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ON THE CATCH ASSESSMENT SURVEY (CAS) OF LAKE VICTORIA.

by

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PART 1

UGANDA WATERS OF LAKE VICTORIA

1 Introduction

If recent estimates are accurate, the world's human population can be expected to double in the next thirty years. The rate of growth will likely be even greater in many African nations. Yet food supplies in these countries, especially of essential animal proteins, are even now inadequate. Clearly, increased production of food for domestic consumption must become a high-priority development goal.

The inland fisheries of Africa will play an increasingly important role in augmenting protein supplies. In 1970, production of the inland fisheries was already about 1.4 million metric tons, and had increased some 71 per cent in the previous six years. With further development and more effective fishery management a two-fold increase in output over the present level can reasonably be expected (CIFA/72/8).

Effective management of the fisheries at optimum exploitation levels and development of under-utilized fish resources will necessitate major improvements in the statistical systems employed to produce information on the fish stocks and fisheries. More reliable and detailed information on the catch, effort and other important aspects of the fishing enterprises will be required.

The improvement of systems for the collection and processing of inland fishery statistics has been a major goal of FAO and various host countries in connection with research and development programs on African Lakes and reservoirs Systems have already been introduced with varying success to Lake Kariba, Lake Tanganyika (Burundi), Lake Volta, Kainji Lake, Lake Nasser and Lake Victoria. An important feature of these systems is that they will permit the comparison of fishery statistics on a continental basis and, on bodies of water straddling national boundaries, enable integrated management of the shared resources.

A second important attribute of the systems is that they are based on simple yet thoroughly proven concepts of efficient sample survey design, and provide detailed information of known precision at relatively low cost. This may be contrasted to the systems prevailing now in many fisheries, which produce patchy information, often biased, in a manner that precludes meaningful comparisons either geographically or temporally.

On Lake Victoria a new system of Catch Assessment Surveys (CAS) was introduced in 1972 by Dr. George Bazigos, FAO fishery statistician, as part of the FAO/UNDP input to the Lake Victoria Fisheries Research Project. The CAS program was intended to be a joint effort of EAFFRO and the fisheries departments of Uganda, Kenya and Tanzania. Details of the survey design and procedures are given in a series of documents prepared by Bazigos and deposited at EAFFRO. In addition, a brief description of the CAS program was presented by Wetherall (1972).

The Lake Victoria CAS program began in the first quarter of 1972 in all three countries, but ran into trouble around mid-year and has since been idle. It is hoped that the surveys will be resumed in the future. In spite of the problems encountered, the surveys produced a great deal of useful information and the initial experiences, both good and bad, will form a valuable basis for further efforts.

The purpose of this report is to provide a provisional summary of information on landings and fishing effort produced in the Uganda CAS during January-March, 1972. The information presented represents only a small part of the total information produced in the survey. It was intended that a complete analysis be done using a high-speed computer, such as the one available at Makerere University. Indeed, this is the only sensible way of analysing such a large quantity of data, and must be a central feature of the CAS program. However, the provisional estimates reported here were produced manually.

Several people collaborated to produce the CAS results. Dr. Bazigos, of course, was instrumental. The frame surveys were carried out by Dr. D. A. P. Butcher and his staff. The Uganda Fisheries Department provided the manpower and financial resources for the CAS itself. In particular, R. S. Walker of the Fisheries Department supervised the field work and assisted with analysis. The contributions of these people and many others who assisted in various ways is gratefully acknowledged.

11. CAS Design and Procedures

Only a brief description of the design and procedures of the CAS will be given here. A more detailed account may be found in the documents and reports mentioned previously. Further, the methods employed are well-known and reference may be made to standard texts on sample survey techniques.

We will consider here four basic aspects of the CAS (1) the sampling frame, (2) stratification, (3) sample selection and survey procedures, and (4) computations.

11. 1. The Sampling Frame

The first step in the design of the CAS is the selection of the basic sampling units and the construction of a list of these units, which we call the sampling frame In the CAS the basic sampling unit is the fishing economic unit (FEU), which consists usually of a fishing canoe, its crew and their fishing gear, It is this Unit on which observations are made concerning survey characteristics, such as number of crew members, number of gillnets, catch in a day's fishing, and so on,

In the Lake Victoria fisheries there is no handy complete list of the FEU s, so the size and structure of the sampling frame must be estimated. This is accomplished in two phases. First, an aerial survey is conducted around the lake shore and the islands. All canoes seen, either on land or in the water, are counted and their position is marked on a map. Second, a coverage check survey is conducted from the water. There shoreline is divided into equal segments of, say, 20 km, and a number of these segments are selected for complete coverage. In the coverage check survey all canoes are counted, and put in categories depending on whether they are local, non-local, used for fishing, out of order, etc. A comparison of the exact information gathered from the selected segments of shoreline with the corresponding aerial survey data provides us with correction factors and estimates of the errors associated with the aerial survey It is therefore possible to obtain fairly accurate estimates of the number of active fishing canoes and their distribution around the lake shore

11 2 Stratification

Since the sampling frame is established, random samples of FEUs could be selected and estimates of the various survey characteristics such as total landings could be calculated in the usual way, using the sample observations and expanding to the entire frame. This is the basic approach in simple random sampling, but in order to increase precision in the overall estimates and to provide more detailed information we use the technique called stratification. Before drawing a sample of canoes for observation, we first break the frame list down into sections or strata in such a way that within each stratum the characteristics of interest, such as catch per canoe-day, do not vary much. At the same time the strata are chosen so that there are significant differences between strata. When the total frame is stratified in this manner, a very small sample can be selected within each stratum. The result will be that independent estimates of the survey characteristics are obtained for each stratum. These can be added to obtain total estimates for the complete frame and the resulting estimates will be much more precise, even though the total sample size may be no larger.

Stratification was used extensively in the design of the Lake Victoria CAS. A diagram showing the different strata is given in Figure 1. First, the total frame was divided into three parts, corresponding to the three countries. This was done for administrative reasons - obviously we want separate estimates for each country. Next, within each country a further sub-division was made into areas called limnological zones (LZs). The boundries of these zones were selected by G.E.B. Kitaka, EAFFRO Limnologist, on the basis of his extensive studies. Basic limnological characteristics are presumed to differ from zone to zone but to be fairly uniform within each zone. The idea of this stratification is of course that differences in limnological characteristics will result in differences in basic aquatic productivity, fish density, catch rates, species composition, and so on.

In the Uganda waters, the limnological zones were defined as follows (See Figure 2).

LZ 1 Uganda - Tanzania border to Bunjako Bay

LZ 2 Sesse Islands

LZ 3 Bunjako Bay to Rosebery Channel (Entebbe Region).

LZ 4 Rosebery Channel to point about 15 miles east of Jinja, including western part of Buvuma.

LZ 5 Remainder of Uganda waters to Kenya border.

The next level of stratification is a division of the frame, within each limnological zone, into categories depending on the size of the fishing site in which the canoe is located. Within each limnological zone, the fishing canoes (elements of the sampling frame) are clustered into fishing sites, which vary in size from just a few canoes to perhaps 50 or more. We expected that some important survey characteristics would vary according to the size of the fishing site. In the Uganda CAS we established two classes, one consisting of small sites with 10 or fewer canoes, the other made up of large sites with more than 10 FEUs.

As the stratification diagram indicates, there are two more levels of classification. First a canoe or FEU may be classified according to the fishing method it uses. Here we have defined two classes: units in one class use gillnets and/or long lines,and/or traps and those in the other class fish with beach seines. Second, we distinguish canoes according to propulsion type - whether they have outboard motors or are non-motorized. Clearly, we may expect to find differences in survey characteristics due to differences in fishing method or type of propulsion.

The frame survey (aerial survey plus coverage check survey) provides estimates of the size of the entire frame, its division into limnological zones, and within the zones, the size distribution of fishing sites The classification of FEUs according to fishing methods and propulsion type is accomplished later in the CAS itself

11. 3 Survey Procedures

The CAS in Lake Victoria is set up to run on a quarterly basis That is, a complete, independent set of estimates for all survey characteristics is to be produced for each quarter of the year. In the jargon of the CAS, each time period is called a round. Annual estimates are obtained by combining sample data from the four rounds.

During each round of the CAS, samples of fishing economic units or fishing canoes are selected from the stratified frame lists. The selection of the samples is done in two stages. First, since the FEUs are clustered into fishing sites we begin by selecting a sample of fishing sites from the frame list In each limnological zone, four fishing sites are selected in a random manner- two small-size sites and two large-size sites In addition, replacement sites are selected in case some of the principal sites turn out to have exceptionally poor access or are too inconvenient to sample for some other reason. The location of selected sites is marked on a map, and lists of the sites are prepared for the teams of field recorders A time-table is constructed in such a way that the sites can be visited conveniently and so that the sampling is spread out over the round.

When the recorders visit a selected fishing site, they carry out the survey in two phases In the first phase, (PSI survey) which normally takes two days, they begin by making a complete list of the FEUs in the site Each unit on the list is classified according to the fishing method used and the type of propulsion. Within each of these categories, a sample of FEUs is then chosen (this is the second stage of selection) and the crews of the selected units are interviewed. Information is obtained on the type and age of their canoe, the number of crew members, their ages and years of schooling, the number of dependents, amount and size of gear owned, replacement interval for gear, and so on. For motorized canoes, information is also obtained on engine horsepower and weekly petrol consumption.

During the second phase of the survey (PS2 survey) the recorders work on the local landing beach for three consecutive days. Each day they make a complete list of the outgoing canoes, again classifying them according to fishing method and type of propulsion. They then select from each category a sample of canoes to be checked on their return to the landing. The catch of the selected canoes is sorted into species, then counted and weighted. Additional information is gathered on the make-up of the crew, the amount and size of gear fished, distance to the fishing grounds, type of habitat fished and so on

11 4 Computations

Since the Lake Victoria CAS is set up in a very systematic fashion, the computations and the calculation of various estimates is quite straight-forward. The data on the field forms, or source documents, must first be checked and edited by the supervisors in charge of the recorders. It is then transferred to working sheets, which are designed in such a way that manual calculations are easy to perform, but also so that the data may be key-punched directly from the sheets for computer processing. There are two styles of working sheets, one for the survey's first phase and one for the second phase.

Even though the computations are straightforward, they involve a great amount of labour if done by hand or even with the aid of a desk calculator. The deep stratification of the CAS gives us roughly 40 classes or sub-strata, and there are easily 20-25 survey characteristics of interest to us. This means there are 800 to 1,000 final estimates to calculate, for each country, in each round of the survey

Note that each of these final estimates involves computations using sample data from 2 fishing sites and, in many cases, from three consecutive days, so the amount of intermediate computations is staggering. The obvious solution, especially since the computational scheme is so systematic, is to use a digital computer. EAFFRO has access to the computer at Makerere University, and Dr. Bazigos has a series of computer programs written specifically to carry out all the computations

11 5 Modification of the CAS

The Lake Victoria CAS is designed to be quite flexible. As we gain experience or as our objectives change, different aspects of the survey can be modified. There are three areas where changes can be expected:

1. Changes in the sampling frame. Periodically it will be necessary to reconstruct the sampling frame by conducting new aerial surveys and/or coverage check surveys.

2. Changes in the design or stratification. As we accumulate experience with the CAS and carry out appropriate analyses of the results, we may find that there are no significant differences between certain strata or categories as far as the major survey characteristics are concerned We may then decide that certain strata can be combined, so that the CAS can be simplified and costs can be reduced. On the other hand, we may find that deeper stratification would be useful, and the design may therefore become more elaborate.

3. Changes in the list of survey characteristics After a time we may decide to discard certain items of information from the source documents and/or to add new survey characteristics. Any characteristic that can be taken as an observation on the basic sampling units (FEUs) can be accommodated in the CAS.

111. Results of the CAS

111. 1. Classification of FEUs

As discussed previously, the FEUs were classified according to fishing methods and two propulsion types were defined. Estimates of the proportion of FEUs in each of the four resulting classes were obtained in the PS1 survey. The resulting estimates of the number of fishing canoes in each category are given in Table 1. No motorized beach seiners were encountered in any of the selected fishing sites.

In Table 2 (A) the percentage composition is given for data summed over all limnological zones. About 87 percent of all FEUs use fishing method - 1 (FM - 1) and the proportion using FM - 1 is greater in large fishing sites than in small ones. Among all canoes using FM - 1, only 7 per cent have them. In the second part (B) of Table 2 we see that among motorized canoes using gill-nets or longlines, 81 per cent are in the small fishing sites

111. 2. Sample Sizes and Sampling Fractions in the PS2 Survey

In the PS2 survey, samples of FUEs were selected from the lists of outgoing fishing canoes made up at the landing beaches. The basic unit of observation in the PS2 is therefore a canoe-day of fishing activity. The theoretical maximum number of canoe-days of activity during the round is found by multiplying the estimated number of canoes (from the frame list- Table 1) by 90, the number of days in the round.

The actual number of canoe-days of fishing activity is calculated using the lists of outgoing canoes, and the results are given in Table 3. The total activity of 232, 454 canoe-days represents 79 per cent of the theoretical maximum.

The number of canoe-days of fishing activity actually sampled is given in Table 4(A). The sampling fractions, for data combined over limnological zones, are shown in Table 4(B). These were computed by dividing the appropriate elements in Table 4(A) by their counterparts in Table 3 Considering all categories of FEUs, less than one tenth of one percent of the total fishing activity was sampled. Sampling fractions were more than 10 times larger in the class of large fishing sites than in the small-site category. And, among fishing method - propulsion type combinations, they were greatest in motorized canoes using FM - 1.

Looking at Table 4 (A), note that only one canoe-day of activity was sampled among motorized canoes using FM - 1 in the small fishing sites. Further, for beach seiners only 12 canoe-days were sampled. Estimates appearing later in the paper for these categories, and for any sub-categories with small sample sizes, must be treated circumspectly.

111. 3 Number of Gill Nets per Canoe and Mesh-Size Composition

During the FS2 survey, the number and mesh-size of gill nets used in fishing was recorded for the sampled FEUs The average number of nets used and their mesh size composition was computed for all strata. The estimates are shown in Table 5.

Several interesting results may be noted. First, on the average, motorized canoes use more nets than non-motorized FEUs (about 50 nets versus 31). Second, canoes in the large fishing sites, both motorized and non-motorized, use more nets than FEUs in the small sites (overall, about 49 nets versus 28.4).

Turning now to the size composition of the nets used, on the average 54 per cent of the nets had meshes 3 inches or smaller, and only 11.6 percent were of a mesh size larger than 5 inches. Further, the proportion of small-mesh nets was far greater in small fishing sites than in large ones (60.5 per cent versus 36.4 per cent).

In Table 6, it is seen that 59.2 per cent of the nets used by non-motorized gill-netters were small mesh (3 inches or less) In contrast, the motorized canoes used no small-mesh nets, and about 36 per cent of their nets were large-mesh (greater than 5 inches) compared to only 9 3 per cent for non-motorized canoes.

The composition of gill nets used by non-motorized canoes was not the same in large as in small sites (Table 7) The data for motorized canoes are inadequate for such a comparison. Still, it would appear that differences in gear composition are a function both of propulsion type and the size of the fishing site.

Finally, a comparison of gear composition by limnological zone indicates that larger mesh nets are used, on the average in zones 4 and 5 than in the other three regions (Table 5

111. 4. Fishing Efforts

From the FS2 data, a measure of fishing effort by gill-netters may be constructed. This was done by multiplying estimates of the number of canoe-days of activity for each category of FEU (Table 3) by the corresponding estimate of the number of gill nets used per canoe (Table 5). The resulting measure of fishing effort is the number of gill net-days, or more appropriately, gill net-nights of fishing activity.

Estimates of fishing effort, in thousands of gill net-nights, are shown in Table 8 the results coming from the pooled data in each limnological zone. The breakdown of total effort into the three broad mesh-size categories is also indicated.

111 5. Average Landings per Canoe-day and Total Landings for the Round

The most vital information sought in the CAS is an estimate of total landings. Of further interest is a measure of fishing success, such as landings per canoe-day of fishing activity. Data for estimating both come from the FS2 surveys where the landings of sampled canoes are sorted by species, counted and weighed. In this report weight units will be used. However, the corresponding enumeration data are available, and would be useful for estimating, for each mesh size, the average individual weight of fish landed, by species. In addition, the count data could be used to calculate measures of fishing success similar to those used historically on Lake Victoria, such as the average number of fish landed per gill net-night.

The estimates of average landings per canoe-day of fishing activity are presented in Table 9. Figures are given in kilograms. The overall average is 25.8 kg per canoe-day. The average for beach seiners is about 33 kg. per canoe-day, but is based on only 12 sampled canoe-days of activity. The estimates for FM - 1 (mostly gill nets, but a few long lines) are more reliable - 23.7 kg per canoe-day for non-motorized FEUs (sample of 149 canoe-days) and 41.9 kgs for motorized canoes (sample of 44 units).

Overall, the landings per canoe-day are nearly twice as great in large sites as in small ones, and greater for motorized canoes than for the non-motorized. Apparent differences between limnological zones may not be significant. In particular, the low estimate for zone 5 may be inaccurate since in the small fishing site category only one site was visited and only 10 canoe-days were sampled. The same remark would apply to a number of other estimates as well, particularly those in the smaller cells of the table.

In Table 9, estimates are also given of the total landings in metric tons. These figures are obtained by multiply estimates of average landings per canoe-day by the total activity estimates in Table 3 and converting to tons. The total landings in the Uganda waters of Lake Victoria during the first quarter of 1972 were estimated to be about 6000 tons. About one-sixth of this was landed by beach seiners, and about 74 per cent of the landings came from small fishing sites. Nearly 75 per cent of the total was taken by a non-motorized canoes using fishing method-1.

A comparison of the landings estimates with figures given by the Uganda Fisheries Department will be deferred to the discussion section.

111. 6. Species Composition of the Landings.

Estimates of the species composition of the landings are presented in Table 10 and 11. In Table 10, results are given for the landings of both fishing methods combined, for each limnological zone and fishing site size category. The composition of the total landings is shown in the last column and is repeated in Table 12, where the species are re-ordered by overall rank and the ranks are given for each limnological zone.

Protopterus is seen to be the most prominent species in the total first-quarter landings, making up over 36 per cent. Haplochromis follows closely with 34 per cent. In third position is the aggregate of Tilapia species, mostly Tilapia nilotica, with 14.2 per cent (Note that no Tilapia leucosticta were recorded, hence this species is not listed). The remainder of the landings consist of Clarias (6.3 per cent), Bagrus (5.7 per cent) and other species (3.4 per cent).

In Table 11, estimates of species composition are given for the different combinations of fishing method, propulsion type and size of fishing site. The calculations were made with data pooled over all limnological zones.

The estimates for beach seining in Table 11 are, as noted previously, based on only 12 sampled canoe-days of fishing activity. Keeping this limitation in mind, we note that Tilapia species account for 31.5 per cent of the total beach seine landings, followed by Protopterus (29.8 per cent), Haplochromis (21.6 per cent, Clarias (6.4 per cent) and Bagrus (5.9 per cent).

For fishing method - 1, Protopterus and Haplochromis dominate the total landings, with Tilapia, Clarias and Bagrus much less important. However, there is a striking difference between propulsion types. For motorized canoes, Protopterus still dominates the landings (34 per cent) but is closely followed by Tilapia (29.6 per cent). Bagrus is also important (21.3 per cent). Haplochromis landings by the motorized canoes are virtually nil, since these FEUs do not use small-mesh nets.

Non-motorized canoes using fishing method - 1 present a different picture. Now Haplochromis dominates the landings (40.5 per cent), followed by Protopterus (38.1 per cent), Tilapia (8.6 per cent), Clarias (5.7 per cent) and Bagrus (3.9 per cent). Within this class of FEUs the composition of the landings differs according to size of the fishing site. In the small fishing sites, Haplochromis dominates the landings with 49 per cent. Protopterus make up 38.6 per cent and the other genera such as Tilapia, Clarias and Bagrus are of only minor importance. In the large sites, however, Protopterus dominates with 36.8 per cent, followed by Tilapia (20.3 per cent). Haplochromis are less important (14.1 per cent) while the proportions of Clarias (13.4 per cent) and Bagrus (10.3 per cent) are greater than in the small sites.

The difference in composition of the landings between large and small sites is partially a function of mesh size composition of the gill nets. In the small sites, 62 per cent of the nets used are small mesh (less than 3 inches) and only 6 per cent are large (greater than 5 inches). In the large sites the respective percentages are 49 and 21 (Table 7).

The preceding comments on species composition of the landings refer to major classes of FEUs summed over limnological zones. Differences between limnological zones are also of major interest, but sample sizes are not uniformly adequate for detailed inferences of this type. For example, the overall compositions for zones 1 and 2 indicate that Haplochromis is most important there. In zone 2, however, there is a great difference between large and small sites (Table 10). The overall composition gets much more weight from the small site results, yet these results are based on only 6 sampled canoe-days in one fishing site. The estimates for the large site category are more reliable, being based on 33 canoe-days of activity.

The reader should refrain from using the landings data to draw inferences about the species composition of the stocks themselves and about differences in stock composition between various classes. Inferences of this type might be based on extensive sampling with graded fleets of nets with known selectivity and catchability characteristics. However, in view of the differences between species in morphology, behaviour, and mobility, results from the use of passive gear such as set gill nets are apt to be grossly misleading. The investigator must rely instead on the use of active gear such as purse seines

Attention has so far been given to major taxa such as cichlids, the large cat fishes, and Protopterus Other species made up less than one per cent of the landings in limnological zones 2 and 3, but were somewhat more important in the other three zones In these regions, the landings of minor species consisted mainly of Barbus, Mormyrus, Labeo and Lates. Barbus was landed in all five zones, whereas Lates was found only in zones 4 and 5. Labeo was landed only in zones, 1,4 and 5 and Mormyrus in all areas except zone 2.

111. 7 Bias and Precision of the Estimates

Bias and precision are the fishery manager's basic guideposts for judging the validity and utility of his estimates. A consideration of both of them is an essential part of a good sample survey or experiment. A brief review of these concepts should be useful

An estimate is said to be unbiased if its expected value over a large number of surveys or experiments (imagining that these could be performed repeatedly under the same circumstances) is equal to the true value of the characteristic being estimated. There are two kinds of bias, statistical and experimental. In general, bias of the first type, which arises from statistical or mathematical properties of sampling and estimation procedures, is not very serious Its magnitude may usually be calculated from information internal to the experiment and adjustments are therefore easily made. Most of the estimators used in the CAS are unbiased in this first sence

The second kind of bias arises when basic assumptions of the estimation or sampling procedures (i.e. the model) are violated. Bias of this type is often difficult to detect and must be guarded against by giving careful attention to basic elements of good sampling or experimentation, such as proper randomization. In the CAS, randomization was normally carried out at both stages of sample selection, i.e. during the selection of fishing sites and during the selection of FEUs within sites.

The likelihood of a persistent experimental bias in the Uganda CAS still remains. It stems from the possible errors in estimating the size and structure of the sampling frame, i.e. the number of FEUs in each stratum. The aerial survey and coverage check surveys are therefore critical stages in the CAS. Uncertainly about the results of the frame survey are the main reason the results reported here are marked provisional. The kinds of errors arising in frame surveys of inland fisheries are discussed else-where by Bazigos (see references).

The second tool for determining the trustworthiness of an estimate is its precision. An estimation procedure is said to give rise to precise estimates if the values it produces in a large number of (imaginary) repetitions of the experiment or survey are clustered in a tight band around the true value. A tacit assumption here is that the estimate is also unbiased, for a highly precise but wrong estimate is clearly of little value.

The precision of an estimate is inversely proportional to its variance, and therefore directly proportional to the size of the sample on which the estimate is based. This is an important feature, since it means the investigator may achieve a desired level of precision in his estimates by regulating sample size. Naturally, increasing precision by taking larger samples is accompanied by higher costs, and the investigator must strike a balance between the two.

The precision of estimates may be expressed in a variety of ways. Generally, the variance estimates are used to construct confidence intervals for important items of interest (e.g. total landings), or, equivalently, to make probability statements about the percentage error in the estimates. At this stage it is necessary to make some assumptions about the distribution of the estimates typically we assume they are normally distributed, and this assumption is often reasonable.

The CAS was designed in such a way that the variance of the most important estimates, such as total landings, could be estimated from inter-penetrating sub-samples. In this method, also referred to as replicated sampling, the total landings for a particular category (say motorized canoes in the large fishing sites of a particular limnological zone) is estimated by the average of two or more independent estimates, one arising from each selected fishing site in that category. The variance of this overall average estimate is then computed using the standard formula for the variance of a sample mean, with each independent estimate treated as a single observation.

The use of replicated sampling is advantageous for two reasons First, the procedure gives rise to empirical variance estimates. These are much less complicated in their construction than the estimates usually employed in multi-stage stratified sampling and have more intuitive appeal Second, the variance estimates are extremely simple to calculate. For the method to be valid, the independent estimates must be based on random samples drawn in a uniform manner, i.e they must have the same structure However, small deviations from this condition, such as slight variation in sample sizes will not affect the results seriously.

In the CAS, once the variances of the sub-classes are calculated, the variances for total estimates, i.e. those formed by summing over sub-classes, are computed easily, simply by adding the individual variances. Thus the precision of estimates at all stages or levels of the survey design is easily estimated.

Turning now to results for the Uganda CAS, variance estimates were calculated for the estimates of total quarterly landings in each sub-class (all species combined). In some sub-classes, only one fishing site was sampled so no variance estimate was available In the others, either two or three sites were sampled. For these sub-classes the landings estimates were summed, as were the corresponding variances estimates. The resulting overall coefficient of variation was about 0.13.

If we apply this coefficient to the total quarterly landings for all classes, we conclude with about 95 per cent certainty that our overall estimate of 6000 metric tons is within approximately 26 per cent of the true value Put in a different way, the 95 per cent confidence limits for total first-quarter landings are about 4500 tons and 7500 tons.

If the first-round procedures of the Uganda CAS were extended through an entire year, the precision of the resulting estimate of total annual landings could be expected to double, since it would be based on four times as much information (The relative precision of the estimate is roughly proportional to the square root of sample size). This level of precision, i e within 10 to 15 per cent of actual landings with about 95 per cent confidence, would be adequate for virtually all management purposes and, as discussed below, could be achieved with only a very moderate investment in manpower.

Recalling the earlier discussion of bias, it should be emphasized that any reference to precision presupposes the absence of experimental bias. Thus until the size and structure of the Uganda sampling frame is known with greater certainty, the probability statements concerning intervals and relative precision must be viewed with caution.

IV Discussion

The results presented in this report refer to fishing activity in the Uganda waters of Lake Victoria during the first quarter of 1972. The total landings during this period were estimated to be about 6000 metric tons. Keeping in mind the usual hazards of extrapolation, it is interesting to expand this figure to produce an estimate of annual landings. The result is an estimate of about 24,000 metric tons, with provisional 95 per cent confidence limits of 18,000 tons and 30,000 tons. If this annual estimate had resulted from a sampling of all four quarters, the limits would likely be even narrower - perhaps 21,000 tons and 27,000 tons.

While this expansion to annual landings is admittedly rough, it cannot be dismissed lightly, for the resulting estimate is considerably lower than the figures given by the Uganda Fisheries Department. Two such figures are listed in recent CIFA documents (CIFA/72/8, CIFA/72/9), these being 42,000 metric tons (1969-1970) and 34,790 tons (1970). The general pattern of landings reported by the Uganda authorities is characterized by annual increases, so the figure for 1972, yet to be reported, is apt to be at least 35,000 tons. Plainly, either the average fishing success is considerably greater in in the last three quarters of the year, or the UFD figures have an inherent positive bias on the order of 50 per cent.

The second explanantion may well be the correct one when one considers the sampling methods employed by the Department Under the current system, statistics on fishing activity and landings per canoe-day are gathered primarily from major landing sites, and these are invariably the larger sites with good access and a fairly high proportion of motorized canoes (R.S. Walker, personal communication). Our CAS information indicates that in fact, most fishing effort is in smaller sites by non-motorized canoes. There fishing economic units have lower success, on the average, than those sampled by the UFD.

Table 9 shows that the overall average landings per canoe-day of fishing activity was 25.84 kg. However, for the large fishing sites, those typically sampled by the UFD, the corresponding figure is 41.33 kg. per canoe-day for all fishing methods and 39.83 kg for fishing method-1. It is obvious how a positive bias of at least 50 per cent could enter the UFD estimats of total landings.

A comparison at this stage of UFD estimates with the limited CAS information should naturally be viewed with some skepticism. Still the mere suggestion that the current system may be producing badly biased estimates should provoke further study.

What is needed is a concerted effort to establish the CAS program on a full-time basis and a willingness to scrutinize both the CAS and the UFD system objectively. It should be recognized that the information requirements of the department are quite varied and that neither system by itself is likely to be adequate. The best approach may be to develop a hybrid statistics program incorporating the best features of both systems.

On one hand, the department needs unbiased estimates of landings and effort of the type the CAS is designed to produce-that is, quarterly estimates for major classes of FEUs and hydrogeographical strata. Such information is vital for long-term management and for an integrated understanding of the Lake Victoria fisheries.

On the other hand, the fisheries department has various other objectives to satisfy in its statistics collection programs, and these will require an approach somewhat different from the CAS.

For example, the department is developing landing and marketing facilities in several places and must collect information at these sites for proper evaluation of these development programs. In addition the department must be able to respond on a short-term basis to public and private inquiries concerning the strata of particular fisheries Thus some current practices of the UFD with regard to statistics collection, such as a concentration on major landing. sites, may be justified. However, it must be understood that the manner in which such data are gathered may preclude their use for other purposes, such as the unbiased estimation of total landings over large areas and time periods.

Thus the CAS is not intended to replace entirely the statistical system now employed by the department. Rather, it is designed to improve certain aspects of the system, and in particular to provide a sound and common statistical basis for comparison of fishing activity and yield between the three countries sharing the Lake Victoria fish resources.

It is hoped that this report, however brief, has demonstrated some of the virtues of the CAS program and that it will stimulate a continuation of the surveys The reader has been cautioned at several junctures that the report is only provisional. This is so for two main reasons. First, the report deals only with certain aspects of the PS2 survey of landings and fishing effort. Much of the PS2 information and virtually all of the data gathered in the PS1 survey were not included.

Second, the weighted estimates reported here are subject to revision pending a more careful assessment of the size and structure of the sampling frame. It is recognized that the frame surveys are an extremely critical aspect of the system and that the ones on which the estimates are based stand improvement.

Various operational problems in the CAS should be overcome in future surveys as more experience is gained, In particular, there were problems in achieving balance during the first go around. That is, in some categories only 1 site was sampled instead of the minimum of two called for in the survey design, and frequently FEUs of the minor categories (such as beach seiners) were not adequately sampled. Thus there were several "holes" in the data and in certain instances missing values had to be estimated from other data. Whenever this happens, a complete analysis becomes more difficult.

The Uganda CAS was carried out by a crew of six full-time field recorders and one UFD supervisor who was handling several other duties as well. If in the future the supervisor is assigned to the program on a full-time basis, this amount of manpower should be adequate. Since the fisheries department now employs several times as many recorders in its Lake Victoria statistics collection program, the allocation of seven men to the CAS on a full-time basis would not appear to create an unacceptable strain on the department's manpower resources. Of course, a firm commitment of manpower by EAFFRO is also required. The Organization needs one man with some background in statistics to coordinate the CAS on a full-time basis, to assist the country supervisors, and to be in charge of the more mechanical aspects of the data processing. In addition, EAFFRO would need a competent statistician with computer experience to devote part of his time to the CAS program.

7 References

Bazigos, George P. 1970. Sampling techniques in inland fisheries with special reference to Volta Lake. FAO/UNDP Lake Volta Research Project. Statistics Studies - 1.

________ Frame surveys at Volta Lake. Statistical Studies - 2.

________ 1972 Lake Victoria CAS manuals.

1. Code system of the survey units.

2. Instructions for completion of the source documents of the survey.

3. Processing of the sample data - manual calculations

________ 1971 Lake Victoria Fisheries Research Project. Training course in fisheries statistics (Two manuals, one for senior staff, one for recorders).

________ 1971 Statistical analysis of the results of the aerial survey. Lake Victoria Fisheries Research Project. Statistical Studies - 1

Committee for Inland Fisheries of Africa (CIFA)
1972 The development of fishing industries in the inland waters of Africa.
CIFA/73/Inf.9.

__________ 1972. A brief review of the current status of the inland fisheries of Africa. CIFA/72/8 .

Wetherall, J. 1972. Catch assessment surveys in Lake Victoria. (Paper presented at Fisheries Technical Committe meeting, Tanga, Tanzania).

Table 1 Estimated number of fishing canoes in various categories, Uganda waters of Lake Victoria. From 1971 Frame Survey.

Limnological Zone	Size of Fishing Site	Fishing Method 1			Fishing Method 11	Total Both Methods
		with motor	no motor	Total		
1	S	0	122	122	14	136
	L	20	107	127	18	145
	Total	20	229	249	32	281
2	S	0	526	526	176	702
	L	8	42	50	0	50
	Total	8	568	576	176	752
3	S	27	790	817	0	817
	L	35	113	148	0	148
	Total	62	903	965	0	965
4	S	0	62	62	12	74
	L	59	76	135	9	144
	Total	59	138	197	21	218
5	S	11	638	649	185	834
	L	37	177	214	0	214
	Total	48	815	863	185	1048
All Zones	S	38	2138	2176	387	2563
	L	159	515	674	27	701
	Total	197	2653	2850	414	3264

Table 2 (a) Estimated percentage composition of fishing canoes within small and large fishing sites, with respect to fishing method and type of propulsion. (Uganda)

(b) Estimated percentage composition of fishing canoes within fishing methods and propulsion types, with respect to size of fishing site. (Uganda)

(A)

Size of Fishing Site	Fishing Method 1: with motor	Fishing Method 1: no motor	Total	Fishing Method 1	Fishing Method 11	Total
S	1.8	98.2	100	84.9	15.1	100
L	23.6	76.4	100	93.2	3.8	100
All Sites	6.9	93.1	100	87.3	12.7	100

(B)

Size of Fishing Site	Fishing Method 1: with motor	Fishing Method 1: no motor	Fishing Method 1: Both Types	Fishing Method 11	Both Methods
S	19.3	80.6	76.4	93.5	78.5
L	80.7	19.4	23.6	6.5	21.5
Total	100	100	100	100	100

Table 3 Estimated number of canoe-days of fishing activity, first quarter 1972. (Uganda)

Limno-logical Zone	Size of Fishing	Fishing Method 1			Fishing Method 11	Total Both Methods
		with motor	without motor	Total		
1	S	0	11,016	11,016	1,224	12,240
	L	1,513	7,815	9,328	1,399	10,727
	Total	1,513	18,831	20,344	2,623	22,967
2	S	0	47,385	47,385	15,795	63,180
	L	631	3,329	3,960	0	3,960
	Total	631	50,714	51,345	15,795	67,140
3	S	2,451	61,888	64,339	0	64,339
	L	1,116	3,692	4,808	0	4,808
	Total	3,567	65,580	69,147	0	69,147
4	S	0	4,070	4,070	1,110	5,180
	L	1,884	2,422	4,306	269	4,575
	Total	1,884	6,492	8,376	1,379	9,755
5	S	688	38,268	38,956	11,084	50,040
	L	3,405	10,000	13,405	0	13,405
	Total	4,093	48,268	52,361	11,084	63,445
All Zones	S	3,139	162,627	165,766	29,213	194,979
	L	8,549	27,258	35,807	1,668	37,475
	Total	11,688	189,885	201,573	30,881	232,454

Table 4(a) Number of canoe days of fishing activity sampled, RCP survey . (Uganda)

(b) Sampling Fractions in the RCD Survey - number of canoe-days sampled per 100 canoe-days of estimated activity (Uganda)

(A)

Limnological Zone	Size of Fishing Site	No. of Canoe-days of Fishing Activity Sampled					No. of Fishing Sites Sampled
		Fishing Method 1			Fishing Method 11	Total Both Methods	
		with motor	without motor	Total			
1	S	0	4	4	1	5	1
	L	11	34	45	5	50	3
	Total	11	38	49	6	55	4
2	S	0	6	6	0	6	1
	L	3	26	33	0	33	2
	Total	7	32	39	0	39	3
3	S	1	23	24	0	24	3
	L	6	0	6	0	6	1
	Total	7	23	30	0	30	4
4	S	0	15	15	3	18	3
	L	9	6	15	3	18	1
	Total	9	21	30	6	36	4
5	S	0	10	10	0	10	1
	L	10	25	35	0	35	3
	Total	10	35	45	0	45	4
All Zones	S	1	58	59	4	63	9
	L	43	91	134	8	142	10
	Total	44	149	193	12	205	19

(B)

Size of Fishing Site	Fishing Method 1			Fishing Method 11	Both Methods
	with motor	without motor	Both types		
S	032	036	.036	014	032
L	50	33	37	42	.30
All Sites	38	070	096	039	062

Table 5 Estimates of the average number of gill nets fished per canoe day, and mesh-size composition (Uganda)

Zones	Size of Fishing Site	Average Number of Gill Nets Fishing Per Canoe-Day, All mesh Sizes			Percentages of Total (Both types) by Mesh Size Category		
		non-motorized	motorized	Both Types	3" .. 3	3" – 5"	> 5"
1	Small	31.75	–	31.75	67.8	32.2	0
	Large	56.35	50.37	55.30	70.4	24.6	5.0
	All Sites	36.11	50.37	37.17	69.6	27.0	3.4
2	Small	35.17	–	35.17	88.6	11.4	0
	Large	28.80	59.50	30.70	3.4	83.4	13.2
	All Sites	34.[illegible]	[illegible]	35.06	[illegible]	16.[illegible]	1.0
3	Small	[illegible] 49	40.[illegible]	[illegible].09	41.3	52.1	6.6
	Large	31.[illegible]	36.[illegible]	[illegible].13	4.[illegible]	45.[illegible]	[illegible]
	All Sites	29.34	[illegible]	[illegible].14	41.[illegible]	51.4	6.[illegible]
4	Small	15.00	–	15.00	45.[illegible]	39.3	15.5
	Large	35.50	66.[illegible]	[illegible]	6	56.[illegible]	34.8
	All Sites	22.65	66.15	[illegible].46	16.1	50.9	[illegible]
5	Small	32.30	31.50	[illegible]	45.0	33.0	21.0
	Large	5[illegible].08	54.47	53.24	23.6	43.6	33.0
	All Sites	36.55	53.6[illegible]	37.65	31.[illegible]	36.5	26.[illegible]
All Zones	Small	36.[illegible]	[illegible].14	[illegible].4[illegible]	60.5	31.4	8.1
	Large	47.46	54.[illegible]	49.09	36.4	41.5	22.1
	All Sites	33.9[illegible]	4[illegible]	35.09	54.[illegible]	34.4	11.6

Table 6 Percentage mesh-sizes composition of gill nets used by motorized and non-motorized canoes (all zones and sites) in Uganda waters .

Mesh Size	Non-motorized	Motorized	Both types
0"-3"	59.2	0	54.0
3"-5"	31.5	64.1	34.4
>5"	9.3	35.9	11.6

Table 7 Estimated number of nets used by non-motorized gill-netters, and mesh-size composition (all zones).

Mesh Size	Small Fishing Sites		Large Fishing Sites	
	Number per canoe	%	Number per canoe	%
0"-3"	17.50	62	23.50	49
3"-5"	9.03	32	14.16	30
> 5"	1.00	6	9.60	21
Total	28.23	100	47.446	100

	UGANDA								KENYA								TANZANIA							
LZ 1	Small Sites				Large Sites				Small Sites				Large Sites				Small Sites				Large Sites			
	FM 1		FM 2		FM 1		FM 2		FM 1		FM 2		FM 1		FM 2		FM 1		FM 2		FM 1		FM 2	
	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$
LZ 2	Small Sites				Large Sites				Small Sites				Large Sites				Small Sites				Large Sites			
	FM 1		FM 2		FM 1		FM 2		FM 1		FM 2		FM 1		FM 2		FM 1		FM 2		FM 1		FM 2	
	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$	$\bar{w}$

Figure 1. Stratification scheme for the Lake Victoria CAS. Only two limnological zones are shown in detail for each country, although in practice there are 5 to 8 zones. Fishing sites are categorized as either small or large. Fishing method is denoted by FM, w stands for motorized canoes, and $\tilde{w}$ means non-motorized canoes.

Table 8 Estimated fishing effort in thousands of gillnet-nights, and breakdown by mesh-size, category, first-quarter 1972 in Uganda waters.

Zones	Overall Ave. Tot. Catch per gill net nights (kg)	Fishing Effort in Thousands of Gill Net Nights (and % of total), by mesh size category. Motorized and Non-motorized canoes combined			
		All Meshes	0"-3"	3"-5"	> 5"
1	0.585	756.19	526.28 (69.6)	204.12 (27.0)	25.79 (3.4)
2	0.849	1800.00	1481.58 (82.3)	300.77 (16.7)	17.64 (1.0)
3	1.185	1668.89	699.55 (41.9)	857.82 (51.4)	111.50 (6.7)
4	1.011	271.85	45.75 (16.8)	143.74 (52.9)	82.34 (30.3)
5	.386	1971.40	734.17 (37.3)	719.18 (36.5)	516.52 (26.2)
All Zones (Total)	.770	6468.33	3487.33 (54.0)	2225.63 (34.4)	753.79 (11.6)

Table 9 Estimates of average landings per canoe-day of fishing activity (kg) and total first-quarter landings (metric tons), all species in Uganda waters.

Zone	Size of Fishing Site	Fishing Method 1 non-motorized	Fishing Method 1 motorized	Fishing Method 1 Both Types*	Fishing Method 11	All Categories combined	Total Landings All Categories
1	Small	13.08	-	13.08	20.09	13.78	169
	Large	29.43	45.12	31.98	73.55	37.40	401
	All Sites	19.86	45.12	21.74	48.60	24.81	570
2	Small	29.00	-	29.00	30.78	29.44	1860
	Large	39.45	37.24	39.10	-	39.10	155
	All Sites	29.68	37.24	29.78	30.78	30.01	2015
3	Small	25.14	63.40	26.60	-	26.60	1711
	Large	52.89	63.72	55.40	-	55.40	266
	All Sites	26.70	63.50	28.60	-	28.60	1977
4	Small	15.46	-	15.46	42.55	21.27	110
	Large	55.00	41.72	49.19	73.83	50.64	232
	All Sites	30.21	41.72	32.80	48.66	35.04	342
5	Small	6.72	11.83	6.81	30.78	12.12	606
	Large	41.02	24.09	36.92	-	36.92	495
	All Sites	13.83	32.97	14.52	30.78	17.36	1101
All Zones	Small	20.87	52.10	21.46	30.78	22.86	4457
	Large	40.36	38.16	39.83	73.60	41.33	1549
	All Sites	23.67	41.90	24.72	33.09	25.84	6006

Total Landings All Zones	Small	3394	164	3558	899	4457
	Large	1100	326	1426	123	1549
	All Sites	4494	490	4984	1022	6006

Table 10 Estimated percentage species composition of the first-quarter landings, by limnological zone and size of fishing site in Uganda waters.

	LZ1			LZ2			LZ3			LZ4			LZ5			All Zones		
	Small Sites	Large Sites	All Sites	Small Sites	Large Sites	All Sites	Small Sites	Large Sites	All Sites	Small Sites	Large Sites	All Sites	Small Sites	Large Sites	All Sites	Small Sites	Large Sites	All Sites
Tilapia esculenta	0	1.44	1.02	0.46	2.45	0.51	1.70	0.22	1.50	0	0	0	0.21	0.51	0.34	0.87	0.82	0.86
T. variabilis	14.86	2.04	5.83	1.22	6.32	1.75	0.14	8.93	1.33	5.13	8.66	7.52	3.99	4.27	4.12	1.79	5.55	2.76
T. zillii	0	0.31	0.57	0.32	0.59	0.34	0.69	0.20	0.62	1.54	0.84	1.06	9.70	0.71	5.66	1.75	0.66	1.47
T. nilotica	14.70	6.50	8.92	8.58	49.22	11.70	3.05	18.00	5.15	21.70	14.24	16.65	6.93	11.87	9.15	6.79	15.72	9.09
All Tilapia	29.56	10.79	16.35	10.58	0.58	14.41	5.58	27.94	8.60	28.38	23.74	25.23	20.83	17.35	19.27	11.21	22.75	14.19
Bagrus	5.00	15.41	12.33	0.20	1.01	0.26	0.36	18.32	2.78	17.61	20.48	19.56	14.21	11.70	13.08	2.78	14.05	5.69
Clarias	0	7.87	5.40	0.98	4.57	1.26	5.53	13.96	6.66	17.09	21.67	20.19	8.73	13.94	11.07	4.14	12.54	6.31
Protopterus	12.28	23.00	19.03	5.57	32.60	8.66	79.45	36.71	73.69	7.36	24.71	19.21	26.20	43.51	33.98	37.50	33.13	36.38
Haplochromis	33.32	40.69	38.51	81.07	0.26	74.86	8.57	1.14	7.57	2.14	5.82	10.94	17.84	3.83	11.55	41.37	12.83	34.00
Total Major Species (above)	80.16	97.57	92.57	92.42	99.49	99.05	99.49	98.07	99.30	92.58	96.22	95.05	87.81	90.35	88.95	97.00	95.29	96.56
Total Minor Species	19.84	2.43	7.58	0.51	0.98	0.55	0.51	1.93	0.70	7.42	3.78	4.95	12.19	9.65	11.05	3.00	4.71	3.44

Table 11 Estimated percentage species composition of the first-quarter landings, by fishing method, type of propulsion, and size of fishing site in Uganda waters.

	Small Fishing Sites (minor Stratum-1)					Large Fishing Sites (minor Stratum-2)					Gill Nets			
	Gill Nets					Gill Nets								
	$\bar{w}$	w	Total	Beach Seines	Total	$\bar{w}$	w	Total	Beach Seines	Total	$\bar{w}$	w	Total	Beach Seines
Tilapia esculenta	0.86	0.02	0.82	1.08	0.87	0.98	0.54	0.88	0.11	0.82	0.89	0.37	0.84	0.97
T. variabilis	0.71	0.34	0.69	6.14	1.79	3.85	12.47	5.82	2.43	5.95	1.48	8.42	2.16	5.70
T. zillii	1.79	0.14	1.71	1.92	1.75	0.22	1.60	0.54	2.00	0.66	1.41	1.11	1.38	1.92
T. nilotica	1.39	25.39	2.39	24.20	6.79	15.28	17.96	15.89	13.77	15.72	4.79	19.67	6.25	22.94
All *Tilapia*	4.75	23.58	5.61	33.34	11.21	20.34	32.57	23.13	18.31	22.75	8.56	29.57	10.63	31.54
Bagrus	1.86	0.68	1.81	6.62	2.78	10.29	31.65	15.18	0.93	14.05	3.93	21.31	5.64	5.94
Clarias	3.17	8.11	3.40	7.07	4.14	13.81	13.48	1.62	11.62	12.54	5.67	11.91	6.28	6.42
Protopterus	38.58	66.87	39.88	28.10	37.50	36.76	17.52	32.36	42.07	33.13	38.13	34.00	37.73	29.78
Haplochromis	49.04	0.29	46.80	19.88	41.37	14.08	10.46	10.97	[illegible]	12.83	40.40	30.48	36.54	21.63
Total Major Species (above)	97.40	99.54	97.50	95.02	97.00	94.85	96.02	95.12	97.33	95.29	96.78	97.20	96.82	95.30
Total Minor Species	2.60	0.46	2.50	4.98	3.00	5.15	3.98	4.88	2.67	4.71	3.22	2.80	3.18	4.70

Table 12 Percentage contribution of major genera to total first-quarter landings, and ranking of the genera within limnological zones in Uganda waters.

GENUS	Percentage Composition of total Landings	Rank in Landings				
		LZ1	LZ2	LZ3	LZ4	LZ5
Protopterus	36.38	2	3	1	4	1
Haplochromis	34.00	1	1	3	5	4
Tilapia	14.19	3	2	2	1	2
Clarias	6.31	5	4	4	2	5
Bagrus	5.69	4	6	5	3	3
Others	3.44	6	5	6	6	6

The basis of the CAS, as with other efficient sample surveys, is a list of the basic units on which sample observations are made. In the CAS these units are the fishing canoes, and the list is obtained from a frame survey of the lake shoreline. This survey is conducted in two steps. First an aerial survey is made over the whole shoreline, all fishing canoes seen are counted and their positions are marked on a map. Then a coverage check survey, by land and water, is carried out in selected sections of the shoreline. The exact counts obtained in the coverage-check survey are used to obtain correction factors for the aerial survey. In this way, reasonably accurate estimates of the number of fishing canoes can be made.

The frame survey enables us to divide the total number of canoes into sections representing selected hydrogeographical regions. Further, we are able to determine the number of canoes in small fishing sites (1-10 canoes), medium-size sites (11-50 canoes) and large sites (more than 50 canoes). This classification of canoes by regions (called Limnological Zones, or LZs) and by size of fishing sites may be extended by such criterial as fishing method used and type of propulsión. As a result we may construct several classes of canoes, and the CAS is designed to produce separate estimates of all survey characteristics (such as quarterly landings) fo each class. For example, estimates are produced for non-motorized gill netters in the medium size fishing sites of Nyanza Gulf.

With this system of stratification established, estimates of survey characteristics are obtained by observing the characteristics on samples of canoes within each class or stratum, and then expanding the sample information to the entire class. The samples are chosen randomly in two stages. First, since the canoes are clustered into fishing sites, we begin by selecting several fishing sites within each limnological zone, some small, some medium and some large. Then, when the selected fishing sites are visited by the recorders a sample of canoes within each site is chosen for observation.

The Kenya waters were divided into five limnological zones, with boundaries as indicated in Figure 1. The three size categories for fishing sites have already been mentioned. Two fishing methods were defined. Canoes in the first class (FM1) use passive gear such as gill nets, longlines or traps. Canoes in the second class

(FMs) use beach seines. Concerning the fourth classification criterion, canoes were identified as either motorized or non-motorized.

111. Results

It has been pointed out that the results presented here are provisional and represent only part of the information obtained in the survey. The actual survey operations are carried out in two phases. During the first phase (PS1) crews of selected canoes are asked for information of a sociological and economic nature and basic questions on ownership of gear and fishing habits. The second phase (PS2), which is the basis of this report, concerns mainly the kind and amount of gear used in fishing and the types and quantities of fish landed during sampled days of fishing activity.

111. 1 Number of Canoes in the Various Classes

The Kenya aerial survey and coverage check survey were carried out by personnel of the Lake Victoria Fisheries Research Project. From these surveys the number of canoes in each limnological zone and fishing site size category was determined. Within these classes, the breakdown by fishing method and type of propulsion was to be estimated from PS1 data.

The CAS was planned to begin in the first quarter of 1972, and in Uganda and Tanzania the first round was completed during the three-month period of January-March. However, problems in the Kenya survey delayed the operations until late March, and most sites were visited in April and May. Because of the April-August ban on beach seining in Kenya waters, no information could be gathered on the use of this fishing method during the survey period. Only a few canoe-days of beach seining activity were sampled in late March, and during the rest of the survey no beach seiners were encountered in the PS1 or PS2 surveys. However, it is recognized that some beach seining is carried out, illegally, during the closed period, so that this class of canoes was in fact active during the survey.

In addition, although some motorized canoes are used in Kenya, particularly in limnological zone 1, only two were encountered in the selected fishing sites and only one canoe-day of activity was sampled.

For this reason and the one cited in the previous paragraph, all canoes in the Kenya waters, for the purpose of this analysis, are assumed to be non-motorized canoes using fishing method-1

The results of the frame survey are shown in Table 1. Of the estimated total of 3,979 canoes about half are in Nyanza Gulf (limnological zones 2 and 3) and about two thirds are in medium size fishing sites.

111. 2. Size of the Samples and Sampling Fractions

In the PC2 survey the unit of observation is a canoe-day of fishing activity. The numbers of canoe-days of activity sampled in the Kenya survey in each class are shown in Table 2. Also given are the sampling fractions for each limnological zone and for the fishing site size classes. These are computed from the estimates in Table 1 and the assumption (based on detailed results of the Uganda survey) that about 80 per cent of the possible number of canoe-days of activity during the three-month survey period were actually realized. Overall, the sampling fraction in Kenya was about six-hundredths of one percent, slightly less than in Tanzania (0.08 per cent) and Uganda (0.09 per cent).

When interpreting the results that follow, the reader should bear in mind the size of samples on which the estimates are based. Because of variation in sample size, some estimates are more reliable than others.

111. 3 Number of Gill Nets per Canoe and Mesh Size Composition

During the PC2 survey, information was obtained on the average number of gill nets used per canoe and on mesh-size composition of the nets. For the purposes of this analysis, mesh sizes were grouped into three categories: small mesh (0"-3" inclusive) mesh (5" or less but greater than 3"), and large mesh (greater than 5"). The results are shown in Table 3. On the average, about 47 nets were used per canoe, although the overall estimates range from about 40 nets per canoe in large sites to 54.4 nets in small sites. There appears to be quite a bit of variation between limnological zones, although the estimates for individual zones (and within them) are less reliable.

Overall, 54.7 per cent of the nets used were small mesh, 23.9 per cent medium mesh, and 21.4 per cent were large mesh. Larger-meshed nets seem to be used in the medium and large size fishing sites. The overall estimates are weighted averages of the estimates for the various limnological zones. The results for individual zones, again less reliable, indicate that small-mesh nets predominate in zones 1,3 and 5 while medium and large mesh nets are more common in zones 2 and 4.

111. 4. Average Landings per Canoe-day and Total Landings for the Survey Period

During the FS2 survey in each selected fishing site, the landings of sampled canoes were sorted into species, counted and weighed. Data collected in these operations were used to estimate average landings per canoe-day of fishing activity. These figures, coupled with information on total canoe-days of activity were in turn used to estimate total landings for the survey period. The results are presented in Table 4.

The overall weighted average landings per canoe-day was 24.9 kg (compared with 23.7 kg in Uganda and 55 kg in Tanzania). Average landings per canoe-day were considerably greater in zone 1 (43.7 kg) than in the other four regions, and are apparently greater in medium size fishing sites than small ones (the sample size for large sites is rather too small for a similar comparison).

The total landings in the Kenya waters of Lake Victoria during the survey period were estimated to be about 7,033 metric tons. If seasonal variation in landings could be assumed to be small, it would appear that annual landings in the Kenya waters are on the order of 25,000 tons to 30,000 tons. Almost half of the landings during the survey period was estimated to have been in zone 1. When the CAS is resumed on a full-time basis it will be possible to obtain an accurate assessment of seasonal variation. The estimate of annual landings, then computed by summing the quarterly figures, might be closer to the estimate currently given by the Kenya Fisheries Department. According to recent documents of the Committee for Inland Fisheries of Africa, this was 18,500 metric tons for 1970 (CIFA/72/8 and CIFA/72/Inf.9)

111 5 Species Composition of the Landings

Estimates of the species composition of the landings are presented in Tables 5 and 6 In Table 5 estimates are given for each limnological zone (weighted averages over all fishing sites) and for the entire Kenya region. Sample sizes are also indicated along with estimates of mesh-size composition of the gear (while the landings are mainly from gill nets, they include a small amount from long lines).

It is seen from Table 5 that Haplochromis lead in the total landings with about 20 percent, followed closely by Protopterus (19.6 per cent) and then by Tilapia (16.8 per cent), Clarias (13. per cent), Synodontis (10.3 per cent) and Bagrus (7.2 per cent).

Tilapia appear to be most important in zones 1 (mainly T. esculenta and T. variabilis). Haplochromis do not seem to be predominant in any zone, but are quite significant in zones 1, 3 and 4. Clarias is dominant in the zone 4 landings, Protopterus in zone 3 and Synodontis i zone 5.

In Table 6. estimates of species composition of the landings are given for the fishing site size categories, within each zone and over all zones The reader is reminded that some of these estimates are based on rather small samples.

References

Committee for Inland Fisheries of Africa - 1972. A brief review of the Current status of the inland fisheries of Africa. CIFA/72/8.

_____________ 1972 The development of fishing industries in the inland waters of Africa. CIFA/72/Inf.9.

Wetheral, J 1972. A provisional report on the catch assessment survey (CAS) in the Uganda waters of Lake Victoria, Jan-March 1972 EAFFRO, mimeo.

Table 2 Sample sizes and sampling fractions in Kenya [illegible] Survey.

Limno-logical Zone	Size of Fishing Site	Number of Fishing Sites Sampled	Number of canoe-days Sampled	Sampling Fraction (Percent of total canoe-days)
1	S	0	0	
	M	2	12	
	L	1	6	
	Total	3	18	0.02
2	S	2	6	
	M	4	17	
	L	0	0	
	Total	6	23	0.04
3	S	2	15	
	M	4	60	
	L	0	0	
	Total	6	75	0.09
4	S	2	6	
	M	2	11	
	L	0	0	
	Total	4	17	0.06
5	S	2	6	
	M	2	12	
	L	1	8	
	Total	5	26	0.07
All Zones	S	8	33	0.06
	M	14	112	0.06
	L	2	14	0.04
	Total	24	159	0.06

Table 3. Estimates of average number of gill nets used per canoe, and mesh-size composition (Kenya)

Limno-logical Zone	Size of Fishing Site	Average No. Gill Nets Fished per Canoe-day	Percentage Mesh-Size Composition			Average Landings per Net-night (kg)
			0"-3"	3"-5"	>5"	
1	S	64.70	66.3	4.4	29.3	
	M	66.67	65.5	4.5	30.0	
	L	31.67	95.3	0	4.7	
	Total	64.70	66.3	4.4	29.3	0.675
2	S	43.00	0	57.4	42.6	
	M	31.47	26.2	73.8	0	
	L	34.96	16.4	67.7	15.9	
	Total	34.96	16.4	67.7	15.9	0.399
3	S	70.93	100.0	0	0	
	M	46.15	38.4	22.5	39.1	
	L	53.63	63.0	13.5	23.5	
	Total	53.63	63.0	13.5	23.5	0.372
4	S	30.50	21.9	69.9	8.2	
	M	24.09	4.5	95.5	0	
	L	25.08	7.8	90.7	1.5	
	Total	25.08	7.8	90.7	1.5	0.822
5	S	11.00	100.0	0	0	
	M	35.08	70.3	29.7	0	
	L	35.50	81.0	16.2	2.8	
	Total	32.06	73.6	25.9	0.5	0.493
All Zones	S	54.36	66.6	16.3	17.1	0.386
	M	46.40	51.0	25.2	23.8	0.585
	L	39.97	52.8	31.6	15.6	0.458
	Total	47.12	54.7	23.9	21.4	0.528

Table 4. Estimates of landings per canoe day and total landings for the survey period in Kenya waters.

Limno-logical Zone	Size of Fishing Site	Average Landings per canoe-day (kg)	Average Landings per canoe (metric tons)	Estimated Total Landings (metric tons)
1	S	43.71	3.147	522.4
	M	45.42	3.270	2858.0
	L	15.05	1.083	56.3
	Total	43.71	3.147	3436.7
2	S	16.53	1.190	254.7
	M	12.86	0.925	456.9
	L	13.96	1.005	137.7
	Total	13.96	1.005	849.3
3	S	13.53	0.974	272.7
	M	22.77	1.639	1062.1
	L	19.97	1.438	258.9
	Total	19.97	1.438	1593.7
4	S	17.00	1.224	63.6
	M	21.28	1.532	433.6
	L	20.61	1.484	97.9
	Total	20.61	1.484	595.1
5	S	12.28	0.884	54.8
	M	14.50	1.044	356.0
	L	24.19	1.741	139.3
	Total	15.82	1.139	550.1
All Zones	S	21.01	1.513	1171.7
	M	27.15	1.955	5163.5
	L	18.33	1.356	698.2
	Total	24.86	1.790	7033.4

Table 5. Estimates of Species Composition of the landings during the survey period (Kenya)

Species		LZ 1	LZ 2	LZ 3	LZ 4	LZ 5	All Zones
<u>Tilapia esculenta</u>		6.48	14.40	0.17		0.19	4.96
<u>T. zillii</u>				0.52	0.06		0.12
<u>T. variabilis</u>			22.16	0.46	0.06	0.19	2.80
<u>T. nilotica</u>		16.64	5.86	0.26		0.81	8.97
Total <u>Tilapia</u>		23.12	42.42	1.41	0.12	1.19	16.85
<u>Bagrus</u>		2.25	9.30	11.59	26.42	1.74	7.22
<u>Clarias</u>		8.46	12.19	11.88	44.94	11.91	13.04
<u>Haplochromis</u>		18.71	8.02	30.86	26.19	10.72	20.17
<u>Protopterus</u>		14.52	28.06	36.86	0.31	9.53	19.61
<u>Barbus</u>		1.53		0.23	0.50	4.25	1.18
<u>Labeo</u>		10.44		0.01	0.63	8.39	5.81
<u>Lates</u>				0.26			0.06
<u>Mormyrus</u>				0.83		0.74	0.25
<u>Schilbe</u>		9.55				9.67	5.43
<u>Synodontis</u>		11.42		6.05	0.87	41.86	10.31
Number of Fishing Sites Sampled		3	6	6	4	5	24
Number of Canoe-days Sampled		18	23	75	17	26	159
Percentage Mesh-Size	0"-3"	66.3	16.4	63.0	7.8	73.6	54.7
Composition of	3"-5"	4.4	67.7	13.5	90.7	25.9	23.9
Gill Nets	>5"	29.3	15.9	23.5	1.5	0.5	21.4

Table 6. Estimates of Species Composition of the landings during the survey period (Kenya)

Species	LZ 1			LZ 2			LZ 3			LZ 4			LZ 5			All Zones		
	Small Sites	Med Sites	Large Sites	Small Sites	Med Sites	Large Sites	Small Sites	Med Sites	Large Sites	Small Sites	Med Sites	Large Sites	Small Sites	Med Sites	Large Sites	Small Sites	Med Sites	Large Sites
Tilapia esculenta	6.48	6.60		8.57	17.66	14.40		0.22	0.17					0.29		4.75	5.28	2.90
T. zillii								0.66	0.52	0.49		0.06				0.03	0.14	0.20
T. variabilis				1.51	33.67	22.16		0.58	0.46	0.49		0.06		0.29		0.36	3.12	4.55
T. nilotica	16.64	16.97		9.48	3.84	5.86		0.33	0.26					1.15	0.26	9.48	9.88	1.30
Total Tilapia	23.12	23.57		19.56	55.17	42.42		1.79	1.43	0.98		0.12		1.72	0.26	14.61	18.42	8.96
Bagrus	2.25	2.29		16.65	5.22	9.30		14.57	11.59	38.24	24.69	26.42	0.68	2.59		6.72	6.98	9.84
Clarias	8.46	8.02		7.50	14.78	12.19		14.93	11.88	41.18	45.49	44.94	12.21	15.52	1.58	8.22	14.04	13.63
Haplochromis	18.71	19.08			12.49	8.02	81.03	17.97	30.86	5.88	29.18	26.19	21.71	13.22		28.54	15.72	16.70
Protopterus	14.52	14.12	34.33	56.25	12.35	28.06	4.93	45.06	36.86	2.45		0.31	43.42	8.04		22.01	18.73	22.01
Barbus	1.53	1.56						0.29	0.23	2.45	0.21	0.50			16.80	0.81	0.94	3.51
Labeo	10.44	9.36	65.67					0.01	0.01	4.90		0.63	7.46	5.75	15.50	5.27	5.58	8.48
Lates								0.33	0.26								0.30	0.01
Mormyrus							1.23	0.75	0.83					1.15		0.29	0.23	0.31
Schilbe	9.55	9.74											0.27	8.33	16.80	4.27	5.97	3.35
Synodontis	11.42	11.65					12.81	4.32	6.05	3.92	0.43	0.87	14.25	43.68	48.06	8.95	10.38	11.95
Number of Fishing Sites Sampled	0	2	1	2	4	0	2	4	0	2	2	0	2	2	1	8	14	2
Number of Canoe - days Sampled	0	12	6	6	17	0	15	60	0	6	11	0	6	12	8	33	112	14

PART 111

TANZANIA WATERS OF LAKE VICTORIA

1. Introduction

The purpose of this brief report is to provide a provisional summary of estimates on fish landings, catch rates and gear obtained during the Tanzania Catch Assessment Survey (CAS). The survey was carried out during the first quarter of 1972 by personnel of the Tanzania Fisheries Department under the supervision of Mr. Mutabihirwa and Mr. Ndoka. Although the survey program was intended to be continuous, problems arose during 1972 which have halted the program temporarily. The surveys are expected to continue in the near future.

The purpose of the CAS program has been discussed in other reports by this author (Wetherall; 1972, 1973) to which the reader is referred for details. Briefly, the CAS, introduced by Dr. George Bazigos of FAO, is intended to provide a common and statistically sound basis for gathering information on the Lake Victoria fisheries. The system will permit the comparison of various statistics between Tanzania, Kenya and Uganda and between the Lake Victoria fisheries and those in other regions of Africa.

11. Methods

The reader should consult the reports mentioned previously for a detailed account of the design and procedures of the CAS. However, the basic approach of the CAS is as follows. The total number of fishing canoes in each country is estimated by a frame survey followed by a coverage-check survey conducted in selected regions of the shoreline. The total number of canoes is then divided by geographical regions called Limnological Zones. Within the zones, fishing canoes are classified according to the size of the fishing site in which they are located (size is determined by the number of canoes in the site). Fishing canoes may also be classified by the fishing method they use, and by their type of propulsion.

The criteria listed above, i.e limnological zone, size of fishing site, fishing method and propulsion type define a large number of classes of fishing canoes. One such class, for example, consists of all the motorized gill netters in the medium size fishing sites of Mwanza Gulf. The CAS is designed in such a way that separate, independent estimates for all the survey characteristics (such as quarterly landings) can be computed for each class of canoes

In the CAS, estimates of survey characteristics are obtained by observing these characteristics on samples of canoes within each class, and then expanding the sample information to the entire class. The samples are chosen randomly in two stages, First, since the canoes are clustered into fishing sites, we begin by selecting several fishing sites within each limnological zone. Then, when the selected fishing sites are visited by the recorders, a sample of canoes within each site is chosen for observation.

The Tanzania inshore waters were divided into eight limnological zones with boundaries as indicated in Figure 1. The number of fishing canoes within each zone was determined from a mile-by-mile land and water survey conducted by the Tanzania Fisheries Department in December 1971. An aerial survey covering most of the zones was also carried out by FAO personnel of the Lake Victoria Fisheries Research Project, but these data and information from the corresponding coverage check survey were not available when this report was being prepared.

Three size categories were chosen for fishing sites. One category consists of small fishing sites (10 or fewer canoes), one of medium sites (11-50 canoes) and one of large sites (more than 50 canoes).

Two fishing methods were defined The first method (FM1) includes passive gear such as gill nets, longlines and traps. The second method is beach seining. Regarding propulsion type, canoes were classified as either motorized or non-motorized

111. Results

As indicated previously, the results presented here, produced manually, represent only a small part of the information gathered in the Survey. Ultimately, the survey analysis is to be done on a high-speed computer, such as the one at Makerere University. The computerization will enable the results to be produced much more quickly and completely.

111 1. Number of Canoes in the Various Classes

The breakdown of the total number of canoes in the Tanzania waters into limnological zones and fishing site categories was determined from the mile-by-mile census. Information on the breakdown by fishing method and propulsion type was obtained in the CAS itself. The results are presented in Table 1.

A total of 4,047 canoes were counted in the census. Of these, 64.6 per cent were in medium sized sites and about 30 per cent in small sites. Nearly all the canoes (92 per cent) appear to be non-motorized canoes using fishing method-1. Beach seiners make up about 11.3 per cent of the canoes in small fishing sites, compared to 6 per cent in the medium size sites. Motorized canoes are rare. Since no large fishing sites were sampled in the CAS no information was obtained on the composition of canoes in this category. The results given for large fishing sites in the bottom section of the table were obtained by assuming the same composition here as in medium size sites.

111. 2. Size of the Samples and Sampling fractions

In the CAS the survey operations in each selected fishing site are carried out in two phases. In the first phase (PS1) the crews of selected canoes are asked for information of a sociological and economic nature and basic questions on ownership of gear and fishing habits. The second phase (PS2), which is the basis of this report, concerns mainly the kind and amount of gear used in fishing and the types and quantities of fish landed during sampled days of fishing activity. The unit of observation in the PS2 is therefore a canoe-day of fishing activity.

The size of samples in the PS2 survey, i.e. the number of canoe-days of activity sampled are shown in Table 2. Also shown are overall sampling fractions for each limnological zone and for the two fishing methods. These are based on the assumption (from the Uganda results) that about 80 per cent of the possible canoe-days of activity are actually realized. Of this estimated number of canoe-days of activity, slightly less than one tenth of one per cent were sampled in the PS2 (About the same fraction as in the Uganda and Kenya surveys).

111. 3. Number of Gill Nets per Canoe and Mesh Size Composition

During the PSZ survey, information was obtained from each sampled gill netter on the number of nets being used in fishing and their mesh sizes. The average number of nets used per canoe and average mesh size composition were estimated for each limnological zone and fishing site size category. The results for non-motorised gill netters are shown in Tables 3 and 4. (No data were obtained on the few motorised canoes in Tanzania)

The estimates for each limnological zone in Table 3 are weighted averages for all classes of fishing sites. The overall averages, for all zones, are given in the right-most column. On the average, about 38 nets are used per canoe, with about two-thirds of these being small-mesh (0"-3") and one-third medium-mesh (3"-5"). A higher percentage of medium-mesh nets is found in LZ-1 (Musoma region), LZ-3 (Mwanza Gulf) and LZ-5 (Emin Pasha Gulf). The sample sizes at the bottom of the table give the reader some idea of the relative precision of the various estimates. The overall results are quite precise, being based on 207 sampled canoe-days from 27 fishing sites.

In Table 4, estimates are given for the two categories of fishing sites sampled, small (0-10 canoes) and medium (11-50 canoes). It is apparent that smaller-mesh nets are more predominant in the medium-size fishing sites than in the small ones, although the average number of nets used per canoe is about the same. These results may be contrasted to the Uganda findings, which showed that smaller-mesh nets were more predominant in small fishing sites. These results must be viewed with some caution, however, since the sampled fishing sites were not evenly distributed among the limnological zones.

111. 4 Average Landings per Canoe-day for Fishing Method-1 and Species Composition of the Landings

In Tables 3 and 4 results are also presented on landings per canoe day (in kgs) for fishing method-1, and on species composition. Overall, the average landings per canoe-day were 55 kgs, although estimates for the individual zones ranged widely, from 25.6 kgs in LZ4 to almost 99 kg in LZ5. The figure of 55 kg per canoe-day is about twice as great as the estimates for Uganda (23.7 kg) and Kenya (24.9 kg)

Overall, 38.4 per cent of the landings is Haplochromis, while Tilapia species make up 15.4 per cent. These are followed by Synondotis (10.3 per cent), Bagrus (9.5 per cent), Schilbe (8.8 per cent), Clarias (7.6 per cent) and Protopterus (4.2 per cent).

There are wide differences, in species composition of the landings between limnological zones. Haplochromis is usually dominant where small-mesh nets are most common (zones 6, 7 and 8), an exception being zone 2, where the small-mesh nets take large quantities of synodontis and Schilbe. In zone 5, where very high landings per day were recorded, Tilapia species, mainly T. esculenta and T. nilotica make up about 69 per cent of the landings. Tilapia is also important in zone 3 and, to a lesser extent, zone 4.

As Table 4 indicates, the main differences in species composition of landings between small and medium-size fishing sites is the higher percentages of Haplochromis, Schilbe and Synodontis in the medium-size sites, where smaller-mesh nets are predominant.

111. 5. Landings per CAnoe-day and Species Composition of Landings for Beach Seiners

Altogether, 26 canoe-days of activity by beach seiners were sampled. Inferences drawn concerning beach seiners within particular zones cannot be made reliably due to small sample sizes. However, the average landings per canoe-day and species composition are shown in Table 5. The landings per canoe day were very high on the average - over 200 kg per canoe-day in zone 2, where the largest sample was taken (7 canoe-days in one fishing site). Haplochromis and Tilapia together make up most of the beach seine landings. Also in Table 5, it is apparent that beach seine landings, per canoe-day, are roughly 2.5 to 4.0 times greater than those for fishing method-1.

111. 6. Estimates of Total Quarterly Landings

The estimates of landings per canoe for the various categories were combined with figures on total activity to produce estimates of total landings for the first quarter. The results, shown in Table 6, indicate that a total of about 19,000 metirc tons were landed in Tanzania waters of Lake Victoria during January-March 1972.

Although no data on landings were available for large fishing sites, estimates were computed for this category by assuming fishing success was the same as in medium sites. Similarly, motorised-canoes using FM-1 were assumed to have the same landings per day as non-motorised. In Uganda, at least, this latter assumption cannot be justified, but here it makes little difference to the final results.

Information on seasonal variations in fishing activity and landings will be available when the CAS gets underway on a full-time basis. For the present, assuming (perhaps wrongly) that quarterly landings do not differ much, it appears that total annual landings are on the order of 70,000 tons to 80,000 tons. This very crude estimate may be compared to the figures reported by the Committee for Inland Fisheries of Africa which are about 50,000 tons for 1970 (CIFA/72/8) and 65,000 tons, apparently for 1971 (CIFA/72/Inf.9).

References

Committee For Inland Fisheries of Africa - 1972
A brief review of the current status of the inland fisheries of Africa CIFA/72/8.

________ 1972. The development of fishing industries in the inland waters of Africa. CIFA/72/Inf.9.

Wetherall, J. 1972. Catch Assessment Surveys in Lake Victoria. (Report to Fisheries Technical Committee).

________ 1973. A provisional report on the Catch Assessment Survey (CAS) in Uganda waters of Lake Victoria, January-March 1972. EAFFRO, mimeo.

Tablo 7: Estimates of number of fishing canoes in Tanzania Waters of Lake Victoria.

Limno-logical Zone	Size of Fishing Site	Fishing Method			Fishing Method 11	Total Both Methods
		without motor	with motor	Total		
1.	1	352	0	352	18	370
	2	479	5	484	31	515
	3					67
	Total					952
2.	1	90	0	90	23	113
	2	470	0	470	76	546
	3					117
	Total					776
3	1	71	0	71	12	83
	2	257	11	268	17	285
	3					53
	Total					421
4.	1	32	0	32	8	40
	2	14	0	14	5	19
	3					0
	Total					59
5.	1	77	0	77	26	103
	2	286	3	286	18	307
	3					0
	Total					410
6	1	105	0	105	0	105
	2	758	0	758	0	758
	3					103
	Total					966
7	1	121	0	121	0	121
	2	126	1	127	8	135
	3					0
	Total					256
8	1	120	0	120	36	156
	2	47	1	48	3	51
	3					0
	Total					207
All Zones	1	968	0	968	123	1091
	2	2437	21	2458	158	2616
	3	317	3	320	20	340
	Total	3722	24	3746	301	4047

Table 2. Number of canoe-days sampled and sampling fractions during PS2 Survey (anzania)

Limnological Zone	Size of Fishing Site	No. of Sites Sampled	No. of Canoe-days sampled: Fishing Method I: without motor	with motor	Total	Fishing Method II	Total Both Methods	Sampling Fractions (%)
1	1	4	29	0	29	0	29	
	2	0	0	0	0	0	0	
	3	0	0	0	0	0	0	
	Total	4	29	0	29	0	29	0.04
2	1	1	9	0	9	0	9	
	2	3	32	0	32	7	39	
	3	0	0	0	0	0	0	
	Total	4	41	0	41	7	48	0.08
3	1	2	15	0	15	0	15	
	2	2	27	1	28	3	31	
	3	0	0	0	0	0	0	
	Total	4	42	1	43	3	46	0.15
4	1	3	15	0	15	4	19	
	2	1	8	0	8	6	14	
	3	0	0	0	0	0	0	
	Total	4	23	0	23	10	33	0.78
5	1	2	15	0	15	3	18	
	2	0	0	0	0	0	0	
	3	0	0	0	0	0	0	
	Total	2	15	0	15	3	18	0.06
6	1	1	9	0	9	0	9	
	2	1	12	0	12	0	12	
	3	0	0	0	0	0	0	
	Total	2	21	0	21	0	21	0.03
7	1	4	24	0	24	0	24	
	2	0	0	0	0	0	0	
	3	0	0	0	0	0	0	
	Total	4	24	0	24	0	24	0.13
8	1	3	12	0	12	2	14	
	2	0	0	0	0	1	1	
	3	0	0	0	0	0	0	
	Total	3	12	0	12	3	15	0.10
All Zones	1	20	128	0	128	9	137	
	2	7	79	1	80	17	97	
	3	0	0	0	0	0	0	
	Total	27	207	1	208	26	234	0.08
Sampling Fractions (per cent of total canoe - days)			0.08	0.06	0.08	0.12	0.08	

Table 3. Estimated landings per canoe-day, average number of gill nets used per canoe, species composition of landings and mesh-size composition of gill nets for non-motorized canoes using Fishing method - 1 (Tanzania)

Species		LZ 1	LZ 2	LZ 3	LZ 4	LZ 5	LZ 6	LZ 7	LZ 8	All Limnological Zones
<u>Tilapia esculenta</u>		8.85	5.41	19.77	21.26	37.69	0.80	0.30		8.46
<u>T. zillii</u>		0.41		0.09		1.38		0.10		0.25
<u>T. variabilis</u>		1.45	4.08	3.74	0.61	3.74	0.03	5.21	1.56	2.24
<u>T. nilotica</u>				16.77		26 30	3.10	1.14		4.44
Total <u>Tilapia</u>		10.69	9.49	40.37	21.87	69.11	3.93	6.75	1.56	15.39
<u>Bagrus</u>		24.32	2.65	0.39	6.03	1.75	5.30	4.38	38.25	9.52
<u>Clarias</u>		20.06	4.52	11.82	6.82	1.36	3.04	1.96	5.03	7.55
<u>Haplochromis</u>		21.82	1.90	15.63	18.77	23.73	84.69	62.09	50.34	38.44
<u>Protopterus</u>		2.49	4.11	26.05	45.02	3.40	2.15	2.38		4.24
<u>Alestes</u>		0.57	0.22	0.25	0.18		0.40	0.82	0.15	0.36
<u>Barbus</u>		1.81	3.50	0.74	1.04	0.13		0.85	0.12	1.36
<u>Engraulicypris</u>			1.45	0.54						0.35
<u>Labeo</u>		12.57								2.78
<u>Mormyrus</u>		2.02	0.28	0.07	0.05	0.25	0.59	0.16	0.06	0.73
<u>Schilbe</u>		3.06	32.96	2.05	0.15			4.94		8.75
<u>Synodontis</u>		0.51	38.81	0.40	0.09	0.25		15.67	4.53	10.32
Percentage Mesh - size Composition of Gill Nets	0"-3"	46.0	79.5	40.6	60.4	36.8	84.0	93.3	60.1	65.6
	3"-5"	54.0	17.3	54.7	39.6	63.2	16.0	5.8	38.6	33.2
	75"	0	3.2	4.7	0	0	0	0.9	1.3	1.2
Average No. Nets Used per canoe		43.05	60.52	21.20	24.96	25.00	31.79	26.75	51.83	37.83
Average Landings per Canoe - day (kg)		33.17	74.71	25.82	25.62	98.83	59.19	32.31	26.68	55.07
Average Landings per Gill Net-night (kg)		0.770	1.234	1.217	1.026	4.256	1.861	1.200	0.514	1.455
Number of fiching sites sampled		4	4	4	4	2	2	4	3	27
Number of canoe-days sampled		29	41	42	25	15	21	24	12	207

Table 4. Average landings for canoe-day, species composition of landings, mesh size composition for non-motorized canoes using Fishing method - 1. in Tanzania Waters.

Species		Small Fishing Sites	Medium Fishing Sites
Tilapia esculenta		9.39	7.87
T. zillii		0.18	0.25
T. variabilis		6.23	1.21
T. nilotica		0.75	5.11
Total *Tilapia*		16.55	14.44
Bagrus		15.32	7.75
Clarias		10.21	6.59
Haplochromis		22.43	40.48
Protopterus		5.11	3.85
Alestes		0.86	0.23
Barbus		0.81	1.42
Engraulicypris		0.08	0.40
Labeo		4.13	2.47
Mormyrus		1.07	0.61
Schilbe		1.78	10.00
Synodontis		2.33	11.73
Percentage Mesh-size Composition of Gill Nets	0"-3"	45.5	73.3
	3"-5"	53.6	25.3
	75"	0.9	1.4
Average No. Nets used per canoe		37.03	38.14
Average Landings per canoe-day (kg)		36.68	62.38
Average Landings per Gill-net-night (kg)		0.99	1.64
Number of fishing Sites Sampled		20	7
Number of canoe-days sampled		128	78

Table 5. Average landings per canoe-day and Species composition of landings for beach seiners (Tanzania)

Limnological Zone	2	3	4	4	5	8	8
Size of Fishing Site	Med	Med	Small	Med	Small	Small	Med
Tilapia esculenta	30.68		15.29	2.99	22.74	65.46	0.35
T. zillii					0.33	4.51	1.06
T. variabilis	0.57		6.66	1.87	0.39	16.10	10.56
T. nilotica		26.10			2.67		
Total *Tilapia*	31.25	25.10	22.55	4.87	26.13	86.07	11.97
Bagrus	2.94		2.49	0.45			2.46
Clarias	4.60		0.86		3.98		
Haplochromis	31.89	73.90	74.10	79.86	64.35	12.04	85.56
Protopterus	1.06			14.82	3.77		
Alestes					1.15	1.88	
Barbus	0.21						
Labeo					0.63		
Schilbe	21.20						
Synodontis	0.34						
Average Landings per Canoe-day	207.91	86.60	70.18	146.92	382.18	66.45	28.4
No. of Fishing Sites Sampled	1	1	1	2	1	1	1
No. of Canoe-days Sampled	7	3	4	6	3	2	1
Ratio of Landings per canoe-day of FM2 to FM1	2.73	3.35	3.89		3.87	2.38	

Table 6. Estimation of total landings in Tanzania waters of Lake Victoria during the survey period

Limnological Zone	Size of Fishing Site	Fishing Method I			Fishing Method II	Total Both Methods
		without motor	with motor	Total		
1	S	839.4	0	839.4	257.5	1096.9
	M	2150.9	12.3	2163.2	430.0	2593.2
	L					337.3
	Total					4027.4
2	S	342.4	0	342.4	331.8	674.2
	M	2669.9	0	2669.9	1122.2	3792.1
	L					812.6
	Total					5278.9
3	S	83.4	0	83.4	72.4	155.8
	M	526.3	23.4	549.7	106.6	656.3
	L					122.0
	Total					934.1
4	S	53.8	0	53.8	42.4	96.2
	M	30.2	0	30.2	54.3	84.5
	L					0
	Total					180.7
5	S	549.7	0	549.7	708.6	1258.3
	M	1282.2	21.8	1304.0	506.9	1810.9
	L					0
	Total					3069.2
6	S	177.1	0	177.1	0	177.1
	M	3501.2	0	3501.2	0	3501.2
	L					475.6
	Total					4153.9
7	S	281.5	0	281.5	0	281.5
	M	563.9	3.1	567.0	112.7	679.7
	L					0
	Total					961.2
8	S	230.8	0	230.8	171.6	402.4
	M	213.0	1.0	214.0	6.2	220.2
	L					0
	Total					622.6
All Zones	S	2558.0	0	2558.0	1584.3	4142.4
	M	10937.7	61.7	10999.4	2339.0	13338.3
	L					1747.6
	Total					19228.3