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CATCH ASSESSMENT SURVEY ON THE NIGER RIVER IN NIGER

by

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Proposal for a Catch Assessment Survey on the Niger River in Niger

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This proposal stems from a joint USAID/Peace Corps request to Auburn University for technical assistance in formulation of a catch assessment survey (CAS) on the Niger River in Niger. The Fisheries Department at Auburn University has been actively involved in training Peace Corps Volunteers for capture fishery positions with the Department of Water and Forests in Niger since 1978; the Fisheries Department at Auburn also has considerable experience in designing fishermen surveys for lakes and rivers in the United States as well as overseas (Malvestuto et al. 1978 and 1980). Initial communication between Peace Corps Niger and the Fisheries Department at Auburn suggested the need to restructure the Peace Corps capture fishery program in Niger to provide a more meaningful focus to volunteer assistance. Two other donner organizations in Niger were identified, USAID and FAO, both with parallel interests in fishery development and management on the Niger River. The opportunity for a collaborative effort between the Niger Department of Water and Forests, Peace Corps, USAID, FAO and Auburn University for rationale development of the Niger River fishery in Niger was apparent using a CAS as the central focus around which a cooperative effort might be initiated.

The current proposal defines: (1) the need for a CAS, as well as other biological fish population sampling, on the Niger River at the present time; (2) the design for a preliminary CAS for sampling both fishermen actively engaged in fishing on the river and fishermen returning to landings at the end of their fishing trips; (3) the manner in which information from the preliminary survey will be used to improve the sampling design for future data collection; (4) the primary considerations for the fish population sampling program; and (5) the assistance roles of all cooperating agencies with particular elaboration of Peace Corps Volunteer assistance. The concluding remarks address issues concerned with fishery management polices and overall resource development.

The Current Need for a Catch Assessment Survey and other Fish Population Sampling on the Niger River in Niger

Rationale formulation of fishing regulations and management strategies is necessarily based on valid information concerning the selectivity of various fishing gears, the status (underexploited or overexploited) of the fish stocks and the number of fishermen that the resource can reasonably support. Additionally, the identification of particular problems associated with boat and gear construction and useage, fish preservation and storage, distribution and marketing systems and fish preparation and consumption habits, can provide other avenues for bringing benefits to the people through overall development of the fishery.

Traditionally, the CAS provides estimates of the number of fishermen (or fishing boats) operating on the resource, the amount of harvest (by species) from the resource, and the harvest per unit of fishing effort (catch per boat) which is taken as a measure of fishing success, as well as an index of stock density. A series of this information over a number of years allows predication of maximimum sustainable yield and optimum fishing effort by using, for example, the Graham-Schaefer surplus production model (Ricker, 1975) which has been shown to have applicability for multispecies stocks in African waters (Turner, 1978). Also, estimates of harvest from the CAS can be compared to expected levels of harvest from intensively fished rivers as predicted by Welcomme's (1976) models which are based on data from large Arican river systems. Other kinds of information, such as the length frequency distribution of harvested species and the relative abundance of various species in the catch, are available through the CAS and can provide

valuable insight through time as to the effect of fishing pressure on the fish stocks. Currently, none of this information is available for the Niger River in Niger. Given that: (1) the Niger River is the single permanent fishery resource of major importance in Niger; (2) population centers adjacent to the river have increased dramatically over the past few years due to the draught of 1973-1975; (3) the fishery resource is shared by the countries of Nigeria, Benin, and Mali; and (4) a major portion of the fish harvested from Niger waters are preserved and transported out of the country for sale by Nigerian and Malian fishermen, the immediate need for fishery evaluation leading to management policy is clear.

In a more general sense, the CAS can be viewed as a means of social interaction and information exchange between administrative organizations and fishermen; interviewers obtain information through the interview process and directly observe the activities of fishermen. Appropriately formulated questions can provide information on a variety of fishery-related problems that limit the efficient use of the resource. Complementary surveys of fisherman households and markets can provide an integrated picture of the role of the fishery in the social-economic-nutritional structure of the population. Given that: (1) preliminary observations by FAO personnel and this author in Niger suggest that boat and gear construction techniques, fishing methodologies and fish preservation and storage techniques can be greatly improved; (2) fish distribution channels are almost non-existent on certain parts of the river; (3) cultural preferences limit the consumption of certain species of fish; and (4) variable rainfall patterns in most of Niger make dependence on agricultural food production unpredictable from year to year, the necessity for an integrated approach to fishery resource development is clear.

Collection of biological information on commercially important fish species is difficult using a CAS. Lengths and weights can usually be obtained at landings, but information that requires that the fish be cut open, such as gonadal development and stomach contents, is usually impossible to collect unless the fish are purchased. Additionally, it is often difficult through a CAS to determine which fish have come from which gears, and gear selectivity data thus are difficult to acquire. For these reasons, it is valuable to complement the CAS with an independent fish population sampling program. Important types of information such as length frequency distributions, lengths at maturity, food habits, spatial and seasonal distribution and weight/length relationships can be obtained for particular species using appropriate sampling gear. Experimental sampling using various types of fishing gear will allow gear selectivity to be evaluated; this information together with data on length at maturity will permit appropriate fishing gear regulations to be established for rationale exploitation of particular fishes.

Catch Assessment Survey Designs

Fishing activities on the Niger River in Niger suggest that valid information on exploitation of the fish stocks best be collected via two independent catch assessment surveys: one, an on-water survey of active fishing canoes, and the other, a survey of major fish landings. The primary objectives of the on-water survey will be to: (1) obtain estimates of fishing effort based on counts of active fishing canoes (fishing economic units or FEU's) and the number of fishermen per canoe; (2) estimate the relative use of particular kinds of fishing gears; (3) identify fishing locations and the particular ways various types of gear are used; and (4) collect information on gear selectivity (when possible).

Given that fishermen will be intercepted and interviewed while in the act of fishing via the on-water survey, catch per unit of effort (CPUE), or kilograms of fish caught per canoe per day, cannot be estimated because the fishing trip has not been completed. Completed fishing trip information can best be obtained via a landing survey where fishermen are intercepted as they come ashore with their catch. Other major objectives of the landing survey will be to: (1) establish the species composition of the catch by number and weight; and (2) determine the length frequency distribution of species in the commercial harvest. It should also be possible to weigh fish at the landings by species and length groups so that weight/length information will be forthcoming, although the logistics associated with this endeavor may limit the amount of data collectable. There is also the option of purchasing particular species and sizes at the landings to supplement biological information obtained through fish population sampling. It should be noted that because the fishermen typically leave their gear in the water, data on

relative gear useage and gear selectivity cannot be collected via the landing survey. The survey sampling designs presented here are taken to be preliminary, based on information presently available and on the need to consider logistical constraints on the random sampling process. The preliminary designs will be implemented for one full year, during which time, more specific information can be collected and subsequently used to improve the sampling procedures.

A. Basic Design Concepts

The on-water and landing survey designs will be based on division of the hydrological year into seasonal strata (categories) and the on-water survey will also entail division of the Niger River into geographical strata (segments). The seasonal and geographical strata will both be further divided into sampling units (SU's) which will be chosen at random for sampling purposes. For presentation here, sampling through time will be discussed first, followed by a discussion of the spatial sampling scheme.

1. Temporal Sampling Scheme

It is proposed that the sampling year be divided into 4 seasonal strata representing 4 distinct periods of the annual hydrological cycle. These strata will be called the high water, falling water, low water and rising water seasons. Each of the these seasonal strata will be divided into major or primary sampling units (PSU's) and each PSU will, in turn, be sub-divided into minor or secondary sampling units (SSU's). More specifically, the hydrological year will be divided into the following seasonal strata:

High Water: 1 October - 21 February = 144 days

Falling Water: 24 February - 6 May = 72 days

Low Water: 7 May - 17 July = 72 days

Rising Water: 18 July - 27 September = 72 days

With reference to the seasonal strata as defined above, it should be noted that the exact dates associated with the beginning and the end of each seasonal stratum are somewhat arbitrary. The general hydrological categories were defined based on water level data from the years 1976-1979. There was usually a gradual phasing from one cycle to the next within any given year and the cycles varied from year to year. The dates shown were chosen so that each stratum could be evenly divided into PSU's of 12 days each. Thus, the high water season contains 144 days and can be divided in 12 PSU's of 12 days each and the falling water, low water and rising water seasons each contain 72 days and can be divided into 6 PSU's of 12 days each. It should be noted that 3 days between the rising and high water seasons (September 28-30) and 2 days between the high and falling water seasons (February 22-23) had to be eliminated from the sampling scheme, but this should cause no significant problem since they represent a very small portion of the whole can be corrected for in the final analysis.

With reference to the sampling procedure, it is recommended that for the preliminary survey, the first PSU within each seasonal stratum be randomly allocated to either the on-water survey or the landing survey. From that point on, the two survey types will progressively alternate between PSU's within each seasonal stratum. Thus, for example, if the first PSU within a seasonal stratum is randomly allocated to the on-water survey, then the second PSU will be devoted to the landing survey, the third to the on-water survey, the fourth to the landing survey, etc. This scheme will insure that each type of survey takes place consistently over each season during the preliminary phase of the study. Based on the previous seasonal strata definitions, the

high water stratum will contain 6 PSU's devoted to the on-water survey and 6 devoted to the landing survey; the falling, low and rising water seasons will each have 3 PSU's devoted to the on-water survey and 3 to the landing survey.

Once PSU's have been allocated to either the on-water or landing survey, the actual days on which sampling will be conducted must be chosen. Given the relatively large geographical areas under consideration, it is expected that one full day may be needed to travel to certain locations and another full day to return from certain locations. It is thus logical to further subdivide each 12-day PSU into 4 SSU's (secondary sampling units) of 3 days each. These 3-day SSU's will always allow adequate time to arrive to the sampling location (first day), sample the location (second day) and return home from the location (third day). It is proposed that 3 of the 4 SSU's be randomly chosen from each PSU and that the middle day of the chosen SSU be the actual day of the sample. Figure 1 shows how the entire hydrological year will be categorized into seasonal strata, PSU's and SSU's. Figure 2 shows a hypothetical random sample chosen during the falling water season.

2. Spatial Sampling Scheme (On-Water Survey)

The proposed survey is designed to obtain estimates of fishing effort and fish harvest for the entire Niger River in Niger which entails sampling approximately 550-600 km of river. For logistical reasons then, it is necessary to stratify the river into geographical or spatial segments and, in turn, divide these strata into sampling units which are small enough to be canvassed during the morning of a chosen sampling day, when most of the fishing activity occurs.

Based on the man-power available for sampling purposes (4 Peace Corps Volunteers plus their counter-parts) it is proposed that the river be divided

Figure 1. Diagramatic representation of temporal sampling design showing seasonal strata, primary sampling units (PSU) and secondary sampling units (SSU).

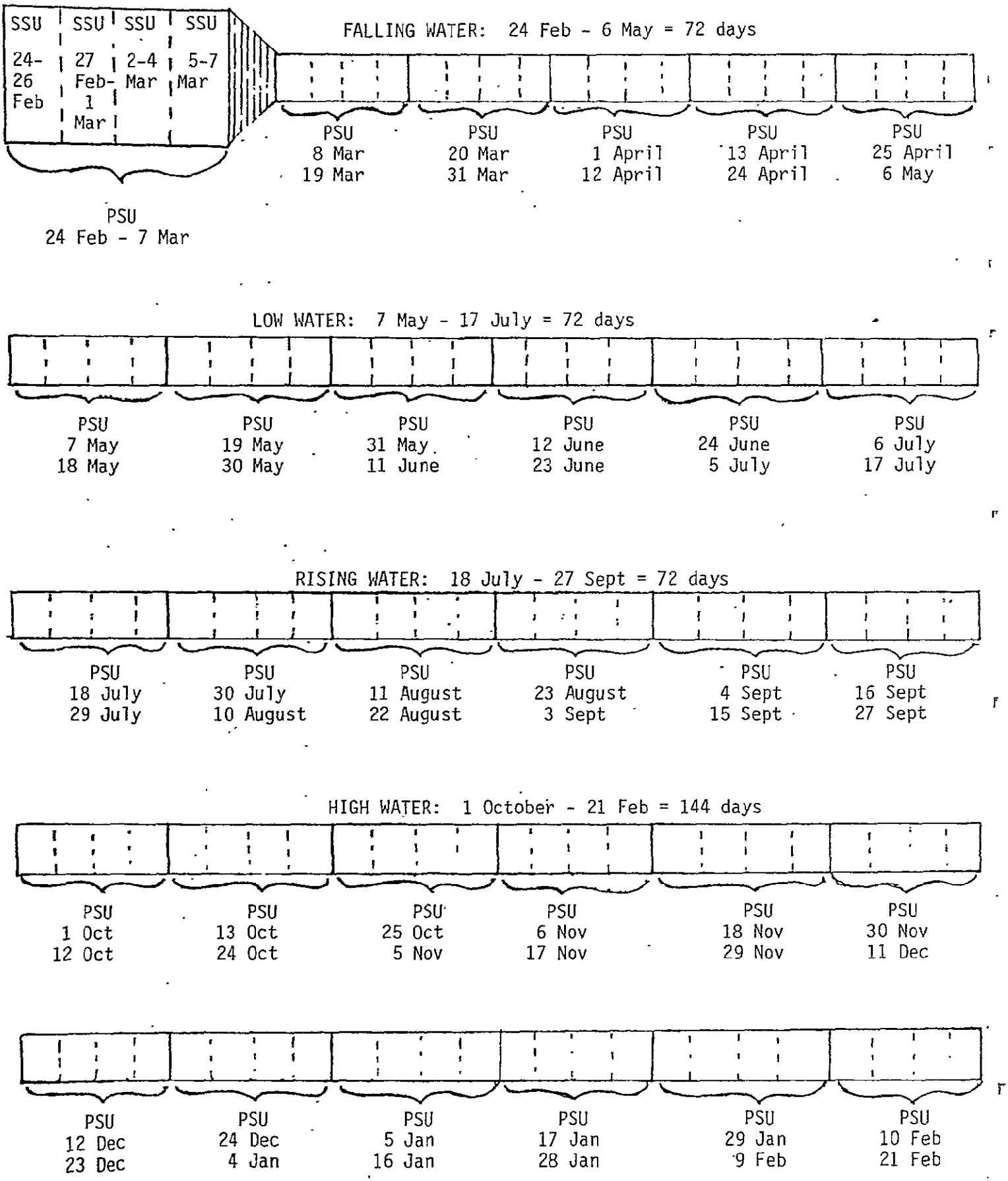
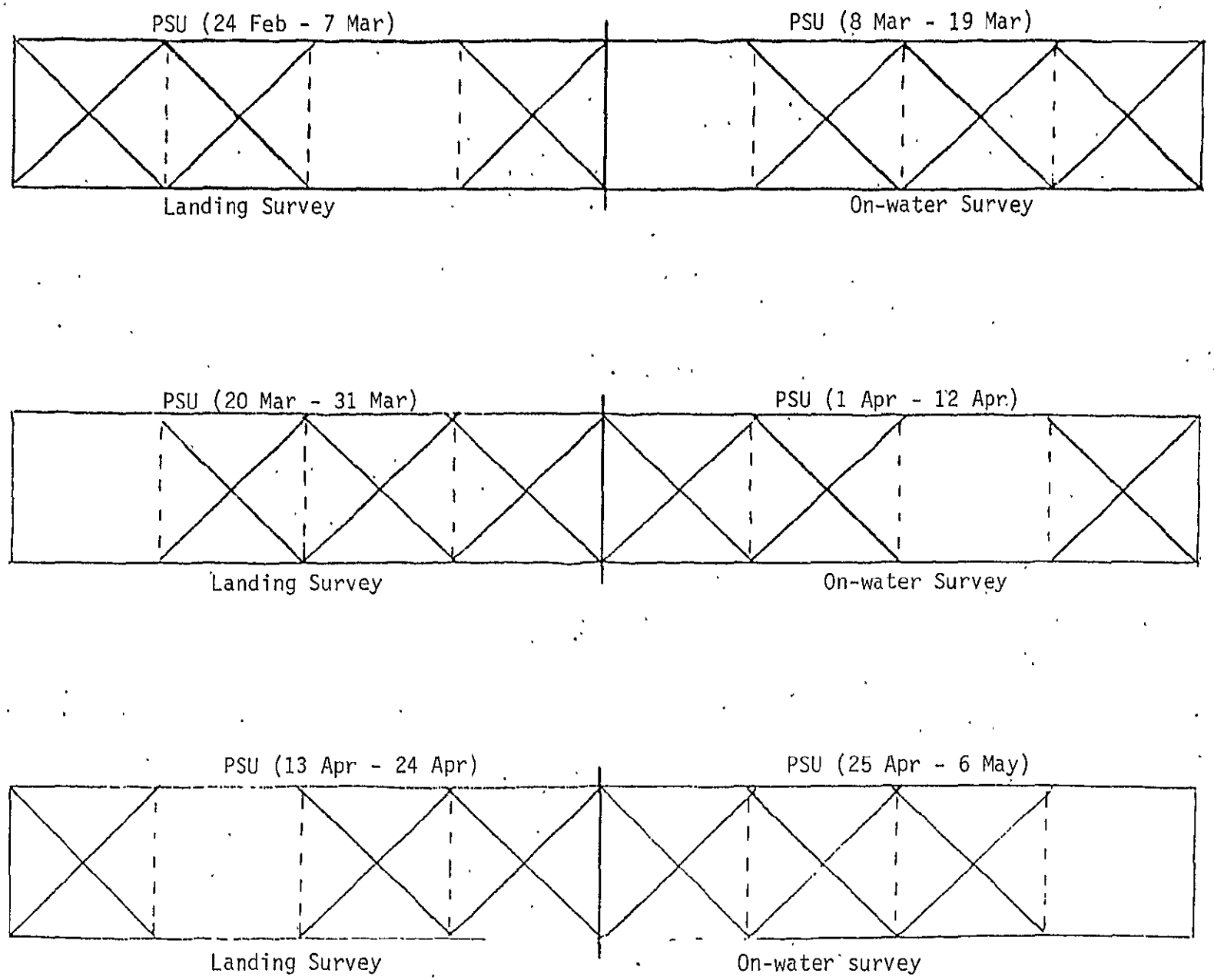


Figure 2. Example of alternating allocation (with random start) of PSU's to on-water and landing surveys and random choice of 3 out of 4 SSU's within each PSU for the falling water seasonal stratum. Random chosen SSU's are marked with an X.



into 4 geographical strata defined as follows:

Stratum I: Mali Border - Tillaberi (~ 125 km)

Stratum II: Tillaberi - Niamey (~ 135 km)

Stratum III: Niamey - Tapoa River (~ 140 km)

Stratum IV: Tapoa River - Dole (~ 195 km).

Peace Corps Volunteers working in the Gaya area (Stratum IV) were able to conduct two on-water surveys, one during low water and one during high water. Their experience suggests that it is not reasonable to divide strata into spatial SU's any larger than 50 km and much smaller SU's may be required depending on localized river conditions. At this point in time, definition of spatial SU's is speculative at best; however, the following break-down is offered as a reasonable starting point:

Stratum	Spatial Sampling Unit
I	A: Mali Border - Ayorou (~ 35 km)
	B: Ayorou - Kandadji (~ 15 km)
	C: Kandadji - Mamassey (20 km)
	D: Mamassey - Gari (~ 25 km)
	E: Gari - Tillaberi (~ 30 km)
II	A: Tillaberi - Kokomani (~ 30 km)
	B: Kokomani - Farie Haoussa (~ 35 km)
	C: Farie Haoussa - Karma (~ 30 km)
	D: Karma - Niamey (~ 40 km)
III	A: Niamey - Kollo (~ 35 km)
	B: Kollo - Say (~ 25 km)
	C: Say - Dyamongou River (~ 40 km)
	D: Dyamongou River - Tapoa River (~ 40 km)
IV	A: Tapoa River - Kendofati (~ 35 km)
	B: Kendofati - Dyboukina (~ 35 km)
	C: Dyeboukina - Albarkaize (~ 50 km)
	D: Albarkaize - Malanville (~ 35 km)
	E: Malanville - Dole (~ 40 km).

In general, SU's occurring in more braided sections of the river are smaller than SU's associated with locations represented by a single dominant channel. The region around Ayorou and Tillaberi contains extremely braided sections; below Niamey the system appears less complex.

The identification of sampling days (as per the previous section) will be done by each Peace Corps Volunteer independently for his or her stratum of the river. Once this is done, then each volunteer will randomly choose a section of the river (spatial SU) within his or her river stratum to be sampled during the previously identified sampling days. Sampling on the water will be done by randomly choosing (by coin toss) the end of a river section (up-river or down-river) from which travel will begin. The entire section of river will be canvassed from 6 a.m. until 12 noon; all active fishing canoes will be counted and as many fishermen will be interviewed as time permits. Once reaching the opposite end of the river section, the volunteer will wait until 3 p.m. and then return back to the starting point, again counting all active canoes and interviewing as many fishermen as possible. Most fishing actively occurs during the morning hours, but some fishermen are active in the late afternoon and early evening; thus 6 hours for morning sampling and 4 hours for evening sampling.

3. Spatial Sampling Scheme (Landing Survey)

It is proposed that the same geographical strata as previously defined for the on-water survey be maintained for the landing survey; however, no further spatial division of the system should be necessary for the landing survey so that the spatial SU's previously defined will apply only to the on-water survey. It is proposed that landings be directly chosen at random from within the 4 geographical strata; thus, once the sampling days for the landing survey have been identified, it will be a simple matter to randomly choose one landing to sample during the morning of that chosen day from a list of all landings occurring in the geographical stratum. The volunteer must be at the landing before fishermen begin to arrive and must monitor all fishermen that arrive at the landing that day.

B. The Interview Process

Estimates of fishing effort from the on-water survey will be obtained by counting active fishing canoes during the morning and evening sample periods within a river sampling unit; statistical procedures will be used to expand this count to an estimate of the total number of canoes fishing that day in the entire geographical stratum. It is important that canoe counts be as accurate as possible so that effort estimates are truly representative of the situation at hand. Boats on the move should not be counted unless there is no doubt that they are fishing during the sample period in the sample section. Figure 3 gives an example of the type of general information that might be recorded for a sample period during a sample day. Canoe counts are entered on this form; note that environmental data can also be recorded here and may later be used to determine factors affecting fishing effort and fishing success.

Peace Corps Volunteers will interview fishermen by stopping along side canoes and asking questions as per a pre-determined interview schedule. An example interview schedule is shown in Figure 4. Information of concern includes sample section, the time of interview, number of fishermen in the boat, location of the boat relative to a reference village (to be determined later), particular information on the fisherman, gear information, and easily obtainable environmental data which may allow factors affecting fishing success to be identified. It should be noted that all fishermen in a sample section need not be interviewed; the important aspect of the sample is that the entire river section be tranversed during the allotted time period and that all active fishermen are counted. Interviews will have to be adjusted to accomplish this task. If there are many fishermen on the water, then perhaps only every third or fourth boat, for example, can be interviewed.

Figure 3.

On-River Survey of Active Fishermen

General Information for Sample Day

Date _____ Geo Stratum _____ River SU _____

Department de _____ Arrondissement de _____

Sample Period: Morning _____ Evening _____

Started: Up-river _____ Down-river _____

Number Canoes Counted: Active _____ Inactive _____

Number Active Fishermen Counted _____

Environmental Information

River Level _____ Water Temp _____

Air Temp: Start _____ Finish _____

Wind Velocity: Start _____ Finish _____

Dissolved Oxygen: Start _____ Finish _____

Figure 4.

On-River Survey of Active Fishermen

Interview Schedule

Date _____ Geo Stratum _____ River SU _____ Time _____

Fishermen _____ Nearest Reference Village _____

Canoe location from reference village: ____ km up-river ____ km down-river

Fisherman's: Nationality _____ Age _____

Fishing Camp _____ Fishery Service Card # _____

Type of gear being checked: _____

Mesh size _____ Hook size _____ Hook distance _____

Kinds of fish caught _____

How many days has this gear been here? _____ days

When did you last check this gear? _____

Type of gear already checked today:

Nets:

Type	Mesh	Number	Kinds of Fish Caught

Hook-lines: # lines _____ Hook distance _____ Hook size _____

Fish Caught _____

Type and number of gears yet to be checked today?

Nets:

Type	Number

Hook-lines: Number _____

Motor: No ____ Yes ____ Make _____ H.P. _____

Environment: Secchi _____ Depth _____ Current: N S M F

Comments:

Figure 5 gives an example of the biological data sheet that will accompany each interview schedule. This sheet will allow the interviewer to record the lengths and weights (by centimeter group) of all species (or genera, as the case may be) of fish captured by the fisherman. If many kinds of fish have been caught, two biological data sheets may be necessary. This biological data can be related to the fishing gear data on the interview schedule to obtain preliminary information on gear selectivity; also, the length and weight data will allow weight/length relationships to be determined.

Example interview forms for the landing survey will be similar to those for the on-water survey, except that the landing site will be identified rather than the on-river location of the canoe; the same biological data form will be used for both surveys. Fishermen will be intercepted at landings as they arrive with their catch; it is imperative that all fish be weighed by species and that all boats landing at the site during the sample period be counted so the CPUE can be calculated. It would be best if a system could be devised such that the catch from each canoe (or a sample of canoes) could be enumerated separately by species and centimeter groups, and weights taken for each centimeter group. Also, as previously mentioned, species and sizes of fish that are lacking from the fish population sampling program could be purchased at the landings to supplement biological information such as sex, maturity stage and food habits. If fishing gear is present in the canoes, then gear type and construction can be recorded.

Figure 5.

BIOLOGICAL INFORMATION

Centimeter Group (Specify)

SPECIES CAUGHT																		Total
	No																	
	Wt																	
	No																	
	Wt																	
	No																	
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Initiation of the Preliminary CAS and Modification of the Original Survey Designs

A. Initiation of the Preliminary CAS

It is recommended that the initial year of the preliminary on-water and landing surveys (as per the methodology presented here) not be started until the 24th of February 1983 or at the beginning of the falling water seasonal stratum. There are several reasons for this recommendation which are discussed below.

First, the Peace Corps Volunteers who will be stationed along the river will not arrive at their posts until about 1 October 1982. After arrival, there will be a "settling-in" period when house-hold supplies will be purchased, local officials will be identified, Department of Water and Forest co-workers will be introduced, work policies will be established, and in general, the volunteers will become familiar with their local working and living environments. Additionally, work-related equipment and supplies must be transported to the volunteers before actual on-water and landing activities are possible. It is envisioned that this "settling-in" period will take approximately one month so that it will be early November before survey-related activities can begin. It is probable that the volunteers will be able to acquire additional training in gear/boat/engine construction/maintenance/repair and fish preservation techniques from the FAO sponsored Fishery Development Project. The exact dates of this training have not been set, but it is likely to occur sometime between 15 September and 30 November. This training will be extremely valuable as gear construction, fishing methodology and fish preservation techniques have already been identified by FAO as areas where substantial improvements are possible, and indeed necessary, for more efficient resource utilization by local fishermen.

Secondly, there are particular pieces of information which must be obtained before the preliminary survey proper can be undertaken. With reference to the on-water survey, the feasibility of sampling the river SU's as defined herein must be established. There may be particular on-water travel problems associated with the extremely braided sections of river around Ayorou and Tillaberi; fuel consumption must be assessed and the feasibility of reaching the extreme river sections in one day must be determined. Also, once the exact river sections have been decided on, land marks dividing one section from another must be chosen and consistently used throughout the study. It is also probable, based on trial interviews, that the interview schedules will have to be modified to ensure that the proper information is indeed being elicited from the fishrmen.

As concerns the landing survey, the primary problem at present is that the landing sites have not been identified; however, the FAO/Department of Water and Forests Fishery Development Project will undertake a survey of fishing camps along the river during the months of August and September, 1982, so that by 1 October, most landings of significance will have been identified. These landing sites can be verified, and perhaps others identified, through trial on-water surveys by the volunteers and their host government co-workers during the high water period before 24 February 1983.

The particular kind of random sampling to be used with the on-water and landing surveys was not stipulated previously. It is recommended that for the initial year of the preliminary survey, simple random sampling be used to allocate the first PSU within each seasonal stratum to either the on-water or landing survey and that SSU's also be chosen using simple random sampling; in other words, the first PSU within each seasonal stratum will be given an

equal chance of being allocated to either the on-water or landing survey and each SSU will be given an equal probability of being included in the sample. Additionally, to ensure that adequate information is forthcoming from all sections of the river during the initial year of sampling, it is suggested that river sections (SU's) also be given an equal probability of occurring in the sample (again, simple random sampling).

In contrast, given that there will certainly be a great disparity between the relative size and importance of individual landing sites, it will be most efficient if landings are randomly chosen for sample using probabilities proportional to the size of the landings; that is, landings should be chosen with nonuniform probabilities where probabilities are set proportional to the average number of canoes using each landing. This random sampling scheme for the landing survey will ensure that the survey teams spend most of their time at the most important landings where more information can be obtained per unit time expended.

Given the desirability of using non-uniform probability sampling for the landing survey, not only will landings have to be identified before the on-set of the falling water season, but some idea of the number of canoes utilizing these landings also will have to be obtained. Again, the majority of this information should be forthcoming through the FAO/Department of Water and Forests Fishery Development Project survey of fishing camps, and supplementary information can be collected via trial on-water samples taken during the up-and-coming high water season.

In general, then, the period from 1 October 1982 to 24 February 1983 must necessarily be utilized for survey preparation and the initial year of sampling best not begin until the on-set of the falling water season. It is recommended that the Peace Corps Volunteers, together with their co-workers,

coordinate a systematic trial sampling schedule with the team leader (an extending Peace Corps Volunteer) during the 1982-83 high water season so that all river SU's are surveyed at least twice before 24 February and major landings within each geographical stratum are surveyed at least once during this period. Thus, cursory information will be available from the up-and-coming high water season, although not collected as per the sampling designs described earlier in this report.

B. Modification of the Original Survey Designs

It should be understood that not until a sound body of information encompassing one full hydrological year has been collected can the most effective survey methodology be adopted. It will ultimately be advantageous to apply non-uniform probability sampling to river sections, as well as to landing sites, but not until good estimates of the relative amount of fishing pressure and fish harvest from these sections is obtained, can reasonable sampling probabilities be applied. Additionally, the relative use of both river sections and landings will probably change seasonally so that, ultimately, different sets of seasonal sampling probabilities will be required to obtain the most precise estimates of effort, harvest and catch per unit of effort.

To aid in the development of appropriate sampling probabilities, it is recommended that at least two sets of overflights be conducted on the river, one during the high water season, and one during the low water season. These overflights will allow relative fishing activity to be assessed on the entire Niger River in Niger during a single morning thus eliminating day-to-day variability. Because it will take approximately 4 to 5 hours to fly the entire river and relative fishing pressure is likely to change during this

period, it is suggested that overflights be conducted on 2 consecutive days, the plane moving in one direction the first day and in the opposite direction the second day. A total, then, of four overflights, two during high water and two during low water, should suffice. As well as providing information on relative fishing pressure between river sections via active canoe counts, the overflights will provide accurate enumeration of villages, fishing camps and boat landings along the river (see Supplement #1). This information will prove invaluable for CAS design modification and implementation of appropriate sampling schemes for village and fishing camp surveys in the future.

Overview of Fish Population Sampling Program

The fish population sampling program will provide biological information on particular fish populations which will supplement catch, effort and catch per unit of effort data obtained via the CAS. The biological information will help determine the status of the fish stocks, with reference to intensity of exploitation, in a more precise manner than would otherwise be possible with only a CAS. In addition, particular kinds of fish population data will aid in the development of appropriate management regulations, especially with respect to gear useage.

The basic kinds of information that can be obtained through proper sampling of the fish populations are: estimates of relative abundance of various species and size classes, changes in relative abundance through time, seasonal distribution of certain species, season and size of spawning, stock structure or length frequency distributions, sex ratios, food habits and gear selectivity. It is not the place of this proposal to elaborate on how these various pieces of information can be used for fish stock assessment; rather, an overview of particular sampling considerations will be given.

The ultimate objective of the sampling program will be to obtain representative estimates of the characteristics mentioned above; that is, the goal is to obtain a true picture of the fish stocks. This is usually a very difficult task, particularly because all fishing gears are selective for particular species and sizes of fish so that unbiased information is rarely forthcoming. The best approach is to use fishing gears that are known to be selective for particular species and to use these gears such that the catch represents a wide range of sizes. Thus, the investigator may target particular fishes and obtain acceptable data for these species, but may not

expect to obtain adequate information on others. Hopefully, in the current situation, useful information on the species of major commercial importance will be forthcoming. Relevant information on certain biological aspects of many species of commercial importance in the Niger River system already exists (Reed et al., 1967, for example), but characteristics can change depending on local environmental situations and man-induced pressures so that specific information should be collected for rationale exploitation of the fish stocks in Niger.

A commonly used method of obtaining representative information on particular fishes (Alestes, Hydrocynus, Lates, Labeo, Citharinus, Tilapia, and others) is the experimental gill net which is basically a single net, or fleet of individual nets, sewn together so that several different mesh sizes are represented. A net composed of 10- or 20-meter panels progressing from 2.5 to 20 cm stretch mesh, in 2.5 cm increments, will catch a range of fish sizes. A hanging coefficient of 50% is common and mono-filament is usually more effective than multi-filament; surface and bottom set nets can be tried. Experimental hook-lines, composed of different hook sizes (perhaps hook numbers 1-20) mounted along equal segments of line, might be effective in catching a wide size range of catfishes, in particular.

It is difficult to specify the exact methodology which should be used for the fish population sampling program. Local environmental conditions and habitat types will determine, in a specific sense, how and where various sampling gear should be set. In a general sense, it is suggested that temporal and spatial random sampling be incorporated into the program by setting gear in association with the on-water CAS sampling. Given the 3-day blocks of time associated with each CAS sample, there should be ample

opportunity to set and harvest experimental gear. For statistical purposes, it is recommended that at least two replicate sets of any one gear be placed in each sampling location. As with the CAS, the Peace Corps Volunteers and their Department of Water and Forest co-workers will have the period from approximately 1 November - 24 February to decide on specific methods associated with the fish population sampling program.

Roles of Cooperating Agencies

The purpose of this section is to define the roles or responsibilities of the agencies that will be cooperating in the implementation of the CAS previously described in this report. The responsibilities enumerated here are tentative in nature and subject to modification based on final negotiations between the parties involved. The roles outlined here are based on preliminary discussions with all organizations and are designed to provide a workable and on-going project with the capacity to benefit all those concerned, particularly the people of Niger. The suggested roles are presented below, agency by agency, in list format. Because of the critical nature of Peace Corps Volunteer involvement at the community level, a detailed description of Peace Corps Volunteer participation is included.

A. Nigerian Department of Water and Forests

1. Provide overall governmental support for the program.
2. Provide co-workers (at least one) for each volunteer (except the team leader) stationed on the river to be specifically involved in the CAS and fish population sampling.
3. Provide logistical support, through the local offices, to each volunteer; for example, getting boats and engines down to the river if stored elsewhere, transporting boats and engines to specific sites on the river if more efficient to do so by road than by water, organizing fishermen at landings so that catches can be efficiently enumerated.

B. FAO/Fishery Development Project

1. Provide short-term training to each volunteer in gear construction, useage and repair, and in fish preservation techniques.

2. Provide a Zodiac light-weight boat and small engine (~ 20 h.p.) to each volunteer stationed on the River (4).
3. Provide maintenance and replacement of Zodiac boats and engines (one spare boat and two spare engines in Niamey would be ideal).
4. Provide various mesh sizes of multi-filament gill nets for net selectivity evaluation.
5. Provide minor transportation support when possible; for example, use of the mobile fishery development unit when it visits various points on the river.
6. Provide informational support through fishing camp and village surveys.

C. USAID/Project for Soil and Forest Utilization

1. Provide all equipment (other than Zodiac boats and engines) for implementation of CAS and fish population sampling (see Supplement #2).
2. Provide technical support through the Department of Fisheries and Allied Aquacultures at Auburn University.
3. Provide data analysis capabilities, with support from the Department of Fisheries and Allied Aquacultures at Auburn University, in Niamey and stateside.
4. Provide overflights of Niger River in Niger as per Supplement # 1.

D. U.S. Peace Corps

Peace Corps will be responsible for providing the in-country, on-site expertise, through Peace Corps Volunteers, for implementation of the program described in this report. The program is meant not only to provide information necessary for appropriate management of Niger's river resource, but also to provide a basic focus to the Peace Corps fishery program in Niger.

The information gained through the CAS is based on direct social interaction with the fishermen through the interview process; volunteers must live and work at the community level, speak the local language, and build the trust and rapport necessary to communicate with the people so that valid information is forthcoming. At the same time, the volunteers must be technically competent in interview and survey methodology, fish population sampling techniques and basic data organization and summary.

This survey, together with the FAO/Fishery Development Project surveys, will identify basic limitations to efficient utilization of the fishery resource. These limitations will most likely relate to fish preservation, gear construction and fishing methods, organization of fishing cooperatives and fish useage and consumption. All of these areas will provide on-going opportunities for direct involvement of Peace Corps Volunteers at the community level (see Supplement # 3 for a detailed orientation to community development). Given that Peace Corps involvement in the CAS should continue for at least a two to three year period, and that additional areas for assistance will be identified, this program should provide a central focus for fishery volunteers in Niger for many years to come. If positive results stem from this effort, then expansion of the fishery program to one or two other permanent water bodies in Niger, hopefully with interagency support, will be warrented. Efforts at these other areas, Lakes Madarounfa and Tabalak, in particular, have not been successful in the past.

It is recommended that the four new fishery volunteers now in country be stationed at Ayorou, Tillaberi, Say and Gaya; Gothèye would be a reasonable substitute for Tillaberi. These sites will be logistically favorable for

allocation of each volunteer to each of the geographical survey strata defined previously. Given the survey design presented earlier, each volunteer will probably be spending, on the average, 50-60% of his or her time directly involved in on-water and landing survey activities. Remaining time can be devoted to other fishery development problem areas of primary importance in the specific locations at which the volunteers are stationed. The volunteer at Gaya will have the additional responsibility of working with the fishing cooperative, now with 20 members, which was established with the assistance of a previous Peace Corps Volunteer.

In addition to the four new fishery volunteers stationed along the river, it is likely that project success will be dependent on a team leader, or coordinator, most logically stationed in Niamey. There is a fishery volunteer extending for a third year in Niger; he is familiar with the survey methodology, has travelled on the river, can identify fish species, speaks both French and the local language and is ideally suited for the team leader position. The team leader would spend roughly 50-70% of his time in the field working with the volunteers, serving as a "trouble-shooter" and liason between the volunteers and agency personnel in Niamey. He will also be responsible for collecting the interview and other data forms periodically, bringing them to Niamey, and subjecting the data to on-going summary and analysis. Direct involvement by the team leader in improving the fish monitoring program at the "petit marche" in Niamey would be warrented. The team leader can also serve as a "safety-valve" in case one of the volunteers stationed on the river should fall sick or decide to terminate. The CAS design, as presented, necessitates the presence of all four volunteers because each one is responsible for a large geographical region of the river; absence of any one

volunteer implies absence of data collection, and fishery development activities, on that particular portion of the river. The team leader will serve a vital fill-in role should volunteer difficulties arise. In this light, it would be logical for Peace Corps to consider overlapping the current four volunteers with four more fishery volunteers after one year's time (next June, 1983); two volunteers at each site would insure project stability and efficient operation on the river, at landings, and in the community.

Peace Corps will need to supply each volunteer on the river with a motor cycle, as well as incidental items such as wood for making measuring boards, plastic buckets, minor office supplies and technical literature.

Concluding Remarks

As mentioned several times previously in this proposal, the ultimate goal of the CAS and fish population sampling is to acquire the information necessary to rationally manage the fishery resource. In terms of traditional fishery management strategies, this implies determining the maximum sustainable yield and the level of fishing effort associated with this maximum. Fishery regulations would aim to maintain fishing effort (number of canoes) at the appropriate level with adjustments, if necessary, because of unpredicable environmental or man-induced influences, for example. In reality, the best management may be to set flexible regulations to the extent that if continued monitoring of the system dictates that previous regulations are no longer appropriate, then the regulatory agency should have the power to modify the regulations as need be. Other basic types of fishery regulations might involve restrictions on the use of various kinds of fishing gears or on variations (mesh sizes) of particular gears. If overexploitation of particular species is documented, then protection of spawning or nursery areas may be warrented.

Regardless of the types of regulations eventually established for the Niger River fishery in Niger, benefits will not accure unless the regulations are enforced. Serious enforcement of fishery regulations, or more appropriately, the lack thereof, is a primary reason for management failure of natural fishery resources. Another basic limitation to effective management, one alluded to above, is the unpredictability of environmental circumstances that may have drastic effects on the status of the fish stocks. Only continued monitoring of the fishery will allow these changes to be assessed so that appropriate regulatory modifications can be implemented. The Niger

government, if serious about the conservation of their fishery resources, should begin now to acquire the necessary trained personnel and build the appropriate intrastructure so that management is, indeed, a realistic goal.

This proposal has also stressed previously that there are aspects other than strict fishery regulations that play a role in effective utilization of a food resource. Present estimates are that roughly 40% of the fish harvest is lost due to ineffective preservation and storage methods (personal communication, Alan Burtonboy, FAO Fishery Development Project, Niamey, Niger). Most smoked fish that I observed being brought into riverside markets was infested with beetles and/or maggots and, if smoked several months previously, had become hollow shells of skin and bones with very little preserved flesh. Pest control practices in some regions of the river involve application of harmful chemicals (HCH, DDT) directly on the preserved fish with the obvious potential for deleterious effects on the consumer. Thus, real production from the Niger River could be increased substantially through more effective fish preservation and storage techniques.

The production aspects of the fishery should not be isolated from the distribution and consumption components of the system. At present, very little is known about the fish distribution patterns and the segments of the population being impacted by fish production. Fishery regulations by themselves are of no value unless economic and nutritional benefits accrue to the people. Thus, there is a need to identify factors limiting effective distribution and marketing of fishes and to document the role of fish in the household food economy (Intech Inc. 1977). Only when these objectives are met, will the ultimate goal of effective management of the food resource be realized.

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Supplement # 1: Overflight Specifications

Niger River Survey

1) Number of flights: Two during the high water season (1 Oct - 24 Feb) and two during the low water season (7 May - 17 July). The 2 flights within each season are to be done on 2 consecutive days where the river is canvassed in opposite directions, starting from Niamey, each day. Overall, then, 4 overflights of approximately 5 hours duration each (6 am - 11 am).

2) Count Data:

a) canoes: 3 categories - 1) actively engaged in fishing; 2) moving, but not definitely fishing; 3) moored or stationary on bank.

b) Fishermen in canoes: 3 or more categories - canoes containing only one person; canoes containing 2 persons; canoes containing 3 persons, etc. Thus, canoe count types 1 and 2 above will be categorized according to the number of people in the canoes.

c) Landing beaches (places where there are 2 or more canoes moored on shore): identify places and count canoes at each place (possibly done via photographs).

d) Villages: places where huts are concentrated adjacent to the river - identify locations, specify those where canoe landings (as per c above) are located, and count huts in each village.

Supplement # 2: Recommended USAID Expenditures for Niger River Fishery Survey

	COST
A. Equipment Purchases	
1. Experimental gill nets:	
(25-foot panels, 1-8" stretch mesh, 1" increments)	
16 surface set	$ 4,800
16 bottom set	4,800
	$ 9,600
2. Weighing scales:	
(hanging tube scales)	
4,25/kg capacity, 250 g units	160
4,3/kg capacity, 25 g units	160
(spring dial scales)	
4,1/kg capacity, 2 gm units	240
	$ 560
3. Dissolved oxygen/temperature meters	
4,YSI model 51B	$ 1,900
4. Sonar depth guns	
4	$ 640
5. Anemometers	
4 cup-type	$ 380
6. Hooks	
200 each, mustad kirby, sizes 1-8/0	$ 80
200 each, mustad limerick, sizes 4, 6, 8, 10	
7. Secchi disks	
4, 20-cm diameter	$ 110
8. Net mounting & mending twine & needles	
8 roles, # 139	$ 15
8 roles, # 9	$ 35
16 needles	$ 10
	60
9. Microcomputer	
Apple II (with monitor, floppy disc drive & printer)	3,000
Software (Data base manager, statistics pac)	1,000
	$ 4,000
10. Project vehicle	
Small pick-up truck	$ 9,000
11. Miscellaneous Equipment	$ 1,000

Supplement # 2: Continued

	COST
12. Purchasing & Processing Overhead	$ 1,200
13. Air Freight	$ 1,400
	$ 2,700
Sub-Total (Equipment)	$29,930
B. Technical Assistance	
1. Per diem & airfare (4 man-months on 4 separate trips)	$24,000
2. Final Publication	$ 2,000
3. Miscellaneous backstopping (secretarial work, computer time, etc.)	$ 1,500
Sub-Total (Technical Assistance)	$27,500
C. Overflights	
1. 4 flights (20 hours @ $350 per hour)	$ 7,000
2. Observer for 4 days	$ 900
3. Data evaluation	$ 900
4. Plane travel to Niger	$ 1,000
Sub-Total (Overflights)	$ 9,800
GRAND TOTAL	$67,230

Supplement # 3: A Community Development Orientation for Peace Corps Fishery Volunteers

A vital aspect of Peace Corps Volunteer involvement in fishery development is the ability to integrate into the local community and become involved in activities which will provide direct benefit to the local populace. The catch assessment survey described in the main body of this report provides a technical orientation to fishery volunteer assistance in Niger and satisfies the host country government's overall desire to develop conservation measures that will insure the long-term viability of their primary freshwater food resource, the Niger River. The catch assessment survey is also, however, a vehicle for identification of specific problems that limit effective use of the resource as a whole, problems which can provide a focus for development activities by volunteers at the community level.

A case in point, and an aspect of the fish production system stressed in this report, is the identification of specific problems associated with fish preservation techniques (see, in particular, the Concluding Remarks section). A cursory view of the situation in Niger suggests that current fish preservation methods (particularly smoking of fish) are inadequate to prevent fish from deteriorating over relatively short periods of time (2-6 weeks) if immediate market outlets are not available, and that storage techniques are inadequate to prevent infestation by beetles and the larvae of egg-laying flies. The survey will allow the assessment of the extent and severity of these problems along the river through interviews with fishermen and observations at fishing camps and markets; thus, the existence of the problem will be properly documented and the need for direct technical assistance by

volunteers will be justified. It is beyond the scope of this author's expertise to specify the most appropriate fish preservation techniques available at this time; however, a sequence of activities that might lead to meaningful assistance by Peace Corps Volunteers is as follows:

(1) Identification of, and training in, the most appropriate technologies. Ideally, given that specific needs have been properly assessed and appropriate technology for alleviating the problem does exist, Peace Corps Volunteers could acquire the appropriate technical training stateside before entering the country in question; thus, volunteers would arrive in country with skill in hand. In the present case in Niger, documentation of the problems is just getting underway, but fish preservation needs do stand out. Appropriate technologies do exist and fishery volunteers will get proper training through another organization in country, the FAO/Department of Water and Forests Fishery Development Project.

(2) Identification of the target group in the community. The group of people that will be impacted by effective extension techniques must be specified. In this instance, the appropriate question is "Who is responsible for fish preservation in Niger?" The answer can be obtained by appropriate survey methods using interviews and direct observation. Cursory observations and literature from neighboring countries suggests that it is the fishermen themselves and in many cases, the fishermen's wives, that are responsible for smoking the commercially valuable portion of the harvest; these are the people that must accept and utilize the new technology.

(3) Identification of particular assistance organizations. Although it is the fishermen and their wives who must adopt the new technology if

positive change is to be achieved, it may be difficult to approach this group directly and appropriate governmental organizations may be effectively used to expedite the process. The governmental extension service is designed for this type of activity; however, extension services are virtually lacking in many developing countries and, if operational, are usually not oriented toward fishery issues. Identification of governmental departments, and especially particular governmental employees, that work directly with fishermen and know the cultural characteristics of fishermen groups, may provide the most meaningful collaborative assistance. In this specific instance, governmental co-workers or counter-parts will hopefully be provided by the Department of Water and Forests. Most of these people are scheduled to attend an FAO sponsored training course on survey interview techniques. The Niger fishery volunteers, as part of their stateside technical training, received instruction and practical field experience in survey methodology, questionnaire construction, interview techniques and data evaluation to document characteristics of a fishery and to identify particular problems faced by fishermen. The collaboration between governmental counter-part, a person familiar with local fishing customs, language and some interview methodology, and Peace Corps Volunteer, a person with more advanced technical skills, but limited knowledge of customs and language, will lead to an effective team that is able to work with the fishermen to identify their needs and also to collect valid information that can be used to characterize the fishery so that long-term conservation measures can be formulated. Additionally, a mutual transfer of

knowledge should be possible, whereby the Peace Corps Volunteer is able to more readily integrate into the local fishing community and the governmental counter-part acquires the necessary expertise to carry-on in a technically sound manner once the volunteer completes his or her assignment.

(4) Application of extension methods. Societal organization of particular fishermen groups may dictate appropriate channels for approaching the target individuals so that they are, as much as possible, receptive to the extension effort. In this respect, the personal role of the volunteer is extremely important. The necessity to integrate into the community by gaining the trust, respect and friendship of the people and to understand the inner-workings of the society such that real avenues of change can be identified, is the basic philosophy being stressed here. Only when the people are helped to identify their own problems, to themselves perceive that there truly is a need for change, will positive change be possible. Stimulating this self-realization can be a slow, painstaking and usually very frustrating process; identification of appropriate host country individuals (as per (3) above) can expedite the process. With reference to specific extension methods, the general rule is that "seeing is believing" and demonstration projects are usually a necessity. In the present case, then, building and demonstrating the use of more fuel and preservation efficient smokers, and comparing the longevity of the final product to traditional techniques, will be a vital step to acceptance by the fishermen and their wives. Once the idea is accepted, appropriate training in the construction, use and maintenance of the smokers will be required.

(5) Continued monitoring of the situation and assistance in transferring the new technology. Hopefully, if the new technology is truly appropriate and real advantages can be demonstrated, then acceptance of the technology will proceed on its own. There may, however, be many unforeseen political, social and cultural obstacles associated with acceptance, and continued monitoring of the success of the development effort will certainly be necessary. Additional, perhaps different, extension and training inputs may be needed to finally succeed in transferring the new technology.

The above considerations represent a general strategy for approaching community development activities with particular reference to a fishery development objective, namely improvement of fish preservation methods. There are other fishery development activities that potentially may be identified through application of catch assessment and fishing camp surveys. For example, new boat and gear construction technologies, more efficient fishing methods, better gear maintenance and repair techniques, establishment of fishing and marketing cooperatives, improvement of fish distribution systems and extension and education in better utilization of fish as food for nutritionally vulnerable segments of the community. In this light, Peace Corps should consider integrating the roles of volunteers in the community by, for example, coordinating the efforts of fishery, nutrition and extension volunteers. There may be host country agency limitations to such integrated schemes, but where possible, the coordinated effort may produce a greater impact in a shorter period of time. Also, the inclusion of community development

training in both stateside and in-country technical training programs should be stressed. The short two-week training program at Auburn University for freshwater capture fishery volunteers now devotes two to five days, depending upon available personnel, to community development strategies. The five-day option culminates in a field trip to a rural commercial fishing community in Alabama where trainees, on their own with some facilitation by the trainers, must identify particular problems faced by the local fishermen and develop a plan of work for solving these problems based on direct social interaction (fact finding) with various segments of the community. Training programs should, at minimum, be of four to six weeks duration in order to adequately incorporate all pertinent technical, community development and cross-cultural components.