JESS FISHERIES

CONSULTANCY I REPORT

JESS Report No. 12

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ACRONYMS AND ABBREVIATIONS

AID	U.S. Agency for International Development
ARD	Associates in Rural Development, Inc.
BuRec	U.S. Bureau of Reclamation
C	total catch or harvest of fish by fishermen
CAS	catch assessment survey
CPUE	catch per unit of fishing effort
E	fishing effort
FBS	fish biology sampling
FPS	Fish Sampling Program
GSDR	Government of the Somali Democratic Republic
ha	hectare
HP	horsepower
ICA	International Center for Aquaculture
JESS	Jubba Environmental and Socioeconomic Studies
JuDAS	Jubba Development Analytical Studies
kg	kilogram
MEI	Morpho-edaphic index
MFMP	Ministry of Fisheries and Marine Products
MJVD	Ministry of Jubba Valley Development
MSY	Maximum Sustainable Yield
SEBS	socioeconomic baseline study
SES	Socioeconomic Survey
spp.	species
TDS	total dissolved solids
USA	United States of America
USAID	U.S. Agency for International Development

PREFACE

The Jubba Environmental and Socioeconomic Studies (JESS) project is a three-year program of river basin investigations in southern Somalia. This project is part of a larger project, called Jubba Development Analytical Studies (JuDAS), which is a cooperative effort between the U.S. Agency for International Development (AID) and the Ministry of Jubba Valley Development (MJVD) of the Government of the Somali Democratic Republic (GSDR). Associates in Rural Development, Inc. (ARD) was contracted to provide technical assistance and project management for JESS.

Under contract with ARD, Earl Meredith, a fisheries biologist, is providing technical consulting for the assessment of the fishery resource in the Jubba Valley. Mr. Mohamad Hassan Aden of the MJVD assisted Mr. Meredith with the frame survey during this consultancy. Further technical assistance was provided by Mr. Ahmed Abdouli Yassin of the Ministry of Fisheries and Marine Products (MFMP). The first field trip from the mouth of the Jubba River to the Fanoole hydroelectric facility took place from 6 October to 20 October 1986. The second field trip was conducted from 30 October to 17 November 1986. Field notes and data from these trips are included in the appendices to this report.

I. EXECUTIVE SUMMARY

As part of Phase II of the Jubba Environmental and Socioeconomic Studies (JESS) program, a fisheries biologist from Associates in Rural Development, Inc. (ARD) conducted a two-month consultancy in Somalia. The purpose of this consultancy was to determine the existing extent and value of fisheries resource use in the Jubba Valley as well as begin studies that will how the existing resource will be changed by construction of the Baardheere Dam.

Using predictive models developed after work on other African reservoirs, it is estimated at this time that the annual sustainable yield for the Jubba River fishery ranges from 1,600 to 1,800 metric tons having a value of 80 to 90 million Somali shillings (or between $888,000 and one million U.S. dollars at an exchange rate of 90 Somali shillings to the dollar).

If the newly created Baardheere Dam reservoir behaves similarly to other African reservoirs, and there is no reason to doubt that it will, a very high, but temporary, rate of primary production and potential fish yield will be available for exploitation during the first few years of reservoir establishment. This surge in production represents an economically significant resource that river basin planners in Somalia should take into consideration as projects are developed in the valley.

Preliminary results of a reconnaissance (frame) survey on fisheries activities during the high-water Deyr season of 1986 (roughly October to December) in the Jubba Valley indicate very little fisheries exploitation on the river itself but much higher levels of activity on the dhesheegs. However, fisheries activity apparently is much higher during low-water months (i.e., January to March). Fishermen were observed using hook-and-line techniques as well as nets of different sizes. Most of the fishing activity appears to be artisanal (i.e., personal use) with the exception of dried and fresh fish being caught on the dhesheegs.

Reconnaissance-level fish sampling, using seine nets and limited chemofishing, indicates that the current level of fishing on the Jubba River is low, particularly in the northern sections of Somalia. Much larger fish were caught in the upper reaches, though this may be explained by upstream migration. This reconnaissance work was used to design a proposed series of more statistically dependable surveys that would take place later during JESS' Phase II. These future surveys would include both fish biology sampling (FBS) as well as assessments of the level of fish marketing and consumption (catch assessment survey--CAS) in the valley. Also, the socioeconomic baseline study (SEBS)

being implemented by JESS social scientists has also incorporated fisheries questions and issues.

Based on this initial consultancy, which included a preliminary review of trained manpower in the area of freshwater fisheries, the consultant also suggests that the GSDR and the MJVD consider seeking long-term overseas training for Somalis. The fisheries and aquaculture program at Auburn University is one appropriate option for such training.

II. INTRODUCTION

The long range goals of the JESS project are to provide the MJVD with necessary information on soils/land use, natural resource utilization, social and environmental issues, staff training, and technical support.

The overall objectives of this work were as follows:

- conduct a frame survey to determine the type of fish population monitoring program required to document changes in the resource due to proposed development activities in the Jubba Valley;
- identify fish landings, market places and fishing villages for a sampling frame applicable to a catch assessment survey (CAS);
- design a fish population and environmental sampling program and integrate this sampling with existing environmental and socioeconomic surveys;
- identify cooperating agencies and personnel requirements;
- train field personnel in fish sampling techniques, identification and measurement of fish, equipment use and care, and proper recording of data; and
- begin the fish sampling program, compile a list of potential species present in the river, and assess the possibility of a fish tagging program to detect fish migrations.

The purpose of this report is to briefly describe the frame survey and its results, and discuss future fishery sampling programs. Other objectives are to list scheduling of sampling for 1987, list possible species (spp.) and spp. codes for data entry purposes, list equipment needs for fieldwork, and discuss personnel requirements.

Fisheries biologists working on the African continent have directed their efforts primarily toward assessing the status and potential of marine and lake fisheries. Until recently, rivers have received relatively little attention, as is the case on a worldwide basis. The possible reasons for this reside in the very nature of riverine systems. Rivers are usually very complex ecosystems. They are open-ended, with potentially large variations in river environments due primarily to seasonal changes in hydrological cycles and fluctuations in flow regimes. The large diversity of ecological habitats that may exist makes

sampling, characterization, assessment and management very difficult. The sheer size of these systems, which sometimes cross international boundaries, increases this difficulty.

A major use of African rivers by humans is fishing. The preponderance of these fisheries are artisanal in nature. These small-scale fisheries provide fishing families with a source of income and valuable protein-rich food. Fisheries of this kind are usually localized or regional in nature, with the producing, processing, distributing, marketing and consuming segments all very simple and closely located geographically. Fishing usually is not a full-time activity. It is highly integrated into the household agricultural and pastoral customs which progress or change seasonally with the hydrological cycle. On a continental basis, African rivers provide 40 to 50 percent of the total fish harvest (Welcomme and Shell 1986) and 25 percent of the total animal protein consumed by people of that continent (Shell 1986).

The Jubba River flows south from the highlands of south-central Ethiopia and the northeastern corner of Kenya. The headwaters of the Jubba are composed primarily of three main tributaries--the Gestro, the Genale and the Dawa. The confluence of these streams at Dolo, as it flows into Somalia, forms the Jubba River. Daget and Iltis (1965) and Welcomme (1985) would classify this river as a Sudanian flood plain river, flowing through an arid savanna region, with a Nilotic fish species composition.

III. GENERAL FISHERY ESTIMATES FROM PREDICTIVE MODELS

The necessity for comprehensive preimpoundment studies for African reservoirs has been clearly recognized and discussed by several authors. Thorton (1980), Adenifi et al. (1981) and Marshall (1984) were among the first to discuss this matter and to make attempts at predicting the ecology and fish yields in African reservoirs using available preimpoundment information. Welcomme (1985) discussed the effects on fish populations and ecology of river basins due to many diverse management and flood plain development practices. He presented a summary of the effects of hydraulic works on river fish communities (see Table 1).

Welcomme (1976) pointed out that despite serious inadequacies of the available catch data for African rivers, an analysis of fish yield patterns has given a fairly coherent picture of the factors involved in determining the catch that can be expected from any particular system. Welcomme (1985) presented predictive models for annual fish catch for African rivers using total basin area and main channel length. These models were tested on 20 African rivers and the results are presented in Table 2. Excluding catches from exceptionally large flooded areas, the sample conformed to the following relationship:

$$C = 0.03A^{0.97} \quad (r=0.91)$$

where C and A are equal to annual catch (tons per year) and basin area (km^2) respectively. Welcomme stated that, "Because the basin area and total length of the longest channel of the river are also simply related," the following relationship was established for African rivers:

$$\text{Main channel length} = A^{0.45}.$$

This equation, transformed into a relationship for yield in tons per year as a function of the main channel length (L in km), gives the following equation:

$$C = 0.0032L^{1.98} \quad (r=0.90)$$

or approximately one three-hundredth of the square of the length of the stream ($L^2/300$).

Marshall (1984) discussed predicting ecological parameters and fish yields using physical, hydrological and chemical data in preimpoundment river basin studies. Probably the most well known of these predictive models is the Morpho-edaphic index (MEI). Henderson and Welcomme (1974) first pioneered the relationship

Table 1. Effects of Hydraulic Works on River Fish Communities*

Changes in Flow	
Temporal Changes	
Disruption of spawning patterns through inappropriate stimuli or unnatural short-term flows.	Changes in community structure away from seasonal spawners to species with more flexible spawning.
Shift from pulse regulated to stable system dynamics.	Diminished productivity at community level.
Changes in Velocity	
Increases in flow rate (usually due to channelization).	Young fish in drift swept past appropriate sites for colonization.
	Local shifts in species composition in tail race with accumulation of rheophilic predators.
Decreased flow rate.	Shifts from rheophilic to lentic communities in reservoir upstream and in controlled reaches downstream.
	Changes in flushing rate resulting in accumulation or low dilution of toxic wastes or anoxic conditions leading to fish mortality.
Loss of Habitat	
Prevention of flooding by dams and levees.	Loss of floodplain area available for spawning growth; loss of habitat diversity; change in species composition with loss of obligate floodplain spawners.
	General diminution in productivity of whole system.

Table 1 Continued

Drowning of spawning substrates upstream of dams or in channelized reaches.	Variable effects usually involving decline of lithophils or psammophils although new wave washed shore or rock rip-rap may simulate rhithronic habitats.
Blocking of Channel	
Interruption of migratory pathways by dam walls or by the creation of unsuitable conditions for passage.	Elimination of diadromous or obligate migrants by preventing movement to upstream breeding sites by adults and slowing downstream movements of juveniles.
Changes in Silt Loading	
Changes in channel form (due to channelization or to changes in deposition/erosion process).	Reduction of habitat and community diversity loss of species.
Increased rate of silt deposition (usually upstream of dams but also in newly cut off portions of channel or channelized reaches downstream).	Choking of substrates for reproduction leading to failure to reproduce in lithophils/psammophils.
	Changes in density of vegetation usually in favor of phytophilis.
	Changes in quantity and type of food available and in the benthos leading to restructuring of the fish community toward illiophages.
Decrease in suspended silt load.	Changes in fish community reduction in number of non-visual predators and omnivores.
Lack of sediment (downstream of dams).	Changes in nutrient cycle and in nature of the benthos leading to loss of illiophages and increase in benthic limnivores.

Table 1 Continued

Changes in Plankton Abundance	
Increases in photoplankton in reservoir or downstream due to slower flow and higher water transparency.	Increase in abundance of planktonivorous fish.
Changes in Temperature	
Changes in mean temperature caused by low flow regimes.	Increasing temperature variation can cause shifts in success of spawning due to adverse temperatures either for cold or warm water spawners.
Stratification in reservoirs.	Difficulties of passage for migrant species.
	Elimination of fish in deoxygenated hypolimnion.
	Mortalities downstream of dams due to emission of anoxic waters and H_2S.
Uptake of Water	
Induction of water into power stations or through pumps or irrigation canals.	Entrainment of fish into currents diverting them; impingement of fish on turbines and pumps resulting in loss of fish particularly juveniles.
Water transfers between river systems.	Transfer of species and disease organisms from one system to another.

*Source: Welcomme, 1985.

Table 2. Main Channel Length, Basin Area and Catch from African Rivers*

River	Channel Length (km)	Basin Area (km2)	Catch (t)
Nile	6,669	3,000,000	40,840
Zaire	4,700	4,014,500	82,000
Ubangi	1,060	772,800	4,670
Kasai	1,735	342,116	7,750
Niger	4,183	1,125,000	30,000
Benue	1,400	219,964	12,570
Zambezi	2,574	1,300,000	21,000
Senegal	1,641	335,000	16,000
Gambia	1,120	77,000	3,000
Volta B.	650	45,324	1,560
Volta R.	260	6,871	370
Volta W.	255	6,602	70
Pendjari	330	11,226	140
Oueme	700	40,150	646
Mono	360	22,000	533
Tana	600	38,000	500
Bandama	950	97,000	3,408
Sassandra	650	75,000	1,518
Comoe	1,160	78,000	2,142
Rufigi/Ruaha	750	17,700	3,600

*Source: Welcomme, 1985.

between MEI and fish yield (Y) for African reservoirs and presented the following relationship:

$$Y = 14.3136\ MEI^{0.4681}$$

where MEI = total dissolved solids (TDS) or conductivity divided by mean depth (md). This relationship was subsequently modified by Toews and Griffith (1979) by addition of lake surface area (A_o) in km^2 to produce the following equation:

$$\text{Log } Y = 1.4071 + 0.3697 \log MEI - 0.00004565\ A_o.$$

Marshall (1984) discussed the data needs for several morphometric models. The following list presents data which can be used in predicting fish yield in reservoirs.

Physical Data

- reservoir shoreline length (L_o) km
- surface area (A_o) km^2
- mean depth (md) m
- volume (V) $m^3 \times 10^6$
- catchment area (A_c) km^2

Chemical Data

- conductivity (S cm^{-1})
- total dissolved solids (TDS) mg L^{-1}

Predictions made by the World Concern project using Welcomme's basin area model, estimated that the potential annual catch for the Jubba River is 2,407 metric tons. This is using the value of 98,000 km^2 for basin area (A). More up-to-date estimates of basin area for the entire Jubba Valley for each of the three countries sharing this drainage basin are shown in Table 3.

Table 3. Drainage Basin Areas for Countries Sharing the Jubba Valley.[1]

Country	Area (A) in Km^2
Ethiopia	134,000
Somalia	76,000
Kenya	10,000
Total	220,000
up river from dam site [2]	190,000
down river from dam site	30,000

Note:

(1) Data provided by the MJVD-Baardheere Dam Project.

(2) The proposed dam site is located approximately 20 kilometers up river from Baardheere.

Using 76,000 km^2 of basin area in Somalia, in Welcomme's basin area model, the estimated annual sustainable yield for the Jubba River fishery in Somalia would be 1,600 metric tons. Expanding this to a U.S. dollar value using 50 Somali shillings (So. Sh.) per kilogram of fish and 90 Somali shillings per dollar gives an annual value for this fishery of U.S. $888,000 or 80 million So. Sh.

Using Welcomme's main channel length model, the estimated catch on an annual basis could be approximately 1,800 metric tons. This expands to an estimated value of approximately $1 million or 90 million So. Sh.

Estimates of catch and economic (market) value of potential fisheries resulting from the proposed reservoir that will be created by the Baardheere dam will be made using the preimpoundment data discussed above. This information will become available when engineering and surveying data are collected.

Most newly impounded reservoirs display very high primary production and fish yields which last for the first few years, and then decline and stabilize at some lower equilibrium. This "new lake phenomenon" results from the increased nutrients released into the aquatic environment from the newly inundated land and the decay of organic matter in submerged terrestrial macrophytes (land vegetation). This nutrient release causes a surge of primary production by aquatic algae, subsequently resulting in a larger population of zooplankton and periphyton (free-floating and attached aquatic animals), all of which are the foundation of the food webs in aquatic and marine ecosystems.

The fisheries associated with these newly impounded reservoirs usually expand accordingly. The reservoir that will result from the Baardheere Dam will undoubtedly display the same behavior, and it would be very advantageous for fishery development schemes to be prepared to harvest this initial excess of fish production.

IV. FISHERIES FRAME SURVEY

A frame survey is essentially a reconnaissance survey to identify existing fish landings, markets, and fishing villages in order to establish a statistical sampling frame. Estimates of the number of fishermen or fisher families per village, gear inventories and avenues of fish distribution are important secondary objectives of this survey. In river fisheries with high levels of exploitation and non-dispersed fishermen, fishing villages can be identified and the number of fishermen and their gear counted. Centralized landings or markets then are identified for sampling of fishing effort and the catch. Socioeconomic data should also be collected at these locations or at household levels.

In less exploited river systems or very dispersed fisheries, it is much more difficult to sample fisheries to determine effort and catch, because landings are not centralized or well defined and few, if any, fish markets exist to allow for easy data collection. Because of the sheer size of some river systems and extremely low water conditions due to the hydrological cycle or drought, sampling is especially difficult. In these situations, other sampling methods that incorporate transportation and consumption surveys have proven to be of greater value.

Statistical sampling designs are varied and depend on the complexity of the system. Gulland (1972) described several sampling and statistical methods used by fishery biologists. In many sample designs, it is desirable to stratify the river system into relatively homogeneous spatial and temporal units in order to reduce variability and increase the effectiveness of sampling. It is also necessary to randomize sampling to reduce any potential bias that would result in inaccurate estimates of the values to be determined. Therefore, stratified random sampling is a very common sampling method if physical and logistical conditions are favorable.

Basic estimates needed for fisheries assessment, monitoring and subsequent management are:

- Effort (E) or estimate of the number of fishing units operating on the system--fishing units can vary from individual fishermen operating out of small dugout canoes and hook-and-line fishermen walking along the bank to a group of fishermen operating out of a larger boat.

- Catch (C) is an estimate of total harvest from the fishery.

- Catch per unit of fishing effort (CPUE) is a measure of fishing success and is dependent on catchability and relative abundance of fish. CPUE can also be a measure of the profitability for an individual unit of fishing effort. Malvestuto and Meredith (in press) used the distribution of CPUE's on the Niger River in Niger, West Africa, to determine the percentage of fisheries operating at no-profit days. This could be a way that JESS can estimate the potential profitability for people who might consider starting to fish as a means of livelihood.

Relationships between E, C, and CPUE have been established, and predictions of maximum sustainable yield (MSY) can be derived for management purposes. Welcomme (1986) discussed these relationships for African rivers. The annual estimation of catch and effort, over many years, will allow for estimation of MSY for the Jubba River. Government agencies involved in fisheries management and development in the Jubba Valley can determine at what level the fishery has developed, thus implementing expansions or restrictions of fishing activities.

Other important information lies in the biology of the fish stocks in the system. Stock structures, lengths at maturity, predator-prey relationships, feeding habits, spawning habits and habitats are all important factors for the management of small-scale artisanal fisheries.

A. Preliminary Results of the Frame Survey

Frame survey results on the Jubba River showed very little exploitation in the river itself during the Deyr rains of the 1986 season (high water). However, higher levels of fishing activities in the adjacent dhesheegs indicate that more fishing activity occurred in the river during the low-water season. This is very typical in most African flood plain fisheries because fish are very dispersed in high water and swift flow rates hinder fishing gears.

A very small number of fishermen were observed in the lower Jubba Valley between the mouth of the river close to Gob Weyn and the Fanoole hydroelectric facility. A couple fishermen were observed using gill nets of mesh sizes from 40 to 80 centimeters of stretch mesh. Some fishermen were found using hook-and-line techniques. These people were usually young boys or irrigation pump operators who were baiting hooks and placing them in the water during the day while they worked on an irrigated farm plot adjacent to the river. They usually harvested their hook and line in the early afternoon, using the fish for personal consumption.

Most people interviewed in this area indicated that fishing in the river during the low-water season is much more common. In most cases, the people indicated that fishing is done for personal consumption as opposed to marketing for income, but several fishermen indicated that they occasionally sold some fish if they had more than they needed for their households on that day. However, this marketing of small amounts of river fish is very uncommon, and there exists no centralized or established marketplace for fish, with the exception of dried and fresh fish being transported from the dhesheegs.

The marketing of the catch from the dhesheegs seems to be fairly well organized. Further investigations into this marketing system will be very valuable. The fishery associated with the Jubba River has virtually no centralized landings or markets, and fishing is restricted primarily to a very few people along the shore. The situation in northern Jubba Valley is very similar, with the exception of the lack of dhesheeg fishing.

B. Fish Biology Sampling

Fish biology sampling was initiated using experimental monofilament gill nets, hoop nets, long lines, a hoop larval fish sampler, rotenone and seine sampling. These techniques were tested for their applicability and practicality. It was determined that the monofilament gill nets are very effective, however the small filament size coupled with crocodile damage makes them less appropriate. The gill net in the worst condition should be scrapped for material to repair the less damaged net. Spools of replacement monofilament line should be purchased for repair of the one remaining net. Replacement gill nets should be purchased and sent from the United States. The float and lead lines from the scrapped gill net can be used to mount polyfilament nylon mesh, which is much more durable and available in the fisheries supply store in Mogadishu. Identified field personnel from the Ministry of Fisheries and Marine Products (MFMP) are well trained and are very capable of modifying and repairing gears. Comparisons between the catch of these two different kinds of gill nets can then be made and differences in fish species and size selectivities tested. A minimum of four nets, two monofilament and two polyfilament, are needed.

The JESS hoop nets are of a design suggested by Mr. Ahmed Yassin and proved to be quite effective when set properly. The only problem with this gear is that turtles sometimes get stuck in the funnel and prohibit fish from entering the trap. This problem is currently being dealt with by design modifications considered by Mr. Ahmed Yassin. With a few more trial fishing trips, this problem should be solved.

Long lines were also very effective at catching fish. Again, turtles caused some problems, but not as severe as with the hoop net.

Several seine samples were attempted with limited success. This was probably due to the strong current and the depth of the water. The seines used were 8 and 12 feet in depth, and in many locations the water was deeper than the seine. This sampling technique will be more applicable during the low-water season when current and depth are less.

One rotenone sample was attempted and, as with the seine sampling, this technique might be more appropriately applied during low-flow conditions. The University of Michigan (1971) used seine nets and rotenone sampling during low-water conditions on the Kafue River in Zambia to estimate fish biomass (kg of fish/ha). These same techniques will be employed during subsequent low-water samplings on the Jubba River in 1987.

Problems associated with experimental use of all of these gear types were the strong currents, danger of crocodile damage, turtle interference with fishing success, and theft of fish by local villagers and crocodiles. A tremendous amount of free-floating and bottom debris such as logs, branches, leaves and entire trees posed some problems when using gill nets.

Despite these problems much valuable data were collected. All of these data are not yet entered on the computer, and preliminary results will be forthcoming at the completion of Phase II fisheries studies. A list of species caught, CPUE's for each gear type, length frequency distributions, and maturity states will be included in future fisheries reports prepared in the United States.

The size ranges of the different species and their abundance confirms that the current level of fishing on the Jubba River is very low. This was obvious for the northern region, but on the lower Jubba River, the fish were slightly smaller, perhaps owing to a higher level of exploitation. Another explanation could be that since all the fish caught were mature and in a nuptial (spawning) condition, upstream migrations of the larger fish were taking place and these larger, mature individuals were more abundant and more easily caught.

The data collected during these trips were insufficient to make statistically valid conclusions. However, preliminary indications are that there is a very valuable fishery resource which is under exploited.

V. PROPOSED ONGOING FISHERY ASSESSMENT SURVEYS

Recommendations for future fishery sampling are outlined and explained in this section. The proposed ongoing fishery surveys will entail three different sampling programs. The major sampling schemes for the fishery assessment of the Jubba River will be made up of the fish biology sampling (FBS), the catch assessment survey (CAS) and the modifications made on the socioeconomic and household surveys for fisheries purposes.

A. Temporal and Geographical Stratification

The FBS and CAS will take advantage of the same temporal and geographical stratification scheme. The baseline socioeconomic and household surveys will be conducted by Dr. K. Craven and Dr. J. Merryman of the JESS long-term field team. Details of this study can be obtained from the JESS SEBS reports.

Spatially, the 800 kilometers of the Jubba River in Somalia will be stratified from north to south into two geographical regions or geostrata. The northern geostratum (geostratum 1) extends from the Ethiopian border at Dolo to just upriver from the village of Saakow. This region is defined as the "non-fishing region" because there is very little or no fishing activity. The southern geostratum (geostratum 2) starts at the village of Saakow and ends at the mouth of the river. This region is the "fishing region" because there were many indications that fishing is somewhat established--either in the dhesheegs or in the river, primarily during the low-water season--as noted earlier.

This spatial stratification will allow not only regional comparisons of the fishery and fish populations, but also logistical and sampling convenience. Due to limited personnel and time available for fishery sampling, it is felt that two geostrata is the maximum number that can be attempted at present. For the future, sampling intensity should be increased by allocating more manpower and increasing the number of sampling days.

Based on monthly river discharge data dating back to 1951, the hydrological year was divided into four time periods or hydrostrata. These seasons are defined as follows: January through March (lowest water, Jilaal), April through June (rising water, Gu'), July through September (mid-water, Xagaa) and October through December (highest water, Deyr). The spatial and temporal sampling design of this survey is similar to that used by Bazigos et al. (1975) on the Magdalena River, Malvestuto et al. (1980) on the Upper Meta River, both in Colombia, South

America, and Malvestuto and Meredith (in press, see references) on the Niger River in Niger, West Africa.

Owing to personnel and financial constraints, only 20 sampling days per season can be allocated for fishery assessment activities and 10 sample days for each geostrata. The hydrostrata will be divided into 10-day sampling units which will be randomly chosen for field trips. Two 10-day field trips per season, one in each geostrata, will be conducted (see Appendix B for schedule of sampling trips).

Sampling for the CAS and FBS, within each combination of geostrata and hydrostrata blocks, will be done in the villages along the river. Villages will be randomly chosen for sampling, one village per day. Choice of villages will need to be randomized by numbering the villages in each geostratum and randomly selecting one village. A coin can then be tossed to determine whether the team will work up or down stream, sampling consecutive villages until 10 sampling days are completed. The FBS will be conducted in the surrounding area up and down river from each village being sampled for the CAS.

B. Fish Biology Sampling

The objectives of the FBS program are to:

- identify species present in the river;
- determine relative abundance of each species;
- establish length-frequency distributions for each species caught;
- establish weight-length relationships and condition factors for each species;
- determine length at maturity and seasonality of spawning for valuable commercial species;
- attempt to identify fish migrations;
- establish baseline CPUE's for experimental fishing gears for future comparisons of relative stock density;
- determine species selectivities for each experimental fishing gear; and
- estimate standing stocks.

In order for an FBS program to be effective, several gear types must be utilized in capturing fish. Since a particular type of gear will have a certain selectivity for a particular species and/or size of fish, it is necessary to diversify sampling gears so that a broad spectrum of species and sizes will be caught. Some techniques, such as seining or rotenone sampling, are less selective than gill nets or hoop net traps, but are less easily used during certain seasons. As mentioned earlier, river current is too strong and depth of water too deep during the high-water season for effective sampling with seines and rotenone. Gears most effective during this season include gill nets, hook lines and hoop nets.

A two-stage sampling scheme is proposed. During the mid- to high-water seasons, sampling will use gill nets, long lines and hoop nets. These gears will be standardized (see Appendix F) and set for 24-hour intervals. Gears will be checked every 12 hours, once in the early morning and once in the late evening. The catch (kilograms) per gear type and mesh size for gill nets per 12 hours of fishing time will be the unit for CPUE. Details of the techniques in using these gear types can be found in Fisheries Techniques, published by the American Fisheries Society (Nielsen 1984). Field personnel have been trained and are familiar with the techniques.

During the low-water seasons, the above-mentioned gears can continue to be used, with the addition of seine and rotenone sampling for a more comprehensive sample. The majority of this sampling will take place during the proposed "down the river expedition," if it occurs.

All fish captured in the FBS will be identified by appropriate taxa, weighed, measured, and sex and maturity state will be determined by visual observations of the gonads. Maturity states will be ranked according to the following scale:

- sex not visually discernable;
- immature--sex discernable, but gonads translucent;
- developed gonads, i.e., maturing--testis creamy white, ovaries with eggs that are colored and lightly granulated;
- mature and in spawning condition--running eggs or milt either by stripping or upon handling of the fish; or
- mature and spent--gonads well developed but empty and flaccid, much vascularization.

The adult stock of a particular species is considered to represent all individuals equal to, or larger than, the smallest fish collected at the fourth maturity stage. Field personnel have received training in this aspect and have proven their competency in using the proposed scheme.

Data will be recorded on standardized data forms (see Appendix C) and later entered into a data base format specifically designed for FBS on the IBM/AT using DBase III+ data base management software. Statistical analysis will be done using the STATPAC and SAS software programs.

C. Catch Assessment Survey

Objectives for the CAS, as previously discussed are:

- estimate levels of fishing effort (E);
- estimate levels of harvest or catch (C);
- estimate catch per unit of effort (CPUE);
- characterize gear usage and selectivities fishery; and
- determine species composition and relative abundance in the fishery.

Due to the apparent low levels of fishing activity and the rather dispersed nature of fishing on the Jubba River, the CAS will be rather difficult to conduct and results could be marginally valuable. It should, however, be attempted because estimates of the above-mentioned values are important for development project planning and fishery management.

As previously mentioned, the CAS will be conducted concurrently with the FBS using the stratification scheme described previously. The survey team will randomly choose 10 villages along the river to be sampled within each geostratum. After the experimental fishing gear is installed within close proximity of the chosen village, the survey team will remain at that village for the rest of the day. People engaged in any kind of fishing activity will be counted and any fish caught will be identified, weighed and measured. Fishermen will be interviewed and data recorded concerning the type of fishing gear used, the time spent in catching fish, and the destination of the catch, i.e., household or personal consumption or for market.

The mean number of fishermen per village per day will be applicable to the entire geostratum. This value will be expanded to an estimate of total fishing effort for the entire geostratum

over the entire hydrostratum. The mean CPUE will be calculated by taking an average of catch per fishermen over the entire 10-day sampling period. Catch can then be estimated by multiplying the mean CPUE for the entire stratum by the estimated number of active fishermen.

In order to estimate the amount of dhesheeg fishing, villages chosen for sampling with a dhesheeg located close by will have to be monitored as best as possible along with the dhesheeg. The data form will have a field that will allow the number of river and dhesheeg fishermen to be recorded separately.

D. Baseline Socioeconomic Studies with Reference to Fisheries

Estimates of fish consumption on a household basis have been used by Bayley (in press) to make estimates of total catch for very dispersed river fisheries in South America. Data from the baseline socioeconomic and household surveys will prove beneficial for estimating total catch from the river and dhesheegs as well as attempting to place a monetary value on this resource. These surveys are designed to estimate levels of household fish consumption and marketing from the river, dhesheegs and estuarine fisheries.

VI. DISCUSSION

Due to the lack of adequately trained fishery personnel in the MJVD as well as time that can be allocated for fisheries surveys, the above sampling program is the best possible at this time. Results from this survey will probably be highly variable, but can be useful for planning purposes. More trained personnel and increased time allocation for fisheries would result in larger sample sizes that would improve the precision and accuracy of the CAS data. The optimum number of field personnel for fisheries work on this river system would be three trained fishery technicians in each geostrata and at least 20 samples per hydrological season.

More extensive training of selected field personnel in fisheries and aquatic ecology is strongly encouraged. The aquaculture training program at the International Center of Aquaculture (ICA) at Auburn University is highly recommended. This is a very good hands-on training course in aquaculture and fisheries management. It is sponsored by AID. Somalia desperately needs to develop technical expertise within the staff at the MJVD or MFMP. The Auburn training program is an excellent opportunity to begin this development.

The potential for freshwater fisheries development on the Jubba and Shabeelle rivers is very evident. AID and MJVD should seriously consider ongoing assessment surveys and short-term fishery development programs with extension activities that include encouragement of fish consumption, development of new markets, fish preservation techniques, and formation of professional fishermen organizations. Project proposals could be generated for capture fisheries during subsequent consultancies if AID deems it necessary.

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APPENDIX A

Fisheries Equipment List

Boats

Two aluminum jon boats, one 18 foot and one 14 foot, with two 25-HP and one 40-HP Evinrude outboard motors are needed. The small boat and motor will be stored in the Baardheere field house and the large boat and motor will be stored in the Jilib field house. Outboard motor oil, spare props, spark plugs, manuals, and tool kits should be taken on each field trip.

Fishing Gear

Two experimental gill nets, two experimental hoop nets, two long lines, weighing scales (one 1000-gm, one 5-kg, one 250-lb hanging scales and one 50-lb platform scale are presently available). One 35-kg Pesola tube scale should be purchased and sent as soon as possible. Also needed are a measuring board, fish identification book and keys, plastic buckets, rubber basins, spools of rope and various sizes of twine, formaldehyde and collection jars, data sheets, paddles flotation cushions and life vests, pens and pencils, seines, block nets and rotenone for low-water sampling, wood poles, gas tanks and gerry cans, needle nose pliers and fillet knife.

APPENDIX B

Fisheries Sampling Schedule (1987)

Dates of Field Trip	Geostratum
31 January to 9 February	2
20 February to 1 March	1
21 May to 30 May	2
31 May to 9 June	1
30 August to 8 September	1
19 September to 26 September	2
31 October to 9 November	1
10 December to 19 December	2

APPENDIX C

Sample of FBS Data Sheet

MINISTRY OF JUBBA VALLEY DEVELOPMENT
Jubba Environmental and Socioeconomic Studies
Fisheries Stock Assessment
Form A
Fish Biology Sampling Data Form

Date:_____ Location:_____ Strata:_____
Season:_____ AM:___ PM:____ Recorder:_____
River:_____ Dhesheeg:_____

Sp.	Sp. code	Lgth(cm)	wght(gm)	Gear type	Gear size	sex	maturity

APPENDIX D

Sample of CAS Data Sheet

MINISTRY OF JUBBA VALLEY DEVELOPMENT
Jubba Environmental and Socioeconomic Studies
Fisheries Stock Assessment

Form B
Catch Assessment Survey Data Form

Date:_____ Village:_____ Strata:_____
Season:_____ Number of active fishermen:_____
total catch:_____(kg) River:_____ dhesheeg:_____

Fisher no.	hrs. fished	gear type	catch	market	house

APPENDIX E

List of Species and Codes

Family, Genus, Species	Code
Lepidosirenidae	010000
Protopterus annectens	010101
Anguillidae	020000
Anguilla bengalensis	020101
Mormyridae	030000
Mormyrops deliciosus	030101
Petrocephalus catostoma	030201
Mormyrus kannume	030301
Chanidae	040000
Chanos chanos	040101
Characidae	050000
Alestes affinis	050101
Microalestes acutidens	050201
Cyprinidae	060000
Labeo bottegi	060101
L. cylindricus	060102
L. mesops	060103
L. ruddi	060104
Barbus gananensis	060201
B. intermedius	060202
B. trimaculatus	060203
B. zanzibaricus	060204
Varicorhinus sp. nov.	060301
Neobola bottegi	060401
Bagridae	070000
Bagrus urostigma	070101
B. bayad macropterus	070102
B. docmoc niger	070103
Pardiglanis tarabinii	070201
Clarotes laticeps	070301
C. bidorsalis	070302
Malapteruidae	080000
Malapterurus electricus	080101
Schilbeidae	090000
Eutropius depressirostris	090101
Schilbe mystus	090201
Physalia somalensis	090301

List of species (continued)

Clariidae	100000
Clarias gariepinus	100101
C. lazera	100102
C. anguillaris	100103
C. submarginatus	100104
Heterobranchus bidorsalis	100201
H. longifilis	100202
Mochocidae	110000
Synodontis schall	110101
S. zambesensis	110102
S. serratus	110103
S. geledensis	110104
Hemisynodontis membranaceus	110201
Brachysyondontis batensoda	110301
Chiloglanis modjensis	110401
C. brecibarbis	110402
Mochocus niloticus	110501
Ariidae	120000
Arius brunellii	120101
A. gigas	120102
A. heudeloti	120103
A. latiscutatus	120104
Cyprinodontidae	130000
Nothobranchius cyaneus	130101
N. jubbi	130102
N. microlepis	130103
N. patrizii	130104
Cichlidae	140000
Oreochromis niloticus	140101
O. mossambicus	140102
Gobiidae	150000
Glossogobius giurus	150101
Gobius aenofuscus	150201
G. gymnopomus	150201

Remarks:
- Each code contains 3 parts,
    1) the first two digits are code for the Family,
    2) the second two digits are code for the Genus,
    3) the third two digits are code for the species.

- An identification of a fish to the Genus level only will have the last two digits as two zeros. For example: a fish that cannot be identified to the species but can be identified as a Synodontis should receive the code of 100100.

APPENDIX F

Field Notes and Data

Field Notes for Fisheries Frame Survey

Fishery frame survey field notes. Trip 1
6 October - 17 October 1986.
Mouth of river to Fanoole Dam

Monday 6 October 1986 and Tuesday 7 October 1986.

Final preparations for field trip and travel to Qorioli where we stayed the night in the Save the Children compound. This is a convenient stop off if a team gets a late start to Jilib and needs a comfortable place to stay about three hours from Mogadishu. This stop allowed us to check the boat and trailer for any modifications or adjustments that needed to be made after the assembling in Mogadishu. On Tuesday, we drove as far as Jilib and stayed the night in the JESS, BuRec compound. We met with the Mayor as the DC was out of his office and busy with other matters. The Mayor, Mr. Djamma, answered many of our questions and gave us his impressions of the value of fishery resources in this region. His impressions were that fish is consumed quite a lot here. He said that there is no set price on fish and that it is based on supply and demand. He told me that there is no central fish market in Jilib but that when people want to buy fish they go to a fisherman's house to see if he has caught any that day. I later found that there is a special location in the market where dried and fresh fish are sold. The majority of the fish consumed in Jilib is from the local dhesheegs. He said that people even go out to the dhesheegs to buy fish. I found that there is a vehicle which goes out to the dhesheegs on a daily basis and distributes fish along the road from Yontoy up to Jilib. He indicated that there are a few people who are more or less, occasional fishermen who fish in the river and use hooks and lines. He indicated that occasionally there are deliveries of frozen fish from Kismaayo marine fishery and that these are sold in the market place in Jilib and distributed around the district to other villages. We saw a broken down refrigerator truck that Mohamad Hassan told me was once used by a private merchant to haul frozen fish from Kismaayo.

Wednesday 8 October 1986.

Drove to Kismaayo and met with the DC and local authorities to inform them of our intentions and work schedule. Met Captain J.R. Christensen of the Somali Marine Product to discuss trawl design and marine fishery systems in this area. Two trawl designs were discussed and plans made to build these nets and necessary equipment to facilitate fish sampling along the coastal

area outside of the mouth of the Jubba River. We also discussed the possibility of hiring a trawl vessel from SMP to conduct these trawls but J.R. said that he had no vessel available and did not want to commit himself to this type of activity. We discussed using our boat for this type of sampling and I expressed doubt as to the applicability and safety of using this boat in the ocean. Nevertheless, two trawl nets were designed and begun. One is a tri-net to be used with two 15 kilogram trawl doors and towed behind the boat along the coast. The second net is a two meter beam net that is to be used in the river for sampling deep mid-river habitat. The mesh size of this net (2" stretch) will allow sampling of adult fish and a special bag can be inserted into the large mesh which is finer mesh (1/4" woven mesh) allowing larval or juvenile fish studies. J.R. told us that there had been a man from upriver (Malenda, a village north of Jilib just down river river from the Fanoole dam) who wanted to establish fresh water fish sales to SMP. He claimed that he would organize a group of fishermen in that area and could supply SMP with three tons per day of fresh fish from the river. This never materialized however. J.R. asked him to bring in a 20 kilogram sample but never saw the man again. J.R. told us of an organization (PRODMA, a subsidiary of Kellogg Seafoods) that did experimental trawls off the Kismaayo coast in the late 1960's. Perhaps this information can be found and comparisons drawn from pre- and post-impoundment sampling to determine changes in the coastal-estuarine fish communities. J.R. told us that some river fishermen sometimes buy fishing nets and hooks from the SMP stores and some build seines called "Yashi" which are small beach seines of 50 to 60 feet in length and "Yuma" which are larger seines of 100 to 150 feet in length and most commonly used in the marine fishery. These nets are also purchased in the Yashi store in Mogadishu. He did not know the prices. Hooks can be purchased in most towns or villages.

Thursday 9 October 1986.
Gob Weyn to Mouth of river (on-water work)

This was the first on water reconnaissance. We launched the boat at the old ferry site where there is an old concrete ramp which made a nice launching pad. It is easier to launch the boat during high tide as there are many large rocks in the water at the foot of the ramp which have a tendency to eat props. This is a difficult location to land the boat because the current is very swift just as you line the boat up for pulling onto the trailer. You must have experience in boat loading in order to drive right up onto the trailer. I showed Mohammed Hassan how to do this and he tried it himself a couple of times. I think he needs more practice and experience in boat handling but he learns very fast and will pick it up soon.

We found one hippo near the mouth and the fishermen whom we hired to help us said that they smelled crocodiles. I entered

the water near the mouth to see if the current was too fast for a 50 foot beach seine trial. The fishermen started yelling for me to get out of the water and not go in again as the current would carry me out to sea and that the crocodiles would eat me. We saw many ducks and various other water birds along this section of the river. A trial seine sample using the 150 foot seine was attempted and was partially successful. The water was very shallow and the current was very strong which made maneuvering the boat very difficult. We did however catch three fish in the family Cyprinidae. I gave Mohammed Hassan some training in boat handling and launching. The trial seine haul was also intended as a training experience and proved to be valuable as it was marginally successful and very difficult. This demonstrated the difficulty in fish sampling in flowing water environments.

Friday 10 October 1986.
Yontoy
Location: on the main road from Jilib to Kismaayo about 10 to 12 kilometers north or Gob Weyn.

Upon arriving at Yontoy we found a fishermen checking his gill net and we intersected him before he could take his fish into town for marketing. His name is Mohammed Aweys Hadji. He works at the agricultural project in Yontoy and was fishing out of a small fiberglass boat, which belongs to the agricultural project and is used for repairs. He was fishing just down stream from the pump station for that project. He caught one Clarotes laticeps which weighed about 1.5 kilos. We did not have the scales with us so we could not weigh this fish. He was using a four finger (40 mm stretch mesh) gill net which was 15 fathoms long and 35 meshes deep. He set this net yesterday evening at about five p.m. and harvested at about eight a.m. this morning. He bought the net last year in Kismaayo for 900 shillings. He also fishes with a hook and line when the water is low in the river. Hooks are purchased in Kismaayo for 10 shillings each and line costs about 100 shillings. He sells fish in Yontoy for about 50 shillings/kilo although I do not know how he weighs his fish. He said that he cuts the fish up and sells it to people who come to his house. He fishes in the early morning and evening and works for the irrigation project during the day. Problems that he has with fishing are that the crocodiles eat the fish out of his net and the hippos knock his boat. During the high-water seasons he has problems with debris caught in his net. When asked if he ever caught Lates niloticus he said yes but mostly during the low-water season. We showed him several fish drawings and asked him to give us their local names. The following is a list of species or species groups and local Somali names:

Species or spp. group	Somali Name
Lates niloticus	Abungishar
Protopterus annectens	Mayumbe
Polypterus spp.	Mayumbe
Heterotis niloticus	Gomia
Mormyridae family	Ballan
Hydrocunys spp.	Abusef
Alestes spp.	Gishar
Alestes brevis	Tewa
Citharinus spp.	Mashirfato
Bagrus spp.	Sharib
Clarotes laticeps	Lubi
Clarias or Heterobranchus	Malay Madow
Synodontis spp.	Kurtay
Chiloglanis micropogon	Fumi
Crustacea	
Atya gabonensis	Kambo Kambo

This list of names was compiled by showing the fisherman the pictures in Reed (1967) so it might not reflect the actual fish species or crustacea present in the Jubba River. More work needs to be done on this matter. It also is interesting to note that in less developed fisheries there is not as well developed local or traditional naming system for individual fish species as there are for more developed fisheries. For example in Niger there are names for almost every species of fish. We also recorded the local names of the fishing gear most commonly used in this area. The following is a list of these gear types and Somali names:

Gear Type	Somali name
fish trap	Sab or Irman
hook	Makalin
hook and line	Hadak makalin
gill net	Shabak
small seine	Yashi
large seine	Yuwa

The site where we found this fisherman is also a major watering site and an excellent launching ramp for the boat. We decided to return the next day and launch the boat here and go down river on-water to Gob Weyn to do some trial fishing and interview more fishermen along the way.

Mukummani
Location: from Yontoy we drove down a dirt road about three to five kilometers along the river.

This village has up to 40 families and people indicated to us that almost each family has a hook and line that they use to fish with for their own consumption. Three other adjacent villages of significance for fishing are Yontoy, Wirkoy, and Boulogudud. The people told us that they fish in the river near the village during low-water season using hook and lines. They do the majority of their fishing during the early morning or late afternoon hours. They told us that they only fish for personal consumption and that if they catch more fish than they need, they dry the leftover fish for future consumption. They never sell fish in their village or other villages.

I discussed with Drannon, the possibilities of sampling along the river and the dhesheegs. He indicated that a 16-day sampling trip could be organized during a three-month period that would correspond to the phases of water level in the river. These phases are as follows: mid- to low-water dry season (August through October), high-water season (mid-October or early November through December to mid-January), low-water dry season (January through March), high-water rainy season (April through July). These are only approximate dates and seasons and further research will need to be made in order to temporally stratify for sampling purposes. These sampling trips could be carried out in conjunction with other sampling being carried out in the river basin. For example, trips could be coordinated with sampling water quality teams or other socioeconomic sampling trips. More of this will be discussed in the final report and proposal for Catch Assessment Survey (CAS), Fish Sampling Program (FSP), and Socioeconomic Survey (SES).

Saturday 11 October 1986.
Yontoy to Gob Weyn
On-water reconnaissance survey for fishing villages and fishing trails.

We hired one fisherman to work with us and guide us down the river. We saw about five cable ferries along the section of river that we traversed. We stopped at the largest of these and interviewed an old man who was running the ferry. His name is Hadji Mohammed Moussa. The cable ties the two villages of Moukamani and Hadji Ali together. There are approximately 100 families there. The old man told us that his people fish there with hook and line for their own consumption. He really likes fish and said that he values them very much. He told us that when he was young, he was in a local market one day and someone told him that he had fish to sell. He went to see the fish but the man did not have fish, he had fish oil which he claimed to have made from fish caught from Dhesheeg Wamo. It was at that

point that the old man said that he learned to eat fish and learned of their value.

He told us that during the "Jilaal" season which is the low-water season, that the salt intrusion is very high and that they have to dig shallow wells to get drinking water for themselves and their livestock. He also said that the women have to walk into the bush to find water. He told us that they only eat fish during the low-water season.

We did some drift gill netting and a mini-rotenone sample. The catch was very interesting from the gill net as there were several large Synodontis spp. and Siluridae spp. that were the largest specimens that I have ever seen. They were caught in the 1.5 and two inch bar mesh nets. The drift gill net samples were rather difficult as we got hung up in the bottom about ten minutes after we put the net in. The result was a very short sample and a couple holes in the larger mesh panels. We are in the need of mending line and net needles and I need to teach Mohammed and the other fishery personnel how to mend torn nets. I think that it will also be valuable to purchase some locally available nylon net materials and teach Mohammed Hassan how to build his own experimental gill nets thus eliminating the need to import expensive nets as well as increasing our units of experimental fishing. I will check this out when we return to Mogadishu.

I went to have a meeting with the Ministry of Fisheries to discuss the possibility of integrating them into the fresh water fisheries evaluation and training since they are mostly concerned with the development of their extensive coastal marine fishery resource. They should also have some participation in the evaluation and development of their inland riverine and reservoir fisheries.

We did one trial with rotenone that was partially successful in that we caught several Silurides, Labeo, and an interesting Gobie that skips along the shore and can leave the water in pursuit of cover in the grass and reeds. The bottom was very muddy and made it very difficult to move around in the water. I do not think that we should do any more of this kind of sampling until the low-water season or we should at least stay in the boat and use dipnets to retrieve dead fish. It is also probably very dangerous to be in the water like that. The threat of crocodile attack is something about which we must to be very cognizant. We need to have some form of security like a policeman with a gun or someone armed in the team.

We saw six to 10 hippos and two crocodiles at an island just about at the point in the river where Luglouw is. The hippos were at the head of the island and the crocodiles were at the foot of the island on a small sand bar with grass and reeds just

on the perimeter of the sand bar. This seems like a type of habitat that they prefer. So far I have heard many stories of villagers along the river being eaten or taken away by the crocodiles. They also seem to cause a lot of trouble in the few fishing nets that we have seen along the river.

The Blazer broke down due to two bad batteries so we had to tow it back to Kismaayo with the jeep and deposit it at the local garage for repair.

Sunday 12 October 1986.
Dhesheeg Wamo
Location: Dhesheeg Wamo is a large (approximately 72 sq. km.) low land area which is located west of the Jubba River from about the town of Gaduub to Baar, (see map).

We traveled 10 kilometers on the Jilib road past Goduub and turned west on a pretty rough dirt road. The dhesheeg is approximately 30 kilometers down this road but there are many branches which are very confusing and I recommend that future teams either take along a guide that is very familiar with Wamo or take the transport vehicle which travels this road almost daily to buy fish from the fishermen and transport goods and people from the dhesheeg. You can find this vehicle in Kansuma by inquiring at the taxi stop or talking to Mohammed Ali Aden (the Village Chairman) or Abdulkadir Hassan Ali (the fishing organizer and transport coordinator).

Dhesheeg Wamo is inundated periodically by rains and river floodings that are controlled by opening flood control gates located along the dyke which parallels the river. This dyke was built by the Italians and a canal was dug from the river to the dhesheeg. I was told that the Ministry of Agriculture authorizes the opening of these gates which takes place whenever the river is high enough.

We found that there is a large component of fishermen operating here and a very large amount of fish harvested. There were two fishermen walking with bundles of dried Clarias spp. (probably C. gariepinus). These two fishermen were from Jamaame and come here to fish for four to five days at a time. They said that they are part of an organization of about 20 people who trade off shifts of fishing that are comprised of from four days to one week. They are organized by someone in the village who coordinates who goes out to Wamo and who sends out the transport vehicle to pick up the dried fish and change groups of fishermen. The fishermen were on their way to meet the vehicle then, so they were in a hurry. However, I did get to ask them several questions concerning their fish. They told me that one bundle of fish would be sold for about 1,000 SS (Somali Shillings: 89 SS = $ 1.00 U.S.). This bundle of dried fish weighed about 10 to 15 kilograms and contained about 30 to 35 dried Clarias.

We found two other fishermen fishing and we interviewed them much more extensively. These two men were from Kansuma and were part of a similar organization of people who come here for a few days to work and then return to their village. They indicated that there is a coordinator type person (probably Mr. Abdulkadir Hassan Ali mentioned earlier) who hires people or sends his sons to fish using his nets. They said that it is common for several people to purchase a net or two and form a co-op fishing group that operates in much the same fashion. These two fishermen indicated that a vehicle comes three times a week to pick up their fish and change fishermen. They are part of about 50 people who are organized into a kind of co-op.

These two fishermen were using gill nets which were four and eight fingers (one finger equals 10 mm stretch mesh), 30 double arms lengths (two outstretched arms are equal to one fathom or 1.9 meters) and about two meters deep. They learned to make and set these nets from the ocean fishermen in Kismaayo. They bought the line to make these nets in Kismaayo or Mogadishu. for about 2,600 SS. It required 1.5 kilograms of cotton line to make these nets. One fisherman told us that they sometimes buy pre-made nets made of "plastic", meaning nylon and that they cost about the same. The lifetime of the cotton nets are about three to four years if they repair them periodically. However, the lifetime of the pre-made nylon nets are six months.

They indicated that they do not use hook and line or long lines in their fishing here in Wamo. During the high-water season they use canoes which they rent or borrow from someone on the other side of the dhesheeg. Usually there are three to four fishermen per canoe and they set one or two nets per fisherman.

They told us that the price of their fish is the same for dried or fresh. One fish would sell here for about 35 SS and 100 to 135 SS in their village. They had one very large Clarias spp which measured about one meter long, maybe longer, and probably weighed 10 to 15 kilograms. They cut the fish into strips and hang them in trees or racks to dry.

They indicated that there are problems with hippos getting into their nets and sometimes crocodiles in the high-water season. They fish in the river only when the dhesheeg is too high or during low-water season in the river. When they fish in the river they use hook and line. When asked if their catches have changed in the past few years, they indicated that the number of fish has increased and that the size distribution has not changed.

Monday 13 October 1986.
Kismaayo and Gob Weyn

This was a relatively down day as the Blazer was not yet fixed and the trawl nets were not either. We decided to run several errands and to try a dormant set gill net overnight at Gob Weyn. This was also a very good opportunity to train Mohammed Hassan Aden and give him some boat handling experience. So in the afternoon we went up to Gob Weyn and practiced launching and landing the boat and set the gill net. The net was set at 5:30 p.m. and was set just up river from Gob Weyn on the left bank in a fairly shallow area on the edge of the river.

The gill net is a Memphis Net and Twine product with seven panels that are 50 feet in length. The mesh sizes and twine sizes are given in the following table:

Panel No.	Mesh Size (bar in inches)	Monofil Size
1	1	69
2	1.5	69
3	2	104
4	2.5	139
5	3	139
6	3.5	208
7	4	208

The experimental gill nets are built with two inch hollow plastic floats and one inch lead sinkers, enough to give it neutral buoyancy. This should be a standard unit of effort in the future so as to enable comparisons between catch per unit of effort in subsequent fish sampling surveys.

Tuesday 14 October 1986.
Gob Weyn and Bangeeni

We got a late start and ended up harvesting the gill net later than I had planned. It was 11 a.m. when we finally pulled in the net. The data from the catch is listed below:

Mesh	Species Group	Length(cm)	Weight(gm)
4	Clarotes spp.	36	1,000
4	"	55	1,600
4	Eutropius	47	910
1.5	Synodontis spp.	41	700
1.5	Eutropius	29	150

This was a very small catch for this kind of a net but it was improperly set and has two holes in it from the drifting gill net trials that we conducted the other day. The fish however are very large specimens and in fact, the largest of these species

that I have ever seen. This is an indication of little or no exploitation.

I suspect that larger catches can be had if the net is set properly and that we harvest in proper times. We should try setting the net in the morning and checking it both in the evening and morning. This will give us a better idea of night time versus day time catchabilities. I am very surprised at the low level of diversity of species in the catch.

Bangeeni

We moved on up river and set up camp in Jamaame. From there we covered the section of river between Jamaame and Bangeeni to look for fishermen and fishing villages. We found that Bangeeni is composed of two villages, one on each side of the river. There is a cable ferry between the two. This is the next village down river from Jamaame (see map of Dhesheeg Wamo). We talked to several people there and it was indicated that there are two or three people who fish here, but because there is no market for fish and plenty of meat, they do not fish for commercial reasons. They fish strictly for personal consumption.

At the ferry we found a gill net installed in the water and we searched out the owner. He is the operator of the ferry and he answered all of our questions. He lives in Bangeeni on the left side. He set this net yesterday and told us that the crocodiles have eaten the lower halves of all the fish in the net. This net is 12 fathoms long and 1.5 deep. He said that he made this net himself and that the mesh sizes are variable from four to eight fingers. He purchased the cotton line to build this net in Kismaayo. His uncle taught him how to make and set nets. He told us that he fishes in the dhesheegs during the "Gu" season. He thinks contrary to the other fishermen that we have interviewed so far, saying that he catches more fish when the river is in flood stages as opposed to low-water stages. During the low-water stages he prefers to fish in the dhesheegs. Then later on in the interview he confessed that he does fish in the pools left in the river during the low-water period. He said that there is no market where he sells his catch, but that people come to his house when they know that he has fish for sale.

Wednesday 15 October 1986.
Sunguuni, Kobon, Aboro, Balad Raxan, Mana Moofi, and Fagan.
Location: These villages are all located close to the river on the opposite side from Jamaame. There is a turn off about three to four kilometers past the turn off to cross the bridge for Jamaame. The road starts out paved and turns to dirt about a kilometer down the road. This road eventually goes back to the Jilib road.

Sunguuni

The people to whom we spoke said that there are many fishermen here, but that they were all out fishing at the dhesheeg. Ten fishermen were out at Dhesheeg Wamo. They indicated that 100 percent of the population in this village eat fish on a somewhat regular basis. They told us that during low-water, the men use nets in the river and that there is a problem with crocodiles here. During the high-water season, several people use hook and line in the river for personal consumption.

Kobon

There are no commercial fishermen there but many people use hook and line to catch fish for their personal consumption. They indicated that a merchant does bring fish from Wamo to sell there. They told us that occasionally they jump on the vehicle that goes to Wamo to buy fish. They too indicated that there are problems with the crocodiles in the river.

Aboro

This village has about 40 families. There are four fishermen that live in this village. At that time, they were out at Wamo. During the low-water season they use gill nets in the river. They sell fish to people in other villages along the river as far up as Jamaame. They said that everyone in this village eats fish on a regular basis. Many young people fish in the river during the high-water season with hook and line for personal consumption.

Balad Raxan

We found that there are two fishermen who fish there on a regular basis. These two fishermen own nets which were seven and eight finger mesh sizes and 41 to 32 fathoms in length and 2.5 fathoms deep. These nets were ready made and purchased in the Mogambo market. The fishermen mounted them on float and bottom lead lines. The 41 fathom net cost 1,500 So. Sh. and the 32 fathom net cost 950 So. Sh. These nets have lasted for two years and three months. If the nets are properly mended they can last up to three and a half years. They are presently being used at Dhesheeg Wamo.

The fisherman with whom we spoke, told us that his nets are being used by two young men from this village. He pays them 10 So. Sh. per fish. He transports these fish back from Wamo and sells them from his house. The price is from 70 to 100 So. Sh. per fish. He get fresh fish on occasion and sells them at the same price. This fishing and selling of fish from Wamo is carried out all year. He does not fish in the river because he

is afraid of the crocodiles. The villagers told us that there was a crocodile fatality just two nights ago.

Most families in this village have someone in the family, usually small children, who fish. The main type of fishing gear used by these people are hooks and line. These lines are baited and placed in the river from the bank.

For monitoring this catch from the dhesheeg, there is a young man by the name of Abdulcadir Ibrahim Abcou, who speaks English and could possibly measure and weigh the fish as they move through the village.

Mana Moofi

The estimated population of this village is 3,570. Villagers told us of a group of Americans who came through here several years ago in an attempt to eradicate the crocodiles. A man related a story of one woman who was eaten last Saturday, and several other attacks in the last three months.

We found that there are about 20 fishermen living in this village. One fisherman uses a net and the others use hook lines. They fish for personal consumption only but sell fish if they have surplus. The villagers usually buy fish from Dhesheeg Wamo. They told us of a daily supply of fresh fish from Wamo that is sold along the road from a transporter going to Jilib. This vehicle usually comes by around three to five p.m. The villagers prefer fresh fish and pay from 80-100 So. Sh. per fish. They usually consume one fish per family per day.

Fagan

The people of this village do not eat fish and gave us displeasing looks and scrunched noses when we asked them about fish. They told us that the people who live next to the river eat fish.

Mogambo

We visited this village, however no field notes were taken.

Thursday 16 October 1986.
Jilib to Fanoole

We drove up to the Fanoole barrage and searched for a location to launch the boat. After looking around on the east side of the river with no luck, I walked across the barrage and found a suitable launch site. However the guard at the electric facility would not move the tractor blocking the road.

We turned around and drove down river to a small village where I was determined to launch. The name of this village is Nasib and it is located approximately three to five kilometers down river from the barrage. We launched the boat over a 12-foot high cliff which was a monumental task. Launching this boat requires great skill and care. After launching the boat, we motored upstream to the barrage and counted about five crocodiles. We set the gill nets and attempted three trials with the beam trawl. All three trials were unsuccessful because the beam is made of wood and did not sink to an adequate depth for sampling fish on the bottom. We harvested the nets and drove back to Jilib the next day.

Saturday 18 October 1986.
Qalalio

This village is four kilometers south of Jilib. We found that there are 12 fishermen living in this village. We talked to two of these fishermen and they told us that they own gill nets. One fisherman has four nets and the other fisherman has one net. These two fishermen are presently fishing at a local dhesheeg called Harnaca. This dhesheeg is probably from the Shabeelle river. It is located on the road to Mogadishu. Most of the fish from this dhesheeg are sold in the Jilib market. They told us that there is a lot of fish that is sold here and that they like to eat fish, one man even prefers it over meat. The fishermen bring dried fish, from the dhesheeg, which has been stored for 10 to 14 days. All twelve fishermen come and go as one group and they hire a vehicle to transport themselves and their fish.

The villagers told us of another dhesheeg called Shatole. This dhesheeg is farther up the road to Mogadishu. (approximately 12 to 15 kilometers).

The fishermen told us that they have small plots (approximately one to two hectares) of land that they cultivate and grow corn, sesame, and some millet.

One fisherman told us that he uses one hook and line in the river during the high-water season. During the low-water season he used several hooks and he indicated that there are a lot more fish and fishing during this season. During the low-water season they use nets in the dhesheegs and during the high-water season they use hooks. They sell these fish for 60-100 So. Sh. per fish no matter what size. They hire a truck from Jilib to transport their catch to that market. He told us that there are some people who use canoes that are rented from villagers in surrounding villages, but that there are no canoes in this village. A canoe rents for about 120 So. Sh. per day. Most fishermen do not like to fish in the river because they are afraid of the crocodiles and hippos.

Buruuji
About 40 families living here.

Most of the men and women of this village work in the rice project. The folks here told us that almost every family has at least one family member who fishes in the river with hook and line. These people fish only for their personal consumption. They told us that they buy dried fish from the Jilib market. They like to eat fish and in some cases they prefer it over meat. They would like to begin fishing but they do not have the money, knowledge, or collaboration to buy fishing gear or a cooperative to purchase fishing gear.

There were two men who tried fishing and they showed me a net that had been destroyed by the crocodiles. They gave up fishing with nets and began using hooks that are less susceptible to crocodile damage. They said that they had tried the crocodile medicine but that that is a bunch of bunk and does not work.

Mubarak

We found three fishermen there that use hook and line to catch fish. There is one fisherman living here who owns a gill net and he is presently at dhesheeg Wamo. The fishermen catch fish from the river and sell them to the villagers who were the original inhabitants of this village. The resettled villagers, probably refugees, will not eat fish. The same problem with crocodiles and hippos exist here. We found one canoe which is used for transporting people and goods across the river and is occasionally rented to a fisherman.

Kansuma

We talked at length with Mr. Mohamad Ali Aden, the village chairmen. he told us that the dhesheeg fishing is very important to the population of Kansuma. He said that there is a high level of fish consumption and a quantity of that fish comes from the ocean. The fish arrive on a daily basis via a transporter from Kismaayo and Dhesheeg Wamo. The reason very few people fish in the river is that they are afraid of the crocodiles. Two fishermen were brought to talk to us and it turned out that one man is the coordinator of the vehicle which goes to pick up the fish from Dhesheeg Wamo. His name is Abdoulkadir Hassan Ali. He owns six nets, three are pre-made cotton and three are cotton. These nets were purchased in Kismaayo and are mesh size from 60 to 70 mm stretch mesh. The nylon nets cost 4,000 So. Sh. for one large section of net which was cut up into smaller sections for mounting as individual nets. The cotton nets cost 360 So. Sh. for all the twine to weave the nets by hand. All six nets are one year old and his two sons are presently out at Wamo fishing with these nets.

He told us that he sells his fish by size; small fish for 40 So. Sh. per fish and large fish for 150 So. Sh. per fish. The price is the same for dried and fresh fish.

The fishermen told us that when Wamo dries up and the fishing is over, that they move to Dhesheeg Kombi Robbi where there are a lot more fish. So many in fact that they make fish oil and sell it in large cans in the Jilib market. They sometimes go to Dhesheeg Harnaca as well.

Jilib Market

I have been told that there are some fish in the market so we went down to check this out. There was one woman fish monger selling dried fish. She was sitting near a shed just across the street from the meat market. She told me that she bough 50 dried fish for 55 So. Sh. per fish and that she is selling them at 55 So. Sh. per fish. We observed her sell one later for 60 So. Sh. She told us that she can sell from one to four bundles a day, each containing about 50 fish. She was the only fish monger at that time but she told us that there are many in the morning. She sells both fresh and dried fish, but mostly dried.

Maniagabo

This village is very close to Jilib. Approximately 80 families reside here. There are many fishermen here but only four with nets. Most fishing is occasional in nature and the use of hook and lines is most prevalent. The four fishermen with gill nets are presently at Dhesheeg Harnaca. There is some indication that the fish from Dhesheeg Harnaca are smaller than those from Wamo. The average price of fish from Harnaca is 10 So. Sh. per fish. Either the fish are smaller or the folks here are selling their fish at a much lower rate than the rest of the fishing community. Gill nets are used in the river during the low-water season. Canoes are seldom used and there is a good ferry close by to cross the river.

Limole

About 40 families reside here. There are two fishermen who jointly own a gill net and they are presently here in the village working on their farm plots. They fish mostly in Dhesheeg Harnaca. There are several occasional fishermen who use hook lines in the river. This type of fishing is for personal consumption only. Almost everybody eats fish here on a daily basis. The perennial problem of crocodiles and hippos was found here.

Sunday 19 October 1986.

Travel back to Mogadishu for repairs, rest and restocking.

Field Trip Number Two (30 October 1986 to 17 November 1986).

The second field trip was conducted from 30 October to 17 November in the northern part of the river. This trip extended from the villages of Saakow to Luuq. We began our trip on 30 October, but due to the death of a family member of a key team member, we were not able to begin our field work until 3 November. We interviewed several people in villages along this section of the river. However, the fishing is so sparse that the majority of the people to whom we talked indicated that fishing is not an activity undertaken in this region. We did, however, find a couple of people who fish during low-water season. The majority of this trip was consumed in sampling the fish population and testing experimental fishing gear. The team was composed of Mohamad Hassan Aden, MJVD, Ahamed Abdouli Yassim, MFMP and Earl Meredith, ARD.

Anole, 3 November 1986.

The only two villages where people indicated that they fish is Anole and Saakow. We interviewed the village chief and he said that many young boys fish here but for personal consumption only. There is a river cable crossing and people cross here to farm on small plots on the other side. There is a small farm cooperative where folks irrigate. These people do catch some fish during the low-water season, January to March.

Saakow

We talked to the cable ferry operator here. He told us that he fished here while he operates the ferry. He uses a hook and line which he baits and sets in the morning. In the afternoon he pulls in his line and usually has a fish or two for personal consumption. He said that occasionally there are other people who come here to fish, but not very many and not very often. He said that during the season when the Dhesheeg Saakow is inundated that there are several fishermen that come clear from Jilib to fish here. He said that when the rains come and the river over flows, filling the dhesheeg with water, that there are many fishermen and they sell their catch to a truck that transports the dried fish back to Jilib. This is usually during the months of April, May and June. During the low-water season in the river, there are more fishermen that dry their catch and sell to the same transporter. The dominant fish in the catch is "Balin" in Somali or Eutropius depressirostris.

This dhesheeg fishing is very interesting because it seems that it is fairly well organized. They fish other dhesheegs in

the area, one down river approximately five to six kilometers and others up river. They fish them in succession from the most shallow to the next until they are either dry or the fish are all caught. They have no boats or canoes and use mostly gill nets and hooks. They used traps in the past when the flooding from the river was more common. It seems that the annual flood cycle has changed for some reason. People who once fished on a regular basis are now involved in agriculture on a full-time basis.

After fishing in the Baardheere region for four days, we moved up to a refugee camp where people have told us that the refugees were trained and equipped to fish. This camp was named Burdubo. We stayed with a couple who are MCC volunteers. They were most gracious and let us set up camp in their compound. However, they expressed reservations about our teams coming on a regular basis and staying for more than a couple days. The primary problem is that their latrine is filling up and drinking water is scarce.

We set several experimental gill nets, long lines, hoop nets, and tried seining.