were involved in fishery-related activities. The greatest proportion of wives that were involved in fisheries was reported from Kenya (48%) compared to Uganda at (16%) and Tanzania (10%). Women respondents indicated that 56% of their husbands were involved in fisheries-related activities such as owning boat, being a crew member or trading in fish.

Table 2. The proportions (%) of men and women employed in different aspects of the Lake Victoria fisheries (LVFO data base 2005-2007).

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boat owner</td>
<td>97</td>
<td>5</td>
</tr>
<tr>
<td>Processing/trade</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Trading</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Factory agents*</td>
<td>92</td>
<td>8</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

* Kenyan data only (Yongo et al., 2009)

Ownership of resources

In patrilineal communities men have always owned productive assets such as land, animals, trees, farm inputs and fishing gear while women may have access rights to, but not control over, family resources. This functioned well in traditional societies where gender roles were clearly defined and there were inbuilt safeguards for all the members of society. But with commercialisation of commodities, the breakdown of traditional systems and the changing roles of women in the society there is a need for them to have some control over productive assets to meet their needs. Among the fishing communities, about 69% of women and 78% of boat owners (men?) had access to farmland; fewer fishers (both men and women) had access to farmland in Uganda because land ownership policies differed from those in Kenya and Tanzania. Ownership of land is significant as a means of increasing the income and food production in fisher households and provides some security of fishing were to decline.

Patterns of access to resources by gender

Although both men and women are in the fishery to earn a living, men are at an advantage because they can inherit assets from their parents, but a woman has to purchase them or can only be a custodian on behalf of a male child. Most women who have sole ownership of boats are mostly separated or from polygamous families and staying on their own. The fact that they have to break, or not establish, relationships with men highlights the importance of culture in denying women access to assets; if they are with a man then he will control the assets. This was confirmed by a case study in Kenya which found that even if a woman had contributed most to the family assets the community considers that those assets belong to her husband. According to a discussion group in Uganda most women entered the fishery to assist their husbands in post-harvest handling and processing. It is clear therefore that marriage is the commonest way for a woman to enter the fishery.

Economic empowerment is another avenue through which women gain access to fishery resources. Most women, especially in Kenya, indicated that they were involved in petty trade to raise money to purchase fish. Some have also learned the skills needed to be middlemen between the boat owners and traders from the hinterland markets. These women get fish from the boats, sell them for a small profit to an outside trader, and then pay the boat owners their due. At some beaches, where competition amongst fish traders is high, boat owners expect women trader to make a fixed monthly or weekly payment, in addition to the cost of the fish, to maintain the boat. So women with little cash have limited access to fish and are therefore forced to buy from other women at a higher cost.

Surprisingly, women married to fisherman are not guaranteed access to their husband’s fish and only 6% get fish from their husbands. Most women (68%) buy from any fishermen, while 21% of them have regular suppliers, 1% get it from boyfriends and 4% from their own boats. Almost all women pay cash but about 7% buy on credit. This phenomenon of changing sources of supply is probably a result of commercialization of the fishery (Madanda, 2004). This was a survival strategy to
diversify fish supply sources so that if the husband failed to catch anything there would still be some income on that day.

Fish exports from the lake created a division of labour where men and women deal with different species (as in agriculture sector where men grow cash crops and women grow crops of lesser value). Women mainly have access to fish species that are not exported such as tilapia and dagaa, and Nile perch of low quality and value while most men are involved in the more valuable Nile perch fishery. About 60.6% of boat owners target Nile perch, 20% tilapia, 19% dagaa and 1% other species. The Nile Perch slot size (50-85cm) has implications for women fish traders who cannot afford to buy these fish, which is why women traders do not obtain fish from their husbands’ boats because these fish are destined for the export market which is dominated by male fish agents. The second issue is that women had access to only 40% of the boats, which target tilapia and dagaa, because the remaining boats target Nile perch and sell their fish to factory agents. This creates stiff competition amongst women fish traders who devise strategies to ensure supply of fish but leaves them vulnerable to exploitation by male fish suppliers.

Access to fish by women is not homogeneous across the lake; Ugandan women tend to have more access to tilapia and dagaa (50%) than those in Kenya (44%) and Tanzania (24%). Most boats in Tanzania target Nile perch, while Kenyan woman trade more in Rasbrouxobola (“dagaa/mukene”) and Ugandan woman in tilapia. Women only participate in the Nile perch fishery by dealing with products of low value, such as factory rejects. Dagaa is preferred by many women because of its affordability and the fact that it can be dealt with in any quantity, from small dishes to large sacks and is therefore suitable for women with differing financial resources.

**Fish marketing and gender**

Women predominate in local marketing of fish while males dominate the export market; the latter mainly deals with Nile perch leaving other species for the local and regional markets. The export market is characterised by relatively few persons but deals with high-value products while local markets involve many small traders. Wealth from the fishery is therefore unequally distributed and where only a few fishers dominate most benefits go to men. About 92% of the fish agents were men who also derived an income from owning boats.

Both men and women are involved in the regional fish trade but it is dominated by women in Kenya and Uganda and by men in Tanzania (Table 3). The regional fish trade involved four fish species, tilapia, dagaa, Nile perch, and haplochromines. Most traders who dealt in tilapia sold smoked, fresh and dried forms while Nile perch traders dealt mostly in by-products such as fried skin and frames and factory rejects, as well as undersized fish. Dagaa (mukene) and haplochromines were mostly sold in a sun-dried form. People involved in cross-border trade are very important in the chain of fish distribution but they have no organisation that enables them to participate in co-management and most were ignorant of the fisheries regulations. It is important that they become involved because they deal in undersized fish and therefore contribute the management problems this creates.

| Table 3. Socio-economic profile of cross-border traders involved with the export of fish from Lake Victoria (from Odonkara et al., 2006). |
|---------------------------------|-----------------|-----------------|-----------------|
|                                  | Kenya           | Tanzania        | Uganda          |
| % males                          | 36              | 83              | 46              |
| % females                        | 64              | 17              | 54              |
| Mean age (years)                 | 38              | 37              | 31              |
| Dominant education level         | Incomplete Primary | Incomplete Primary | Incomplete Primary |
| Years in fish trade              | 11              | 9               | 4               |
| Dominant type of traders         | Wholesalers, retailers | Wholesalers, retailers, | Wholesalers |
| Species most traded              | Tilapia         | Dagaa           | Dagaa           |

**Benefits from the fishery by gender**

*Incomes from fishing activities*

The socio-economic monitoring study (LVFO, 2008) indicated that incomes of the fishing community in Kenya rose between 2007 and 2008 but in Tanzania the incomes of boat owners and women increased, but that of boat crews decreased (Table 4). In Uganda incomes declined throughout the fishery with women’s incomes being most severely affected. The income of boat owners with engines who targeted Nile perch surpassed their counterparts by 50% with tilapia fishers earning the least.
Table 4. Changes in the income (US$ per month) of various members of the fishing community on Lake Victoria between 2007 and 2008 (from LVFO, 2008).

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>Change</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boat owners</td>
<td>8.68</td>
<td>13.40</td>
<td>4.72</td>
<td>54.38</td>
</tr>
<tr>
<td>Boat crew</td>
<td>3.34</td>
<td>5.00</td>
<td>1.66</td>
<td>49.70</td>
</tr>
<tr>
<td>Women</td>
<td>3.96</td>
<td>5.00</td>
<td>1.04</td>
<td>26.26</td>
</tr>
<tr>
<td>Tanzania</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boat owners</td>
<td>16.76</td>
<td>26.84</td>
<td>10.08</td>
<td>60.14</td>
</tr>
<tr>
<td>Boat crew</td>
<td>3.80</td>
<td>2.07</td>
<td>-1.73</td>
<td>-45.53</td>
</tr>
<tr>
<td>Women</td>
<td>3.09</td>
<td>7.80</td>
<td>4.71</td>
<td>152.43</td>
</tr>
<tr>
<td>Uganda</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boat owners</td>
<td>19.09</td>
<td>13.20</td>
<td>-5.89</td>
<td>-30.85</td>
</tr>
<tr>
<td>Boat crew</td>
<td>7.79</td>
<td>4.70</td>
<td>-3.09</td>
<td>-39.67</td>
</tr>
<tr>
<td>Women</td>
<td>16.12</td>
<td>5.60</td>
<td>-10.52</td>
<td>-65.26</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boat owners</td>
<td>14.84</td>
<td>17.81</td>
<td>2.97</td>
<td>20.01</td>
</tr>
<tr>
<td>Boat crew</td>
<td>4.98</td>
<td>3.92</td>
<td>-1.05</td>
<td>-21.17</td>
</tr>
<tr>
<td>Women</td>
<td>7.72</td>
<td>6.13</td>
<td>-1.59</td>
<td>-20.59</td>
</tr>
</tbody>
</table>

Changes in Household Incomes by gender

Respondents were asked to state how their incomes had changed in 2007 and 2008 from the year before and most respondents indicated that their incomes had declined, with only a quarter in each category indicating that it had increased (Table 5). The fewest respondents indicating an increased income were women although there was a slight increase in the percentage of respondents who thought their incomes had increased in 2008 compared to 2007.

Most boat owners (52%) who reported increased incomes were from Tanzania, compared to 37% from Kenya and 25% from Uganda. The largest proportion of fishers whose incomes had declined were in Uganda (61%), followed by Kenya (52%) and Tanzania (43%). Those who reported increased incomes attributed this to better fish catches and higher prices, while those reporting a decline blamed it on fewer fish or a decline in the stock.

Table 5. Perceptions of income changes by gender, 2007 – 2008. Data are expressed as the percentage of respondents who agreed with the question (from LVFO, 2008).

<table>
<thead>
<tr>
<th>Question</th>
<th>Income in 2007</th>
<th>Income in 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boat Owners</td>
<td>Crew</td>
</tr>
<tr>
<td>Increased</td>
<td>21</td>
<td>23</td>
</tr>
<tr>
<td>Decreased</td>
<td>71</td>
<td>64</td>
</tr>
<tr>
<td>Stayed the same</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Don’t know</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Access to Savings and credit

Access to financial services is needed for fishing communities to be able to save and borrow money but most people in these communities had no access to them. Respondents were asked if they had personal accounts where they saved their money and the results indicated a low level of saving with only 12% of women having accounts compared to 30% in men. The highest numbers of men and women with savings accounts was in Uganda while the lowest was Tanzania, even though their incomes were the highest. On average, men had held bank accounts for 5.3 years compared to 4.5 years in women. The principal reasons given for not having a bank account were that facilities were too far away or they had no money to save (Table 6).

Despite the fact that these communities have no access to formal banking institutions, they have social support groups that enable them to save money for their seasonal and short-term needs (Table 7). More women (51%) than men (31%) use these informal schemes and most respondents used them because they were run by local people, were more accessible and their rules more easily understood. They were also better able to supply women with the small amounts of money they needed at short.

Table 6. Reasons given by respondents (%) for not having bank accounts or saving money (from LVFO 2007).

<table>
<thead>
<tr>
<th>Reason</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saving facilities too far away</td>
<td>41</td>
<td>26</td>
</tr>
<tr>
<td>Not enough money to save</td>
<td>38</td>
<td>60</td>
</tr>
<tr>
<td>Other reasons</td>
<td>21</td>
<td>14</td>
</tr>
</tbody>
</table>
These schemes were more prevalent in Kenya (women 79%, men 51%) and least in Tanzania (women 31%, men 22.5%). These informal saving schemes are based on group formation, and it is believed that women co-operate more with each other in groups than men do. Furthermore, microfinance institutions mostly target women’s groups thus marginalising men especially the youth who do not benefit from savings and credit. On the other hand, credit institutions such as fishermen cooperatives have been known to marginalise women and crew members as membership is based on boat ownership.

Table 7. The types of saving schemes utilised by respondents (%) in the fishing communities (from 2007).

<table>
<thead>
<tr>
<th>Type</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run by local people themselves</td>
<td>71</td>
<td>87</td>
</tr>
<tr>
<td>Run by NGO</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Other financial institutions</td>
<td>20</td>
<td>6</td>
</tr>
</tbody>
</table>

As with most businesses, fishing communities need credit to improve their operations meet unexpected crises but access to credit in these communites is low with only 21% of boat owners, 5% of crew members and 16% women using credit. Women and the youth are further disadvantaged because they lack assets like boats or land that can be used as collateral although men often lack information on the operations of financial institutions and their credit systems.

Sources of credit included NGOs, fishermen cooperatives, microfinance institutions, relatives, fish factory agents and friends. Most women borrowed money to start a new business (42.7%) and invest in fishing activities (36.4%), while most men (74.5%) borrowed to invest in the fishery. Crew needed credit to start a new business (31%), invest in the fisheries (33%) or build a house (25%). Most men indicated that they would use credit to buy fishing gear and boats while women indicated that they would expand their fish trade business. This indicates that men and women use credit in their specialised occupational spheres there is a need for credit so that both can raise the level of their operations. Loan repayment, of course, is always a problem for many in these communities and in Kenya and Uganda women found it most difficult to service their loans while in Tanzania it was crew who experienced the greatest. This is explained by the wide income disparities between boat owners and crew in Tanzania with crew in that country being the lowest-paid. Other mechanisms for informal credit involve relations between fishermen and fish traders based on trust, where a trader may buy nets for a fisherman and he supplies fish to the trader until the loan is fully repaid.

Participation in Co-management

Everyone working in fisheries at a fish landing site on Lake Victoria must be a registered member of a BMU and only BMU members are legally entitled to fish on the lake. At first BMU membership was very low; in 2005 only 50% of fishers in Kenya were members, followed by Uganda (24%) and Tanzania (8%). There has since been a remarkable increase in BMU membership, which increased by 16% for women, 10% for boat crew (youth) and 6% for boat owners between 2007 and 2008 (Table 8).

Table 8. The proportion of respondents (%) taking part in BMU activities (from LVFO 2007 and 2008).

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration in BMU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boat owners</td>
<td>90.3</td>
<td>95.6</td>
</tr>
<tr>
<td>Crew</td>
<td>76.7</td>
<td>85.2</td>
</tr>
<tr>
<td>Women</td>
<td>69.0</td>
<td>80.2</td>
</tr>
<tr>
<td>Participation by voting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boat owners</td>
<td>86.0</td>
<td>92.3</td>
</tr>
<tr>
<td>Crew</td>
<td>72.0</td>
<td>76.2</td>
</tr>
<tr>
<td>Women</td>
<td>65.0</td>
<td>72.5</td>
</tr>
<tr>
<td>Attendance at BMU meetings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boat owners</td>
<td>80.0</td>
<td>83.7</td>
</tr>
<tr>
<td>Crew</td>
<td>69.6</td>
<td>75.8</td>
</tr>
<tr>
<td>Women</td>
<td>58.6</td>
<td>66.3</td>
</tr>
<tr>
<td>Have a greater say in decisions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boat owners</td>
<td>85.0</td>
<td>78.7</td>
</tr>
<tr>
<td>Crew</td>
<td>64.0</td>
<td>88.1</td>
</tr>
<tr>
<td>Women</td>
<td>49.0</td>
<td>70.9</td>
</tr>
</tbody>
</table>

There was a high level of participation in voting for the BMU executive committee although in general more men than women voted (Table 8) with the lowest proportion of women voting being recorded from Tanzania (Kenya 74.4%, Uganda 76.1% and Tanzania 67.3%) (LVFO 2008). Despite the fact that women have been voted into different positions in the BMUs men still dominate the more influential such as the Chairperson. While the BMU guidelines set out criteria for nominations, culture does play a major role in preventing women from contending for the top positions, since cultural and religious perceptions have always placed men in leadership positions. Ironically, although women are normally relegated to lower positions some do not trust men to handle money and therefore prefer a woman to be the Treasurer – but just to keep the money safe and not make decisions over it. The lack of economic power also works against women as they cannot influence voters, unlike boat owners who are able to employ people and supply fish and are therefore much more influential. In some areas the male contenders enjoy higher-level political backing, which is not available to women. Respondents were asked if they had attended any BMU Assembly meeting in the six month prior to March 2008 and levels of attendance were generally high (Table 8). Fewer women than men attended these meetings, especially in Tanzania where only 58% indicated that they attended meetings, compared to 67.5% in Kenya and 74.2% in Uganda.

It is now accepted that rural people and other disadvantaged groups have the right to participate in decisions affecting their lives, to realise their self-worth, and to have their opinions heard and included in the development decisions. The level of participation in decision-making followed the trend in attendance, with men having a greater say in decision-making. The level of improvement in decision making had improved by 42%
for women and by 58% for crew members and having a greater say in decision making over the fishery resources correlated with attendance levels (Table 8). Once again, women and crew in Tanzania had the say in decision making while the highest level of stakeholder participation in decision-making was reported from Kenya. Most people felt they had more say in decision-making because of their attendance at meetings (Table 9).

Table 9. Reasons given by respondents (%) for having a greater say in BMU activities (from LVFO 2008).

<table>
<thead>
<tr>
<th>Reasons for greater participation</th>
<th>Boat Owners</th>
<th>Women</th>
<th>Boat crew</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am on the BMU Committee</td>
<td>19.5</td>
<td>11.6</td>
<td>5.5</td>
</tr>
<tr>
<td>I have attended Assembly meetings</td>
<td>37</td>
<td>36.2</td>
<td>45.3</td>
</tr>
<tr>
<td>I have spoken at Assembly meetings</td>
<td>22.5</td>
<td>16.7</td>
<td>15.0</td>
</tr>
<tr>
<td>The BMU Committee has asked me about my views</td>
<td>8.4</td>
<td>11.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Our leader on the committee represent us well</td>
<td>4.6</td>
<td>5.6</td>
<td>12.8</td>
</tr>
<tr>
<td>Other reasons</td>
<td>8.0</td>
<td>8.1</td>
<td>5.9</td>
</tr>
<tr>
<td>I have no greater say</td>
<td>10.5</td>
<td>8.1</td>
<td>5.9</td>
</tr>
</tbody>
</table>

Incentives to cooperate in co-management

The incentives for governments to participate in co-management included (1) donor-driven initiatives, (2) the high cost of traditional management and limited resources for doing it, (3) poor compliance with regulations as a result of an inability to control the fishery and (4) as a means of reducing poverty. Members of the fishing communities had a variety of reasons for supporting co-management, but both men and hoped for improved fisheries management, zero tolerance of offenders, and development of landing sites. Males wanted access to savings and credit facilities, to see BMUs controlling the scales used to weigh the fish, improved welfare, financial assistance and the collection of revenue at the beach. Incentives for women included improvements in sanitation at the beach, training in business skills, and reduction in taxes and access to loans for fish traders, better fish markets, and the creation of alternative livelihoods. The crew incentives included an improvement of social facilities such as toilets at the landing sites, improved security on the lake, the curbing of illegal fishing through patrols and a reduction in conflicts.

Some of these expectations had been met to a certain extent while others have not; most respondents, in all three categories, indicated that their expectations had not been met. They attributed this to weak leadership, corruption in the BMU and Fisheries Departments, teething problems, lack of facilities for patrol, and inadequate mentorship and coordination from the Fisheries Departments.

Challenges

There of women, men and youths in making decisions on fisheries management has increased, so creating a sense of ownership of decisions and therefore improving compliance. Decisions such as the elimination of illegal fishing gears may have reduced fish catches but the price of fish has risen, having a positive impact on men, but a negative one on women because they have to purchase fish at higher prices. Women respondents indicated that it was very difficult for some of them because if one did not buy immature fish, other traders would do so. In order to adapt to change, most women revealed that they had diversified their sources of income by trading in cereals, purchasing of fish of poor quality that were rejected by factory agents, worked as farm labourers and formed social networks to mobilise finances, while others got married ensure support from a man.

Boat crew indicated that because they had to comply with regulations even though fish catches had declined. This had various impacts, the most severe being a decline in their incomes, but they had to spend more time fishing for fewer fish, having to carry more gear in the boat and an increased workload, and a loss of employment as boat owners reduce their crews. They coped with these challenges by turning to farming, migrating to areas where there were more fish, changing the type of fish they targeted, reducing the number fishing trips, and using illegal gears.

Boat owners experienced a decline in their catches though they caught larger fish because of using the recommended gears, but their income was reduced. To deal with these problems some resorted to other activities such as farming; in Tanzania they reduced the number of boats going out on the lake and the numbers of crew but in Uganda they increased boats and used of illegal gears with only a few complying with the rules and using the right gears. Some boat owners form credit groups to provide funds for purchasing the recommended gears, but changing the target species and migrating to other beaches were also common coping strategies amongst the boat owners.

Conclusions

Community organizing is much more than just establishing organisations, it is a process of empowerment, building awareness, promoting new values and behaviour, establishing self-reliance, building relationships, developing organisations and leadership, and enabling communities to take action. Efforts to strengthen the role of BMUs should aim to promote these values and stakeholders should be able to listen to each other and take action as necessary. Fishers should also be given the right to develop their own organizations and to
form networks and coalitions for cooperation and coordination without influence from the government.

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I would like to acknowledge the support from the European Union, through their funding of the LVFO, which made it possible to obtain the information given in this paper. I also wish to acknowledge the socio-economic researchers at the three LVFO institutions: KMFRI, TAFIRI and NAFFIRI for their contribution to this paper.

References
Management of Fishing Capacity in the Nile Perch Fishery of Lake Victoria*

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Abstract
The International Plan of Action for Management of Fishing Capacity encourages countries to develop regional and/or national plans of action for management of fishing capacity. The Lake Victoria Fisheries Organization (LVFO) working together with FAO have come up with the Regional Plan of Action for Managing fishing capacity (RPOA-Capacity) on Lake Victoria. This paper illustrates the problem of fishing capacity on Lake Victoria and the need for managing the fishing capacity. In managing capacity there is a need to understand the current fishing effort and fish stocks and their interactions. Optimal levels of effort in terms of fishing boats, fishing gear, manpower and time are all needed for effective setting of management measures. A bio-economic model is required to guide management decision on managing fishing capacity. There is an urgent need to collect more reliable disaggregated data on effort targeting different species for effective management of the lake fisheries.

Key words: Lake Victoria, fishing capacity, legislation, stakeholder views, action plan.

Introduction
The National Development Objectives of the three Partner States around Lake Victoria (Kenya, Tanzania and Uganda) are poverty reduction, resource sustainability, and environmental health. These objectives are important in relation to the lake because it is an important economic and social asset and large numbers of people depend on it for their livelihoods. The lake has experienced a number of environmental changes over the last three decades which initially led to great increase in fishery production (Reynolds et al., 1995) but the continuing expansion of the fisheries is now reducing the stocks of some species. A number of challenges will have to be met if the fisheries are to be managed effectively among them: environmental degradation and a loss of fish habitat, excessive fishing effort, outdated laws and regulations, and weak management and extension services.

In 1994, the three Partner States established the Lake Victoria Fisheries Organization (LVFO) to jointly manage the fisheries of Lake Victoria. One of its tasks was to harmonise management measures on the lake and many regional activities have been carried out to meet this objective. These include a Strategic Vision and a Fisheries Management Plan that will implement the International Code of Conduct for Responsible Fisheries (CCRF). The overall objective of the CCRF is sustainable fisheries and each country is required, amongst other things, to ensure that fishing effort is commensurate with sustainable use of fishery resources. In Lake Victoria, the Nile perch fishery is now a cause for concern because catches have declined in recent years and there have been calls for urgent action to reverse the trend. In March 2007 the LVFO Council of Ministers approved a Regional Plan of Action for Management of Fishing Capacity on Lake Victoria (RPOA-Capacity) that had been developed to manage fishing effort as part of the overall fisheries management strategy (LVFO, 2007). The objective of the RPOA-Capacity is to manage fishing capacity on the Lake, in cooperation with fishing communities and the local authorities. The intention is to give Beach Management Units (BMUs), as well as other stakeholders, the power to exercise their full rights and responsibilities as part of the co-management system established around the lake. The RPOA-Capacity document has now been published, along with popular versions in English, Kiswahili, Dholuo and Luganda, enabling information about the plan to be disseminated to stakeholders. The rules and regulations governing fisheries have been reviewed and now include legal provision for implementing the RPOA-Capacity and both national and regional consultations have been held to agree on the process of implementing it. Steps have also been taken to develop an RPOA-Capacity monitoring

programme and to strengthen the capacity of BMUs and other stakeholders to participate in this programme.

\[\text{Figure 1. Estimated annual catch of Nile perch from Lake Victoria (LVFO, 2008a).}\]

\[\text{Figure 2. Distribution of fishing crafts in Lake Victoria between 2000 and 2006: (a) total numbers and (b) relative numbers with the 2000 estimate being the baseline (equal to 1.0).} \]

The current status of fishing effort and fish catches

From the time of its introduction in the 1960s until about 1980 Nile perch were of little economic importance but the population explosion that occurred from 1980 onwards led to a huge increase in fishery yields, which peaked at about 400,000 t in 1990. Catches declined after that but now appear to have stabilised around 25,000 t per annum (Figure 1). The bi-annual lake-wide frame surveys that have been carried out since 2000 provided data on trends in fishing effort which has increased since 2000 but by varying degrees in each country (Figure 2).

What is RPOA-Capacity?

The RPOA-Capacity sets out the principles, goals, interventions and specific actions that need to be taken to manage fishing effort, such as the number of fishers who can fish on the lake, the number and type of fishing crafts and fishing gears. These activities will be based on the principles of participation, phased implementation, holistic approach, conservation, new technologies, mobility and transparency in accordance with the CCRF. The RPOA-Capacity will be implemented by the Partner States directly through the LVFO institutions at grassroots level (BMUs) as well as local, national and regional government levels, and in collaboration with other stakeholders.

The Partner States are currently implementing a number of agreed measures for the management of fishing capacity. They include:

(a) Implementing the decisions of the LVFO Council of Ministers, which control access to the fishery through registration and licensing of fishing crafts and fishers; control the size of Nile perch harvested by setting a slot size of 50 – 85cm and Nile Tilapia by not allowing fish <25cm to be caught and setting a minimum gillnet mesh size of 127 mm (5”);

(b) Implementing the Regional Plan of Action for Illegal, Unlicensed and Undocumented fishing (RPOA-IUU) through monitoring, control and surveillance measures;

(c) Promoting co-management of the fisheries through the formation of Beach Management Units (BMUs) and the involvement of other stakeholders;

(d) Assessing and monitoring the fish stocks through acoustic, trawl, gillnet and other surveys;

(e) Assessing the state of the fishery and the level of fishing effort through frame surveys;

(f) Monitoring commercial fisheries through catch assessment surveys;

(g) Considering suitable mesh sizes and fishing grounds for dagaa;

(h) Prohibiting the use of destructive fishing gears and methods such as monofilament gillnets, beach seines, trawl nets, cast nets, beating the water, and poisons;

(i) Implementation of a closed season for dagaa in the Kenyan part of Lake Victoria; and

(j) Setting up closed areas and seasons to protect breeding and nursery grounds, pathways for migratory fishes, and biodiversity.

The numbers of fishers, fishing crafts and fishing gears have increased although the rate of increase has slowed down over the last few years (Table 1), suggesting that these actions may be having some impact (Table 1). The rapid increase in illegal monofilament nets is a cause for concern although the data may represent more effective enumeration of this gear and the increase may
not be as great as it seems. The optimal numbers of fishers, fishing crafts and fishing gears still need to be determined, agreed and managed.

**Table 1.** The rate of change in some components of the Lake Victoria fishery. From data in LVFO (2008a).

<table>
<thead>
<tr>
<th></th>
<th>Annual rate of increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000-06</td>
</tr>
<tr>
<td>Fishers</td>
<td>8.7</td>
</tr>
<tr>
<td>Boats</td>
<td>10.8</td>
</tr>
<tr>
<td>Illegal gill nets (&lt;5&quot;)</td>
<td>15.0</td>
</tr>
<tr>
<td>Legal gill nets (≥5&quot;)</td>
<td>14.6</td>
</tr>
<tr>
<td>Long line hooks</td>
<td>26.4</td>
</tr>
<tr>
<td>Monofilament nets</td>
<td>No data</td>
</tr>
</tbody>
</table>

**Stakeholder Consultations**

The control of fishing effort in Lake Victoria has been proposed as a management tool to address the issue of overcapacity. The exact nature of such a control can only be determined once there is enough scientific information and after wide consultation with stakeholders. A considerable amount of data on the dynamics of fish stocks in Lake Victoria, their biology, ecology and exploitation patterns already exists and it is supported by information on landings and catches based on Catch Assessment Survey (CAS) and on effort based on Frame Survey (FS). This has made it possible to make a preliminary fishery-specific management plans for Nile perch (Kayanda et al., 2009) with other species to follow. As part of implementation of the RPOA-Capacity, stakeholder consultations were undertaken to determine their views on how to tackle the issue of fishing effort. Consultations were undertaken at two levels, the first was an exploratory study aimed at stakeholders directly concerned with fishing. Various open-ended, structured and semi-structured questionnaires were designed and administered to a cross section of stakeholders in February 2008 to solicit their views and suggestions on what should be done. The second was through national and regional consultation stakeholders’ workshops to build on the findings of the first study to consolidate and harmonise proposed measures and to agree on a monitoring mechanism to manage fishing capacity. The views of various stakeholders are presented in the following sections.

**Field Consultations**

During these consultations a few selected respondents from each identified stakeholder group were interviewed to get information on possible measures to manage fishing capacity. The sample size was agreed upon by the Regional Task Force (RTF) which prepared questionnaires for each stakeholder group. These groups included: (a) BMU committee and assembly members; (b) Local authorities (district and sub-county); (c) NGOs/CBOs representing fisher’s associations and those supporting the fisher communities; (d) the industrial fish processors, their agents, managers and owners, and (e) fish traders in local and regional markets. The consultations were carried out in Busia, Bugiri, Mukono, Mpigi, Kalangala and Rakai districts in Uganda, Bondo, Homa Bay, Migori, Rachunu and Suba districts in Kenya, and Tarime, Musoma, Ukerewe, Sengerema, Muleba, and Buloba districts in Tanzania. Three landing sites were surveyed in each district and 10 BMU respondents were targeted at each landing site.

**Views from BMU’s**

In the opinion of most BMU members the stocks of Nile perch, tilapia and dagaa are declining across the lake although there were some who felt that dagaa and tilapia catches were increasing (Table 2). The decline in stocks was attributed to various factors such as increased illegal fishing activities, an excessive number of fishing boats and gears, environmental degradation (including encroachments on wetlands) and climatic change (Table 2). Other views on status of fishing effort, reasons for illegalities, and measures for controlling undersized fish and priority alternative livelihoods are given in Table 3.

**Table 2.** The views of BMU respondents on the status of the fish stocks in Lake Victoria. Values are the proportion (%) of respondents holding a particular view.

<table>
<thead>
<tr>
<th>Status</th>
<th>Nile perch</th>
<th>Tilapia</th>
<th>Dagaa</th>
</tr>
</thead>
<tbody>
<tr>
<td>The same</td>
<td>1.3</td>
<td>3.3</td>
<td>19.5</td>
</tr>
<tr>
<td>Decreasing</td>
<td>93.5</td>
<td>88.7</td>
<td>43.6</td>
</tr>
<tr>
<td>Increasing</td>
<td>5.2</td>
<td>5.4</td>
<td>21.5</td>
</tr>
<tr>
<td>Do not know</td>
<td>0</td>
<td>2.6</td>
<td>14.4</td>
</tr>
</tbody>
</table>

**Views from Local Authorities**

Local authorities currently undertake regular patrols to enforce the regulations to curb the catching of undersized fish and the trading licenses of offenders may be suspended, while habitual offenders are denied licenses altogether. Informing and educating fishing communities on the dangers of illegal fishing was considered to be an option for controlling effort and it was felt that these actions have led to a reduction of illegal fishing and reduction in the catching of undersized fish. This was indicated by the fact that fishers were apparently changing from using gill nets with five-inch mesh (~ 125 mm) to six or seven-inch (~ 150-175 mm) nets. Some of the measures proposed by Local Authorities to reduce effort are given in Table 4.

**Views of Fish Traders and processors**

Fish traders were of the view that the market demand for undersized fish was driven by their low cost, which made them available to consumers with low incomes. Crop and fish farming were seen as the main sources of alternative income with other sources such as the sale of clothing or trading in cereals but these activities are constrained by inadequate sources of capital for investment. The views of fish processors and factory owners are summarised in Table 5.
Table 3: The views of BMU respondents on aspects of fishery management on Lake Victoria.

<table>
<thead>
<tr>
<th>Issue</th>
<th>Views</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status of fishing effort</td>
<td>Excessive (81-97%). Recommended action: reduce number of fishers, no more than 1-5 boats per fisher; no more than 20-30 nets per boat for Nile perch and tilapia and 1-5 for dagaa; no more than 100-500 hooks per boat; license only law-abiding BMU members. Other options included facilitating investment in alternative sources of income and the establishment of closed seasons.</td>
</tr>
<tr>
<td>Reasons for illegal fishing activities</td>
<td>Approved gears are too expensive; the need to survive, along with greed and corruption coupled with the desire for better catches; weak law enforcement; BMUs unable to carry out law enforcement.</td>
</tr>
<tr>
<td>Sources of illegal gears</td>
<td>Imports from Korea and China; smuggling from neighbouring countries; beach seines and cast nets locally made at beaches.</td>
</tr>
<tr>
<td>Measures for controlling undersized fish</td>
<td>Ban import and manufacture of illegal gears; enforce law at landing sites, markets and border points; sensitisation and education; support alternative livelihoods.</td>
</tr>
<tr>
<td>Priority alternative livelihoods</td>
<td>Crop farming, animal husbandry, fish farming, trade.</td>
</tr>
</tbody>
</table>

Table 4. Views expressed by some local authorities around Lake Victoria on actions needed to control illegal fishing practices.

<table>
<thead>
<tr>
<th>Issue</th>
<th>View</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing methods for controlling fishing effort</td>
<td>Take action against traders in undersized fish by suspending trading licenses</td>
</tr>
<tr>
<td>Proposed new measures</td>
<td>Removal of all illegal fishing methods; vetting applicants for licensing and determining Total Allowable Effort (TAE); increasing license fees; allowing BMUs to conduct MCS; educate and inform communities on reasons for reducing effort; establish closed seasons</td>
</tr>
<tr>
<td>Alternative sources of income</td>
<td>Promote alternative livelihoods</td>
</tr>
<tr>
<td></td>
<td>Crop and animal husbandry; fish farming; trade; investment in marine transport and tourism</td>
</tr>
</tbody>
</table>

Table 5. Views expressed by fish traders and the owners or managers of factories and processors on the management of Lake Victoria fisheries.

<table>
<thead>
<tr>
<th>Issue</th>
<th>Views</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventing undersized fish from reaching the factories</td>
<td>Enforce regulations; appoint inspectors to monitor self policing; reject undersized fish at factories and report to inspectors; educate suppliers on dangers of harvesting undersized fish</td>
</tr>
<tr>
<td>Impact of self policing on factory operations</td>
<td>Supply of raw materials reduced for a short time during initial stages; short-term retrenchment of workers; reduction in exports of chilled and frozen products; increase in cost of fixed overheads in relation to income</td>
</tr>
<tr>
<td>What government can do stop the harvesting of undersized fish</td>
<td>Empower BMUs to monitor slot size compliance at landing sites and to confiscate illegal gears; enact laws to regulate supplies of fishing gears; provide more resources for constant and sustained MCS activities; educate fish suppliers on the dangers of catching undersized fish</td>
</tr>
<tr>
<td>What government should do to control decline of fishery</td>
<td>Establish closed seasons for fishing and processing; reduce fishing effort on agreed terms; enforce regulations on slot size in all three countries; confiscate immature fish from local markets</td>
</tr>
<tr>
<td>Alternative sources of Nile perch</td>
<td>Uganda; Lakes Albert and Kyoga. Tanzania; none. Kenya; possibly Lake Turkana. Develop fish farming</td>
</tr>
</tbody>
</table>
National and Regional Workshops
Findings from field surveys were presented to stakeholders at national workshops where it was agreed that the main problems of the fishery were (a) excessive fishing effort, (b) illegal gears and (c) the catching of undersized, mostly immature, fish. A stakeholder workshop in Bukoba, Tanzania, in March 2008 discussed the implementation of the RPOA-capacity and drew up an action plan, summarised in Table 6 [see page 73].

Priority areas for legislative action to manage fishing capacity
The RPOA-capacity activities also involved a review of the legislation in the three countries to see how far they support the management of fishing capacity. The RPOA-capacity provides for fishing effort to be limited to the level it was in 2006 (based on data from the 2006 Frame Survey) but current fisheries legislation does not adequately provide for the limiting of fishing effort. The review of the legislation undertaken by the Fisheries Policy and Legislation Regional Working Group identified priority areas for legislative actions and indicated a number of gaps (Table 7). The main priority areas for legislative action that were identified included:
(a) The harmonisation of the policy and legal framework for management of fishing capacity;
(b) Regional and international collaboration;
(c) Recognition of BMUs in principal legislation as agencies for the management of fishing capacity;
(d) Legal requirement for information and sharing;
(e) Legal powers for Fisheries Departments to limit fishing licenses to regulate fishing effort in accordance with agreed limits including the ability to limit Nile perch vessel licenses to the 2006 level;
(f) Systems for licensing boats, gears and fishers, and regulating the importation, manufacture and trade of fishing gears; and
(g) Sustainable financing mechanisms for fisheries management and development.

Table 7. The present legal power of Fisheries Departments to regulate fishing in line with agreed limits.

<table>
<thead>
<tr>
<th>Area to be limited</th>
<th>Kenya</th>
<th>Tanzania</th>
<th>Uganda</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of vessels</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>No. of gears</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>No. of fishers</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Duration of fishing trips</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Implementation of the RPOA-Capacity
The main issues facing the Nile perch fisheries of Lake Victoria are the increase in fishing effort as a whole and in particular the use of illegal fishing methods against the declining fish stocks. This has led to a decline in the stocks, which in turn creates more pressure to use illegal methods, such as small-mesh nets, to meet the demand for fish and the need for fishers to maintain their income (Figure 4).

Implementing the RPOA-Capacity may therefore make it necessary to impose strict measures that will directly affect the livelihoods of people in the fishing communities, reduce the revenue earned by local authorities and national governments and affect the fish trade in the short run. Managing fishing capacity may require a reduction in the number of fishers or fishing gear and boats to a sustainable level in order to maintain a reliable and sustainable supply of fish to the fish processing industry. It is imperative that mitigation measures to lessen the adverse effects on the affected communities are developed and implemented. The lake-wide consultations provided an opportunity for policy makers to understand the views of the stakeholders and their ability to cope with the loss of income from fisheries. It is necessary to continue informing them about the need to manage fishing capacity and to solicit their views on how best to implement the RPOA-Capacity. It is also important for them to understand their role in the management of fishing capacity and to appreciate the benefits that may accrue to their communities in the long run.

Figure 4. The positive feedback loop that promotes increased fishing effort for Nile perch on Lake Victoria.

Conclusion
Excessive fishing capacity is a problem that, if not managed, could contribute substantially to depletion of the fish stocks and significant economic losses. It was generally agreed that fishing effort had increased to an undesirable level and stakeholders suggested effort could be reduced by combating illegal fishing, limiting the number of boats owned by an individual and limiting the number of gears per boat, as well as providing alternative sources of livelihood. Limiting access to the fishery through licensing should be strengthened and fishing communities should be given training in fishery management and effective utilisation of income from the fishery.

In conclusion, it was recommended that the following actions need to be taken as a matter of urgency:
(a) Fishing effort should be controlled through means suggested by the stakeholders and further consultations to harmonise the methods is needed before they can be implemented.
(b) Effort could be controlled through the use of licensing as a limited-entry management tool but since fishers with a long history who could be given fishing rights licences cannot be identified all those currently participating in the fishery could be licensed. There should also a 5-year moratorium on new licences and effort reduction would then occur through natural attrition. Future licenses would then be limited only to BMU members.

c) The size of boats, together with the maximum number of nets, longlines and hooks per boat should be specified on the licences. The aim should be to eliminate the dugouts and “parachute” boats which fish in breeding and nursery grounds for tilapia and young Nile perch.

d) The importation and manufacture of prohibited gears should be controlled with customs officials and traders or suppliers of fishing gear being provided with guidelines for the identification of illegal gears. Enforcement should be strengthened and extended to cover local markets with all involved in the fishery being further educated on the impact of such gears.

e) Alternatives sources of livelihood such as farming, horticulture and fish culture should be encouraged and supported but practiced away from the shoreline to avoid possible degradation of wetlands. To be able to achieve such diversification, technical skills should be developed along with partnerships with private sector and financial institutions.

(f) Fishing communities should be given adequate training to enable them to manage fishery resources and effectively utilise their income from the fishery.

(g) More investment should be made in law enforcement but the stakeholders should have a greater involvement in MCS activities in line with the current efforts in co-management.

(h) The extension arms of the fisheries management agencies should be separated from the law enforcement sections to avoid conflicts between intensified MCS activities and the provision of much-needed extension services in education and awareness campaigns.

(i) The control of gear distribution in the region should be carried out in line with the spirit of co-management and this will require harmonisation of tariffs to eliminate price differentials between the countries.

Acknowledgements

Funding from the Food and Agriculture Organisation to initiate the implementation of the RPOA-Capacity and from the European Union is greatly appreciated. The input of the stakeholders towards developing the action plan and the time spared by the BMUs to provide valuable information is acknowledged.

References


<table>
<thead>
<tr>
<th>Issue</th>
<th>Causes</th>
<th>Action</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive fishing effort</td>
<td>Too many boats, gears and fishers on the lake.</td>
<td>Amend legislation to limit the number of vessels, number of fishing gears per boat, number of boats per fisher, number of fishers and duration of fishing initially targeting boats in the Nile perch fishery.</td>
<td>1 year</td>
</tr>
<tr>
<td>Lack of standardised estimates of fishing effort.</td>
<td></td>
<td>Amend TAFIRI and NARS Act to enable the collection of necessary information.</td>
<td>2 years</td>
</tr>
<tr>
<td>Low level of information exchange on fishing effort in the region.</td>
<td>Disaggregate frame survey data by fleets targeting species and identify data gaps in the fishery-specific management plans.</td>
<td>Ongoing</td>
<td></td>
</tr>
<tr>
<td>Inadequate law enforcement to contain illegal fishing.</td>
<td>Maintain and improve MCS activities on land and water.</td>
<td></td>
<td>Ongoing</td>
</tr>
<tr>
<td>Failure of licensing to restrict access to the fishery when main objective is to generate revenue for the local government.</td>
<td>BMUs to register and license only legal fishers and include agreed limits in vetting and licensing process.</td>
<td>1 year</td>
<td></td>
</tr>
<tr>
<td>Inadequate information and education of stakeholders.</td>
<td>Support the preparation of the LVFO Information and Data Policy.</td>
<td></td>
<td>3 months</td>
</tr>
<tr>
<td>High demand from processing factories as a result of over-capacity.</td>
<td>Regulate processing capacity following assessment of processing capacity in relation to resource and if necessary limit new entrants to the industrial processing sector.</td>
<td>1 year</td>
<td></td>
</tr>
<tr>
<td>Lack of alternative (or diversified) livelihoods.</td>
<td>Members of Parliament to use ‘Prosperity for All’ and ‘Constituency Development Fund’ to support AIGs for women and disadvantaged groups.</td>
<td>Ongoing</td>
<td></td>
</tr>
<tr>
<td>Persistent use of illegal gears</td>
<td>Legal gear is too expensive.</td>
<td>BMUs to lobby government and NGOs to provide legal gears in exchange for illegal ones or provide credit facilities.</td>
<td>Immediate</td>
</tr>
<tr>
<td>Availability of illegal gears in the market.</td>
<td>Enact law on importation, manufacture and trade of fishing gear including registration of dealers.</td>
<td></td>
<td>1 year</td>
</tr>
<tr>
<td>Local and political interference in law enforcement.</td>
<td>Educate politicians and BMUs to expose corrupt politicians in the media.</td>
<td></td>
<td>Immediate</td>
</tr>
<tr>
<td>BMUs failing to control members.</td>
<td>Change BMU leadership and deregister BMUs involved in illegalities; develop effective deterrent measures and sanctions.</td>
<td></td>
<td>Immediate</td>
</tr>
<tr>
<td>Continued capture of undersized Nile perch</td>
<td>Demand for undersized fish drives the illegal fishery.</td>
<td>Direct resources and effort to tackle local and regional trade in small Nile perch.</td>
<td>Immediate</td>
</tr>
<tr>
<td>Use of undersized gill nets and beach seines.</td>
<td>Liaise with neighbouring countries on the issue.</td>
<td></td>
<td>6 months</td>
</tr>
</tbody>
</table>
Aquaculture for increased fish production in East Africa*

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Abstract
Fish is produced for human consumption and other purposes through capture fisheries and aquaculture. Fish production from natural stocks has already reached its limits and is declining while aquaculture production is increasing. Aquaculture is making a significant contribution to fish production in several countries thus proving to be a potential alternative to supplement the declining capture fisheries. In East Africa the contribution of aquaculture to the total fish production is still insignificant although it has been practised in the region since the 1900s. The predominant aquaculture production system in East Africa at present is small scale earthen ponds characterised by low inputs and low yields. Important ingredients for the emergence of a commercial aquaculture industry are highlighted with emphasis on the need for a conducive and harmonised policy framework across the region. This paper advocates a focused plan of action for aquaculture development in the region and makes succinct recommendations for fast transformation of the industry.

Key words: Aquaculture, East Africa, Lake Victoria basin, production, marketing, regulation, new technologies.

Introduction
Fish are produced for human consumption and other purposes through capture fisheries and aquaculture, both of which can make substantial contributions to economic growth and food supply. Capture fisheries harvest resources in both marine and freshwater environments and are equivalent to hunting while aquaculture is the farming of aquatic organisms such as fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production and these include regular stocking, feeding, and protection from predators, amongst other things, as well as the manipulation of the environment, the formulation of feed, genetic improvements, and marketing in a manner that maximises profitability.

Although aquaculture has some similarities with capture fisheries, the core issues are different. These include differences in the socio-economic and biophysical environments, tools and operational practices, and the psychology of investment and management. Consequently, the priorities for capture fisheries and aquaculture will differ significantly. It is now recognised that production from capture fisheries cannot be increased much above its current level and the supply of fish from capture fisheries is dwindling on a per capita basis at a time when demand is increasing. It is estimated that in order to maintain the current level of per capita consumption, global aquaculture production will need to reach 80 million tonnes by 2050 (FAO, 2006). The decline is most pronounced in sub-Saharan Africa which is the only region in the world where fish consumption is falling. In East Africa, the gap between supply and demand is widening to such an extent that even the axial skeletons of fish (mungo waizi), eaten by local people, are becoming scarce.

Several countries have now focussed their attention on the development of aquaculture with Egypt being the leading example in Africa. In that country the government proposed an aquaculture development plan in the late 1970s to boost the development of the sector and by the mid-1980s, the annual production from aquaculture had increased dramatically from a mere 17,000 tonnes to 45,000 tonnes. The target is to produce 1.7 million tonnes of fish by 2017 with 1.0 million tonnes coming from aquaculture (FAO-NASO, 2009). Aquaculture production alone in Egypt exceeds the total national fish production (captures fisheries and aquaculture combined) of any of the East African countries (FAO, 2009) in spite of plentiful water resources in the region.

There are several other countries that have considerably increased aquaculture productivity, which suggests that it can mitigate the predicted global shortfall in fish production. In China, for instance, the
landlocked province of Sichuan alone produced more than one million tons of fish from aquaculture in 2006. This is in stark contrast with total fish production in Kenya (159,000 t), Uganda (399,000 tonnes), Rwanda (9,000 t), Tanzania 359,000 and Burundi (14,000 t) (FAO, 2009).

Why then the dismal performance in East Africa?

East Africa has so far relied heavily on capture fisheries with a tendency to marginalise aquaculture as far as resource allocation and manpower development is concerned. The countries in the region are no exceptions to the global trend of declining stocks of wild fish and capture fisheries alone can no longer meet demand for fish, both for local consumption and export. Fish processing plants around Lake Victoria, for example, are operating at less than 50% capacity while some have closed down. Therefore, the need for aquaculture to supplement capture fisheries cannot be overstated.

Aquaculture potential in the region

Aquaculture can generate a wide range of benefits including employment, food and income but governments must develop mechanisms for sustainable aquaculture on a large scale. East African aquaculture not only has significant strengths and opportunities, such as good sites for aquaculture development with adequate water resources, processing capacity, and expanding markets for fish, but it also faces some challenges and threats. These include the lack of an enabling regulatory environment, limited access to appropriate technologies, credit and markets, trade barriers that restrict the trade of farmed fish, and the rising costs of imports and production inputs. The crucial areas where action is needed include suitable production systems, the availability of affordable feeds, quality seed, equipment, capital, outreach, research, education and training, marketing, producer organizations, regulation, control, monitoring and evaluation.

While addressing these issues it should be emphasised that aquaculture is a business, and should provide attractive investment opportunities. The lack of a commercial or business approach to aquaculture production is one of the principal obstacles confronting the expansion of the industry. Early assumptions about the availability of inputs such as land, labour and capital did not realistically consider the economic and financial costs of fish farming and profitable yields were difficult to obtain. Much of this early effort attempted to integrate subsistence crop farming with fish farming by establishing farm ponds and while this may have contributed to household incomes it had little impact on national fisheries production. These low-input family systems are still practiced by rural people in East Africa but new aquaculture paradigms now focus on the development of commercially viable aquaculture enterprises.

Aquaculture operates as a business, no matter how small the enterprise, which is market- and profit-oriented, which will have to attract private sector investment (NEPAD, 2005). The development of aquaculture requires investments in a number of areas such as assessing supply and demand, developing trade policies, improving markets, and building capacity for continued technical innovation, market exploration and self-regulation. New aquaculture technology requires investment in research and development before it can be adapted to local conditions and markets and it is unrealistic to expect pioneer entrepreneurs to shoulder the full burden of these activities. The risk involved in establishing a new technology without state assistance is simply too great for most entrepreneurs and this calls for public-private partnerships. The most successful aquaculture industries have emerged where the state in partnership with the private sector has shared the initial risks, especially in relation to the development of new technologies.

This paper identifies constraints and suggests ameliorative measures that constitute key elements of a private/public partnership required to develop commercial aquaculture in the region. These can be incorporated into a regional strategy and made operational by a regional aquaculture sector plan that is structured and realistic.

Suitable production systems

Appropriate production systems are essential for successful aquaculture and there area number of options available to the fish farmer. These have various advantages and disadvantages and there is a need to prioritise the development of systems that will significantly increase productivity. Efforts should be concentrated on those systems that can maximise returns on investment (whether public or private). It is obviously not possible to suddenly discourage small-scale fish farmers using farm ponds but well-defined support for commercialising other systems such as tanks and cages will be needed since ponds are generally less efficient (Table 1).

Table 1. A comparison of the potential fish yield from different cultures systems (derived from unpublished data, Aquaculture Research Centre, Kajansi, Uganda).

<table>
<thead>
<tr>
<th>Production system</th>
<th>Yield (kg m⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponds</td>
<td>0.2</td>
</tr>
<tr>
<td>Tanks</td>
<td>100</td>
</tr>
<tr>
<td>Cages</td>
<td>150</td>
</tr>
<tr>
<td>Raceways</td>
<td>200</td>
</tr>
</tbody>
</table>

Ponds

Ponds are still widely used in many parts of the world and well constructed and managed ponds can be productive. In East Africa, however, ponds tend to be scattered and far from each other making it difficult to disseminate new knowledge, or to coordinate production and marketing. Aquaculture parks are a possible model for improving this situation and they could be employed to achieve a critical level of production that can meet market demands. Under this approach farmers would be encouraged to own fish farms individually but at one locality to ensure economies of scale and to synchronise programmes leading to well planned and predictable production.
Cages
Cage culture has a great development potential and is currently one of the fastest growing segments of global aquaculture production and plays a significant role in most leading aquaculture producers with a reported production of about 3,500,000 tonnes from 62 countries (Tacon and Halwart, 2007). It is now widely perceived that cage culture has the potential to increase fish production on the scale that will be needed to meet Africa’s fish deficit.

Tanks
Highly productive systems have been developed in tanks and raceways with Nigeria leading the development of these production systems in Africa. Stocking are reported to be as high as 300 fish m\(^{-2}\) with an average harvest weight of 1.5kg achieved in 5-6 months (Rutaisire personal observation, Kaduna, Nigeria). This has been made possible by the availability of high quality feeds and this is an aspect that will need improvement in East Africa.

Availability and access to inputs
The availability of inputs, especially feeds, is a major bottleneck for aquaculture development in East Africa. Unlike the traditional farming systems that have established supply networks, aquaculture inputs are difficult to obtain in local markets because the industry is young and the demand small. It is difficult for farmers to obtain equipment like aerators, fish grinders, water quality test kits, chest waders, fish medications, and so on. These all have to be imported, which is a difficult process for ordinary fish farmers while commercial firms are reluctant to import them because of the limited customer base. Suitable feed is of critical importance as commercial fish farming is impossible without high-quality feed, including specialised types such as the floating pellets used in cage culture. Local feed manufacturers may have the capacity to provide such feed but will not import the necessary equipment until an assured market exists.

Outreach, education and training
Modern aquaculture is a high-technology activity and investors must get the right advice before starting fish farming. In the past some farmers have fallen into the hands of self-declared consultants with no experience in fish farming, resulting in financial losses, abandonment of fish farms and a general reluctance to invest in aquaculture. Much needs to be done to ensure that an extension service system with well-qualified advisors is available in the region to advise potential investors.

Marketing and producer organisations
Farmed fish should be marketed as a different commodity from fish caught from the wild because age and size are not a legal consideration in aquaculture as long as the market accepts the product. A system should be put in place so that farmed fish can be distinguished from wild fish so as to prevent the capture of immature fish. In many countries farmed fish are sold live, thus the purchaser can be certain that it is fresh. Effective organisations that are able to link producers with markets will be needed if aquaculture is to grow and produce enough farmed fish to meet the current and future demand for fish. Such producer organisations can develop systems for transportation to markets, the sale of produce from the farms, information gathering and sharing among members.

Profitability
Successful aquaculture is usually preceded by successful fishing industries that establishes a demand for fishery products, and develops markets and infrastructure for processing and distribution. The opportunities for the growth of aquaculture arise when fishery production begins to decline and the price of fish products increases. The decreasing supply of fish from Lake Victoria creates just such an opportunity for aquaculture development in the region. Farm gate prices are rising to the extent that it may be more profitable to supply fish in regional markets rather than export it to Europe. However cost-benefit ratios will depend on the species being cultured, the availability of quality feeds, and other input costs and it is not possible to predict probable profit margins for all production systems. This is one of the areas where research should help to provide indicative figures to meet the need for bench marks to guide potential investors.

Regulation, control, monitoring and policy implications
Each East African country currently has its own regulations for fish farming. In Uganda, for instance, it is regulated under the Aquaculture Rules 2003, which describe the various requirements, permits and fees set out by the Department of Fisheries Resources. From a farmers’ perspective the rules seem to have been developed ahead of the industry they are supposed to regulate. They need further revision to produce a regulatory framework commensurate with the growth of the industry. A National Aquaculture Development Strategy for Uganda has been developed with support from FAO and is about to be adopted by the government.

In Kenya, a new fisheries policy seeking to regulate aquaculture practices, amongst other things, has been launched. Subsequently, the Fisheries Act Cap 378 (1989) is being reviewed. The government in its effort to promote fisheries and aquaculture created a fully fledged Ministry of Fisheries Development. Like in Uganda, Kenya with the aid of FAO is finalising its National Aquaculture Development Strategy, which is in line with its National Fisheries Policy. The Ministry of Fisheries Development has established a Directorate of Aquaculture Development and a National Aquaculture Development Working Group to spearhead the development of the aquaculture sector. As more emphasis is put on aquaculture there will be need to ensure that the regulations developed are conducive for the growth of the industry and not a hindrance. The National Environment Management Authority (NEMA) of Kenya is mandated to exercise general supervision and co-ordination over all matters relating the environment. One of the environmental aspects of aquaculture that is regulated by NEMA is the introduction of any animal or plant (or any part of plant specimen) whether alien or indigenous in a lake, river or wetland. This regulation is found in the
Environmental Management and Coordination Act (EMCA, 1999).

In Tanzania the government has established a Directorate of Aquaculture Development (DAD) responsible specifically on issues pertaining to aquaculture development. Tanzania also has been formulating a National Aquaculture Development Strategy (NADS) which is in final stages of endorsement.

Conclusions
Capture fisheries can no longer meet East Africa’s fish needs, whether for local consumption or export. The broad strategic approach is to safeguard the capture fisheries whilst promoting regional aquaculture programmes that can make significant contributions to the supply of fish. The gap between the supply and demand of fish is likely to widen if aquaculture programmes do not move from policy pronouncements to a practical transformation of the industry.

East Africa has adequate resources to produce fish from aquaculture but this potential can only be realised if the sector is reorganised and production targets set. Reorganisation should be extensive and take into consideration production systems, infrastructure development, linkages between production and markets, and the harmonisation of development strategies and plans across the region. The linkages between public institutions such as regulating agencies, research institutions, and finance houses with the private sector are particularly important and will need to be given special attention.

In view of the urgent need to increase aquaculture production to a much greater level than at present, the following recommendations have been made:
1. Clear and harmonised policies and legislation for aquaculture development in the region must be developed.
2. The formation of producer organisations should be promoted, and supported until they become self-sufficient.
3. A system for the collection and publication of reliable and up-to-date aquaculture statistics should be developed.
4. Training institutions, such as universities or agricultural colleges, should be assisted to develop aquaculture curricula with an emphasis on practical training.
5. Governments should consider strategic interventions to support the private sector in aquaculture.
6. The efficiency of earthen ponds should be improved through the promotion of aquaculture parks or clusters. At the same time, aquaculture systems should be diversified from earthen ponds to tanks, raceways and cages.
7. Scientists and managers in the region should be encouraged to produce well packaged information for various users.
8. Service providers such as as consultants and other experts, should be certified to safeguard investors from wrong advice.
9. Researchers, managers and the private sector should collaborate to provide bench marks to guide potential investors in aquaculture.

Acknowledgements
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References
The Present Status of the Hook Fishery and its Impact on the Fish Stocks of Lake Victoria

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Abstract
Surveys on the hook fishery of Lake Victoria revealed that long lines are the most important gear used for catching Nile perch. Hand lines and hook and line are used to catch Nile tilapia and also Nile perch. Hooks are increasing because of their cheapness. They now total about 12 million lake-wide. Hooks are preferentially baited with live bait; they select the catch according to their sizes and bait type. Big range of fish sizes is caught. Hooks tend to reduce the size of the brood stock made up of big perch that carry millions of eggs. The use of live bait suppresses the recovery of resurgling species with an adverse impact on the lake’s biodiversity. Use of the recommended hook sizes 4-9 should be enforced and overcapacity reduced for sustenance of the fish stocks. The farming of bait fish should be encouraged for standardisation of bait size to target the right size of the catch and spare the recovering species.

Key words: hook fishery management, fish stocks, biodiversity, bait fish farming

Introduction
Long lines with baited hooks have become the most widely used fishing method for Nile perch Lates niloticus (L.) in Lake Victoria while Nile tilapia Oreochromis niloticus (L.) and haplochromines are caught by hand lines and by angling. The number of hooks has almost trebled over a period of eight years and it is estimated that about 12,000,000 hooks are presently in use on the lake with about half of them in the Tanzanian part (LVFO, 2008). The rapid development of this fishery is explained by the fact that it requires relatively little capital, especially compared to gill nets and therefore allows people with low income to enter the fishery. A regional working group on the hook fishery was established in September 2005 and it undertook a preliminary survey during October-December 2005 followed by other surveys from January-March 2006, while further surveys were carried out along with catch assessment surveys.

Live bait is the most effective type of bait for Nile perch and almost all species found in the lake are used for this purpose. Hooks are a highly selective form of fishing gear and the size of the hook and bait determines the minimum size of fish that can swallow it while the maximum size will be the biggest fish the hook can retain. Catches may therefore include juveniles as well as the largest adults of the target species. The Nile perch hook fishery therefore has the potential to fish out large individual perch which may produce several millions of eggs thereby causing a loss of reproductive potential. In addition, the fishery uses live bait mostly obtained from wild stocks in the lake and its basin thus threatening the recovery of native species and reducing stocks of species valuable in other fisheries.

This paper presents the results of the surveys carried out on the hook fisheries in all three countries around the lake together with observations from catch assessment surveys (CAS) in the Tanzania waters of Lake Victoria. The impact of the fishery on the stocks of the target and bait species is discussed.

Methods
Landing sites where the hook fishery was widespread were visited in Kenya (9 sites), Tanzania (4 sites), and Uganda (10 sites). The type of materials used in rigging hooks, the sizes and number of hooks per gear unit, the types of bait used, type of the types of canoes and their means of propulsion, and the methods of setting the gear were either directly observed or determined from interviews with fishers. The catch rates and size
distribution were determined, especially in later surveys done during the catch assessment surveys (CAS). Additional information was obtained from fishers through questionnaires and informal discussions. The status of the fishery was assessed by observing trends of the number of fishing units counted during frame surveys carried out every two years between 2000 and 2008. The investigation also included visits to fish farmers where catfish *Clarias gariepinus* (Burchell) were being grown for sale as live bait.

**Results**

**Gear Description**

The hooks that were being used ranged from number 4 size (the largest) to number 20 (the smallest) but the most frequently-used were numbers 9-12. Long lines were the most commonly used form of gear, followed by hand lines while angling was the least frequent method. Long lines consist of 0.5-0.7-mm polyamide monofilament lines although multi-strand 15-36-ply nylon twine was occasionally used. They are rigged with snoods ranging from about 10-30 cm in length with snood intervals ranging from about 5 to 10 m. Long lines have, on average, a total of 400 and 1500 hooks for those operated on canoes propelled by sails and outboard engines, respectively, and they specifically target Nile perch.

Hand lines, which target large Nile perch and Nile tilapia, carry on average, about 10 large hooks (numbers 4-8) on 0.7-1.0-mm monofilament lines although number 7-8 hooks are preferred. In angling up to four hooks are attached to various sizes of monofilament lines attached to fishing rods or held in the hand and the hook size depends on the target species; numbers 7-8 for Nile perch, 9-15 for Nile tilapia and 15-20 for haplochromines.

**Bait species, sources and storage**

Almost all fish species that occur in Lake Victoria are used as bait but the most commonly used are the haplochromines (more than 60%), *Clarias* spp. (about 20%) and dead dagaa (less than 5%) since these are the most readily available. Baits used for tilapia include earthworms (over 80%), filamentous algae (about 10%), insects and their larvae, and the shrimp *Caridina nilotica* Roux and earthworms are used to catch haplochromines. *Clarias* needed for bait are caught from wetlands along the lakeshore and along river banks and flood plains, small beach small seines and angling with small hooks are used to catch haplochromines while in the swamps bait is caught by draining pools or using traps. The bait fish are kept alive in covered 20-litre containers with water that must constantly be renewed to prevent oxygen depletion; even so, the loss through asphyxiation is quite common.

Some bait fish are raised in ponds by a few farmers in Kenya, and in Uganda where a number of farmers are making serious efforts to raise fish for bait. All of them are raising the catfish, *C. gariepinus* but farmed fish account for less than 2% of all those used for bait.

**Gear setting**

Long lines are set at various depths from the surface to the bottom through the manipulation of floats and sinkers attached at intervals along the main lines, depending on the depth at which the target fish is expected to occur. Two types of setting are practised: day setting in which the gear is set early in the morning and retrieved in the evening the same day, and overnight setting where the gear is set in the afternoon or evening and retrieved in the following morning. Day setting is the most common method because it this minimises gear theft and reduces interference with gillnets which are normally set overnight.

Hand lines, set in inshore waters, are anchored at one end while the other end bears a few hooks baited with live bait. The gear may be operated actively by trolling in shallow waters and around rocky islets using outboard engines or paddles in an effort to catch large Nile perch; in this case artificial baits such as wooden fish dummies are used. Those fishermen targeting tilapia with hand lines fish in shallow water from canoes or rafts. Anglers mostly stand on rocky shores at the edge of the lake where they are most likely to catch tilapia and haplochromines.

**Status of the hook fishery**

The total number of hooks in use on the lake rose from about 3,500,000 in 2000 (98.5% in long lines) to over 11,000,000 in 2008 (99.4% in long lines). The number of long line hooks used in Kenya increased rapidly between 2000 and 2002 but remained relatively stable thereafter while they rose steadily in Tanzania with a sharp increase between 2006 and 2008 (Table 1). Relatively few hooks were used in Uganda in 2000 but they increased rapidly especially between 2004 and 2008 suggesting a major change in the fishing methods employed in that country. The number of hand line hooks did not change greatly, except in Uganda where there was a sharp increase in their numbers after 2004.

**Table 1.** The number of long line (LL) and hand line (HL) hooks (thousands) in use on Lake Victoria, 2000-2008. From LVFO (2009).

<table>
<thead>
<tr>
<th>Year</th>
<th>Kenya LL</th>
<th>Kenya HL</th>
<th>Tanzania LL</th>
<th>Tanzania HL</th>
<th>Uganda LL</th>
<th>Uganda HL</th>
<th>Total LL</th>
<th>Total HL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1,040</td>
<td>34</td>
<td>2,202</td>
<td>14</td>
<td>254</td>
<td>5</td>
<td>3,496</td>
<td>53</td>
</tr>
<tr>
<td>2002</td>
<td>2,562</td>
<td>12</td>
<td>4,609</td>
<td>39</td>
<td>927</td>
<td>7</td>
<td>8,098</td>
<td>58</td>
</tr>
<tr>
<td>2004</td>
<td>2,046</td>
<td>13</td>
<td>3,082</td>
<td>19</td>
<td>969</td>
<td>8</td>
<td>6,096</td>
<td>41</td>
</tr>
<tr>
<td>2006</td>
<td>2,624</td>
<td>20</td>
<td>4,135</td>
<td>35</td>
<td>2,286</td>
<td>16</td>
<td>9,045</td>
<td>72</td>
</tr>
<tr>
<td>2008</td>
<td>2,502</td>
<td>16</td>
<td>6,002</td>
<td>30</td>
<td>2,764</td>
<td>20</td>
<td>11,268</td>
<td>66</td>
</tr>
</tbody>
</table>
Most hook fishers use Sesse canoes, pointed at both ends, and at some landing sites, e.g., Mchangani on Kome Island, Tanzania, almost all of the boats were engaged in the hook fishery. Overall, about 64% of all fishing boats in Kenya were using hooks, compared to 55% in Tanzania and 34% in Uganda. Most canoes were propelled by paddles in combination with sails but there is an increasing trend towards the use of outboard motors on canoes pointed at one end; in 2000 just under 10% of boats were propelled by motors but this had risen to just under 22% by 2008 (Table 2). Outboard engines enable fishers to reach offshore fishing grounds and they no longer have to rely on favourable winds, and they can therefore fish more frequently.

Table 2. The numbers of fishing craft (thousands) on Lake Victoria according to their mode of propulsion, 2000-2008. From LVFO (2008).

<table>
<thead>
<tr>
<th>Year</th>
<th>Kenya Motor</th>
<th>Kenya Paddle/sail</th>
<th>Tanzania Motor</th>
<th>Tanzania Paddle/sail</th>
<th>Uganda Motor</th>
<th>Uganda Paddle/sail</th>
<th>Total Motor</th>
<th>Total Paddle/sail</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0.64</td>
<td>10.87</td>
<td>1.53</td>
<td>13.95</td>
<td>2.03</td>
<td>13.51</td>
<td>4.20</td>
<td>38.34</td>
</tr>
<tr>
<td>2002</td>
<td>0.69</td>
<td>11.52</td>
<td>2.61</td>
<td>18.55</td>
<td>3.25</td>
<td>15.34</td>
<td>6.55</td>
<td>35.04</td>
</tr>
<tr>
<td>2004</td>
<td>0.86</td>
<td>11.42</td>
<td>5.58</td>
<td>17.06</td>
<td>3.17</td>
<td>13.01</td>
<td>9.61</td>
<td>41.49</td>
</tr>
<tr>
<td>2006</td>
<td>1.30</td>
<td>13.72</td>
<td>6.42</td>
<td>19.95</td>
<td>5.05</td>
<td>18.94</td>
<td>12.77</td>
<td>52.61</td>
</tr>
<tr>
<td>2008</td>
<td>1.18</td>
<td>12.85</td>
<td>6.93</td>
<td>18.89</td>
<td>5.60</td>
<td>17.66</td>
<td>13.71</td>
<td>49.40</td>
</tr>
</tbody>
</table>

Table 3. Catch rates of Nile perch (kg/canoe/day) from long lines at four landing sites in Tanzania, February/March, 2006.

<table>
<thead>
<tr>
<th>Landing site</th>
<th>Catch rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kijwemi</td>
<td>31.1 ± 19.2</td>
</tr>
<tr>
<td>Kinigi</td>
<td>22.9 ± 17.9</td>
</tr>
<tr>
<td>Malehe</td>
<td>36.3 ± 31.1</td>
</tr>
<tr>
<td>Mchangani</td>
<td>26.9 ± 20.0</td>
</tr>
</tbody>
</table>

Figure 1. The length-frequency distribution of Nile perch caught in the long line fishery in Tanzanian waters, February/March, 2006.

Catch rates and structure of exploited stocks

The Nile perch hook fishery is most successful when live bait is used but dead dagaa are also used and, according to the fishers, it is most effective in May/July during the cool, windy, period when the lake is isothermal (Talling, 1966). Catch rates ranged between 30-40 kg/canoe/day in Kenya, 25-45 kg/canoe/day in Uganda and 22-36 kg/canoe/day in Tanzania (Table 3); the wide standard deviations of the latter indicate that catch rates are highly variable. In addition, fishers mentioned that on rare occasions as much as 100-200 kg/canoe/day of Nile perch could be caught. The modal length of Nile perch caught by long lines was around 35-40 cm in all three countries, which is below the minimum slot size of 50 cm TL (Figure 1).

The size of Nile perch in hook sizes 10-12, which are the most commonly used hooks in long lines, do not differ much in size and there is little size-selectivity in the catch by these three hook sizes (Figure 2). The mean size of the fish varied slightly according to hook size, with the largest hook (size 10) catching the largest fish (48.7 cm), compared to 46.9 cm for size 11 hooks and 44.3 cm for size 12 hooks. The differences were not significant (Kruskall-Wallis test, K = 1.47, p > 0.05) indicating that the three hook sizes are exploiting the same fish.

Figure 2. Cumulative length-frequencies of Nile perch caught by three commonly used hook sizes, numbers 10-12 (Note: no. 10 is the largest, no. 12 the smallest).

There was a degree of selectivity according to the type of bait that was used with smaller fish being caught with haplochromines and larger ones with Clarias as bait (Figure 3). The reason for this is that haplochromines used as bait were smaller (6-10 cm TL) than Clarias
(10-20 cm TL) and therefore used on smaller hooks which tended to select the more numerous smaller Nile perch.

**Figure 3.** The length-frequency distribution of Nile perch caught in size 10-12 hooks using *Clarias* and haplochromines as bait.

The hook sizes used in the Nile tilapia fishery ranged from numbers 9-12 in Kenya, 9-11 in Uganda, and 10-15 in Tanzania. The catch of Nile tilapia with these hooks in Tanzania consisted mainly of 18-20 cm fish (Figure 4a) which is close to the length at first maturity in 2004-05 (Njiru et al., 2007). There was some variation in this distribution as in the case of a sample from one area in Tanzania where fish caught with size 11 hooks exhibited a bimodal distribution (Figure 4b). The first mode (16-18 cm TL) was made up of fish that were presumably juveniles whilst the second mode (28-30 cm TL) was composed of mature fish, which suggests that bigger hooks (e.g., sizes 9 and 10) would catch predominantly large and mature Nile tilapia.

**Figure 4.** Length-frequency distribution of Oreochromis niloticus (a) caught with hook sizes 10-15 used in the fishery in Tanzania, February/March 2006 and (b) caught with hook size 11, at Mchangani Kone, Sengerema, March 2006.

**Catfish culture**

Culture of the catfish, *C. gariepinus* for bait was practised in Kenya and Uganda, while two people in Tanzania who intended to culture these fish experienced financial and technical difficulties which prevented them doing so. The major problems reported by farmers were the high mortality of fry, the high cost of feed, cannibalism and competition with cheaper bait obtained from the wild. The current production of bait fish from farms accounted for less than 2% of the bait requirement and there is obviously scope for expansion provided the difficulties can be overcome; this would probably be easier if more people were involved and could take advantage of the economies of scale.

**Discussion**

The long line fishery has grown on Lake Victoria because of the increasing cost of fishing gear, which is often stolen and although hooks are also stolen, the loss is much less than when gillnets are stolen. In the long line fishery, specifically targeting Nile perch, the importance of bait cannot be underrated; indeed, the fishery has evolved through its requirement for live bait. Selectivity seems to be more strongly influenced by the size of the bait than the size of hooks (Figures 2 and 3). Since smaller tends to catch smaller fish there is a demand for larger (> 30 cm) species such as *Mormyrus kannume* Forskal and juvenile lungfish *Protopterus aethiopicus* Heckel, and the fishery uses both adults and juveniles of different species, some of which (e.g. catfish and lungfish) are taken from the wild. Mkumbo and Mlaponi (2007) estimated that about 7,500 t of bait from the wild was needed each year on the Tanzanian side of Lake Victoria. This estimate was based on 4,000,000 hooks then in use there, half of which were considered to be baited each day. The number of hooks has now risen to slightly more than 11,000,000 (LVFO, 2008) suggesting that more than 22,000 t of bait would be required each year. At present, there are few alternative sources of bait and the problem is growing and apparently insoluble; the only possible solution, the culture of bait species, has yet to have any impact.

The demand for tilapia bait is unlikely to have such adverse impacts since the most commonly-used baits are earthworms and filamentous algae, both of which are plentiful around the lake shore and in its basin.

The modal size of Nile perch and Nile tilapia caught in the hook fishery are 35-40 cm TL and 18-20 cm TL, respectively while the minimum legal lengths (the “slot size”) are 50 and 25 cm TL, respectively. Both fisheries therefore catch a high proportion of undersized fish although, in the case of Nile perch at least, the size of first maturity has decreased from 50-65 cm and 80-95 cm TL for males and females in the 1980s (Ogutu-Ohwayo, 1988; Hughes, 1992) to about 40 cm in males and 57 cm in females (LVFO, 2007). This suggests that the catches of both species consists mostly of juveniles which is a potential threat to the stocks as they might become too small to produce enough recruits to the fishable stock thus bringing about recruitment overfishing (Pitcher and Hart, 1982). That the stock now is composed of small fish is
reflected by the shift towards use of smaller hooks (Table 5).

Table 5. Changes in the number of hooks of different sizes used in the hook fishery of Lake Victoria, 2006-2008 (from LVFO, 2008).

<table>
<thead>
<tr>
<th>Hook size</th>
<th>2006</th>
<th>2008</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4</td>
<td>32,000</td>
<td>25,000</td>
<td>-22</td>
</tr>
<tr>
<td>4 to 7</td>
<td>406,000</td>
<td>395,000</td>
<td>-3</td>
</tr>
<tr>
<td>8 to 10</td>
<td>5,224,000</td>
<td>4,845,000</td>
<td>-7</td>
</tr>
<tr>
<td>&gt; 10</td>
<td>3,383,000</td>
<td>6,002,000</td>
<td>77</td>
</tr>
</tbody>
</table>

The legally permitted hook size (4-9) in the Nile perch fishery should be strictly enforced, to protect both undersized fish and the very large females beyond (> 85 cm TL), which can produce millions of eggs and are not caught in gill nets. This might be achieved through the use standard-sized bait fish, but this would only be practical if the bait came from farm-raised fish.

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References


