People's Republic of Bangladesh
Ministry of Irrigation, Water Development
and Flood Control

Flood Plan Coordination Organisation

JAMALPUR PRIORITY PROJECT STUDY

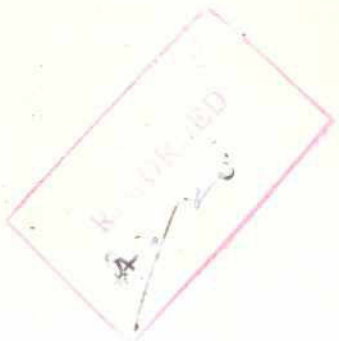
Caisse Francaise de Developpement
and
Commission of the European Communities

FAP 3.1

FINAL FEASIBILITY REPORT

Annex 2 Fisheries

January 1993



Consortium

SOGREAH/ HALCROW/ LAHMEYER

in association with
Engineering & Planning Consultants Ltd.
AQUA Consultants and Associates Ltd.
and Service Civil International.

2

People's Republic of Bangladesh
Ministry of Irrigation, Water Development
and Flood Control

Flood Plan Coordination Organisation

JAMALPUR PRIORITY PROJECT STUDY

Caisse Francaise de Developpement
and
Commission of the European Communities

FAP 3.1

FINAL FEASIBILITY REPORT

Annex 2 Fisheries

January 1993

Consortium

SOGREAH/ HALCROW/ LAHMEYER

in association with
Engineering & Planning Consultants Ltd.
AQUA Consultants and Associates Ltd.
and Service Civil International.

PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL
FLOOD PLAN COORDINATION ORGANISATION

JAMALPUR PRIORITY PROJECT STUDY

FINAL FEASIBILITY REPORT

January 1993

ANNEX 2

FISHERIES

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

GLOSSARY

acres	-	0.45 ha
BBS	-	Bangladesh Bureau of Statistics
Beel	-	Bangali term for a natural depression
BKB	-	Bangladesh Krishi Bank
CFCJ	-	Central Fishermen Co-operative of Jamalpur
CPUE	-	Catch Per Unit Effort
DOF	-	Department of Fisheries
EIA	-	Environmental Impact Assessment
FAO	-	Food and Agriculture Organisation of the United Nations
FAP	-	Flood Action Plan
FCD	-	Flood Control and Drainage
FPCO	-	Flood Plan Co-ordination Organisation
FRSS	-	Fisheries Resource Survey System
FSMF	-	Fish Seed Multiplication Farm
GPA	-	Guidelines for Project Assessment (FPCO Guidelines for the Flood Action Plan)
ha	-	Hectares
HYV	-	High Yielding Variety
Jalmahal	-	Bangali term for Government Fisheries
JPPS	-	Jamalpur Priority Project Study
kg	-	Kilogram
Khal	-	Bangali term for natural drainage channel
NCB	-	National Commercial Bank
SPOT	-	System Pour Observation de la Terre
Tk	-	Taka, Bangladesh Currency, 1 pound sterling = Tk 70
ton	-	An Imperial Ton = 1016 kg
µmhos	-	Micromhos, Unit of Electro-conductivity, a measure of salinity
UN	-	United Nations
WO	-	Without Project
W	-	With Project (Option B) and with mitigation measures
W-M	-	With Project but without Mitigation Measures

SUMMARY AND CONCLUSION

The fisheries sector has an important role in the economic context of the JPP in terms of nutrition, employment and income. It provides the principal source of protein intake of the population (up to 80%).

The various water resources for fish production are flood plains, rivers, beels and ponds accounting respectively for 21%, 44%, 25% and 10% of the total study area present production. The renewal of most of the fish resources depends on natural ecological regimes which conditions the life cycles of most fish species including feeding, growth, migration and reproduction. Yearly floods interconnect the various components of the project water system - internal rivers, flood plains and beels - resulting in a complex biological production system. The flood plain is one of the most important components where fish can find rich nutrient and where the reproduction of the species can take place. The modifications to the natural flow regimes in connection with the development of the agricultural sector, and related water control interventions, as well as the demographic pressure on a limited resource, have already led to a decline of this "free good". Present trends toward decreased catches are likely to continue. Fish culture is taking place to a limited extent but, for the time being, it cannot compensate for the losses in natural fisheries.

This fisheries study has attempted to quantify the present fisheries situation in the study area, to assess the potential effects of the proposed land and water development plan and to propose appropriate mitigation measures. Analysis of the present hydrological and biological system has identified three crucial effects on fisheries production. These are the timing and level of first floods into the area, changes in the extent and average depth of flooding and changes in the duration of flooding.

From both field survey data and existing FRSS data, present and recent past levels of fisheries catches have been calculated. This data has been subdivided according to the locations and methods of fishing. Data have also been collected by the socio-economic team as to the number, nature and status of fishing households. This has produced a classification of three different types of fishing households, full-time, part-time and occasional. Their degree of dependence and links to the cash economy are very different indeed. The nature of fish marketing has also been studied along with pricing.

At the prefeasibility stage of the studies, using a coarse model, the likely effects on each of the different fishing systems of possible alternative land and water development option have been considered. This has produced calculations as to the likely fisheries losses for each fishing system under the assumption that no mitigation measures are taken.

As a result of an economic comparison, a land and water development plan was selected (option B) which provides for controlled flooding in the mainland project area and includes the construction of embankments and drainage infrastructure.

A mitigation programme aiming at compensating the likely losses in fish catches, due to the project, has been included as an integral component of the project.

Mitigation of the losses in fisheries by a long term development programme is feasible. The main idea is to restock controlled water bodies with fingerlings and to promote fisheries management of all water bodies within the Project area through a well organized extension service.

Table 2.S.1 provides a summary of the projections made for the (WO) situation, the situation for a project without mitigation measure (W-M) and with mitigation measures (W).

Table 2.S.1 Estimated Fisheries impacts by Option B5
(production in tons per year, year 2022)

Area	Present (Tonnes)	WO	Option B	
			W-M	W
Floodland	902	582	231	500
Beels	1100	710	183	1335
Riverine	508	328	105	533
Ponds	408	1305	1498	1740
Main Rivers	1445	932	932	932
TOTALS	4363	3857	2949	5040

Note: WO without project
W-M Option B without mitigation measures
W Option B with mitigation measures

The total cost for the fisheries programme is estimated to be Tk 59 million. DOF staff in the project area will be kept at present level. These staff should be seconded to the Project by the Ministry of Fisheries and Livestock, according to the proposed institutional arrangement for project implementation. The implementation of the proposed fisheries management programme will rely on the mobilisation of NGO's. NGO's will operate under the authority of the project organisation for project implementation and in close cooperation with DOF staff.

1 INTRODUCTION

1.1 Aim of the Fisheries Studies

The aim of the fisheries study is to gather both field and archive information as to the present and recent nature of fisheries in the proposed project area. Using this data, combined with predictions as to the likely changed hydrological conditions under the proposed project, the comparative likely effects on fisheries resources have been assessed. Changes to the present situation in the without project situation and for the selected project option have both been made. This information has allowed fisheries impacts to be considered fully in the formulation of the project.

In the extension period to the feasibility study (June - November 1992), mitigation measures were considered in an attempt to ameliorate the negative impacts of the selected option B. This includes development of a fisheries management programme that will allow enhancement of potential benefits to be realised.

1.2 Data Collection and Analysis

Field information was collected during the period November 1991 to January 1992. Fishing patterns, including seasonal variations and differences in fishing techniques and operators, were addressed for each type of capture fishery system and also for aquaculture. This field study of the present fisheries situation in the project area has made it possible to cross-check with the existing data, which is mainly from the Fisheries Resource Survey System (FRSS) of the Department of Fisheries (DOF). This data allows a benchmark to be set for impact assessment and the preparation of the subsequent mitigation programme.

1.3 Impact assessment

Impact assessment has been tentatively addressed using a coarse empirical flood model. This allows estimates to be made as to the likely nature of water levels in each of the sub-sections of the study area (so called compartments, see Figure 2.1.1 for their locations) and the possible effects on each type of fishing production system have been assessed for each of the four initially proposed development options.

2 FISHERIES IMPACT ASSESSMENT METHODOLOGY

2.1 Introduction

There are four fish production systems in the study area and the outputs of these have been assessed separately:

- Riverine fisheries, which are split between the main rivers at the extremities of the study area (the Jamuna and Old Brahmaputra) and the internal rivers within the study area. Fishing in these areas is an all year activity.

- Floodland fisheries, between the internal rivers down to individual paddy field level. This is a seasonal activity, predominantly subsistence in nature.

- Beel fisheries, which are a seasonal professional activity.

- Culture fisheries in ponds which are often individually owned.

In most of the above systems the operators are different. They have been conventionally divided into three categories after FAO/UN 1962:

- Full-time fishermen

- Part-time fishermen

- Occasional fishermen

These represent three very different degrees of time involvement and commitment to fisheries activities and as a result have greatly differing fishing efficiencies.

The assessment has followed the prescribed FPCO GPA guidelines when applicable and has been organized as follows:

- A Socio-economic pilot survey (carried out by the socio-economic team) has been conducted to establish a typology of operators, estimate their numbers and give an idea of the fishing season of each system. (See Appendix A)

- A fish production survey was conducted (see Appendix B), it included:

    - a catch assessment survey of the beels, as there was found to be no existing data for this.

    - a catch assessment of some sections of the internal rivers (Jalmahals) to cross-check with the FRSS data.

- a carp fry production assessment from collection, hatcheries and nurseries

- Data on the pond production of marketable fish was collected through the main socio-economic survey, as well as recall data on subsistence catches. The data on ponds was cross-checked by the results obtained on Jalmahals and ponds during the beel survey.

- Specific surveys and enquiries were carried out that were relevant to the proposed project development options. These include:

  - Fishermen's perception of project development proposal options, their acceptance of these and their willingness to collaborate with any development project. This is split according to those engaged in differing fishing types and of different socio-economic levels.

  - The nature of fish markets and operators

  - The nature of land tenure as it affects fisheries. This is particularly important for floodland, beel and pond fisheries.

2.2 The Socio Economic Pilot Survey

To gain a clearer idea as to the periods and duration of fishing, a questionnaire was administered in which operators were asked to recall the number of days and locations (ranked by order of importance) they have fished in for every month in the past year. This was split by type of habitat and fish production system (floodland, main rivers, other rivers and beels). The same questionnaire was administered to a cross section of all three types of fisherman (full-time, part-time and occasional).

2.3 Fish Production Survey System

2.3.1 Floodland Fisheries

These are essentially subsistence fisheries. Data on these exist from the FRSS and are expressed in terms of kg of fish captured yearly by "subsistence households" over all of Jamalpur District. The average yearly catch per household is about 12 kg and appears to be relatively constant over different years. The projection of this measure of "fishing efficiency" over the recently recorded number of subsistence households in the study area (from the JPPS baseline 5000 household socio-economic frame survey) gives an estimate for the study area based upon data from just one District. To cross check this, a question in the

detailed household socio-economic survey was asked regarding the quantity of the last yearly catch.

The total catch of the subsistence households is dependent upon the volume of fish available for capture. This is itself a function of present and recent past volumes of water inundation in the area, particularly from river flooding, but also that originating from rainfall over the study area. A simple mathematical relationship has been computed between the volume of inundation and the amount of fish caught. This gives a basis for projecting possible future floodland fisheries resources after study of likely new inundation curves for each proposed development option.

2.3.2 Beel Fisheries

i) General

No separate data are available for beel fisheries in the Jamalpur District as it is presently aggregated into data for the old District of Mymensingh. It was therefore necessary to carry out a detailed sample survey to estimate the productivity of beels divided by type of beel, considering their size and permanence, the gear used and the species captured. The productivity (expressed in terms of kg/ha) of a sample of beels has been estimated from this survey data (collected between November 1991 and January 1992) and then projected over the total area of beels in the project area for a whole year.

ii) Sampling

Digitally enhanced SPOT multi-spectral satellite images of the study area, dated February 1989 and 20th November 1990 have been used for the identification of beels by taking a density slice of the visible band. These are shown in Figures 2.2.1 and 2.2.2. These times correspond to the beginning and the end of the beel fishing season, although it must be remembered that they are spaced two years apart and the river flooding patterns for the two years were different.

Comparison of the two images allows identification of beels that were in existence in November but that had dried out by February, and those that had standing water on both occasions. This has been used as the basis for identifying beels, and differentiating those that are permanent from the non-permanent ones. The number and total area of beels obtained using this technique was cross-checked with the existing administrative lists (Jalmahals) of beels and provided a valid positive check.

All beels have been numbered and listed separately into permanent and non-permanent and into two area size groups. A sample of 15 beels was proportionately selected to represent 45% of the beels of less than 20 acres in area and the remaining 55% of over 20 acres.

iii) Survey Methodology

The present beel survey method (see copies of the questionnaires in Appendix B of this report) gives sufficient accuracy of results for study purposes and this method has been used for the sample beel survey. The average duration of the beel fishing season was verified using data collected by the 5000 sample household socio-economic frame survey in which specific questions were asked regarding this (see Annex 6).

2.3.3 Riverine Fisheries

i) Main Rivers

The existing levels of fish capture in the two main rivers have been estimated at 1445 tonnes from "Fish Catch Statistics of Bangladesh - 1988-89 - sixth report" (to be published by DOF). However, there are doubts being expressed about this data, as it indicates an increase in fish landings of +16.5% per annum over the last six years when compared to a national figure of -26.7% for the main river fisheries (see Table 2.3.13).

Of specific concern is the degree of dependence of fishing households in the study area on main river fisheries and the scope for them to transfer their activities to them if, as a result of FCD interventions, internal river fishing is reduced as much as has been predicted.

ii) Internal rivers

Two major internal rivers (the Chatal and the Jhenai) and one major Khal are extensively exploited in the study area. These rivers are not now normally perennial but this has been complicated in the last two years by the construction of a Jamuna protection embankment at the upstream end of the Chatal which has prevented significant river flood water entering this channel at low Jamuna levels. However, there is now a significant breach in this which is likely to result in considerable inflow during forthcoming wet season, possibly continuing well into the dry season. The Jhenai channel has recently been flowing only seasonally as the intake of both the Old Brahmaputra from the Jamuna and the Jhenai from the Old

Brahmaputra have silted up and caused reduced flows along their lengths.

Catch data have been collected from the four sections of river under government lease (Jalmahals) by using the same procedure as for beels (it has the same institutional organization of fisheries as the beels during the dry season). The impact on fisheries in the internal rivers will be related to the modification of the hydraulic regime resulting from changed inflow caused by regulation of flows through controlled flooding and also as a result of improved drainage provision in adjacent areas. This will cause a decline in inflow, especially at former peak times, depending upon operational criteria, and an increase in intensity of inflow from rainfall flooding but for a shorter duration. Thus the degree of permanence of the rivers will be altered still further along with the timing and level of peak flows.

ii) Fry Collection

The impact of proposed project interventions on carp fish fry requires a careful in-depth consideration as recruitment is very sensitive to changes in river hydrology and carp species are the major economic fish in the area. This work has relied upon secondary data collection. The crucial issues are:

- The nature of the modified hydrological regime of the main and internal rivers, specifically the timing and levels of rivers relative to the fish fry development cycle. This will have implications for the catch per area and optimum timing of fishery operations.

- The changed hydrological conditions need to be considered to introduce a fisheries management programme, particularly an extension component and possibilities for restocking as a mitigation measure.

2.3.4 Culture Fisheries

There are existing data on pond productivity in the Jamalpur area collected by the FRSS. This has been used as a basis to assess the present production from ponds in the area by combining yield data with an estimated figure (from the socio-economic survey) for the total number of ponds and their area.
A number of ponds have been surveyed using recalled data from operators, to cross-check the productivity in each stratum of pond. Special attention has to be given to the nursery sector, which will be a limiting factor for the immediate development of restocking programmes.

2.4 Impact Criteria

2.4.1 Overview

Fishing yields in the various production systems will be sensitive to three major effects of any flood control and drainage development programme:

- Effect 1: A situation where flooding will be retarded resulting in the limiting of the timely recruitment of fish fry migrating from the river to the floodplain or the complete blocking of migration.
- Effect 2: Changes in the area and average depth of inundation.
- Effect 3: Shortening of the inundation period which will limit the available period for the growth of fish, thus decreasing the average size of fish at capture. This is likely to be particularly the case after drainage improvement.

2.4.2 Effect 1

The time-wise distribution of fry recruitment is well known and has shown rather regular patterns over years. In the absence of geographical determinism in the recruitment of fry, it is obvious that, as the commencement of river flooding inundation into the area is delayed, a proportion of fry will not be able to carry out its lateral migration. On the inundation curve, (see Figure 2.2.3) if T0 is the date of first flood in the (WO) Situation and T1 the date of first flood in the (W) situation with T1 - T0 = n (days) and if K^i is the daily proportion of fry recruited, the yield of floodplain dependent species (mainly carp) will thus be modified by a factor:

$$F = 1 - \sum_{i=1}^{i=n} k_i$$

It must be clear that the validity of such a computation only stands in case of partial embankments which would have a similar effect measurable on specific sub-divided water management units (compartments) within the protected area.

It is understood that the yearly pattern of fry recruitment shows very short periods of availability. However the variability of occurrence of these cannot be estimated as no detailed data are available for the study area. Thus any attempt to allow recruitment through a programme of operation of conventional regulators is likely to be very much a random process, probably with an expected low quantitative efficiency.

The efficiency will depend upon the size and number of regulators and their programme of operation. Providing these regulators would remain open at the right time, an estimation of the recruitment can be made by calculating the ratio between the length of opened interface between the floodplain and the river when the regulators are operating verses the natural intercommunication length in a normal flood period (estimated at about 4,000 m from aerial photography and satellite imagery).

Systems of conventional "fish passes" have been considered as a means of trying to reduce the level of likely loss of recruitment, but there is a basic contradiction in trying to control peak floods and allow continuation of fish fry recruitment at anything like previous levels using conventional fish passes. The use of more appropriately designed overshot gated structures would seem to offer a far more attractive proposition, particularly when combined with an inlet earthworks design that can draw fish fry from a large reach of the river.

A schematic sketch diagram of this concept is shown in Figures 2.2.4., 2.2.5. The key factor is sensitive design and appropriate operation. Operational criteria need to include consideration of the fact that the peak season for fry recruitment is May-June, i.e. early in the flood season. Ideally, this would require the provision of overshot gates which are recessed into the floor of the structure to allow water to continuously pass at very low flows and yet can be pulled up at a trigger level which represents a point where a dangerous river level is reached and river flood water wishes to be excluded.

2.4.3 Effect 2

The likely modifications in the extent of flooded areas and the average flood depths will induce changes in the fisheries productivity of the area. A morpho-edaphic index (MEI) has been used to estimate these changes, using the following formula:

$$P_i - C \cdot A_i \cdot MEI_i - C \cdot A_i \cdot \frac{k_I}{D_I}$$

where P^i = the total production in the condition "i",
C = a constant (evaluated from the without project (WO) situation),
A^i = the area flooded and
D^i = the average depth of flood in this condition.
K = a factor which is an expression of either water conductivity or hardness (expressed in μmoles).

The relative changes, ∂, (in yields or production) will be expressed by:

$$\delta = \frac{P_{[w]}}{P_{[wo]}}$$

2.4.4 Effect 3

All the development options being considered include provision of improved drainage of run-off. This and other measures will result in a reduction in the duration of inundation, causing a shortening of the period during which fishing can take place. This will be particularly marked in presently non-permanent beels, but is also likely to render some presently permanent beels into non-permanent ones. Assessment of this is impossible to carry out at present because the modification of water retention in the permanent beels fed by rivers requires detailed information on the micro-topography to be integrated into an hydraulic model. This is outside the scope of the present study. The overall effect will be the reduction in area of fish habitats resulting in less fish and also a reduction in the growing period for fish. This is of particular concern for the main commercial carp species found in the beels.

Thus the average size of recruit at capture ($S_{[wo]}$) will be reduced and this will affect the overall yield. To estimate the likely post-project average fish size ($S_{[w]}$), a standard growth curve of *Labeo ruhita* (the most frequently occuring species among carps, and not fundamentally different in growth from the second most frequently occuring species, *Catla catla*) has been used. This growth curve has been extrapolated to give estimated figures for the first year only, as most of the beel fisheries resources are annual ones (i.e. harvested every year, with over 90% of the carp being in the age class 0+). It has also been related to the inundation curve. Both curves have been calibrated by matching the month of first flood with the lowest point of the growth curve.

The new size at capture is estimated by weekly interval steps, with a variation factor, defined as:

$$\sigma = \frac{S_{[w]}}{S_{[wo]}}$$

This is computed in Table 2.2.1 which shows the loss in fish body weight due to shortening of the growth period. This indicates an average relative weight loss of about 10% for each month lost in the growth period.

2.5 Assessment Criteria and Basic Hypotheses

2.5.1 Rivers

The basic hypothesis is that the catch from main rivers (Jamuna and Old Brahmaputra) will be considered unchanged in all policy options. However, there is likely to be a short term decline in carp species in the main rivers due to their potamodromous spawning migration patterns being hampered by the changed hydrology in the beels or floodland and obstructions to their passage between beels or floodland and the main rivers.

The consequence may be a decrease in both the catch of spawn and abundance of carp in the rivers. Such effects may not be detectable as a result of one fairly small and localised FCD intervention such as the JPPS, but the cumulative incremental effects from the phased development of many such projects could be significant.

2.5.2 Floodland

Floodland fisheries will primarily be subject to Effect 2 above (i.e. changes in volume of inundation). There will be little Effect 1 (i.e. retarded flooding reducing recruitment) in the floodland area as this affects the carp species only, the number of which is negligible in the primarily subsistence catch in the floodlands. Effect 1 will thus not be taken into account in the floodlands.

In the without project situation, the total production from the floodland has been estimated, and the present area and depth of inundation have been computed. The present coefficient K (water conductivity or hardness) has been estimated as being primarily a constant having been computed from field measurements made in various places within the project area. However, there is a chance that this could change depending upon the degree of fertilizer use linked to enhanced agricultural development and the increase in all year cropping and wider use of fertilizer responsive HYV's. The without project P figure can thus be calculated from the following formula:

$$P_{[WO]} = A_{[WO]} \cdot C \cdot MEI_{[WO]} = A_{[WO]} \cdot C \cdot \frac{K_{[WO]}}{D_{[WO]}}$$

From this it is then possible to calculate the constant C which is used for quantifying the impact:

$$C = \frac{P_{[WO]} \cdot D_{[WO]}}{K_{[WO]}}$$

The with project figure ($P_{[W]}$) can then be estimated using the above formula. The basic hypothesis has been made that the factor K (related to water quality/chemistry) will not be affected by the project. The final estimate of $P_{[W]}$ has then been corrected for the reduction in recruitment as follows:

$$P_{[W]} = \delta \cdot P_{[WO]}$$

2.5.3 Beels

It has been assumed that for the beel fisheries that the figure for P' includes production from carp species (P_c) and other species (P_m). The value of ∂ (the result of Effect 2 has assumed to be fixed) and the new production is estimated by integrating both Effect 1 (i.e. retarded flooding reducing recruitment) and Effect 3 (i.e. shortening of inundation and fish growth periods) in the case of the non-permanent beels:

$$P_{[WO]} = \delta \cdot (P_{c[WO]} \cdot F \cdot S + P_{m[WO]})$$

In the case of permanent beels, only Effect 1 has been integrated into the calculation:

$$P_{[WO]} = \delta \cdot (P_{c[WO]} \cdot F + P_{m[WO]})$$

2.5.4 Ponds

A basic hypothesis of the impact analysis has assumed that the project will not have major effect on the culture fisheries. There will be positive impacts (such as more regular water supply, and a reduction in the destructive flooding of ponds) depending on the area concerned.

General annual growth factors have been used to estimate changes for the option which does not imply the construction of embankments. For controlled flooding options, present pond production will remain stable.

3 PRESENT FISHERIES SITUATION IN THE PROJECT AREA

3.1 The Fishermen

The Socio-Economic Pilot Survey has shown that, within a sample of 523 households resident in the project area, 313 (60%) are not involved in any fishing activity. The 40% of households who practice fishing to various degrees can be classified as follows:

- 0.6% of all households are full-time fishing households, this comprises 1.4% of all the fishing households. Using the statistics from the socio-economic survey this is estimated to be 1158 households.

- 6.7% of all households are part-time fishing households, this comprises 16.7% of all fishing households. This is estimated to be 12 931 households.

- 32.9% of all households carry out occasional fishing activities and these constitute 81.9% of all fishing households. This is estimated to be 63 497 households.

Due to the small number of full-time fishing households and the statistical dangers inherent in such small samples, it has been decided to aggregate the full-time and part-time fishermen when stratifying the data.

The President of the Central Fishermen's Co-operative of Jamalpur (CFCJ) indicated that there are likely to be about 40 000 professional fishermen in the whole of the District. The study area covers less than 50% of the District and the figure would seem to indicate that their classification of professional fishermen includes those regarded as part-time fisherman as well as full-time fishermen in our classification. Among the 40 000, some 25% (10 000) would belong to a total of 21 cooperatives supported by the CFCJ.

Table 2.3.1 gives the proportional split of the differing fishing household types effort by the three main fishing locations/systems.

Although the preliminary questions asked in the socio-economic survey did not allow an absolute direct estimation of the number of days spent by fishermen in each location category, it has nevertheless been possible to quantify their relative involvement in fishing activities. In total, the fishing effort of the occasional fishermen represents 40% of the overall total fishing effort when all fishing grounds are aggregated. A gross average of the number of days spent yearly in each type of fishing ground was estimated from the socio-economic survey (this included all fishing households regardless of type). This is likely to have resulted in a small over-estimate as most of the responses from beels

and rivers gave preferred fishing ground locations as single answers rather than ranking actual locations used. It is estimated that part/full-time fishermen spend about 60% of their time in fishing, with the corresponding figure for occasional fishermen being around 25%.

Table 2.3.2 summarizes these findings with data being given in days. It should be noted that the figure for beels includes both permanent and non-permanent ones. The periods for the beel and river fishing seasons have been identified from the beel/river survey and cross checked with the results of the socio-economic survey.

3.2 Biological Model of Fisheries Resources

3.2.1 General

In order to gain an initial insight and understanding of the relationship between different categories of fish species and their economic exploitation, a broad categorisation of fish species into three major types has been made as follows:

- Those fish having a high market value and are essentially a commercial resource. These include Hilsa (an anadromous riverine species and as such it is far less likely to be effected by FCD interventions) and Carp (including "Major Carp" and Kalibous) species. The latter depend on the floodplain for their growth and will undoubtedly be effected by FCD projects.

- Other fish species which have a market value and do not totally depend on potamodromous migration. That is they spawn and feed in inundated land, canals and depressions and undertake very little migration to the fringes of the main rivers. These are likely to be less affected by major river side embankments, but could be affected by internal drainage and water control.

- Miscellaneous fishes which include a wide variety of mixed small species.

3.2.2 Major Carp Stock

i) Introduction

The terminology of Major Carp encompasses three species of cyprinids: *Labeo rohita, Catla catla* and *Cirrhinus mrigala.* In the JPPS area the stock depend on a larger one, known as the Brahmaputra stock which is reputed to be the largest in Bangladesh (Ref: Tsai, 1986). This stock covers the following river systems including their tributaries, beels and Khals:

Main Brahmaputra
Jamuna
Old Brahmaputra
Kaligana
Dhalachari
Lower Meghna
Lower Padma
Kumar
Arial khan

In the project area the spawning migration of carp takes place from the end of February to the end of April, when the water levels in the Jamuna start rising from their lowest level. This coincides with the major carp riverine fishing season which peaks in March. It is reported that most of the fish caught are adults ranging from 4 to 20 kg (Ref: Tsai, 1986).

The spawning grounds of this stock seem to be located in the south bank tributaries of the Brahmaputra river on the slopes of the Letha range and Assam hills in India. In addition the Old Brahmaputra might be one of the possible spawning grounds as eggs were recently collected in great quantity in this river (Ref: Personal communication, Tsai, 1991).

The season of spawning can be estimated from the fry catching periods in the rivers. The collection generally commences by the second half of May and lasts up to the first half of July at the latest with the peak season always being in June. In 1988/1989 (the date of the latest available data), 2.5% of the fry were collected from the Old Brahmaputra and the balance from the Jamuna/Brahmaputra. The Old Brahmaputra fry collection was carried out in the first and the last weeks of June coinciding with two spawning periods. In the Jamuna the different collecting sites (see Figure 2.1.1 for their locations) have shown different patterns:

- At Nadagari (in the Madarganj area) where 4% of the fry were collected, there was one spawning period from 12 June to 15 June.

- At Kulkandi (in the Islampur area) where 12% of the fry were collected, there were two peaks of collection between 27 May and 7 June.

- At Jagannathganj Ghat (in the Sarishabari area at the southern end of the study area) where 5% of the fry were collected, there was continuous collection from 27 May until 25 June.

- In Fullakandi and Bahadurabad (in the Dewanganj area) where 77% of fry were collected, collection was estimated to have occurred during the period between the 25 May and 25 June.

From this data it can be seen that carp spawning occurs in May and June at the time the river is starting to rise due to delayed snow melt run-off and the monsoon has yet to break, although there are normally localised heavy rain storms.

When the monsoon starts, major carps appear to avoid the high velocity of the stream waters and migrate transversely to the inundated floodplain for feeding and sheltering, generally before their offspring reach the area. At the end of the monsoon they will generally move back to deeper areas, notably immature and sub-adults to the main rivers. Carp over-wintering in beels are generally all caught as the beels recede. They are in the age class 0+ in annual beels and older in the permanent beels.

ii) Age at Capture - Findings of the Study

Due to the short length of time allowed for the fisheries component of this study, limited samples of major carps were taken in order to tentatively determine the age of fish through reading of their scales or length distribution.

The analysis of the length distribution shows an average length at first capture of about 26.3 cm for Ruhi, 31.5 cm for Catla and 23.9 cm for Mrigal. This indicates that most (90%) of the fish caught are of the age class 0+. The reading of scales (in search of annuli) shows a neat dominance of age classes 0+ and 1+. But to be accurate, such readings need to be followed up to study growth patterns in a known stock of fish. This technique would enable determination of the exact time of the annulus (or annuli as carp might generate 2 marks a year). In the absence of more data it seems safe to presently assume that most of the fish that are caught were born in the same year. This would seem to confirm the existence of a normal seasonal migratory path, i.e. a strong and important timely connection between the river and the floodplain.

3.2.3 Other Species

No specific data are available on the biology and behaviour of the other species living and reproducing in the study area floodplains. The main species caught (i.e the most frequently occurring), are listed in Table 2.3.3.

3.3 An Outline of Fishing Seasonality and its Effect on Fishing Operations

The socio-economic survey provided information which has allowed an understanding of the different fishing seasons and how these vary in each production system. The overall situation with regard to the timing of the different capture fisheries systems is that they are carried out successively through the year with some degree of overlap.

Within a yearly cycle (a Bangladeshi year, which starts in mid April) the first exploited system is the floodland fisheries. Floodlands are exploited from Baysakh to Agrahayan (15 April - 15 November), with a very clear development period between Jaysthaw and Kartik (15 May - 15 October) and a peak in Sraban - Badraw (15 July - 15 August). In terms of preference (i.e. the largest proportion of households in each fishing household type, fishing in the floodlands during any specific month), there appears to be no observed difference between the full-time/part-time fishermen and the occasional fishermen. This can be explained by the simultaneous occurrence of the peak flood, leaving few other alternative fishing grounds available. In terms of gross fishing effort (household days of fishing per month), it is apparent that the involvement of occasional fishing households (although more numerous) is lower throughout the study area than that of the part-time fishing households (about 300 000 HH days against about 450 000 HH days per month in the peak season). The average time involvement of occasional fishing households is about 45% lower than those of full and part-time fishing households.

The second fishing system exploited during the year is the beel fisheries. The survey returns from fishermen show a year round activity in beels with a small peak for full-time fishermen only during Sraban (15 July to 15 August). There is a clear preference period from Badraw to Agrahayan (15 August to 15 November) with the highest peak during Kartik (15 September to 15 October). The low season is from Magh to Baysakh (15 March - 15 April). In terms of preference, by fishing household type, beels are preferred and are more accessible to full and part-time fishermen rather than occasional fishing households. The involvement of full and part-time fishing households in beel fishing is about twice as high as that of occasional households, being around 180 fishing days a year. These estimated figures from the frame survey have been cross-checked with the beel survey which found that full and part-time fishing households spent 215 days a year fishing in 15 specific beels. The difference, which is equivalent to about one month is possibly explained by the fact that the preference data may include a higher proportion of non-permanent beels in which it is impossible to fish for long periods, where as the beel survey data was from permanent beels. Permanent beels are generally exploited from Sraban to Agrahayan (15 July - 15 November) with a secondary peak period in February/March when the last Katas are harvested.

Non-permanent beels are generally fished from Assin/Kartik (15 September - 15 October) through to Magh/Chawitra (15 January - 15 March), depending upon water levels.

Finally, the riverine fisheries are operated all year round, with a preferred peak from Assin to Agrahayan (15 September -15 November), an intermediary phase between Baysakh and Badraw (15 April - 15 August) and a low period from Magh to Chawitra (15 January - 15 March). Riverine fisheries are both the preferred and highest effort locations for full and part-time fishing households.

3.4 Floodplain (Subsistence) Fisheries

3.4.1 Locations and Fishing Practices

The approximate area coverage of floodland fisheries in the study area has been estimated, along with the volume of water contained within this area, by processing the available hydrological and topographic data in the coarse model. The results are as follows:

Area Inundated = 63,965 ha.months (from May to October)

Volume Inundated = 52,813 ha.metres

The volume figure refers to existing semi-contained "compartments" created by the raised road embankments within the project area.

In all, the figures represent an average of 12,800 ha inundated every month during the period May to September, inclusive.

3.4.2 Production Estimates

From project data collection it has been estimated that a maximum of around 40% of all households in the study area participate in subsistence fishing at some time in the year. It should be noted that the proportion observed in the Jamalpur District in the period 1987-1989 estimated from BBS data was about 73% which would include all fishing households plus a considerable number of others. It has also been recorded in project data collection work that full and part-time fishermen also fish for their own direct consumption. There is thus overlap in the concepts of full-time, part-time and occasional fishermen against the notion of subsistence fishing for direct consumption. Of the total 193 000 households estimated from the 5 000 baseline socio-economic survey to be in the JPPS area it is estimated that 77 586 households participate in floodland subsistence fisheries every year.

The FRSS estimate of the average annual catch per household in the Jamalpur District for 1988/1989 was 12.05 kg. Using this figure and the number of households, the total floodland catch in JPPS area can thus

be estimated at 935 tons, consisting mainly of small miscellaneous fish species. An alternative estimate can be made by multiplying the national average productivity of floodlands from FRSS data by the floodland area in the study area. The FRSS figure is reported to be 66 kg/ha and when multiplied by the average project floodlands area of 12,800 ha gives a figure of 845 tons. This gives good confirmation of the alternatively calculated figure of 935 tons. A rough value of about 900 tons has been used for the economic simulations, to represent the present fisheries resources from the flood lands.

3.5 Beel Fisheries

3.5.1 Beel Location and Classification

Beels can be classified into those that are permanent and non-permanent ones. However, the network of interconnected beels and canals in the project area is so complex and dynamic that such a precise classification and assessment of these water bodies is difficult. They vary both seasonally and also from one year to the next, depending upon the nature of flooding, which includes both river and local rainwater sources.

Data on beel locations were mapped from French SPOT satellite imagery for 27 February 1989 and 20 November 1990 (representing a dry season and wet season situation) and also by consultation of the lists of Government Jalmahals (government controlled water bodies that are leased for fisheries purposes). The latter represent nearly all major open water bodies in the study area.

From hard copy data of density slices of the visible band of the multi-spectral SPOT imagery (see Figures 2.2.1 and 2.2.2) printed at 1:50 000 scale for the two dates, it was possible to identify 108 beels on the November 1990 image, of which 32 were in evidence in during the dry season in February 1989. Thus 30% of the beels in the study area are considered permanent and 70% non-permanent. They are estimated to cover 546 ha (in February 1989) and 1 674 ha (in November 1990). The beels in compartment 1A which have been estimated as non-permanent, will be treated as part of the internal river system as they correspond to isolated sections of this in what is a very flood prone and complex area. It should be noted that their fishing yields are also far lower than those for beels and closer to those for internal rivers which they more closely represent.

It was also noticed that 98% of the beels are situated in agro-ecological zones 8 (35%) and 9 (63%). These two zones (see Figure 2.3.1 showing Agro-Ecological zones based upon the modified work of FAO 1988) are the higher and medium level lands in the study area and are less flood prone than the zone 7 riverine areas. In terms of compartments, 17% of the beels (57% in area terms) are spread over

compartments 1A, 1B and 2, while the rest are concentrated in compartments 3 to 7, mainly in the central zone of the project area which appears to be a main "drainage corridor" for the study area. The locations of the compartments are shown in Figure 2.1.1.

The list of Jalmahals obtained from the Jamalpur District Administration shows a total of 89 beels in the study area. In total these cover 1 780 ha and of the 89 beels, 64% were over 20 acres in area. In comparison to field observations and use of the SPOT satellite imagery, this would appear to give a different relationship between the size distribution of the beels , linked as this is to their degree of permanence. The difference between the Jalmahal figure of 1 780 ha and 2 220 ha obtained from the SPOT imagery is likely to be caused by the following factors:

- not all beels or water bodies may be registered as "Jalmahals" by the Administration.

- the Administration records only the winter area of beels, at a date generally situated between two measurement times in December and January. This is not the minimum area which is normally around March/April time and relates more closely to the situation in the February/March 1989 SPOT image.

In order to obtain a figure for the total average beel area over the study area throughout the year it would appear best to use the Jalmahal data of 1 780 ha which is taken at a time between the maximum and minimum water levels. This figure also cross checks with the average between the February and November figures from the SPOT satellite imagery analysis. A breakdown of Beel areas by compartments is shown in Table 2.3.4.

3.5.2 Fishing Gear and Effort

During the period of the field survey work (November/December 1991) seven different types of fishing gear were observed in use. Table 2.3.5 shows the frequency of observation of each type of gear, the corresponding number of man-days (an indicator of the level of fishing effort) and the catch per fisherman (CPUE) all over a five day period of operation. It should be noted that the daily production and the proportion of major carps in the sample decreased during the period covered by the survey and may not therefore be consistent across the different classes of gear.

The catch per fisherman also generally follows a similar pattern of a reduction in the relative abundance of fish through the data collection period. This confirms the seasonality over the November/December period which has been observed in the frame survey data. During February/March, as the last Katas are harvested, it is normal to expect

a peak in carp species catch during this period. This has been confirmed by study of the marketing data, which shows a drop in price during this period reflecting a relatively greater abundance of supply.

3.5.3 Tentative Beel Production Estimates

As part of the first stage of the beel catch survey, the 15 selected beels were visited three times at ten day intervals between 15 November and 15 December 1991. However, as the daily catch levels of this period are not representative of the season average for beels (the period October to December would only account for 45% of the total season catch), further data from more field visits have been collected to check and refine the initial calculations.

- Gear Species Selectivity

  Towards the end of the beel survey, the catch compositions related to the specific selectivity of gear were studied. The results are shown on the next page, in Table 2.3.6.

- Computation of Overall Beel Fisheries Production

The initial stage of the survey covered the months of Kartik and Agrahyan (15 October - 15 December). From interviews with beel fishermen it has been established that the month of Assin (15 September - 15 October) generally follows the same pattern in terms of production. It has thus been considered valid to extrapolate the survey data over the full three month period. It is estimated that out of the total 90 days available 50 days are actually spent fishing during this period. This has been calculated using the following methodology:

In the surveyed sample of beels it has been estimated that the total fishing period is about 200 days over the year. The frame survey indicates that an effective duration period for fishing in the beels is 107 days per year i.e. 54% of the time. This ratio has been applied to the 90 days period. In actual fact it is only possible to accurately estimate this type of data at the end of a complete observed yearly cycle. Reliance on recall data is always prone to error, however in the case of this work there was little choice but to use this data.

From statistical analysis it has been found that there is a significant correlation ($r^2 = 0.78$) between fishing effort (expressed in terms of the number of household days spent fishing) and overall fish production levels. Thus the level of fishing effort can be used as a representative indicator of fish production levels. From the above it is estimated that the beel production for these three months represents 45% of total beel production.

The average total daily catch in the sample beels was found to be 1,836 kg/day over a sample area of 337 ha. Using the estimated figure for total beel area of 1,780 ha, the total production for these 3 months would thus be about 485 tons. This represents a yearly catch of 1 078 tons and is equivalent to a yield of 605 kg/ha.

Analysis of the data carried out in January 1992 using the ratio of the number of observed fishing days against the reported past figure of days actually spent fishing, gave an acceptable confidence interval value between the two sets of data. The initially computed value was therefore used for all future calculations. The equivalent yield figure given by the FRSS for the district of Mymensingh is 526 kg/ha as against a national average figure of 412 kg/ha.

The differences between the FRSS figure and study figure can be explained by:

- the FRSS data covers the whole of the Mymensingh area which is very different to the study area, particularly the fact that the study area lies in much closer proximity to two main river systems and many of the beels are inter-connected to these.

- the number, size and distribution density of beels in the project area is far greater than for the whole of the Mymensingh District.

A computed value of 1,100 tons (618 kg/ha) has thus been used for all calculations of beel fisheries annual production for the study area.

3.6 Riverine Fisheries

3.6.1 Locations and Fishing Practices

Study of fishing in the internal rivers of the project area (mainly the Jhenai and Chatal systems) used the density sliced SPOT imagery of February 1989 and November 1990 to ascertain the area of open water and seasonality of flow in the system. These rivers are not permanently linked with the main rivers or with their tributaries. Some reaches become dry during winter, transforming the rivers into intermittent static water bodies.

For the purposes of this assessment, these rivers have been considered in a similar manner to the analysis of beels, being divided into two classes of "permanent rivers" (sections permanently containing water) and "non-permanent" rivers (sections that dry-out as the season advances). The latter cover a larger area in the study area as can be seen from Table 2.3.7.

3.6.2 Internal Rivers Fishing Gear Use and Fishing Effort

During the field survey reference period (November 1991 - January 1992) seven different types of fishing gear were recorded in use in the internal river areas. Table 2.3.8 indicates the incidence of different gear types and the corresponding number of man days per gear as an indicator of fishing effort along with the catch per fisherman (CPUE). The validity of these figures, particularly those for catch per fisherman, is suspect as the sample sizes are so small, particularly for certain types of gear.

3.6.3 Production Estimates of Riverine Fisheries

The above data has been collected from four selected Jalmahals in the internal rivers in the study area. Whilst it is recognised that this is a small and probably unrepresentative sample, attempts have been made to estimate fishing practices, production and yields from all the internal rivers based upon this sample.

- Species Selectivity of Gear

Table 2.3.9 gives the catch composition by gear type for the fisheries in the internal rivers of the study area.

Although the statistical significance of the above figures may be questionable, it has been noticed that over the period covered by the three successive visits to these riverine Jalmahals, there was a tendency for the total daily catch to increase but also a relative decrease in the proportion of carp (24% against 33% in the first visit). The average catch composition figures for the period of the field survey have been used as the basis for further calculations.

3.6.4 Computation of Overall Riverine Fisheries Production

The yields estimated from the field data of November-December 1991 by extrapolation from the 3 day results, give a figure of 126 kg/ha. Based upon this, the total production would be 786 tons per year from the internal rivers. However, comparison with other data indicates that this could be an over-estimate.

By estimating the catch for the month of Agrahyan (15 October- 15 November) as representing 21% of the total yearly catch (this is estimated from the correlation between the fishing effort and the production observed during the rivers/beel survey, against the 78% of the days spent in fishing shown by results from the frame survey), the figure would be about 507 tons for the year. The equivalent figure from FRSS data is 533 tons. This was later confirmed by further fields data collection work in January 1992 and a rounded figure of 508 tons has been used for subsequent calculations and analysis.

3.7 Aquaculture and Associated Activities

3.7.1 Marketable Fish Pond Production

Ponds are traditionally divided into 3 categories: cultured, culturable and derelict. According to FRSS data the Project area has approximately 3000 ponds with the total area of 871 ha, these are categorised as 43% cultured, 29% culturable and 28% derelict.

The pond fisheries field survey work carried out for the study covered 114 ponds (93 cultured, 15 culturable and 6 derelict) and hence does not conform to the FRSS distribution nor to the same geographical area. However, the data that were obtained have given relevant information concerning the present flood risk to pond fisheries, allowing an assessment of the likely effects of flood control and drainage programmes on pond fisheries. This is summarised in Table 2.3.10.

The stated average yields (calculated from FRSS raw data) of each category of ponds are as follows:

- Cultured - 1 675 kg/ha
- Culturable - 266 kg/ha
- Derelict - 499 kg/ha

Data collected in the preliminary pond survey covering 33 cultured sites in the study area, has produced an average yield of 1835 kg/ha (the confidence interval is 1255 - 2416 kg/ha) which appears to be consistent with the FRSS data. A second sample of cultured ponds studied at a later date also confirmed this figure. On the strength of this it was decided to accept the yield figures calculated from FRSS raw data for all pond types.

It has been assumed that each pond is operated or used by one household. This produces a figure of 1900 fish farmers engaged in cultured pond farming. The number of occasional fishermen engaged in culturable and derelict ponds is estimated to be 1 960.

It is estimated that the project area covers about 50% of the area of Jamalpur District. Assuming an even distribution of ponds, the area and production of ponds in the JPPS area as per FRSS figures, can be estimated to be as follows:

- 185 ha of cultured ponds producing 311 tons
- 128 ha of culturable ponds producing 36 tons
- 122 ha of derelict ponds producing 61 tons

This gives a grand total of 408 tons of production from all pond types in the study area. However, the above figures provide a direct potential mitigation scenario if flood control can be used to convert the 128 ha of culturable ponds to cultured ponds with a consequent increase in production of over 180 tons per year.

3.7.2 Hatcheries, Nurseries

There are 3 hatcheries on the Project area. They are concentrated in Jamalpur area.

(a) GOB FSMF under control of DOF. Production is 25 kg spawn/year. Total area is 1.3 ha.

(b) Unnayan Sangha (NGO) Hatchery. Last year production was 62 kg of spawn on 0.34 ha area.

(c) One private hatchery on 0.2 ha area. Production is not known.

3.8 Fish Marketing, Prices and Production Cost

Fish from the study area appear to be marketed in three different ways, directly on site, at a landing point or sent directly to a market. The latter two ways are carried out either by the fishermen themselves or by middlemen. It is estimated, from a comparison of the species composition of catch and sales, that nearly all of the carp species are sold on markets while the figure for other fish species is about 70% and 30% for the miscellaneous category. The balance is sold on site or at landing points.

It could be considered that the amount of fish sold locally corresponds to the local demand. This could mean that if fish production increased over the human population growth rate then the proportion of fish found in markets may increase, depending upon demand price elasticity. An effect of this could be an increase in the global price of fish. However, this assumes that there are no constraints to increasing the supply of fish. Conversely, the price of fish could also rise if they become scarce, as time spent fishing may still be the same but catches smaller, depending upon demand price elasticity although the overall revenue from fish could fall at the same time.

At village markets 94% of fish is sold by middlemen (agents) with fishermen accounting only for the remaining 6% of sales. Of this 6%, half is accounted for by fishermen buying fish from other fishermen. It is also apparent that the agents are highly specialised, 84% handling only one species on a particular day, with 13% marketing two species and 3% three species. Table 2.3.11 shows the average prices which have been given per habitat and species

A review has been made of the yearly fluctuation in these prices and shows a low-price period in September/October (corresponding to a peak in the supply from beels) and two high price peaks corresponding to diminished supply in the dry season. One of the high price peaks is in January/February and the other in May/June. The trough between these two periods can be explained by an increase in the quantity of fish being sold in March/April as the last catch from the permanent beels is marketed.

Production costs were calculated for all types of habitat, as shown in Table 2.3.12.

3.9 Future Fisheries Trends in the Study Area (WO)

In order to develop predictions of likely project impacts on the fisheries resource system a forecast is required of future trends in a without project situation. Such an exercise is fraught with problems and highly difficult especially for the 30 years period required as per GPA. The whole notion of trying to predict the development of a natural resource system for such a long period ahead, especially when no medium term past data exist, may seem beyond credibility. Applying statistical factors in a conventional economic analytical method does not take into account the natural environmental controls and constraints (particularly maximum production thresholds) that exist in the real world.

The estimation of future trends by studying recent past ones is complicated by the fact that official figures for growth rates in fisheries production in the Jamalpur District over the last 6 years differ widely with the national trend. In overall terms, capture fisheries in the Jamalpur District have been increasing on average by +14% per annum where as in the whole of Bangladesh the corresponding figure is -1.5% per annum. Some of this difference could be explained to a degree by the possible inaccuracy of older data and the possible low statistical significance of the Jamalpur data when compared to the national data set. It has been speculated that the rise in floodland fisheries could be as a result of increased recruitment due to the damage caused to the flood embankments in the 1988 flood which were not subsequently repaired for some time if at all. However, this then raises the question of why the figure for other rivers shows a large fall when it would be expected to follow a similar trend. This would appear to be a contradiction which is very difficult to analyze due to the lack of compatible past data.

Table 2.3.13 shows the average annual trends by fisheries system over the last six years for the Jamalpur District compared to the national average figure.

Under such conditions there are numerous basic hypothesis which could be drawn in an attempt to explain such big differences. With regard to

the future without (WO) project situation there are two conclusions that will be taken into account for the economic analysis:

- the production of capture fisheries should follow the national overall trend using the simplified total figure for all fisheries systems of -1.5% per annum excepted for fish ponds. This may well underestimate the comparative losses to floodland and beel fisheries when compared to the increases in the last six years, however it could well be the case that an upper threshold has already been reached and a situation of over-fishing has already started.

- the production from culture fisheries will be taken to follow the recent trend observed at national level. For the purposes of the analysis it has been assumed that the number of ponds will not increase and that the rise in production will result only from the better management techniques being applied. Further it has been assumed, for this analysis, that the trend will continue for a 30 years.

The adjustment rate is thus calculated to be about +4% per annum over the whole project period.

The implications of these future trend figures are dealt with in Section 5.

It is notable from Table 2.3.10 above that a potential result of controlled flooding will be that the "Culturable Ponds" probably become "Cultured Ponds" and hence extra benefits will occur.

4 FISHERIES IMPACT ANALYSIS (See Appendix C)

4.1 Introduction

The main factors affecting the productivity of fisheries in the floodland, beels and internal rivers would appear to be the average depth, duration, area inundated and the quantity of residual broodstock left over from the previous year to repopulate once the monsoon season begins. At prefeasibility stage, a simplistic empirical flood model has been made which considers monthly stream levels and some notion of topography all set within the framework of the existing compartments of the area. Although of a questionable accuracy, the figures obtained were of sufficient validity to draw conclusions for each of the proposed development options. It would appear that in any case there is little option but to use this technique.

Predicted schematic inundation curves produced using these techniques are shown for each option in Appendix C along with statistical tables broken down by each compartment.

The economic analysis of the GPA places losses totally in the context of cash value. Whilst this approach has been reluctantly followed it is felt that it totally ignores the real issues of replacement and sustainability. The crucial issue is who presently consumes the fish production and how could this be practically replaced? The most serious impact for losses, particularly in the case of floodland fisheries will be the nutritional consequences of a significant reduction in animal protein intake, to those who have no other source and presently rely upon directly consuming the fish they catch on an occasional basis. This will be a particularly acute problem with those who have no access to land and presently rely upon common resource "free-good" fisheries resources. There must also be a considerable number of households who presently purchase or supplement their own directly consumed catch by purchasing fish. This is made still more critical by the trend towards less pulse cultivation and consumption as higher value irrigated rice cropping replaces these traditional sources of non-animal protein.

All fisheries losses are calculated assuming no mitigation and that the management system continues in the way it is at present. This is to provide a common basis for comparison between options and the without project situation. The question of mitigation and future fisheries management is briefly mentioned for each option and outlined in Section 5 for the selected option.

4.2 Option A - Floodproofing and Drainage Improvement

In this option the main impact will be as a result of providing increased drainage provision to the area. It is predicted that the main effect will be a shortening of the inundation period. This is illustrated in Figure

2.4.1. It is likely to cause the areas and depths of beels to be diminished to some degree (Effect 2) and reduce the size of fish at capture (Effect 3) particularly from the non-permanent beels.

4.3 Option B - Controlled Flooding and Drainage Improvement

In this option the main impacts will be as a result of providing both controlled flooding of inflow into the area and increased drainage provision within it. It is predicted that this will produce a major effect of all three types. This will include a reduction in fish recruitment from the river (Effect 1), a reduction in fish habitat (Effect 2) and a reduction in carp size at capture (Effect 3) due to drought advance. These are illustrated in Figure 2.4.2, along with a table of characteristics of area and volume changes by compartment.

Possible operational mitigating measures that might be implemented in an attempt to reduce the negative impacts could include the following:

- Reducing Effect 1 may be obtained to a limited extent by use of sensitive regulation structure design, configuration and location, particularly the type of gates and their operation. Sketches incorporating some of these ideas is shown in Figures 2.2.4 and 2.2.5.

- Reducing the speed of drainage, particularly at the end of the season.

- Other measures, fisheries catch replacement measures and fisheries management measures.

The quantification of impacts given below figure 2.4.2 do not take these steps into consideration in assessing their possible benefits.

4.4 Option C - Controlled Flooding over the Eastern Part of the Study Area and Drainage Improvement

This option takes on the hydrological characteristics of option B but only for the area to the east the Chatal river. The western part of the study area will be subject to drainage provision and flood proofing as for option A. For the purposes of the analysis this has been considered to be the same as the without project situation as the most significant losses for option A were from beel fisheries in the eastern part of the study area. The table of predicted flood areas and volumes is shown in Figure 2.4.3. The inundation effect curve is the same as for option B but only for half of the project area. The same attempts at mitigation could be made as for option B.

4.5 Option D - The Polderisation and Total Exclusion of all River Floodwater in the Maximum Area Possible

The effects of Option D on the internal hydrology of the study area are similar to those of Option B but far more extreme. They are illustrated in Figure 2.4.4 along with a table of flooded areas and volumes compared to the without project situation. The major implication will be that all beels and internal rivers will have to rely totally on direct rainfall for their supply. This will extend the impact of Effect 3, make the impact of Effect 2 total and also prolong the duration of Effect 1.

Mitigation possibilities would have to be limited to specific beel management programmes and pond culture fisheries.

4.6 Feasibility Study Estimates

During the early progress of the study, options C and D were discarded. The large fisheries impact discussed above was a factor in the decision to discard Option D. For the feasibility proper, options A and B were kept for further analysis. For the final analysis, production losses for options A and B without mitigation measures were re-estimated as discussed below in Section 5.

5 FISHERIES DEVELOPMENT PROPOSALS

5.1 General Presentation

Option A has been kept for comparison purpose at feasibility level despite that option B has been already selected at pre-feasibility stage.

Therefore, this section of the report provide a description of the mitigation and management measures that are incorporated into the recommended land and water development plan and included in the economic analysis of the Project (Option B). Further work will be carried out in the detailed design phase which will follow this feasibility phase.

The following three major areas have received consideration:

- The area concerning capture fisheries through the proposal of fisheries management, stocking measures and policies drawn up in the light of the selected development proposal. This includes appropriate design of hydraulic structures for controlled flooding, and provisions for water retention structures.

- The area concerning the very significant potentials in cultured fisheries

- The Institutional strengthening of existing management and extension system

The proposed measures have been designed as a long term programme to mitigate the negative impacts and develop the fisheries sector in the project area.

The measure which perhaps offer the greatest potential for fish production under a controlled flooding situation is the intensification by aquaculture management of those contained areas which will not be so badly affected by reduced inflow. Whilst this is unlikely to directly replace the present fisheries system on flood plain or provide opportunities for many of the occasional fisherman, it does have the potential to produce significant increases in fisheries output. However, it will require resources in terms of training and management.

A replacement to mitigate FCD Project impacts would be to restock water bodies with fingerlings once an assessment of the existing production extension possibilities and a plan for development of new production units have been made and shown to be worthwhile. Water bodies suitable for restocking would need to be identified in terms of area and manageability along with consideration of simultaneous programmes of conservation and protection. This could include beels, ponds (perhaps re-excavated) and particularly new deep borrow pits for

embankments that are near settlements. This will require close liaison with the implementation programme at both detailed design and construction stages. Great care will be needed to draw up an appropriate and sustainable fisheries programme with an emphasis on total participation by local people leading to them being totally self-managed and even owned.

5.2 Capture Fisheries

5.2.1 Fisheries Management Programme

The objective of the fisheries management programme for capture fisheries will be to conserve and develop fish stocks and ultimately to reduce the adverse impact of the flood control and drainage project.

Under the guidance of the Riverine Fisheries Research Station at Chandpur and in coordination with the existing actors dealing with fisheries in the project area, the NGO's will support the DOF for the enforcement of the New Fisheries Management Policy as presented in para 5.4.2. The measures proposed under FAP 3.1 should be implemented with due consideration of this policy.

5.2.2 Main Rivers

Loss of catches in the main rivers results from reductions in the traditional nursing areas of migrator species.

A Riverine Fisheries Development Programme with multipurpose objectives is proposed:

- Maintaining of broodstock of major carps.
- Artificial breeding of carps and restocking of river pools.
- Coordination of fry collection from the river and stocking them in river pools.
- Nursing and releasing management on river pools.

The main target would be to stock as much fingerling back to the river as is possible. Raising fingerlings in nursery ponds and releasing them in the river is not a workable proposition in view of the large number of fingerlings required. Hence, fingerlings should be nursed in suitable pools within or near river stretches before the onset of floods, so that they grow to a suitable size by the time of floods and get dispersed in rivers with the onset of floods. Fry would be sourced from both existing hatcheries and natural fry collection.

The advantages are as below:

- Controlled nursing of endangered species.

- Natural pools within river areas appear a more effective and cheeper solution than providing migration routes inside project area.

The disadvantages are as below:

- This activity depends requires specific funds or government budget.

- The final size of fish may/will be smaller than the fry grown up in the floodplain.

A Riverine Fisheries Research Station with a fish hatchery has been established at Chandpur in 1985 under the Fisheries Research Institute. This Research Station is adequate for providing guidance to the proposed Riverine Fisheries Development Programme under FAP 3.1 Project. The implementation of this mitigation measure will be secured through an adequate institutional strengthening of the fisheries sector in the project area. (see para 5.4 hereafter)

5.2.3 Provision of Fish Sensitive Gated Structure

The opportunity of creating "fish passes" has been already raised in para 2.4.2 above and shown on figures 2.2.4 and 2.2.5.

As explained by FAP 13, the operation of the proposed fish sensitive structures would be as follows: "To permit the spawning migration of fish the regulator gates would need to be wide open in April-June when the mature fish swim in with the first inflow of rising monsoon water. When the mature fish release spawn in the rivers, the spawn and fry generally move in the sub-surface water (2"-4" below the surface), and would normally float into the floodplain during June-August. As the regulator vents are normally opened from the bottom, the fish spawn/fry which are floating near the water surface cannot enter into the project area. To solve this problem one or two vents (depending on the size of the regulator and the intake canal) may be modified to allow passage for the fish spawn/fry/fingerlings into the project area. Figure 2.2.5 shows an example of the modification proposed; the dimensions would depend on the details of a particular project. A suitable slope (perhaps 1:2) should be provided at this passage with a dividing wall to protect the delicate spawn from being damaged by water turbulence. The vertical gate for this passage would be rested below the floor of the passage so that the flow could be adjusted by raising the top of the gate to allow only 6" depth of water over it."

In the Project Area, fish migration will follow the general flooding pattern controlled by hydraulic structures. Three major inlet structure and 55 flushing structures have been provided. The biggest hydraulic structure which will be normally wide open during most of the rainy season is

located at the outfall of the Jhenai/Chatal river system. Migration to the Jamuna will normally take place at this structure.

The main advantage is as follows:

- Use of the original floodplain (what will remain in case of controlled flooding) to grow up fingerlings.

The disadvantages are as follows:

- The efficiency of the structures to reinstate routes for migration through the project area will still remain low
- A decrease of floodplain area and water depth together with continuous "free-good" over-fishing may seriously minimize the chance of migration back to the river
- A big number of predator fish will enter the area in the cultured beels and river beds which may effect seriously the fish production.

This measure has to be taken into account for the detailed design of the hydraulic structures during the next stage of the project. Final conclusions of FAP 13 will also need to be taken into consideration.

5.2.4 Internal Rivers

Utilisation of the internal river beds with managed fisheries is one of the benefits which will be created by the Project. When the embankment and the Jhenai/Chatal outlet will be completed the internal southern rivers will become stagnant water like an "artificial oxbow lake". This gives an excellent opportunity for practising fishery management in this water body. Regulation of water level at 13.0 m (GTS) at the Chatal/Jhenai outlet structure means 666 ha of water surface instead of 233 ha (WO) in dry season (JPPS calculation Appendix D). Further water bodies can be developed in the river bed at the upper part of the project area with check structures which can create a further 100-150 ha of water area. A further positive impact could be obtained with fingerling stocking management.

Table 2.5.1 show the expected production from internal rivers.

5.2.5 Floodplains and Beels Management

Floodplains and beels can be treated as a single biological unit. According to the main findings from Mike-11 computer model the floodplain area will decrease to 54% of the WO situation.

A long term stocking programme is able to mitigate, and even to increase, the production of beels and connected floodplains as shown in Table 2.5.2.

According to the new hydrological conditions, the re-excavation of some of the smallest beels would be very useful. Selection of these beels should be made during detailed design.

5.2.6 Compensation of Deprived Fisherman

A target group oriented approach to fisheries is required. This will focus on compensation measures for fisherman who will be affected by the project. The main component of the Fisheries development proposal which concerns this strata of the population is the restocking programme for internal rivers as described in para 5.2.3 above. With the support of the NGO's and thank's to their skill to organise the concerned population, stretches of the controlled water bodies in internal rivers will be allocated to groups of fishermen who will be able to perform their activity under new conditions.

5.3 Culture Fisheries

5.3.1 General

Cultured Fisheries have been discussed earlier in this report. There is a considerable potential in the project area which should be developed as mitigation and compensation of the project impacts, through an extensive fisheries extension programme.

5.3.2 Fish Ponds

Fish pond farming will become one of the determining production factors in the fisheries sector during the implementation of the Project. The total pond area will be flood protected and suitable for semi intensive culture techniques. With a long term development programme, fish yields of 936 kg/ha could be increased to 4,000 kg/ha as shown in Table 2.5.3.

The techniques of intensification are simple and require low capital cost. A three step approach is necessary:

- Pre-stocking management

  This step concerns actually the pond preparation phase which includes the renovation of the pond, the eradication of undesirable fishes and aquatic weeds, lining of the pond bottom and base manuring of the pond.

- Stocking management

  This step concerns the procurement, the transportation and the stocking of quality fingerlings of different compatible species. The polyculture of fishes in ponds implies a stocking management step taking into account compatible species (Table 2.5.4). These species will be used for the pond stocking programme of other types of water bodies.

- Post stocking management

This step includes the activities to be undertaken for the stocking of fingerlings up to final fish harvesting. These activities are: manuring, feeding, growth and health monitoring water quality monitoring, hazard management, partial harvesting, restocking and final harvesting.

5.3.3 Borrow pits

For the construction of the embankments it is required to excavate about 9 million m^3 of soil. Part of the borrow pits can be converted to fish ponds. Assuming an area of 100 ha of fish ponds, an additional production of 400 tons of fish supply could be achieved annually.

To evaluate the exact production volume of the potential from borrow pits is premature at the present stage. It will be assessed during the detail design phase, when it will be possible, through public participation, to locate borrow pits to be converted into ponds and borrow pits to be reinstated as paddy fields.

5.3.4 Beels and Other Potentials

Other potential can be developed under the extension programmes for cultured fisheries.

At detailed design stage, on the basis of more in depth surveys, the following possibilities will be examinated:

- A big demand of fingerling will arise as the fisheries development plan is implemented. It can be expected that more farmers will establish mini hatcheries and will excavate new ponds for nursing fingerlings.

- integrated farming techniques should be looked into with due consideration of the domestic use of water bodies and health hazards.

- Seasonal beels and excavated beels could be used for hatcheries and nurseries.

5.3.5 Demand and Supply of Fingerling

To run the fisheries program a considerable amount of fingerling will be needed as per Table 2.5.5. (Full programme effective from 1998 onward)

Fingerling requirements have been calculated on the basis of the formula:

$$FR = \frac{TC \cdot HR}{IW \cdot S}$$

where:

FR	=	Fingerling requirement (pc)
TC	=	Total Catch (kg)
IW	=	Average Individual Weight at fishing (kg)
S	=	Survival rate
HR	=	Ratio of Stocked fish as a proportion of the total catch by weight (Harvesting Ratio)

for internal rivers:

$$FR = \frac{TC \cdot 0.7}{0.7 \cdot 0.2}$$

for flood plains and beels:

$$FR = \frac{TC \cdot 0.7}{0.5 \cdot 0.2}$$

for ponds:

$$FR = \frac{TC \cdot 1}{0.5 \cdot 0.7}$$

The total demand of fry will be as shown in Table 2.5.6

The calculation of the figures is based on the following average survival rates:

Fry to nursed fry	:	60%
Nursed fry to fingerling	:	40%
1 kg fingerling	:	200 pcs.
1 kg spawn	:	300,000 fry.

The required nursery area is 1 ha for 1 kg spawn.

5.4 Institutional Strengthening and NGO support

5.4.1 Institutional arrangement and objectives

In order to secure the fisheries development proposals the institutional strongthening of the fishing sector through NGO's is recommended for the project area.

The approach to be followed should derive from the experience of the Mymensingh Aquaculture Extension Project (DANIDA programme)

Existing DOF staff should be kept at the present level. DOF staff will participate to the implementation of the works proposed under the project and carried out by NGO's. DOF staff will be deputed to the project, as proposed in Annex 7, for a multidisciplinary approach of project implementation. Furthermore, a specific Technical Assistance programme will be provided to the DOF and NGO's through the Project consulting staff.

In Jamalpur there is some competition between the DOF and NGO's because they do not have the same target group as beneficiaries. The local NGO's should become partners of the fishery development programme to achieve a wide spread of inland fishery.

The main objectives of the NGO support to be provided through capable and experienced NGO's are:

- to implement the proposed fingerling stocking management programme
- to participate in the identification, design and implementation of check structures and excavation of beels
- to support fisheries production programmes through a credit system
- to provide support services to the population through field training and extension programmes

Some facilities, if provided to the fishermen, would increase catch and thereby increase the income of the poor section of people who are engaged in this occupation. Provision of credit support for fishing boats and nets will make substantial improvement in increasing catches. NGO's have developed approaches to individual fishermen on easy terms for the purchase of inputs, fishing nets, boats.

- Credit

  Due to the nature of the Fisheries sector and the amount of risk involved, formal credit support through the institutional banking system (NCBs, BKB, private banks) is limited.

  Therefore, credit support should be streamlined through NGOs which have much experience in working with the deprived population. The record of NGO's is good and their performances in terms of recovery rates are usually acceptable.

  In this respect, the project will allocate to each NGO involved in the program a specific amount of money to support the credit activities. The NGO will use this fund allocation on a revolving basis and will apply its own methodology with respect to credit disbursement and recovery procedures. However, it is recommended that the loans extended by NGO's be interest free and that their terms be restricted to less than 2 years.

- Contractual links of NGO's

  Each NGO will be bound to the project authorities, either directly or through the foreign consultant, by a contract clearly spelling out the scope of work, the staffing and the budget allocation. Within the budget, NGO's would be allocated funds to support their credit and other activities.

  In this respect, the DOF with the help of the Technical Assistance would be in charge of preparing and administrating the NGO's contracts but these contracts would have to be endorsed by the international aid donors prior to become effective.

- Estimated cost for NGO support

The investment cost to be supported by the project are related to the construction of community houses, the supply of transport facilities, staffing and running costs. The cost of the Technical Assistance is included in the evaluation made separately in Annex 7 for "Engineering and Technical Assistance". On the assumption that three NGO's will be involved in the 7 year project implementation programme, the following estimated cost is proposed:

Designation	unit cost in '000 TK.	Quantity	Total in 'million Tk.
1. Investment cost			
Community houses	200	3u	0.6
Motorbikes	100	9u	0.9
2. Staffing			
3 Coordinators	10	252m/month	2.5
6 Field Supervisors	5	504m/month	2.5
30 Field Workers	3	2880m/month	8.6
4. Running cost			
Consumable	-	LS	9.9
Training Programmes	-	LS	6.0
		Total	31.0

5.4.2 Legislation Enforcement

The institutional strengthening programme should enable greater effectiveness in DOF action towards the enforcement of the existing legislation on fisheries i.e. The Fish Act, the Tank Improvement Act, the New Fisheries Management Policy (NFMP)

(i) The New Fisheries Management Policy

The new Fisheries Management Policy aims to eliminate exploitative practices by replacing the leasing system with a system of licencing, both to redirect benefits to fishermen rather than former lease holders and to improve the productivity and sustainability of fish resources.

(ii) The Tank Improvement Act 1939

Numerous privately owned Tanks remain fallow in rural Bangladesh primarily due to differences of opinion among the shareholders. The Government promulgated The Tanks Improvement Act, 1939 which was amended in 1986. The salient clauses of the said Act are as follows:

- If the Deputy Commissioner is of the opinion that any tank has fallen in disrepair or disuse, he may serve a notice on the person owning the tank requiring him to carry out within a specified period, such improvements of the tank necessary for the proper utilisation of the tank for the purposes of pisciculture.

- If after serving notice the owner of the tank does not take up pisciculture, the Deputy Commissioner will declare the tank to be a derelict and take over its possession. He will, thereafter, hand over possession of the Tank to a local authority, co-operative society or any other person for pisciculture for a specified period not exceding twenty years. On expiry of the above period the tank will be handed over to its owner and during the above period he will receive rents as fixed by the Government.

(iii) The Protection and Conservation of Fish Act, 1950:

To prevent large scale destruction of fish fry and immature fish the Government promulgated 'The Protection and Conservation of Fish Act 1950'. The main clauses of the Act are prohibition of:

- Catching, carrying, transporting, selling Hilsa below 23 centimeters during November - April.

- Catching, carrying, transporting, selling Carps below 23 centimeters during July - December.

- Catching, carrying, transporting, selling Pungus, Silond, Bhola, Aor below 30 centimeters during Februaru - June.

- Catching, carrying, transporting, selling Carps of any size in some specific rivers, khals, beels during March 15 - July 31.

- Catching or destroying fry of Shoal, Gazar and Taki moving in clusters and the parent fish while guarding in open waters in Rivers, Channels, Khals, Beels etc. during April 1 - August 31.

- Catching or prevention of free movement of fish by constructions cross-bands or putting nets permanently in Rivers, Khals, Beels throughout the year.

- Catching fish by use of explosives, throwing industrial wastes in water.

It is essencial for the preservation of the resource and the development of the nation's fishery potential that laws promulgated to this end are enforced.

5.5 Summary of the Project Components

The following basic requirements should be implemented in order to achieve the production of 5040 tons of fish in the Project area in 2022.

- A Central Government Hatchery with training centre (Jamalpur FSMF)
- private mini hatcheries, NGO hatcheries
- 285 ha of nursery area
- an efficient support to the sector provided through NGOs

The renovation and extension of Jamalpur FSMF is also necessary.

For planning purposes, the rehabilitation and extension cost of the Jamalpur FSMF will be assumed as 80% of the cost of a new infrastructure having the required size. The cost of such an infrastructure has been detailed in Appendix E.

5.6 Implementation Schedule

A 2 phase programme is proposed:

- A first Phase which includes:
  - Renovation of Jamalpur FSMF. Start by end 1993 and construction completion by end of 1994.
  - Mobilisation and organisation of NGO support from 1994.
- A second Phase includes
  - Construction of check structures and excavation of beels (if any)between 1995 and 1997 on the basis of local participation
  - Stocking management of beels and floodplains from 1996
  - Stocking management of river beds as from 1997 after the actual completion of main structures

- Stocking programme of main river and elaboration of artificial breeding of endangered species from 1997
- Extension service for all water bodies from 1994
- Training programmes from 1994.

5.7 Cost Estimates

i) Physical components:

• Rehabilitation of Jamalpur FSMF	TK 8.0 million
• Check Structures	TK 20.0 million
Total	TK 28.0 million

ii) NGO component for a 7 year support programme

• Investment cost	TK 1.5 million
• Staff	TK 13.6 million
• running cost	TK 15.9 million
Total	TK 31.0 million

Total programme: TK 59.0 million

The required Technical Assisstance has been included in the cost for the engineering and TA arrangement proposed in Annex 7 on Engineering.

REFERENCES

DOF	Fish Catch Statistics of Bangladesh 1983-84; 1984-85; 1986-87; 1987-88
DOF	Open water fisheries (carp) management programme in Bangladesh, Tsai, C.F. & Ali, L.A.
DOF	Species Wise Length-Weight, S.N. Choudhury, Fish Hatchery & Training Centre, Raipur, 1988.
FAO	Manual on Polyculture and Integrated Fish Farming Techniques for Bangladesh, 1992
FAO/UN 1962	Fisheries Guidelines
FAO/UNDP	Inspection Report of F. Rajts 1985
FAO/WB	Bangladesh Fisheries Sector Project Preparation Mission, 1989.
FAP-3	Preliminary Supporting Report
FAP 3	Fisheries Supporting Report, April 1992 (arrived after this report was drafted)
FPCO	Draft EIA Guidelines and Manual for the FAP
FPCO	Draft GPA Guidelines for the FAP, July 1991
FRSS	Fisheries Information Bulletin Vol. 3, No. 1 (Dec-1986)
JPPS	Interim Planning Report (R2), March 1992
JPPS	Planning Report (R3), April 1992
Tsai 1986	Carp Spawn Fishery in the Padma (Ganges)-Brahmaputra River System, Bangladesh. Indian Journal of Fisheries, Vol 33, No 4, 1986
Tsai (et al)	Spawning of Major Carps in the Lower Halda River, Bangladesh, "Estuaries", Vol 4, No 2, June 1981
World Bank	Operational Directive 4.01 on EIA Policy and Procedures

CONTACTS AND LIAISON

Doug Cross, FAP-2, Ecologist
Chu-Fa Tsai, Third Fisheries Expert
Jim Scullion, FAP-17, Fisheries Support Study and FAP-3
Steve Minkin, FAP-16, Fisheries Environmental Impact Study
Andras Peteri, Danida, Fisheries Expert
Dilip Kumar, FAO, BGD/87/047, Extension Expert
Nazirul Islam, DOF, Deputy Chief of Planning
J. Collins, II ADB Project, Team Leader
D.A.L. Sarkar, FPCO, Panel of Expert
Rafiqul Islam, DFO, Jamalpur.

TABLES

Table 2.2.1 Loss in Fish Body Weight due to Shortening of the Growth Period

Date	Relative loss in body weight
01 - Feb	33.65%
08 - Feb	31.78%
15 - Feb	29.86%
22 - Feb	27.88%
01 - Mar	25.85%
08 - Mar	23.77%
15 - Mar	21.63%
22 - Mar	19.44%
29 - Mar	17.20%
05 - Apr	14.90%
12 - Apr	12.55%
19 - Apr	10.15%
26 - Apr	07.69%
03 - May	05.18%
10 - May	02.62%
17 - May	00.00%
Source: JPPS Calculations from Existing Data	

Table 2.3.1 Percentage Distribution of Fishing Household Types Effort by Location/System

HH type	Beels	Floodland	Rivers
Occasional	47%	41%	12%
Part-time	55%	29%	16%
All	52%	33%	15%
Source: JPPS Field Survey Data 1991-1992			

Table 2.3.2 Fishing Household Mean Activity Rates by Fishing Location/System

	Beels	Floodland	Rivers
Fishing Days	107	75	133
Days in season	200	90	170
Source: JPPS Field Data Collection 1991-1992			

Table 2.3.3 Main Varieties Non-Carp Fish Species Found in the Study Area

Species	Common Name	Family	English Name
Mystus aor	AIR	Bagridae	Fresh water catfish
Wallago attu	BOAL	Siluridae	Fresh water shark
Channa marulius	GOZAR	Chanidae	Snake head
Labeo calbasu	KALIBAUSH	Cyprinidae	Orange-fin labeo
Anabas testudineus	KOI	Anabantidae	Climbing perch
Pangasius pangasius	PANGAS	Pangasiidae	Red fin catfish
Silonia silondia	SHILONG	Schilbeidae	
Heteropneustes fossilis	SHING	Heteropneustidae	Stinging catfish
Notopterus notopterus	PHOLI	Notopteridae	Feather back
Puntius sarana	SHORPUNTI	Cyprinidae	Minor Carp
Source: JPPS Field Data Collection 1991			

Table 2.3.4 Beel Areas (ha) by Compartment

Compart-ment	Permanent Beels				Non Permanent Beels				Total			
	No	Area ha	No %	Area %	No	Area ha	No %	Area %	No	Area ha	No %	Area %
C1B	5	166	16	34	5	537	7	42	10	703	9	39
C2	2	72	6	15	2	198	3	15	4	270	4	15
C3	5	5	16	1	13	57	17	4	18	62	17	3
C1A	0	0	0	0	4	62	5	5	4	62	4	3
C5	13	163	41	33	17	157	22	12	30	320	28	18
C6	4	50	13	10	16	145	21	11	20	195	19	1
C7	3	36	9	7	19	132	25	10	22	168	20	9
Total	32	492	100	100	76	1288	100	100	108	1780	100	100

Source: JPPS calculations based upon SPOT Satellite Imagery Data of February 1989 and November 1990 cross-checked with District Jalmahal data.

Note: Area data are rounded

Table 2.3.5 Frequency of Beel Fisheries Gear Use

Total Estimate		Gill Nets	Seine Nets	Cast Nets	Lift Nets	Traps	Long Line	Kata
	Number in use	774	104	800	356	316	210	21
	Number of fishermen	1548	1040	800	712	316	420	210
	% of Fishermen	31%	21%	16%	14%	6%	8%	4%
Sample	Number observed	197	55	194	113	76	37	19
	% observed	25%	53%	24%	32%	24%	18%	90%
	Total catch	508	358	428	141	108	84	817
	Number of Fishermen	394	550	194	226	76	74	190
	Catch per fishermen	1.29	0.65	2.21	0.62	1.42	1.14	4.30
	Catch per gear	2.58	6.51	2.21	1.25	1.42	2.27	43.00
	% of gear observed	29%	8%	28%	16%	11%	5%	3%
	% of the daily catch	21%	15%	18%	6%	4%	3%	33%

Source: JPPS Field Survey Data 1991

Note: These figures correspond to a total of 5 days observation period spread out during November/December 1991.

Table 2.3.6 Species Selectivity of Gear in Beel Fisheries

Species	Gill net	Seine	Cast	Lift	Trap	Line	Kata	Total
Ruhi	19%	14%	17%	0%	0%	3%	14%	15%
Catla	6%	3%	7%	0%	0%	0%	7%	5%
Mrigal	3%	2%	1%	0%	0%	0%	4%	2%
Total M.Carps	28%	19%	25%	0%	0%	3%	25%	22%
Kalbasu	3%	9%	2%	0%	0%	0%	6%	5%
Chania	0%	0%	0%	0%	0%	0%	1%	0%
Boal	4%	17%	10%	1%	4%	49%	25%	16%
Air	8%	4%	1%	0%	0%	0%	2%	3%
Pangas	0%	0%	0%	0%	0%	0%	0%	0%
Silon	0%	0%	0%	0%	0%	0%	0%	0%
Ghol	2%	1%	8%	0%	2%	42%	2%	4%
Ghital	0%	0%	0%	0%	0%	0%	3%	1%
Koi	17%	0%	5%	2%	2%	1%	1%	5%
Singi	15%	0%	5%	1%	0%	4%	0%	5%
Sar punti	0%	0%	0%	0%	0%	0%	0%	0%
B. Shrimps	0%	0%	0%	0%	0%	0%	0%	0%
S. Shrimps	0%	0%	5%	15%	57%	0%	8%	7%
Other	0%	0%	0%	0%	0%	0%	0%	0%
Total Other	49%	31%	36%	19%	65%	96%	48%	46%
Miscellaneous	23%	50%	39%	81%	35%	1%	27%	32%
Total	100%	100%	100%	100%	100%	100%	100%	100%
Source: JPPS Field Data Collection								

Table 2.3.7 **Area of Internal Rivers by Compartment Area (ha)**

Compartments	Permanent Rivers		Non Permanent Rivers		Total	
	Area Ha	Area %	Area Ha	Area %	Area Ha	Area %
C1B	285	38	2096	38	2381	38
C2	11	1	96	2	107	2
C3	53	7	145	3	198	3
C1A + C4	361	48	3018	55	3379	54
C5	20	3	52	1	72	1
C6	20	3	52	1	72	1
C7	4	1	23	0	27	0
Total	754	100	5482	100	6236	100

Source: Analysis of SPOT Satellite Imagery of Feb 1989 and Nov 1990

Table 2.3.8 Fishing Gear in Use in the Internal Rivers

	Gill Nets	Seine Nets	Cast Nets	Lift Nets	Traps	Long Line	Kata
Number in use	36	36	261	36	18	6	39
Number of fishermen	72	360	261	72	18	6	390
% of fishermen	6%	31%	22%	6%	2%	1%	33%
Number observed	6	16	65	11	2	1	13
% observed	17%	44%	25%	31%	11%	17%	33%
Total catch	68	298	118	15	10	5	307
Number of fishermen	12	160	36	18	2	1	100
Catch per fishermen	5.67	1.86	3.28	0.83	5.00	5.00	3.07
Catch per gear	11.33	18.63	1.82	1.36	5.00	5.00	23.62
% of gear observed	5%	14%	57%	10%	2%	1%	11%
% of the daily catch	8%	36%	14%	2%	1%	1%	37%

Source: JPPS Field Survey Data 1991-1992.

Note: These figures correspond to a total 5 day period of observation.

Table 2.3.9 Internal Rivers Catch Composition by Gear Type

Species	Gill Net	Seine	Cast	Lift	Trap	Line	Kata	Total
Ruhi	12%	12%	11%	0%	0%	31%	16%	13%
Catla	22%	10%	8%	0%	0%	0%	10%	10%
Mrigal	2%	4%	2%	0%	0%	0%	3%	3%
Total M. Carps	36%	26%	21%	0%	0%	31%	29%	26%
Kalbasu	5%	3%	1%	0%	0%	0%	0%	2%
Chania	0%	0%	0%	0%	0%	0%	0%	0%
Boal	18%	22%	5%	0%	80%	21%	27%	21%
Air	18%	13%	2%	0%	0%	0%	0%	7%
Pangas	0%	3%	0%	0%	0%	0%	0%	1%
Silon	0%	0%	0%	0%	0%	0%	0%	0%
Ghol	0%	1%	7%	0%	0%	0%	12%	6%
Ghital	0%	0%	0%	0%	0%	0%	0%	0%
Koi	0%	0%	1%	6%	0%	13%	1%	1%
Singi	0%	0%	0%	5%	0%	14%	0%	0%
Sar punti	0%	0%	0%	0%	0%	0%	0%	0%
B. Shrimps	0%	0%	0%	0%	0%	0%	0%	0%
S. Shrimps	0%	3%	3%	0%	0%	0%	3%	2%
Other	7%	0%	1%	0%	0%	0%	0%	1%
Total other	48%	45%	20%	11%	80%	48%	43%	41%
Miscellaneous	16%	29%	59%	89%	20%	21%	28%	33%
Total	100%	100%	100%	100%	100%	100%	100%	100%
Source: JPPS Field Data Collection 1991-1992								

Table 2.3.10 Summary of Pond Classification and Flood Risk

Pond category	Cultured	Culturable	Derelict
Flooded every year	5%	80%	67%
Rarely flooded	58%	7%	0%
Never flooded	37%	13%	33%
Source: JPPS Field Data Collection 1991			

Table 2.3.11 Fish Prices in January 1992

Habitat	Main Species Group	Price	
		Average (Tk/kg)	Range (Tk/kg)
River	Hilsa,catfish	40	25-65
Beel	Carp,catfish and miscellaneous spp.	30	15-50
Floodplain	Miscellaneous spp.	25	15-40
Pond	Major & exotic carps	35	25-45
Source: JPPS Field Data January 1992.			

Table 2.3.12 Production Cost per 1 kg of Fish

	Equipment (Tk/kg)	Labour (Tk/kg)
Rivers	6	2
Flood land	2	2
Beels	6	2
Ponds	14	6
Source: FAO/UN 1992 Fisheries guidelines - for river, C.E.		

Table 2.3.13 Average Annual Fisheries Production Trends Over the Last Six Years

	Main Rivers	Other Rivers	Floodland	Beels	Ponds	Total
Jamalpur	+16.49%	-21.75%	+11.52%	NA	+18%	+14%
Bangladesh	-26.71%	NA	-1.05%	+0.61%	+3%	-1.5%

Source: FRSS data
Note: NA - not available

Table 2.5.1 Fish Catch in Internal Rivers in Tonnes with Different Options

	1993	1994	1995	1996	1998	2001	2005	2010	2015	2022
WO	508	502	496	489	477	458	434	402	371	328
Option-B W-M	508	502	496	489	171	168	165	162	160	158
Option-B W	508	502	496	489	466	500	533	533	533	533

Method of Calculation:

WO: Use of national trend (about-1.5% per year decrease of catch)

W-M: 1993 - 1997 Use of national trend (-1.5%)

1998 - 2022 National trend on the remaining water surface area (JPPS model)

W: 1993 - 1997 Use of national trend (-1.5%)

1998 - 2010 The yearly catch reach 650 kg/ha (JPPS assumption) through stocking and management programme. Total Water surface calculated as 820 ha through different control and check structures.

2010 - 2022 Increase of fish production will reach biological saturation.

Note: WO Without project
W-M Option B without mitigation measures
W Option B with mitigation measures

Table 2.5.2 Fish Catching (tonnes) in Floodplain and Beels

	1993	1994	1995	1996	1998	2001	2005	2010	2015	2022
WO	2,002	1,978	1,953	1,929	1,880	1,806	1,709	1,585	1,463	1,292
Option-B W-M	2,002	1,966	1,929	1,893	979	936	881	817	756	680
Option-B W	2,002	1,966	1,929	1,893	1,657	1,710	1,800	1,835	1,835	1,835

Method of Calculation:

WO: Use of national trend (about-1.5% per year), without any development plan.

W-M: 1993 - 1997 Calculated with national trend on present area (about-1.5% per year).

1998 - 2022 National trend continued on beel area and 54% of present floodland area (10,200 ha).

W: 1993 - 1997 Decrease, using National trend and decrease of floodland area due to the embankment construction (JPPS assumption).

1998 Stocking and management programme will start on the present beel area and 10 200 ha floodplain area.

1998 - 2010 Fish production increasing due to stocking and management programme to the maximum of 650 kg/ha in beels and 66 kg/ha on floodplain.

2010 - 2022 The system will be saturated thus production will remain stable.

Note: WO Without project
W-M Option B without mitigation measures
W Option B with mitigation measures

Table 2.5.3 Fish Production in Fish Ponds at Different Options

	1993	1994	1995	1996	1998	2001	2005	2010	2015	2022
WO	408	426	448	478	522	609	740	914	1,130	1,305
Option-B W-M	408	447	486	525	564	681	837	1,032	1,227	1,522
Option-B W	408	426	448	478	652	870	1,261	1,522	1,653	1,740

Method of Calculation:

WO: Production assumed to be increased from 938 kg/ha to 3,000 kg/ha until 2022.

W-M: Production assumed to be increased from 938 kg/ha to 3,500 kg/ha. The difference come from the flood control which convert all pond area into cultured pond.

W: Production assumed to be increased from 938 kg to 4,000 kg/ha. The difference will be obtained from the mitigation and extension service programme. (including fingerling supply).

Note:
WO Without project
W-M Option B without mitigation measures
W Option B with mitigation measures

Table 2.5.4: Compatible Carp Species for Polyculture with Their Spatial-trophic habits

Species	Spatio-trophic Habits
Silver carp (Hypophthalmichthys molitrix)	Surface feeder - Phytoplanktophagous
Bighead carp (Aristichthys nobilis)	Surface feeder - Zooplankton feeder
Catla (Catla catla)	Surface feeder - Zooplankton form the major
Grass carp (Ctenopharyngodon idella)	Surface/column feeder - Macrophyte feeder
Rui (Labeo rohita)	Predominantly column feeder - plankton and organic debris form the major diet
Thai Sarputi (Punties gonionotus)	Column/bottom feeder - Plankton and soft aquatic weeds form the major diet
Mrigal (Cirrhinus mrigala)	Bottom feeder - Detritivore
Common/Mirror carp (Cyprinus spp.)	Bottom feeder - Omnivore.

Table 2.5.5 Demand of Fingerling within Project Area with The Mitigation Measures (Data in million pcs)

	Area ha	1993	1994	1995	1996	1998	2001	2005	2010	2015	2022
Internal River	816	-	-	-	-	2.3	2.5	2.7	2.7	2.7	2.7
Flood Plain and Beels	1,882	-	-	-	-	11.6	12.0	12.6	12.8	12.8	12.8
Ponds	435	1.2	1.2	1.3	1.4	1.9	2.56	3.6	4.3	4.7	5.0
Total	3,133	1.2	1.2	1.3	1.4	15.8	17.0	18.9	19.99	20.2	20.51

Table 2.5.6 Demand for Fry in kg

Area	1993	1994	1995	1996	1998	2001	2005	2010	2015	2022
3133	17	17	18	19	220	236	262	276	281	285

Table 2.5.7 DOF Staff present situation

	Existing
1. District fishery Officer	1
2. FSMF Manager	1
3. Thana Fisheries Officer	6
4. Assistant Fisheries Officer	6
	14

FIGURES

FIGURE 2.1.1

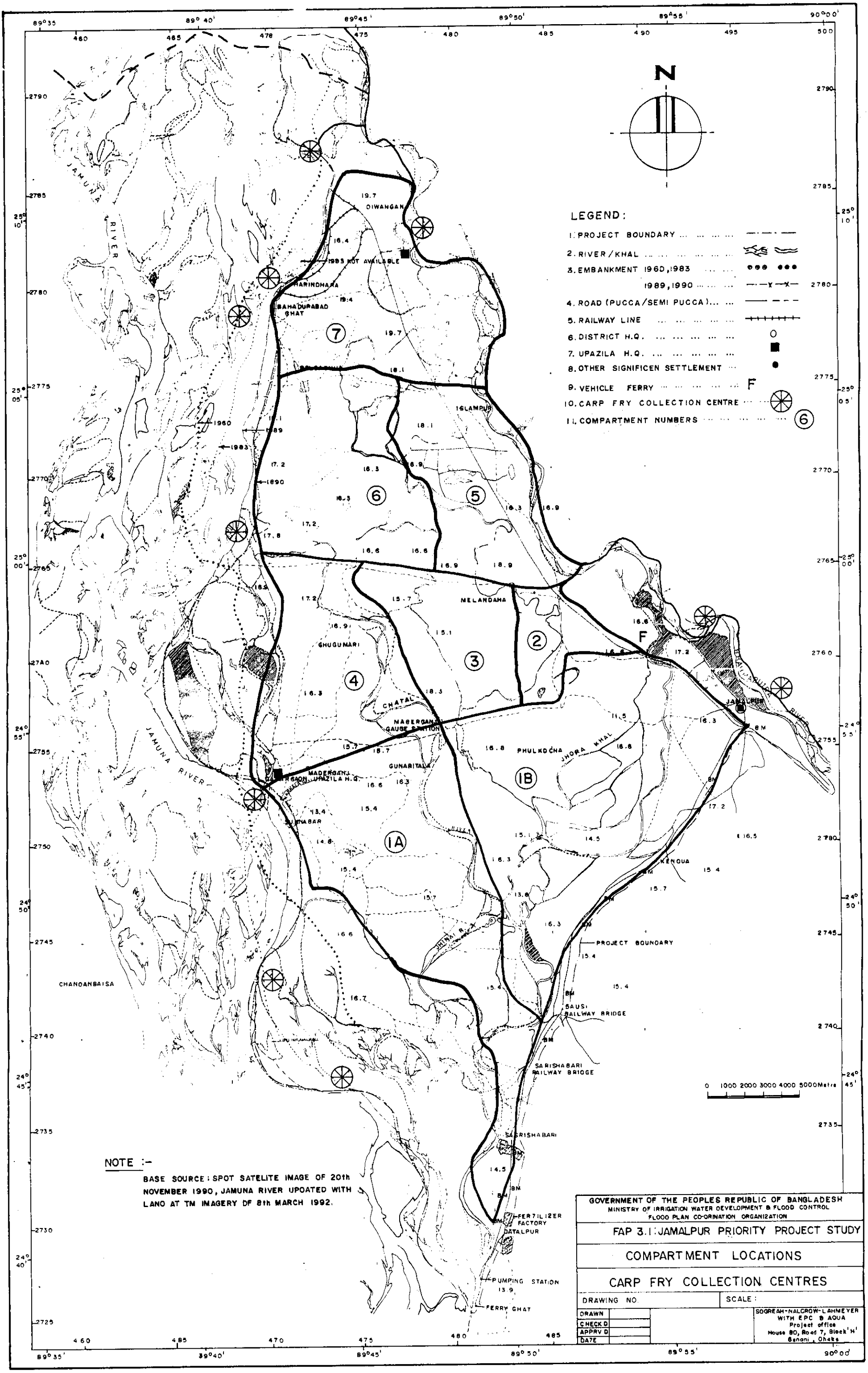
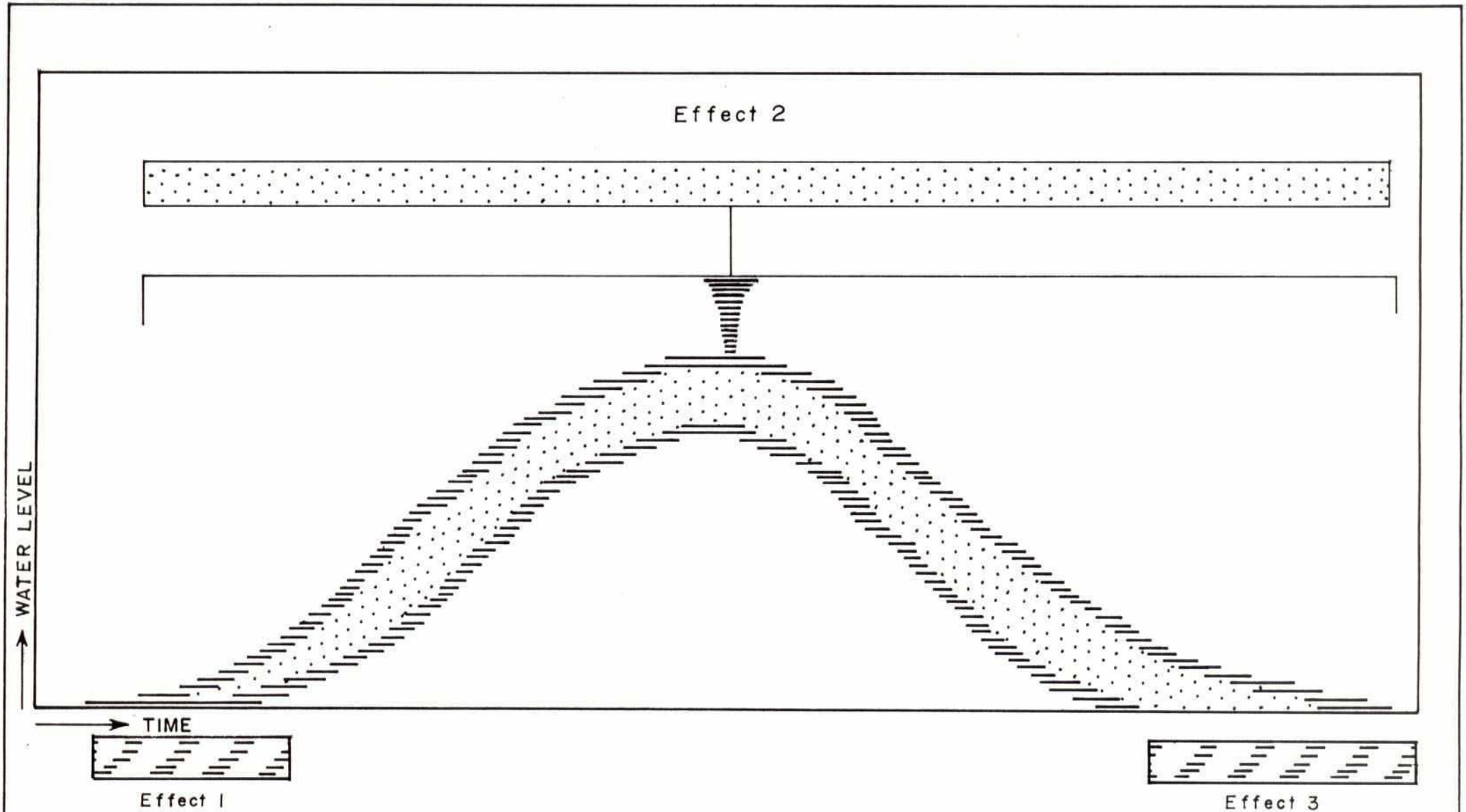


FIGURE 2.1.1

DENSITY SLICE OF SPOT SATELLITE IMAGE OF 27th FEBRUARY 1989 (DRY SEASON) SHOWING STANDING WATER

FIGURE 2.2.2

DENSITY SLICE OF SPOT SATELLITE IMAGE OF 20th NOVEMBER 1990 SHOWING STANDING WATER

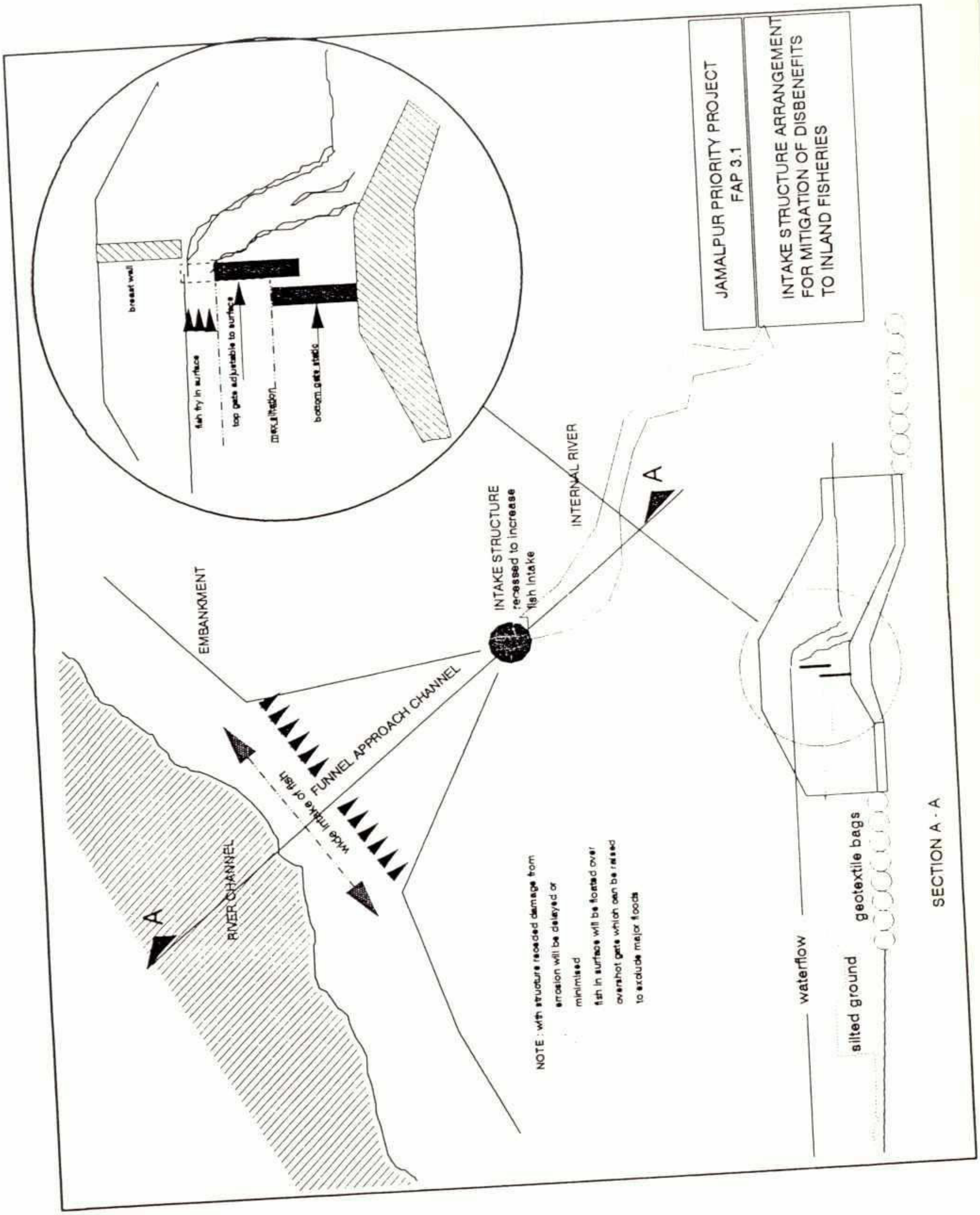


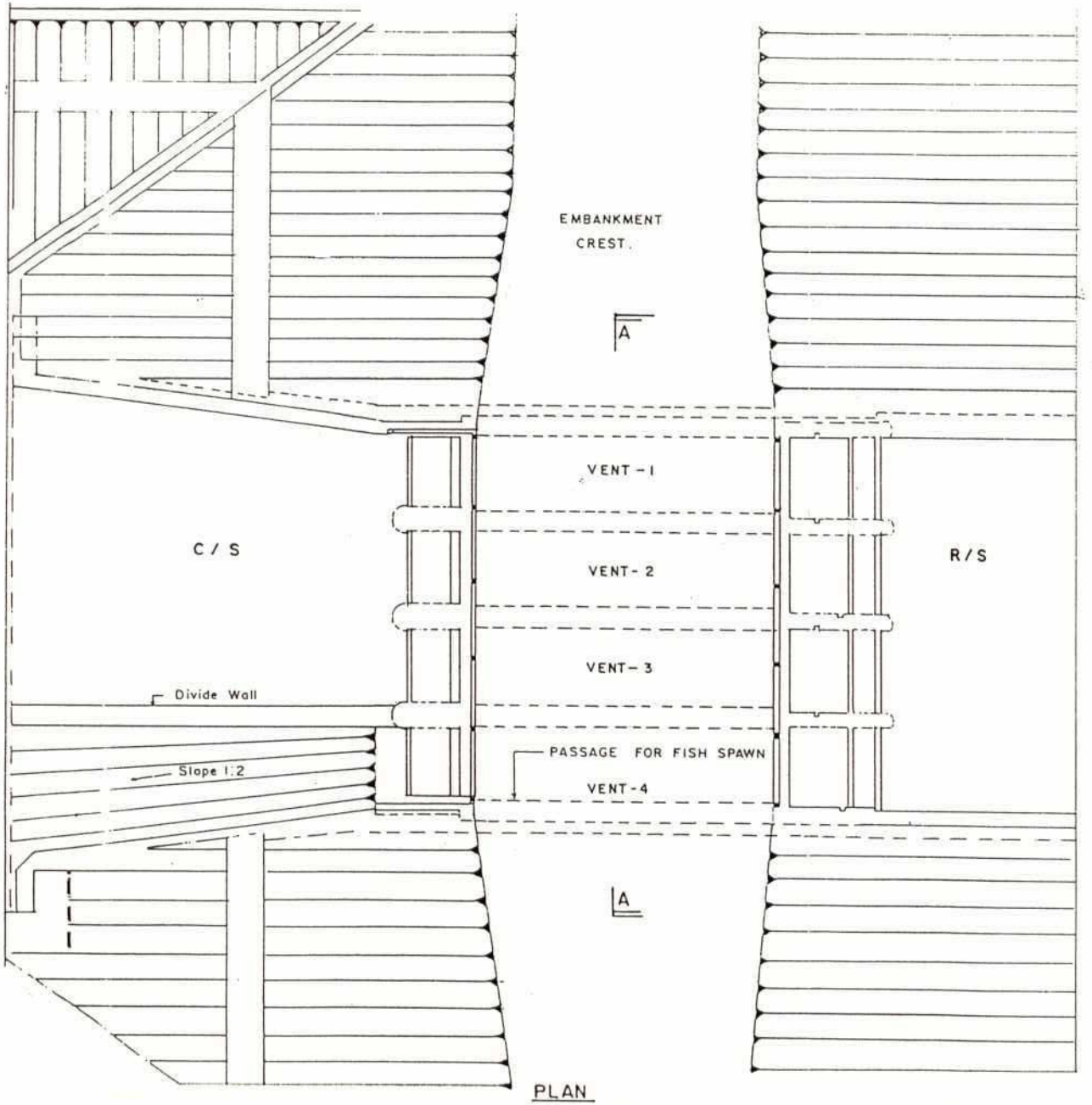
INUNDATION CURVE SHOWING EFFECTS 1, 2 and 3

FIGURE - 2.2.3

72

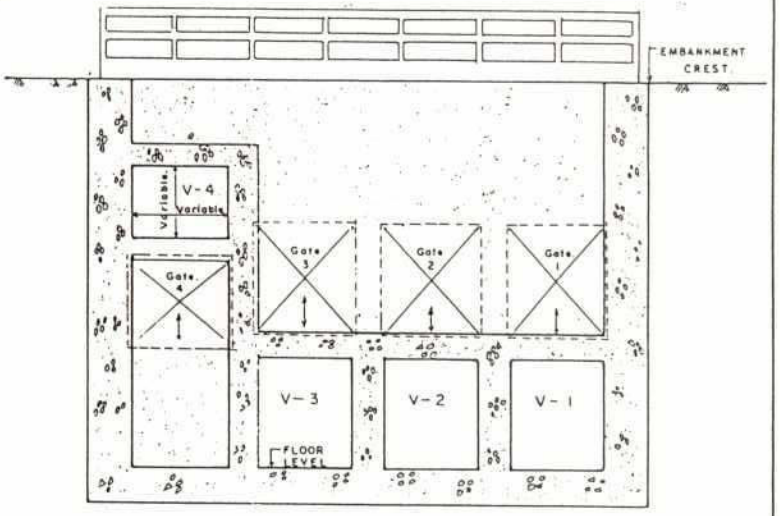
OUTLINE DESIGN FOR A FISH SENSITIVE GATED STRUCTURE





PLAN

NOT TO SCALE



SECTION : A — A

NOT TO SCALE

Source : FAP 13

74

FIGURE 2.2.5

SAMPLE OF MODIFIED REGULATOR / SLUICE DESIGNED TO PERMIT PASSAGE OF FISH SPAWN / FRY.

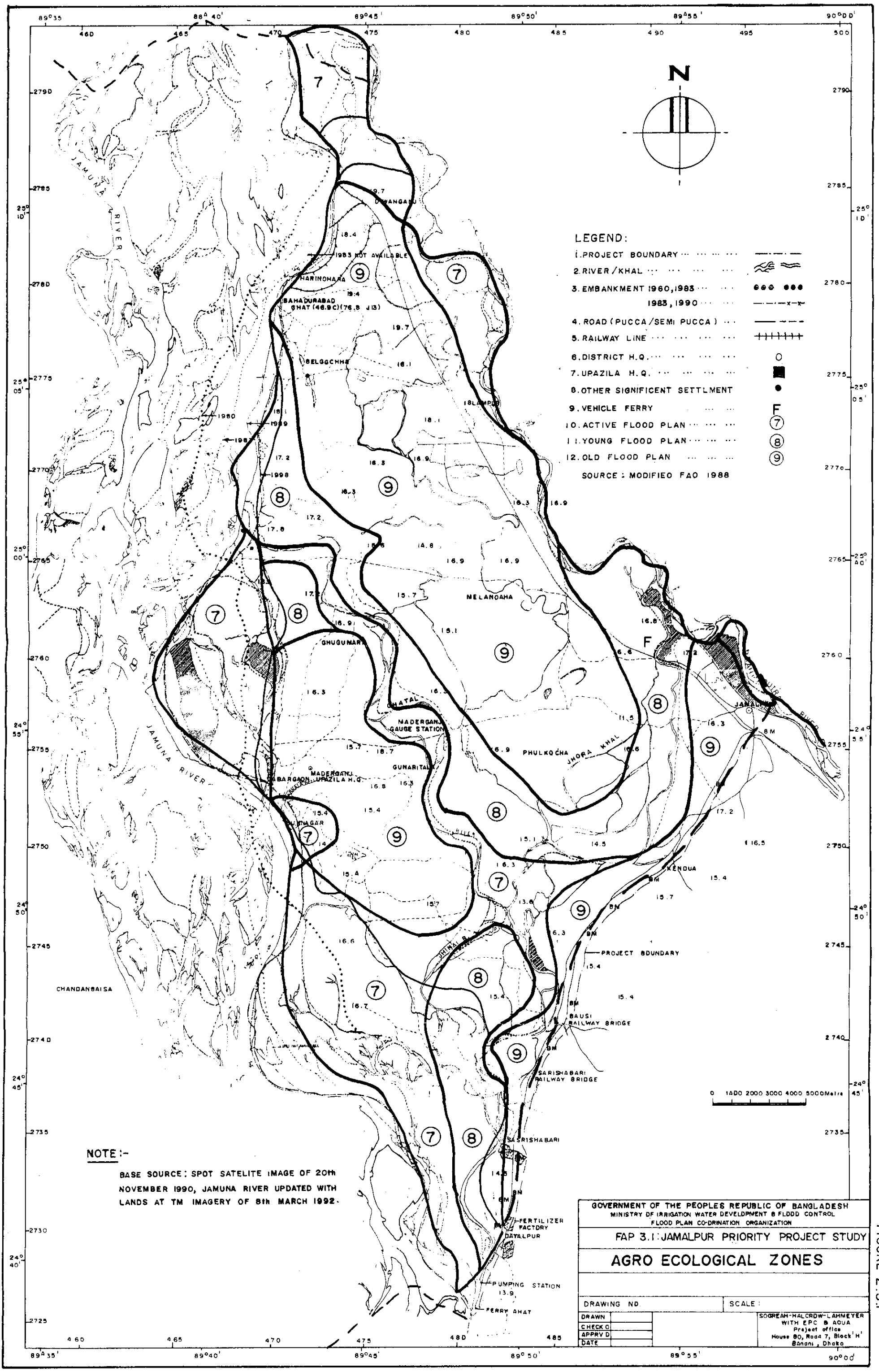
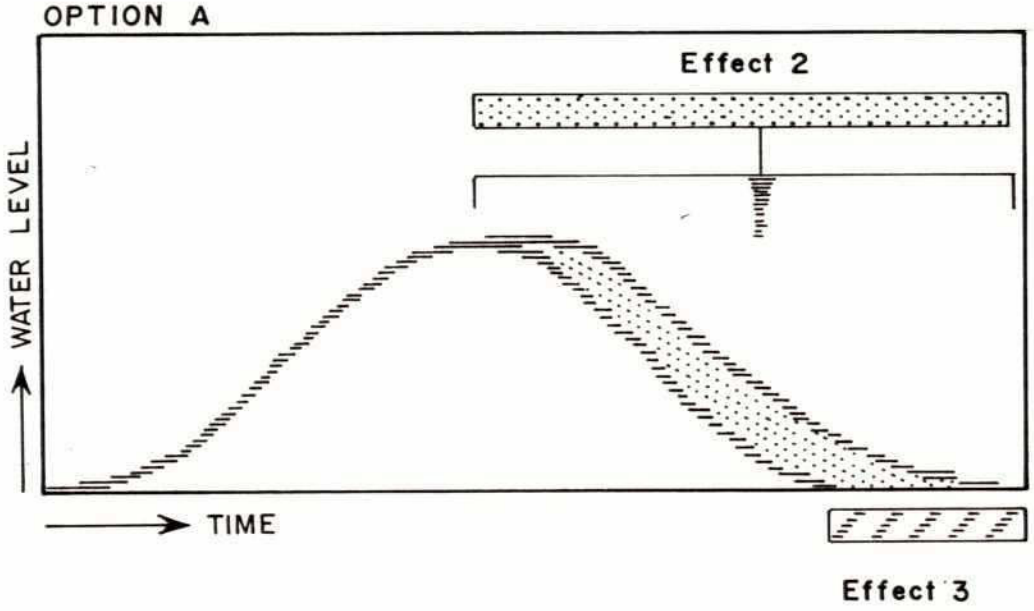

N
LEGEND:
1. PROJECT BOUNDARY
2. RIVER / KHAL
3. EMBANKMENT 1960, 1983
1983, 1990
4. ROAD (PUCCA / SEMI PUCCA)
5. RAILWAY LINE
6. DISTRICT H.Q.
7. UPAZILA H.Q.
8. OTHER SIGNIFICENT SETTLMENT
9. VEHICLE FERRY
10. ACTIVE FLOOD PLAN
11. YOUNG FLOOD PLAN
12. OLD FLOOD PLAN
SOURCE : MODIFIED FAO 1988
JAMUNA RIVER
DEWANGANJ
HARINOHARA
BAHADURABAD GHAT (46.9C)(76.8 J13)
1983 NOT AVAILABLE
BELGACHHA
JAMALPUR
MELANDAHA
GHUGUNARI
CHATAL
MADERGANJ GAUGE STATION
MADERGANJ UPAZILA H.Q.
GUNARITALA
PHULKOCHA
JHORA KHAL
KENDUA
PROJECT BOUNDARY
BAUSI RAILWAY BRIDGE
SARISHABARI RAILWAY BRIDGE
SARISHABARI
FERTILIZER FACTORY DEWANGANJ
PUMPING STATION
FERRY GHAT
CHANDANBAISA
0 1000 2000 3000 4000 5000 Metre
NOTE :-
BASE SOURCE : SPOT SATELITE IMAGE OF 20th NOVEMBER 1990, JAMUNA RIVER UPDATED WITH LANDS AT TM IMAGERY OF 8th MARCH 1992.
GOVERNMENT OF THE PEOPLES REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION WATER DEVELOPMENT & FLOOD CONTROL
FLOOD PLAN CO-ORDINATION ORGANIZATION
FAP 3.1 : JAMALPUR PRIORITY PROJECT STUDY
AGRO ECOLOGICAL ZONES
DRAWING NO.
SCALE :
DRAWN
CHECKED
APPRVD
DATE
SOGREAH-HALCROW-LAHMEYER WITH EPC & AQUA
Project office
House 80, Road 7, Block 'H'
Banani, Dhaka

FIGURE 2.3.1

FIGURE 2.4.1

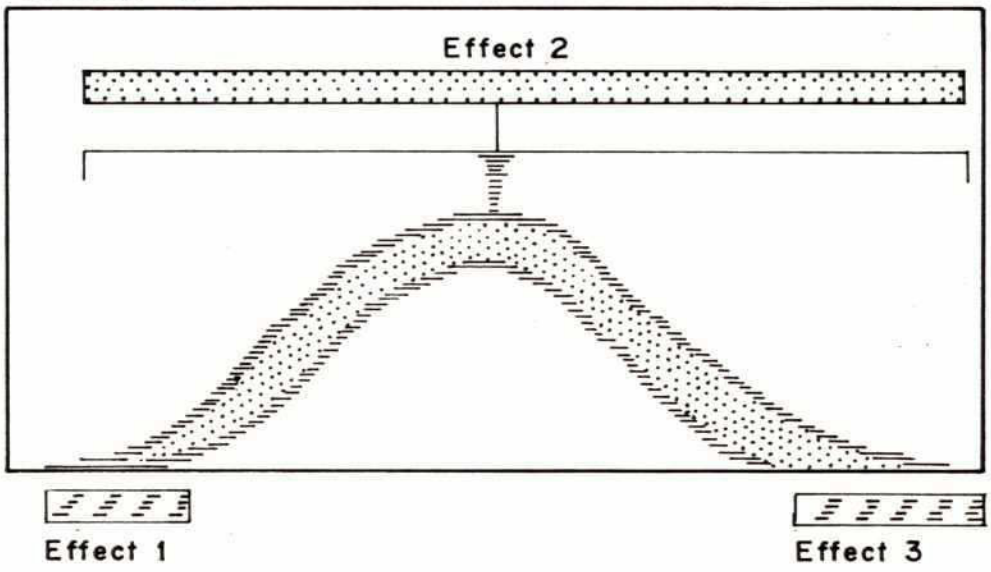
PREDICTED INUNDATION CURVES AND TABLES FOR EACH OPTION



SITUATION	PARAMETER	C1A	C1B	C2	C3	C4	C5	C6	C7	TOTAL
(WO)	AREA	17083	13926	851	2716	5584	8753	6938	8114	63965
	VOLUME	14478	14984	410	1256	3233	5578	4747	8127	52813
	AVERAGE D	0.85	1.08	0.48	0.46	0.58	0.64	0.68	1.00	0.83
(W)	AREA	17083	13386	851	2716	5580	8647	6325	6182	60770
	VOLUME	14478	14655	410	1256	3233	5528	4580	6408	50548
	AVERAGE D	0.85	1.09	0.48	0.46	0.58	0.64	0.72	1.04	0.83

Figure 2.4.2

OPTION B

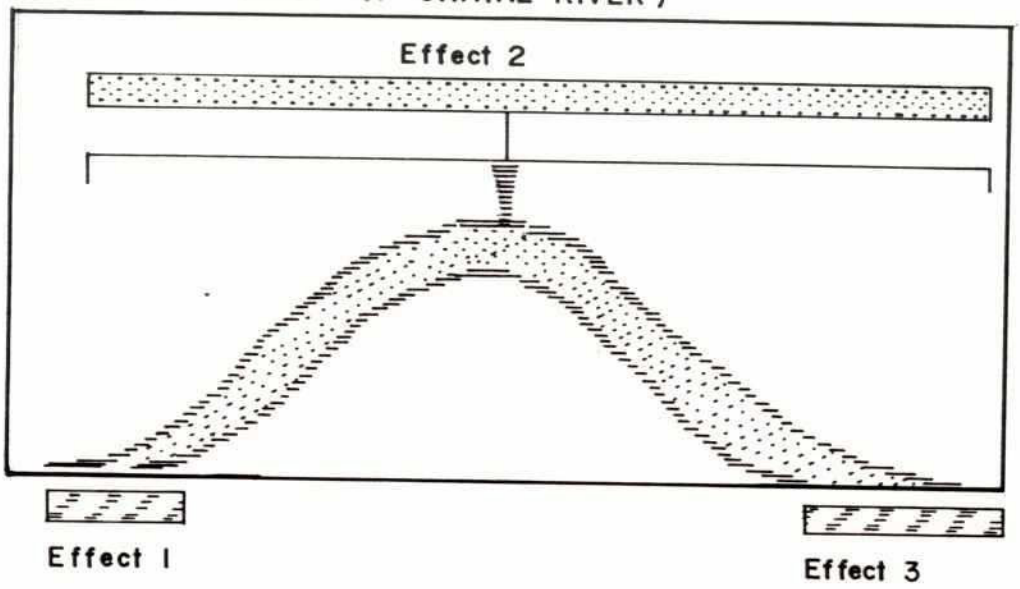


SITUATION	PARAMETER	C1A	C1B	C2	C3	C4	C5	C6	C7	TOTAL
(WO)	AREA	17083	13926	851	2716	5584	8753	6938	8114	63965
	VOLUME	14478	14984	410	1256	3233	5578	4747	8127	52813
	AVERAGE D	0.85	1.08	0.48	0.46	0.58	0.64	0.68	1.00	0.83
(W)	AREA	5826	5234	76	166	3413	1692	878	3329	20614
	VOLUME	3485	5883	15	25	1826	858	367	1583	14042
	AVERAGE D	0.60	1.12	0.20	0.15	0.54	0.51	0.42	0.48	0.68

FIGURE 2.4.3

PREDICTED INUNDATION CURVES AND TABLES FOR EACH OPTION

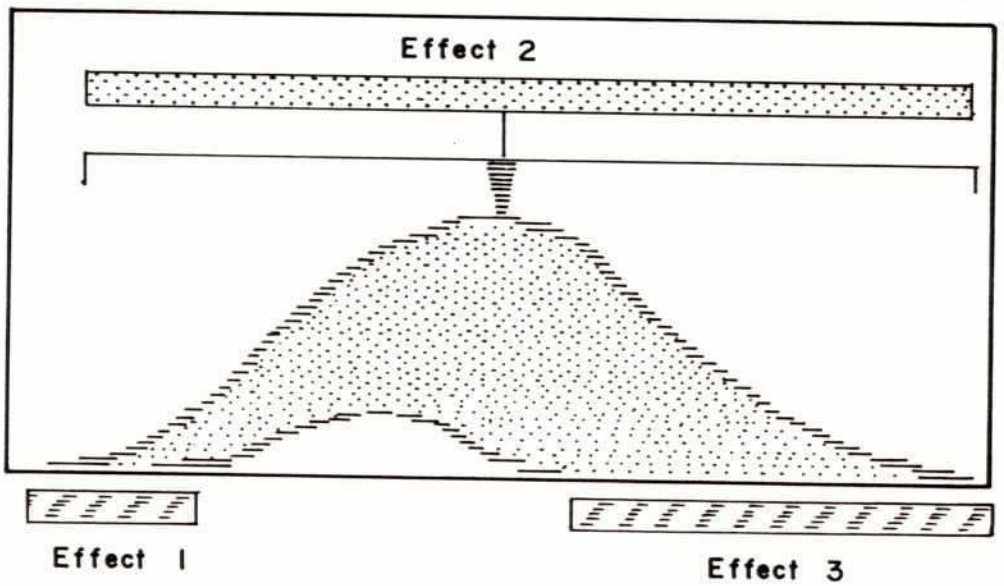
OPTION C (EAST OF CHATAL RIVER)



SITUATION	PARAMETER	C1A	C1B	C2	C3	C4	C5	C6	C7	TOTAL
(WO)	AREA	17083	13926	851	2716	5584	8753	6938	8114	63965
	VOLUME	14478	14984	410	1256	3233	5578	4747	8127	52813
	AVEAGE D	0.85	1.08	0.48	0.46	0.58	0.64	0.68	1.00	0.83
(W)	AREA	17083	5234	76	166	5584	1692	6938	3329	40102
	VOLUME	14478	5883	15	25	3233	858	4747	1583	30822
	AVERAGE D	0.85	1·12	0.20	0.15	0.58	0.51	0.68	0.48	0.77

OPTION D

Figure 2.4.4



SITUATION	PARAMETER	C1A	C1B	C2	C3	C4	C5	C6	C7	TOTAL
(WO)	AREA	17083	13926	851	2716	5584	8753	6938	8114	63965
	VOLUME	14478	14984	410	1256	3233	5578	4747	8127	52813
	AVERAGE D	0.85	1.08	0.48	0.46	0.58	0.64	0.68	1.00	0.83
(W)	AREA	341.66	278.52	17.02	54.32	111.68	175.06	138.76	162.3	1279.3
	VOLUME	144.78	149.84	4.10	12.56	32.33	55.78	47.47	81.27	528.13
	AVERAGE D	0.42	0.54	0.24	0.23	0.29	0.32	0.34	0.50	0.41

APPENDICES

Appendix - A

Socio-Economic Pilot Survey
Sample Completed Questionnaire
and Results

097

81

JAMALPUR PRIORITY PROJECT

Pilot survey

Upazela: MATHERGONG Union: KARICHURA Village: CHUCHUMARY

Para: SOUTH Date: 08-11-01 Serial no. 20.

Sheet No – 220

I. HOUSEHOLD PARTICULARS:

Total cultivable land owned (decimals): .15, Homestead land: .03

Average Tk. spent during the last seven days: 180'00

Does any member of your HH fish ?

Yes [✓] No [ ]

Full Time [ ], Part Time [ ], Occasionaly [✓]

Does any member of your HH belong to cooperative/Group ?

Yes [ ] No [✓]

Agriculture [ ], Fishing [ ], NGO [ ], Others [ ]

II. HOUSEHOLD MEMBER'S INCOME AND EMPLOYMENT:

HH (male) particulars	1	2	3	4	5
Earning Member's name	SOLIMUDDIN MONDAL				
Last Week income	140'00				
Last month income	500'00				
last year income	5,000'00				
How many month unemployed	2				
HH (female) particulars	1	2	3	4	5
Earning Member's name					
Last Week income					
Last month income					
last year income					

III. AGRICULTURE

Total land irrigated (owned +sharecropped): .15

Irrigation means: [ ] Traditional
[✓] Mechanical

Owned cultivable land elevation:
[ ] high (not flooded or up to 1 foot)
[15] Medium high (1 to 3 feet)
[ ] Medium low (3 feet to 6 feet)
[ ] Low land (3 feet to 9 feet)
[ ] very low (never dries up, beels)

IV. FISHERY

INFORMATION ON FISHING PERIODS & LOCATIONS:

MONTH	DAYS/ MONTHS	BEEL	RIVER	FLOOD LAND
KARTICK (90)	X	/		/
AGRAYAN (90)	X	/		/
POUSH (90)	10 days	1		/
MAGH (90)	5 days	1		/
FALGUN (91)	3 days	1		/
CHAWITRA (91)	X	/		/
BAYSAKH (91)	X	/		/
JAYSTHAW (91)	X	/		/
ASSAR (91)	12 days	1		2
SRABAN (91)	11 days	1		2
BHADRAW (91)	15 days	1		X
ASSIN (91)	20	1		X

Type [1],[2],[3] as order of importance of each fishing location. Type [0] each time no fishing was done in one or several locations.

INFORMATION ON CATCH

	Today	Yesterday	Day before yesterday
Total catch (Kg)	1/2	1	1/2
Location	1	1	1

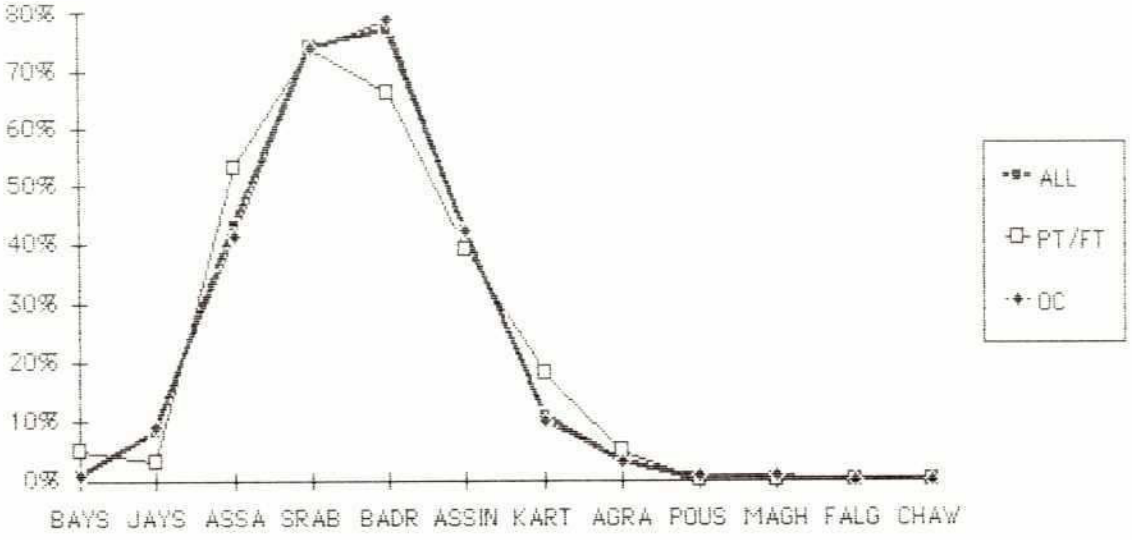
1) Beels and Kua 2) Jamuna 3) Brahmaputra 4) Reverse and K
5) Flood plain

Name of interviewer PRAMEETHA... Supervisor check: --
16.11.91.

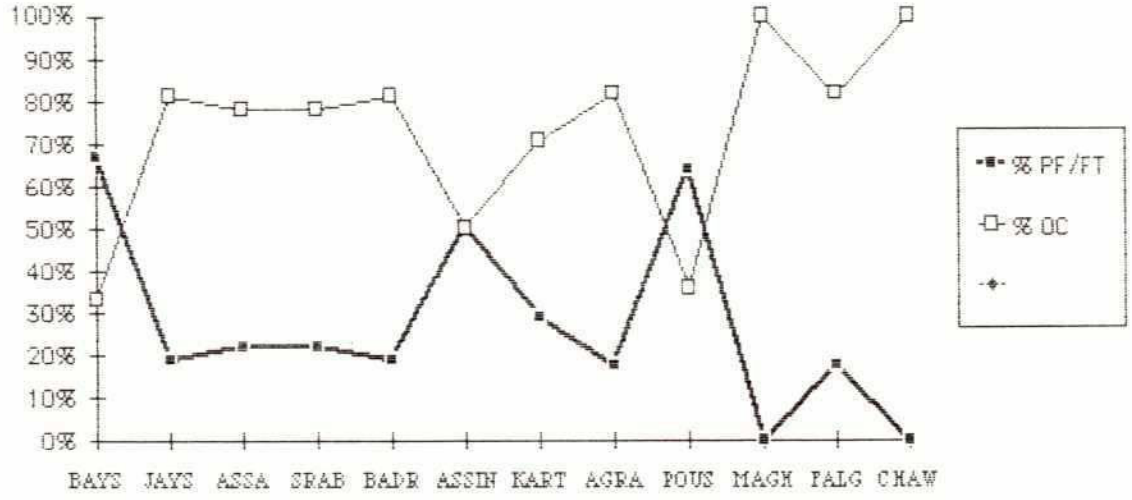
HOUSEHOLDS INVOLVEMENT IN FISHING ACTIVITIES

VILLAGE	Compartment	NUMBER OF HH SAMPLED	FULL TIME	PART TIME	OCCASIONNAL	NO FISHING	% FT	% PT	% OC	% NF	NUMBER IN COOP
Krisnagar		3			3		0.0%	0.0%	100.0%	0.0%	3
Muradabad		37		3	8	26	0.0%	8.1%	21.6%	70.3%	6
Dakshin Jordoba		34		6	9	19	0.0%	17.6%	26.5%	55.9%	7
Kasharidoba		16				16	0.0%	0.0%	0.0%	100.0%	1
Nutonpara		34			8	26	0.0%	0.0%	23.5%	76.5%	12
Kajikata		55		3	17	35	0.0%	5.5%	30.9%	63.6%	9
Naoghata		17		1	3	13	0.0%	5.9%	17.6%	76.5%	8
Bagadoba Daskin		19		3	2	14	0.0%	15.8%	10.5%	73.7%	6
Rajapur		28		2	8	18	0.0%	7.1%	28.6%	64.3%	16
China Sukarpur		17	1	1	4	11	5.9%	5.9%	23.5%	64.7%	6
Haribari		6				6	0.0%	0.0%	0.0%	100.0%	1
Daserbari		12		5		7	0.0%	41.7%	0.0%	58.3%	
Guzimari		32		2	2	28	0.0%	6.3%	6.3%	87.5%	1
Labdoba		33		1	14	18	0.0%	3.0%	42.4%	54.5%	
Ghum Nijpara		43		3	20	20	0.0%	7.0%	46.5%	46.5%	4
Char Gopalpur		49	2	2	38	7	4.1%	4.1%	77.6%	14.3%	2
Adr Kundabari		21			14	7	0.0%	0.0%	66.7%	33.3%	11
Bansdar		39			22	14	0.0%	0.0%	56.4%	35.9%	5
Char Shisua		28		3		28	0.0%	10.7%	0.0%	100.0%	
TOTAL		**523**	**3**	**35**	**172**	**313**					**98**
%		**100%**	**0.6%**	**6.7%**	**32.9%**	**59.8%**					**18.7%**

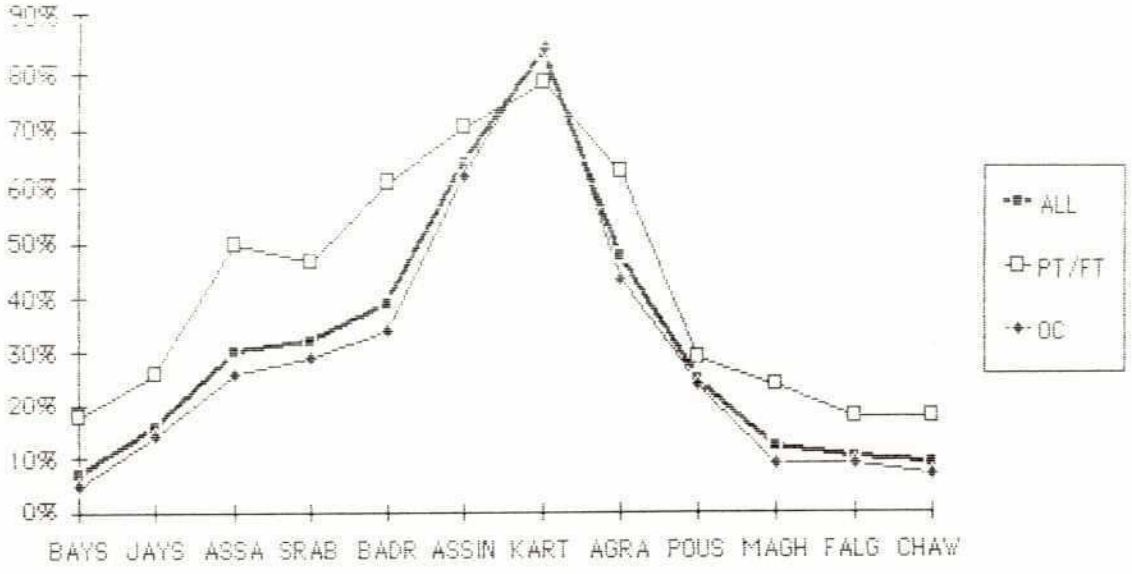
· FISHERMEN FISHING IN FLOODLAND (in % of each category)



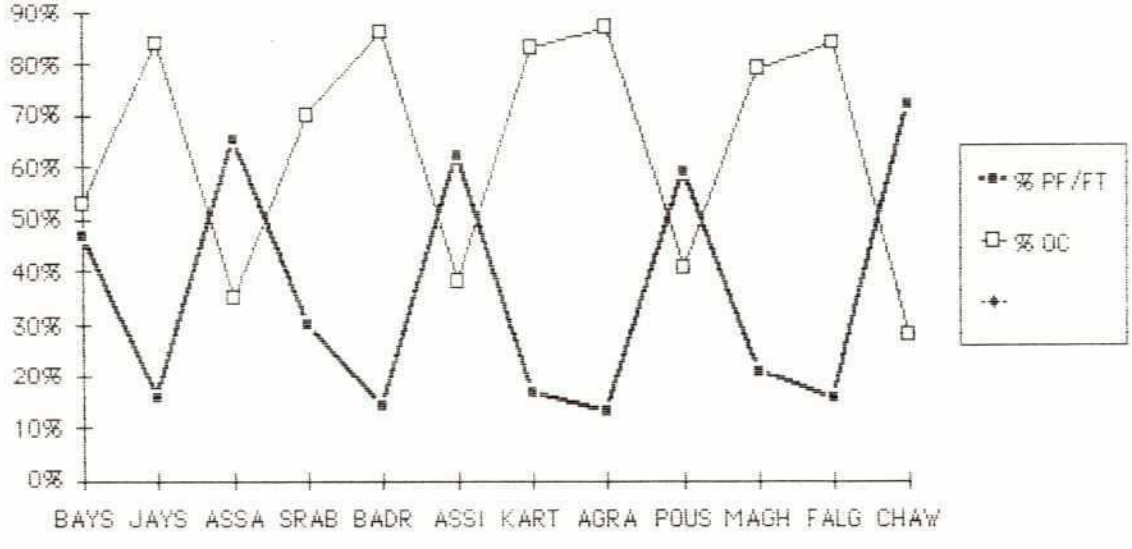
RATIO BETWEEN PT/FT & OC FISHERMEN IN FLOODLAND FISHERIES



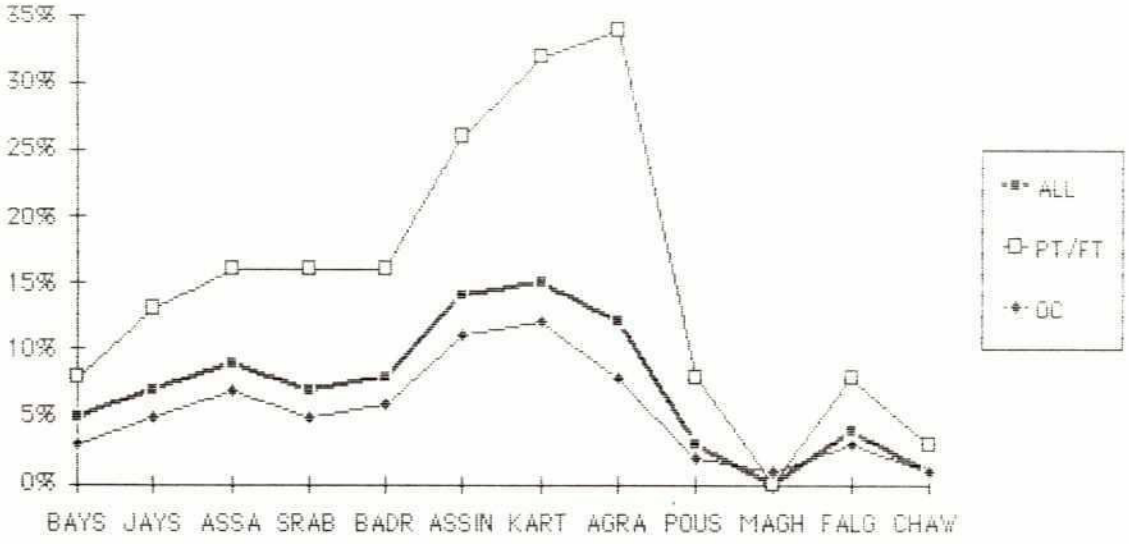
· FISHERMEN FISHING IN BEELS (in % of each category)



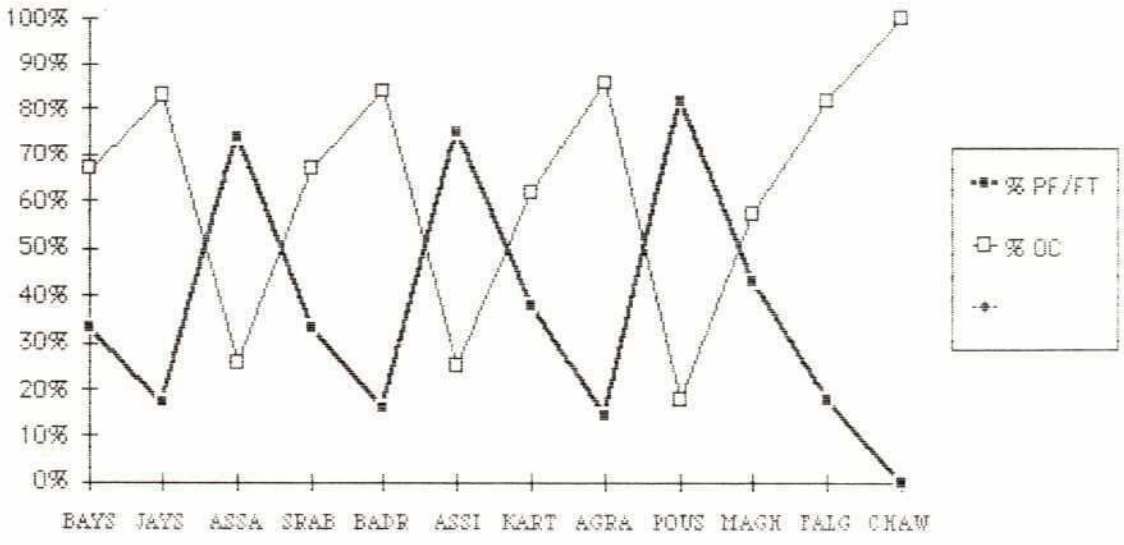
RATIO BETWEEN PT/FT & OC FISHERMEN IN BEEL FISHERIES

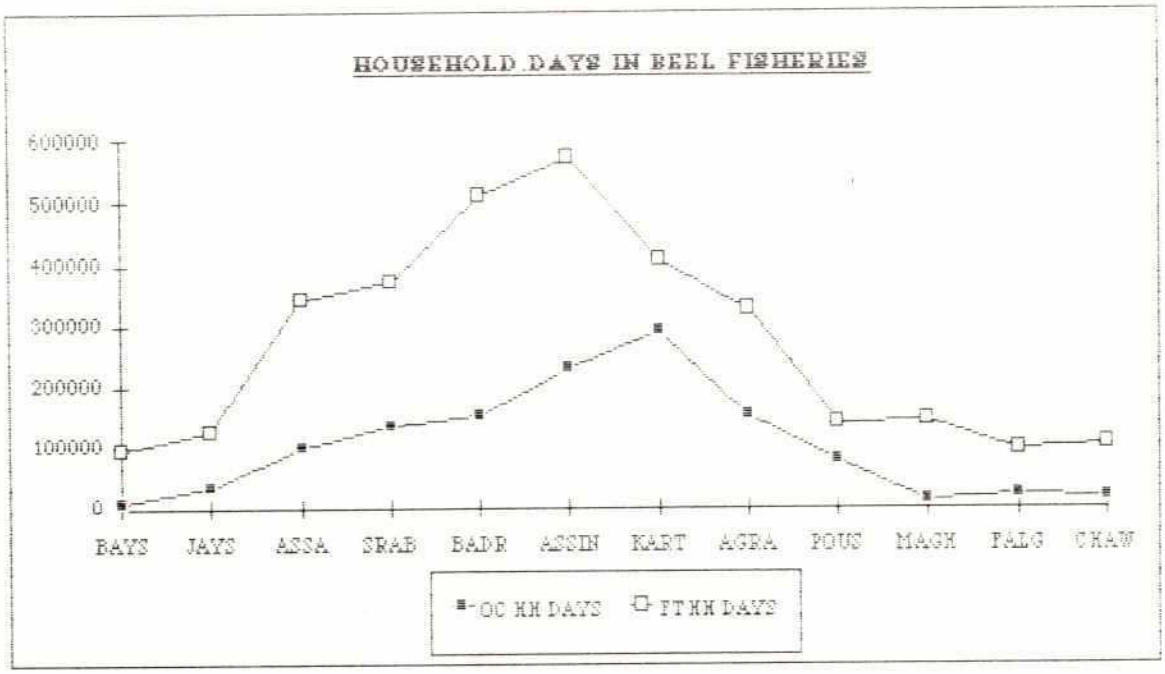


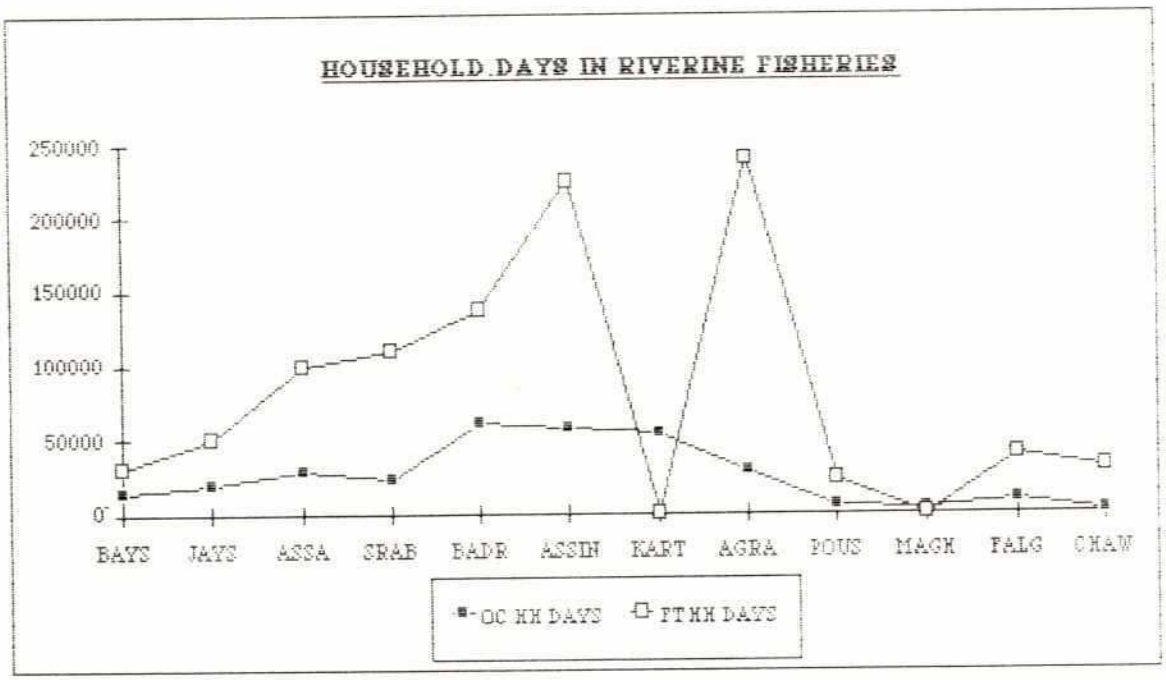
· FISHERMEN FISHING IN RIVERS (in % of each category)

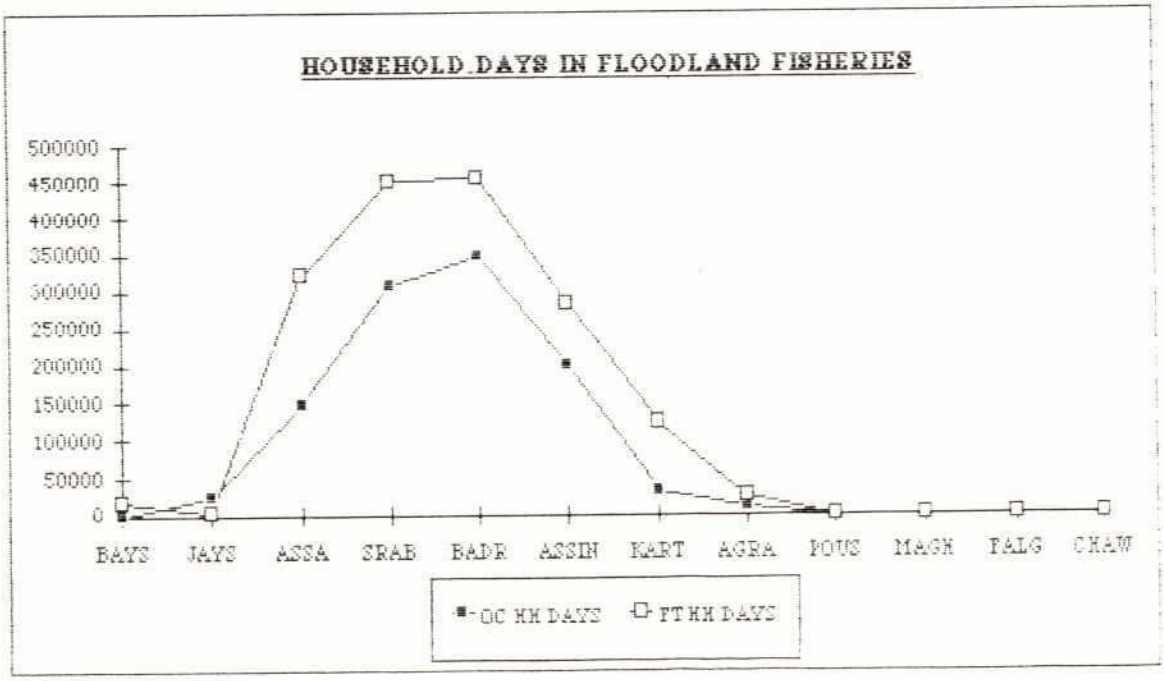


RATIO BETWEEN PT/FT & OC FISHERMEN IN BEEL FISHERIES




HOUSEHOLD DAYS IN BEEL FISHERIES
600000
500000
400000
300000
200000
100000
0
BAYS JAYS ASSA SRAB BADR ASSIN KART AGRA POUS MAGH FALG CHAW
OC MM DAYS
FT MM DAYS


HOUSEHOLD DAYS IN RIVERINE FISHERIES
250000
200000
150000
100000
50000
0
BAYS JAYS ASSA SRAB BADR ASSIN KART AGRA POUS MAGH FALG CHAW
OC MM DAYS
FT MM DAYS


HOUSEHOLD DAYS IN FLOODLAND FISHERIES
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
BAYS JAYS ASSA SRAB BADR ASSIN KART AGRA POUS MAGH FALG CHAW
OC MM DAYS
FT MM DAYS

Appendix - B

Fish Production Survey
Sample Completed Questionnaire
and Results

CATCH ASSESSMENT SURVEY OF BEELS

FORM I - PAGE 1

INVESTIGATOR: MDHAIDERALI | DATE: 20/1/91

UPAZILLA: MELANDAH | COMPARTMENT:

A. GENERAL INFORMATION

1 IDENTIFICATION

Name of beel: GODADANGA

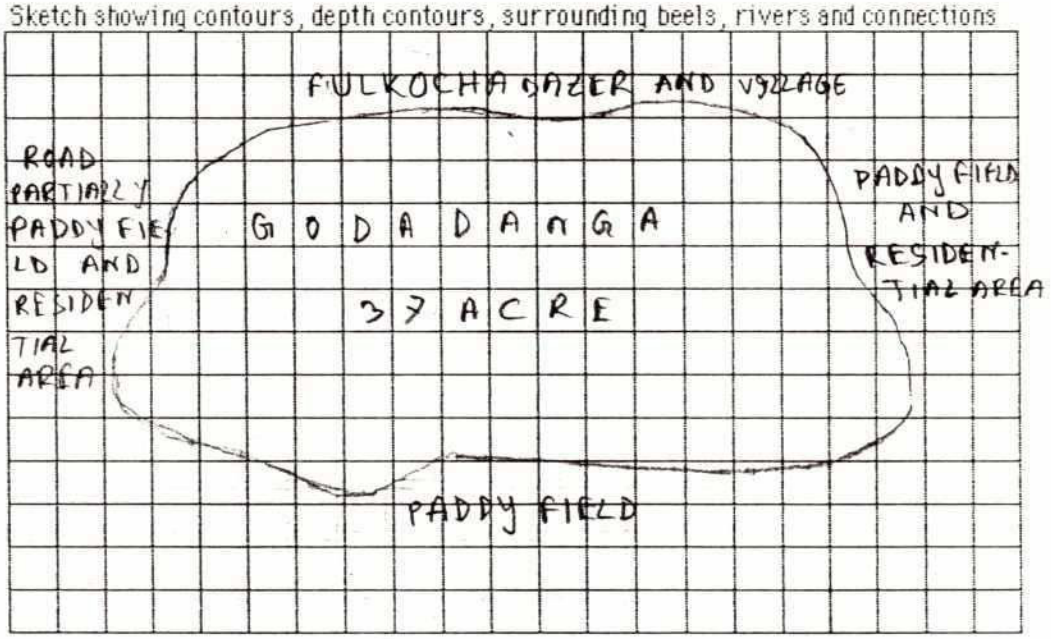
Mouza: FULKOCHA

Union: FULKOCHA

2 DIMENSIONS

Monsoon: 37 hec/~~Acre~~ ✓ Winter: hec. Minimum: hec

Sketch showing contours, depth contours, surrounding beels, rivers and connections



3 OWNERSHIP

GOB kash land ✓ Private Mixed GOB list nº

4 LEASING ARRANGEMENTS

Fishermen cooperate Private individuals ✓ Retained by owner None

Other (specify)

Name & address of leasee: FOCHUDAPARI

Lease period: 3 years Value: 9000 tk. per year/~~total~~

CATCH ASSESSMENT SURVEY OF BEELS

FORM I - PAGE 2

B. FISHING ACTIVITY

1 OPERATORS

Owner ☐ Leasee ☐ Sub-leasee ☑

2 FISHING CONTRACT

Owner ☐ Leasee ☐ Sub-leasee ☐ Hired fishermen ☑

Share basis with fishermen ☑ Villages (in case there is no management) ☐

3 FISHING SCHEDULE

Annual ☑ Alternate year ☐ Pile (reserve) Fishery every third year ☐

4 FISHING PERIOD

From OINOV to MARCH

5 FISHING METHODS

Nets & traps ☑ Partial dewatering ☐ Complete dewatering ☐

Kata fishing ☑ Others

6 KATA FISHERY

Number of katas 16 Area of each kata 0.03 Acre

7 FISH MARKETING

On the site ☑ Landing center

Transport mode

Local market

C. ECONOMICS

1 MANAGEMENT COSTS

Lease value	8000 tk.	Sheds/construction	tk.
Guard salaries	tk.	Feed, fertilizers	tk.
Cost of katas	40000 tk.	Other	tk.

2 FISHING EXPENDITURES

Fish. wages	25000 tk.	Other wages	tk.
Nets/traps	50000 tk.	Boats	35000 tk.
Maintenance	39000 tk.	Housing	tk.
Other costs	tk.		

CATCH ASSESSMENT SURVEY OF BEELS

FORM II

91

LIST OF FISHING UNITS OF THE SAMPLE BEEL

INVESTIGATOR: MDHAIDERALI DATE: 20/11/91

BEEL: GODADANGA COMPARTMENT:

FISHING PERIOD from 01/11/91 to 01/03/92

Sl nº	Name of head fisherman of the unit	Gear				Boat		Fishermen in unit	Number fishing days in season
		Type	Mesh	H	L	H	L		
(1)	ABU BAKAR	GILLNET (01)	4"	6'	150'	1'	13'	2	10+
(2)	KAZAL	GILLNET (01)	4"	6'	150'	1'	13'	2	10+
(3)	ABDUS SATTAR	CASTNET (06)	1/2"	12'	50'	1'	13'	1	14+
(4)	ABUL	CASTNET (06)	2 1/2"	13'	35'	1'	13'	1	14+
(5)	RASHID	CASTNET (06)	~~2 1/2~~ 1/2"	15'	60'	1'	13'	1	14+
(6)	RAFIQUL (KATA)	SEINE (03)	1 1/2"	45'	360'	2'	14'	10	4+

CATCH ASSESSMENT SURVEY OF BEELS

WORKSHEET

OBSERVATION OF SAMPLE CATCHES AND ESTIMATION OF TOTAL CATCH IN THE SAMPLE DAY

INVESTIGATOR: MDHAIDERALI

DATE: 2019/1/1

BEEL: GODADANGA

COMPARTMENT:

TYPE OF FISHING: KATTA ✓ OTHER

TYPE OF GEAR: SEINEDRAG

Total FU in the day: 2 (N)

Sample FU observed: 2 (n)

Raising factor (N/n): 1

SPECIES	Sample catch data observed (kg)								Sample total	Est. total catch ~~of 3 days~~
	1	2								
01. RUHI	22	11							33	33
02. CATLA	16	9							25	25
03. MRIGAL	7	2							9	9
04. KALBASU	4								4	4
05. CHANIA										
06. BOAL	11	14							25	25
07. AIR										
08. PANGAS	2								2	2
09. SILON										
10. GHOL/GAZAR										
11. GHITAL/PHALI ✓	1	2							3	3
12. KOI										
13. SINGI/MAGUR										
14. SAR PUNTI										
15. BIG SHRIMPS										
16. SMALL SHRIMPS										
17										
18										
19										
20. MISCELLANEOUS	17	13							30	30
TOTAL	80	51							131	131

Remark: Estimated total catch of the day = Sample total x raising factor

CATCH ASSESSMENT SURVEY OF BEELS

WORKSHEET

OBSERVATION OF SAMPLE CATCHES AND ESTIMATION OF TOTAL CATCH IN THE SAMPLE DAY

03

INVESTIGATOR: MD HAIDER ALI DATE: 20/11/91

BEEL: GODADANGA COMPARTMENT:

TYPE OF FISHING: KATTA [ ] OTHER [✓]

TYPE OF GEAR: GILLNET

Total FU in the day: 22 (N)

Sample FU observed: 5 (n)

Raising factor (N/n): 4·4

SPECIES	Sample catch data observed (kg)								Sample total	Est. total catch
	1	2	3	4	5					
01. RUHI	2	2½	1½	3	½				9½	41·8
02. CATLA										
03. MRIGAL	1		2	½					3½	15·4
04. KALBASU										
05. CHANIA										
06. BOAL										
07. AIR										
08. PANGAS										
09. SILON										
10. GHOL/GAZAR										
11. GHITAL/PHALI										
12. KOI										
13. SINGI/MAGUR										
14. SAR PUNTI										
15. BIG SHRIMPS										
16. SMALL SHRIMPS										
17										
18										
19										
20. MISCELLANEOUS										
TOTAL,	3	2·50	3·50	3·50	0·5				13	57·2

Remark: Estimated total catch of the day = Sample total × raising factor

94

CATCH ASSESSMENT SURVEY OF BEELS

WORKSHEET

OBSERVATION OF SAMPLE CATCHES AND ESTIMATION OF TOTAL CATCH IN THE SAMPLE DAY

INVESTIGATOR: MDHAIDERALI

DATE: 2011 5 1

BEEL: GODADANGA

COMPARTMENT:

TYPE OF FISHING: KATTA [ ] OTHER [✓]

TYPE OF GEAR: CASTNET

Total FU in the day: 12 (N)

Sample FU observed: 6 (n)

Raising factor (N/n): 2

SPECIES	Sample catch data observed (kg)								Sample total	Est. total catch
	1	2	3	4	5	6				
01. RUHI		1 1/2							1 1/2	3
02. CATLA										
03. MRIGAL										
04. KALBASU										
05. CHANIA										
06. BOAL										
07. AIR										
08. PANGAS										
09. SILON										
10. GHOL/GAZAR										
11. GHITAL/PHALI										
12. KOI										
13. SINGI/MAGUR										
14. SAR PUNTI										
15. BIG SHRIMPS										
16. SMALL SHRIMPS										
17										
18										
19										
20. MISCELLANEOUS	1/2	1	1/2	2	1/2	1/2			6'5	13
TOTAL	0'5	2'50	0'5	2	0'5	0'5			8	16

Remark: Estimated total catch of the day = Sample total x raising factor

CATCH ASSESSMENT SURVEY OF BEELS

FORM III

TOTAL CATCH IN SAMPLE DAY & THE PAST 3 DAYS

INVESTIGATOR: MDHAIDERALI | DATE: 20/1/91

BEEL: GODADANGA | COMPARTMENT:

FISHING PERIOD: from 01/1/91 to 01/03/92

SPECIES	TOTAL CATCH IN SAMPLE DAY (kg)				CATCH IN PAST 3 DAYS (kg)			TOTAL 4 DAYS CATCH (kg)		
	Katta fishing	Other fishing	Total	Price in tk.	Katta fishing	Other fishing	Total	Katta fishing	Other fishing	Total
01. RUHI	33	44'8	77'8		92	132	1234	125	176'8	301'8
02. CATLA	25	0	25		70	0	70	95	0	95
03. MRIGAL	9	15'4	24'4		25	10	35	34	13½	47½
04. KALBASU	4	0	4		10	0	10	14	0	14
05. CHANIA										
06. BOAL	25	0	25		70	0	70	95	0	95
07. AIR										
08. PANGAS	2	0	2		5	0	5	7	0	7
09. SILON										
10. GHOL/GAZAR										
11. GHITAL/PHALI	3	0	3		7	0	7	10	0	10
12. KOI										
13. SINGI/MAGUR										
14. SAR PUNTI										
15. BIG SHRIMPS										
16. SMALL SHRIMPS										
17										
18										
19										
20. MISCELLANEOUS	30	13	43		85	40	125	115	58	168
TOTAL	191	73'2	204'2		364	192	556	495	245'3	738'3

Number of Kattas fished during these 4 days:

Gear used during these 4 days: cast net | gill net | seine |

Average FU operated per day:

Average nº of fishermen per day during these 4 days:

BEEL SURVEY - I

VISITS 2

	GILL			SEINE			CAST			LIFT			TRAPS			LINE			KATAS				
	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%
PUNTI	28	21%	1.8	21	24%	1.6	23	19%	1.1									#DIV/0!	31	14%	6.1	104	17%
CATLA	8	6%	1.3	1	1%	1.0	10	8%	1.4										16	7%	5.3	35	6%
MRIGAL	3	2%	0.3	1	1%	1.0	3	2%	1.4										19	9%	3.7	26	4%
KALBASU	3	2%	0.3	19	21%	3.7	4	3%	0.5										5	2%	2.5	31	5%
CHANDA																							
BOAL	5	3%	1.1	21	24%	1.8	12	10%	1.0							9	60%	1.6	62	29%	10	107	18%
AIR	10	8%	2.5				1	0%	0.5										3	1%	2.5	12	2%
FAINSAB																							
BILON																							
GHOL							8	6%	1.5							4	20%	0.9	7	3%	1.5	19	3%
GHITAL	1	1%	0.5				1	1%	0.5										19	9%	6.3	21	3%
EGI	21	16%	1.3				9	7%	1.1	1	2%	0.4							3	1%	1.0	34	5%
BHOJ	11	9%	1.8	1	1%	1.0	8	6%	0.9													20	3%
SAR PUNTI																							
B. SHRIMPS																			1	0%	0.5	1	0%
B. SHRIMPS							4	3%	0.7				4	40%	0.9				2	1%	2.0	10	2%
OTHER																							
MISCELLANEOUS	40	31%	1.2	24	28%	2.4	41	34%	1.1	34	98%	1.2	6	60%	0.6	12	100%	2.0	52	24%	13.0	146	23%
TOTAL	129	100%	2.2	92	100%	4.4	122	100%	2.3	34	100%	1.2	9	100%	0.7	12	100%	2.0	217	100%	36.2	611	100%
Number in sample	59			20			52			29			13			6			6			185	
% of gears	32%			11%			28%			16%			7%			3%			3%				
Total # nos	268			50			246			95			140			64			37			884	
Fishers/FU	2			10			1			2			1			1			10				
Sample size	28%			40%			21%			31%			10%			9%			29%				
Est Fishers no.	418			500			246			190			130			64			80			1628	
Catch/fisher no.	1.10			0.44			2.34			0.50			0.71			1.95			3.83				

VISITS 1

	GILL			SEINE			CAST			LIFT			TRAPS			LINE			KATAS				
	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%
PUNTI	28	16%	1.8	14	31%	3.4	34	24%	1.5							3	7%	2.5	43	23%	8.6	120	19%
CATLA	14	8%	2.8	4	9%	2.0	14	10%	1.3										32	17%	6.4	64	10%
MRIGAL	4	2%	1.3	3	6%	1.3													9	5%	4.5	16	2%
KALBASU																			4	2%	4.0	4	1%
CHANDA																			8	4%	2.0	8	1%
BOAL				2	5%	2.0	12	8%	2.9							6	18%	0.9	37	19%	6.2	57	9%
AIR	16	9%	3.2																			16	3%
FAINSAB																			2	1%	2.0	2	0%
BILON																							
GHOL	4	2%	0.8	2	4%	0.9	17	12%	1.9							21	64%	1.6	11	6%	2.5	55	9%
GHITAL				0	1%	0.2													3	2%	1.5	3	1%
EGI	32	19%	1.1	0	1%	0.2	4	3%	0.9	1	4%	0.2				1	3%	0.5	5	3%	1.3	43	7%
BHOJ	41	23%	1.9	1	1%	0.5	6	4%	1.1	0	1%	0.2				4	10%	0.4				51	8%
SAR PUNTI	1	1%	0.1	0	1%	0.2																1	0%
B. SHRIMPS																							
B. SHRIMPS							9	6%	0.9				10	71%	8.8							19	3%
OTHER																							
MISCELLANEOUS	36	20%	1.4	19	40%	9.5	49	34%	1.7	22	95%	0.9	4	29%	1.8	1	3%	0.9	37	19%	6.1	167	27%
TOTAL	176	100%	3.4	44	100%	11.1	143	100%	3.0	23	100%	1.0	14	100%	8.8	35	100%	2.5	191	100%	31.8	624	100%
Number in sample	51			4			48			23			13			14			25			165	
% of gears IN SAMPLE	29%			2%			29%			14%			8%			9%			4%				
Total # nos	241			6			202			107			71			66			6			829	
Fishers/FU	2			10			1			2			1			1			10				
Sample size	18%			67%			17%			11%			24%			21%			100%				
Est Fishers no.	582			60			202			214			71			66			60			1195	
Catch/fisher no.	1.72			1.11			2.97			0.50			0.92			2.49			3.18				

VISITS 3

	GILL			SEINE			CAST			LIFT			TRAPS			LINE			KATAS				
	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%
PUNTI	31	21%	2.5	11	13%	1.4	6	7%	0.7										24	26%	4.8	71	
CATLA	10	7%	1.4	8	9%	1.0	5	6%	1.0										5	5%	2.5	24	
MRIGAL	7	5%	1.4				1	1%	0.5										2	2%	1.0	9	
KALBASU	12	8%	1.5				1	1%	1.0										1	1%	0.5	13	
CHANDA																							
BOAL	11	8%	1.6	14	17%	1.8										23	68%	1.5	27	29%	5.4	76	
AIR	7	5%	2.3	6	6%	1.1	2	2%	0.4													14	
FAINSAB																							
BILON																							
GHOL	5	4%		1	1%	0.5	8	9%	2.0							10	31%	1.3	6	6%	1.5	30	
GHITAL	1	1%	1.0																			1	
EGI	9	14%	1.7				9	10%	0.9	1	2%	0.4										30	
BHOJ	12	9%	0.9				2	0%	0.7	1	2%	0.5										29	
SAR PUNTI																							
B. SHRIMPS																							
B. SHRIMPS							2	2%	0.3	4	9%	0.4	2	20%	2.0							8	
OTHER																							
MISCELLANEOUS	9	6%	1.3	51	56%	5.1	14	16%	1.1	37	93%	1.6	16	62%	1.3				31	35	5.4	28	
TOTAL	115	100%	1.4	91	100%	6.2	91	100%	2	43	100%	1.0	26	100%	1.9	33	100%	2.4	96	100%	10.2	361	
Number in sample	59			14			80			25			8			15			5			196	
% of gears	36%			8%			24%			14%			12%			9%			3%				
Total # nos	178			21			116			41			8			39			11			480	
Fishers/FU	2			10			1			2			1			1			10				
Sample size	30%			64%			14%			59%			43%			38%			45%				
Est Fishers no.	230			230			116			82			99			110			110			667	
Catch/fisher no.	1.43			0.8			2.19			0.81			1.06			2.14			1.02				

9 of 9

VISIT# 4

	GILL TOT	GILL %	GILL AVG CPU	SEINE TOT	SEINE %	SEINE AVG CPU	CAST TOT	CAST %	CAST AVG CPU	LIFT TOT	LIFT %	LIFT AVG CPU
RUHI	5	18%	1.2	3	5%	3.0	9	19%	1.2			
CATLA												
MRIGAL				1	2%	1.0						
KALBASU				8	15%	1.6	4	8%	0.6			
CHANIA												
BOAL	2	9%	1.2	9	17%	1.6	11	24%	1.1	2	10%	2.0
AIR				6	11%	0.9						
PANGAS												
SILON												
GHOL	1	2%	0.3									
GHITAL	1	2%	0.5									
KOI	5	19%	0.7				1	1%	0.5			
SINGI	5	21%	0.4									
SAR PUNTI												
B SHRIMPS												
S SHRIMPS							2	5%	0.4	7	37%	0.9
OTHER	1	4%	0.5									
MISCELLANEOUS	6	24%	0.7	27	50%	3.9	18	42%	0.8	10	53%	0.7
TOTAL	26	100%	1.2	55	100%	5.0	44	100%	1.6	19	100%	1.3
Number in sample	22			11			28			15		
% of gear	22%			11%			29%			15%		
Total in use	90			18			101			71		
Fishermen/FU	2			10			1			2		
Sample size	24%			61%			28%			21%		
Est Fishermen	180			180			101			142		
Catch/fishermen	0.59			0.50			1.58			0.64		

	TRAPS TOT	TRAPS %	TRAPS AVG CPU	LINE TOT	LINE %	LINE AVG CPU	KATAS TOT	KATAS %	KATAS AVG CPU	TOT	%
RUHI							25	18%	25.0	41	13%
CATLA							10	7%	10.0	10	3%
MRIGAL							4	3%	4.0	5	2%
KALBASU							12	9%	6.0	24	7%
CHANIA											
BOAL	4	11%	4.0	4	100%	1.3	45	33%	15.0	78	24%
AIR							3	2%	3.0	9	3%
PANGAS											
SILON											
GHOL	2	6%	2.0				2	1%	2.0	5	1%
GHITAL							2	1%	2.0	3	1%
KOI	2	6%	1.0				1	0%	0.5	8	2%
SINGI							1	1%	1.0	6	2%
SAR PUNTI											
B SHRIMPS											
S SHRIMPS	20	56%	1.3				3	2%	2.5	32	10%
OTHER										1	0%
MISCELLANEOUS	7	21%	0.8				30	22%	10.0	99	31%
TOTAL	35	100%	2.1	4	100%	2.0	137	100%	45.7	320	100%
Number in sample	17			2			3			99	
% of gear	17%			2%			3%				
Total in use	57			2			3			342	
Fishermen/FU	1			1			10				
Sample size	30%			100%			100%				
Est Fishermen	57			2			30			692	
Catch/fishermen	2.07			2.00			4.57				

VISIT# 5

	GILL TOT	GILL %	GILL AVG CPU	SEINE TOT	SEINE %	SEINE AVG CPU	CAST TOT	CAST %	CAST AVG CPU	LIFT TOT	LIFT %	LIFT AVG CPU
RUHI	5	15%	1.3	3	4%	3.0	2	6%	0.4			
CATLA												
MRIGAL	1	3%	1.0	2	2%	2.0						
KALBASU	1	2%	0.3	7	8%	3.5	2	6%	0.7			
CHANIA												
BOAL	1	4%	1.2	13	15%	2.5	8	26%	1.6			
AIR	6	18%	2.0	2	3%	0.7	1	3%	0.3			
PANGAS												
SILON												
GHOL												
GHITAL	1	2%	0.5									
KOI	7	21%	1.0	1	1%	0.5	1	3%	0.3			
SINGI	6	18%	0.9									
SAR PUNTI												
B SHRIMPS												
S SHRIMPS							1	3%	0.3	10	43%	0.5
OTHER												
MISCELLANEOUS	6	17%	1.0	58	68%	9.7	17	52%	0.8	13	57%	0.6
TOTAL	33	100%	2.1	85	100%	14.2	32	100%	1.2	23	100%	1.0
Number in sample	16			6			26			23		
% of gear	19%			7%			31%			27%		
Total in use	49			8			55			42		
Fishermen/FU	2			10			1			2		
Sample size	33%			75%			47%			55%		
Est Fishermen	98			80			55			84		
Catch/fishermen	1.03			1.42			1.22			0.56		

	TRAPS TOT	TRAPS %	TRAPS AVG CPU	LINE TOT	LINE %	LINE AVG CPU	KATAS TOT	KATAS %	KATAS AVG CPU	TOT	%
RUHI							16	6%	16.0	26	6%
CATLA											
MRIGAL										3	1%
KALBASU							26	10%	26.0	36	8%
CHANIA											
BOAL							51	20%	17.0	73	17%
AIR							10	4%	3.3	19	4%
PANGAS											
SILON											
GHOL											
GHITAL										1	0%
KOI										9	2%
SINGI										6	1%
SAR PUNTI											
B SHRIMPS											
S SHRIMPS	7	59%	0.8				64	25%	16.0	82	19%
OTHER											
MISCELLANEOUS	5	41%	0.6				85	34%	21.1	183	42%
TOTAL	12	100%	1.4				252	100%	62.9	437	100%
Number in sample	9						4			84	
% of gear	11%						5%				
Total in use	12			39			4			209	
Fishermen/FU	1			1			10				
Sample size	75%						100%				
Est Fishermen	12			39			40			408	
Catch/fishermen	1.36			#DIV/0!			6.29				

GRAND TOTAL

	GILL TOT	GILL %	GILL AVG CPU	SEINE TOT	SEINE %	SEINE AVG CPU	CAST TOT	CAST %	CAST AVG CPU	LIFT TOT	LIFT %	LIFT AVG CPU
RUHI	96	19%	0.5	51	14%	0.9	73	17%	0.4			
CATLA	11	6%	0.2	9	3%	0.2	29	7%	0.2			
MRIGAL	14	3%	0.1	7	2%	0.1	3	1%	0.0			
KALBASU	15	3%	0.1	34	9%	0.6	10	2%	0.1			
CHANIA												
BOAL	30	4%	0.1	60	17%	1.1	42	10%	0.2	2	1%	0.0
AIR	19	6%	0.2	14	4%	0.3	3	1%	0.0			
PANGAS												
SILON												
GHOL	10	2%	0.1	2	1%	0.0	33	8%	0.2			
GHITAL	3	1%	0.0	0	0%	0.0	1	0%	0.0			
KOI	[illegible]	17%	0.4	1	0%	0.0	23	5%	0.1	2	2%	0.0
SINGI	[illegible]	15%	0.4	[illegible]	0%	0.0	20	5%	0.1	1	1%	0.0
SAR PUNTI	1	0%	0.0	0	0%	0.0						
B SHRIMPS												
S SHRIMPS							22	5%	0.1	21	15%	0.2
OTHER	1	[illegible]	0.0									
MISCELLANEOUS	117	[illegible]	0.6	[illegible]	50%	3.3	169	[illegible]	[illegible]	115	81%	1.0
TOTAL	[illegible]	100%	[illegible]	[illegible]	100%	6.5	[illegible]	100%	[illegible]	141	100%	[illegible]
Number in sample	[illegible]			55			144			113		
% of gear	17%			10%			37%			[illegible]		
Total in use	[illegible]			101			[illegible]			[illegible]		
Fishermen/FU	10			50			5			10		
Sample size	[illegible]			[illegible]			[illegible]			[illegible]		
Est Fishermen	[illegible]			[illegible]			[illegible]			[illegible]		

	TRAPS TOT	TRAPS %	TRAPS AVG CPU	LINE TOT	LINE %	LINE AVG CPU	KATAS TOT	KATAS %	KATAS AVG CPU	TOT	%
RUHI				3	3%	0.1	119	14%	6.2	[illegible]	15%
CATLA							50	7%	3.1	[illegible]	5%
MRIGAL							32	4%	1.7	46	2%
KALBASU							47	6%	2.5	94	5%
CHANIA							8	1%	0.4	8	0%
BOAL	4	4%	0.1	42	49%	1.1	203	25%	10.7	315	16%
AIR							16	2%	[illegible]	57	3%
PANGAS							2	0%	0.1	2	0%
SILON											
GHOL	2	2%	0.0	35	42%	0.9	20	2%	1.1	76	4%
GHITAL							24	[illegible]	1	27	1%
KOI	2	2%	0.0	1	1%	0.0	7	1%	0	91	5%
SINGI				4	4%	0.1	1	0%	0.1	83	4%
SAR PUNTI										1	0%
B SHRIMPS							1	0%	0.0	1	0%
S SHRIMPS	62	58%	[illegible]				60	[illegible]	[illegible]	[illegible]	7%
OTHER										1	0%
MISCELLANEOUS	[illegible]	35%	[illegible]	1	1%	0.0	214	26%	11	647	32%
TOTAL	[illegible]	100%	1.1	84	100%	[illegible]	812	100%	[illegible]	[illegible]	100%
Number in sample	26			[illegible]			19			[illegible]	
% of gear	14%			2%			4%			100%	
Total in use	116			[illegible]			[illegible]			[illegible]	
Fishermen/FU	5			5			[illegible]				
Sample size	24%			10%			100%			[illegible]	
Est Fishermen	[illegible]			195			[illegible]				

VISIT 1

	GILL			SEINE			CAST			LIFT			TRAPS			LINE			KATA				
	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%
RUHI	3	14%	1.5	5	14%	2.5	11	31%	1.8										24	21%	6.0	41	26%
CATLA	5	25%	2.5	4	11%	2.0	2	6%	0.8										14	12%	4.7	25	12%
MRIGAL																			1	1%	0.5	1	1%
CALBASU							1	3%	1.0													1	0%
CHANDA																							
BOAL																			26	22%	5.2	37	12%
AIR	11	58%	5.5																			11	5%
PANGAS																							
SILON																							
GHOL				1	3%	1.0	3	9%	1.5										14	12%	7.0	18	6%
GHITAL																							
KOI																							
BHOL																							
BAR PUNTI																							
B. SHRIMPS																							
R. SHRIMPS				4	12%	2.2																4	2%
OTHER																							
MISCELLANEOUS				22	61%	7.2	14	53%	1.3	2	100%	2.0	2	100%	2.0				45	39%	6.4	74	28%
TOTAL	19	100%	9.1	36	100%	7.2	35	100%	2.5	2	100%	2.0	2	100%	2.0				115	100%	22.4	265	100%
Number in sample	2			5			14			1			1						2			25	
% of gear	7%			18%			50%			4%			4%						10%				
Total in use	8			9			66			9			3			1			33				
Fishers/CPU	2			10			1			2			1						80				
Sample size	25%			56%			21%			11%			33%			#DIV/0!			80%				
Est Fishers in	16			90			66			18			3						100				
Catch/fisherman	4.63			0.72			2.52			1.09			2.00			#DIV/0!			2.29				

VISIT 2

	GILL			SEINE			CAST			LIFT			TRAPS			LINE			KATA				
	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%
RUHI	5	13%	5.0	10	25%	6.0	2	7%	0.8							2	31%	1.5	10	10%	5.3	30	17%
CATLA	8	21%	8.0	13	33%	4.3	5	22%	1.4										5	5%	5.0	31	15%
MRIGAL	1	3%	1.0	3	8%	1.3	4	9%	1.0										3	6%	1.5	9	4%
CALBASU	3	8%	3.0	2	5%	2.0													1	2%	1.0	6	3%
CHANDA																							
BOAL	10	26%	10.0	11	15%	3.7	2	8%	2.0				9	100%		1	23%	1.0	18	24%	6.5	45	23%
AIR																							
PANGAS																							
SILON																							
GHOL				1	1%	1.0	2	8%	1.0										4	7%	2.0	7	3%
GHITAL																							
KOI										1	12%	0.3				1	12%	0.6				2	1%
BHOL										1	10%	0.3				1	15%	0.7				2	1%
BAR PUNTI																							
B. SHRIMPS																							
R. SHRIMPS															#DIV/0!								
OTHER	4	10%	4.0				1	4%	1.0													5	2%
MISCELLANEOUS	8	21%	8.0	25	38%	4.3	19	42%	1.1	8	75%	1.5			#DIV/0!	1	21%	1.0	8	12%	2.0	61	32%
TOTAL	39	100%	39.0	72	100%	14.4	25	100%	2.7	8	100%	2.0	9	100%	9.0	4	100%	4.0	54	100%	27.0	191	100%
Number in sample	1			5			9			4			1			1			4			1	
% of gear	4%			24%			39%			17%			4%			4%			19%			100%	
Total in use	1			15			33			11			5			2			9				
Fishers/CPU	2			18			1			2			1			1			6				
Sample size	33%			27%			27%			36%			20%			50%			44%				
Est Fishers in	6			154			33			22			5			4			9				
Catch/fisherman	19.50			1.46			2.72			0.99			8.00			4.00			2.33				

VISIT 3

	GILL			SEINE			CAST			LIFT			TRAPS			LINE			KATA				
	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%
RUHI				13	7%	6.5													4	10%	4.0	21	9%
CATLA				12	7%	12.0	2	9%	0.3										2	12%	2.0	16	7%
MRIGAL				8	4%	8.0													1	2%	1.0	9	4%
CALBASU				8	4%	8.0													1	1%	0.5	9	4%
CHANDA																							
BOAL	1	100%	8.0	50	25%	25.0	3	14%	1.5										8	20%	6.0	62	26%
AIR				80	42%	80.0																80	33%
PANGAS				10	5%	10.0																10	4%
SILON																							
GHOL							2	7%	1.5										2	6%	1.5	4	2%
GHITAL																							
KOI																							
BHOL																							
BAR PUNTI																							
B. SHRIMPS																							
R. SHRIMPS				5	3%	5.0	1	2%	0.5													6	2%
OTHER																							
MISCELLANEOUS				8	20%	8.0	14	53%	1.1	4	100%	1.0							12	30%	4.0	38	16%
TOTAL	1	100%	8.0	192	100%	45.5	21	100%	1.6	4	100%	1.0							50	100%	16.7	295	100%
Number in sample	1			5			11			4									3			3	
% of gear	8%			17%			53%			17%									13%			100%	
Total in use	1			6			43			8			5			2			11				
Fishers/CPU	1			10			1			2			1			1			15				
Sample size	100%			83%			50%			50%									27%				
Est Fishers in	1			60			43			16			5			2			15				
Catch/fisherman	8.00			0.76			1.05			0.50			#DIV/0!			#DIV/0!			1.00				

VIRT 1

	GILL			SEINE			CAST			LIFT			TRAPS			LINE			KATA				
	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%
ROACH																	#DIV/0!		5	6%	2.5	1	5%
CATLA																			4	5%	4.0	1	4%
MINNAL							1	3%	0.5										2	3%	2.0		3%
KALBAUU																							
CHANNA																							
BOAL																			24	31%	12.0	24	25%
AIR							2	13%	2.0													2	2%
PANGAS																							
SILON																							
GHOL							1	6%	1.0										15	19%	15.0	16	17%
SHITAL																							
EOI							1	3%	0.5										3	3%	2.0	3	3%
SIBOR																							
BAR PUNTI																							
B. SHRIMPS																							
M. SHRIMPS							2	9%	0.5													2	2%
OTHER																			5	6%		5	5%
MISCELLANEOUS							11	66%	1.0	1	100%	0.5							21	27%	10.5	33	34%
TOTAL							16	100%	1.5	1	100%	0.5							78	100%	39.0	97	100%
Number in sample							11			2									2			15	
% of spec							48%			9%									3%				
Total in use							43			8			5			2			2				
Fishermen/FU	2			10			140			16									10				
Sample size	#DIV/0!			#DIV/0!			26%			25%									100%				
Est. Fishermen							6020			128									20				
Catch/fisherman							0.01			0.03									3.90				

VIRT 2

	GILL			SEINE			CAST			LIFT			TRAPS			LINE			KATA				
	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%
ROH																			2	19%	2.0	2	5%
CATLA																			2	19%	2.0	2	5%
MRIGAL																							
KALBAUU																							
CHANNA																							
BOAL				4	44%	1.8	1	5%	1.0										4	38%	3.5	9	19%
AIR							1	2%	0.5													1	1%
PANGAS																							
SILON																							
GHOL							1	2%	0.5										1	10%	1.0	2	4%
SHITAL																							
EOI							1	5%	0.5										1	10%	1.0	2	3%
SIBOR				1	13%	0.5																1	2%
BAR PUNTI																							
B. SHRIMPS																							
M. SHRIMPS							2	9%	0.5														3%
OTHER																							
MISCELLANEOUS	2	100%	1.1	4	44%	1.8	16	77%	1.0										1	10%	1.0	2	35%
TOTAL	2	100%	1.1	9	100%	4.0	21	100%	1.2										11	100%	10.5	4	100%
Number in sample	2			2			18												1			2	
% of spec	1%			3%			31%												4%				
Total in use	24			8			76												4				
Fishermen/FU	2			10			1			2			1			1			10				
Sample size	0.8			25%			24%												25%				
Est. Fishermen	49			80			76												40				
Catch/fisherman	0.53			0.80			1.17												1.05				

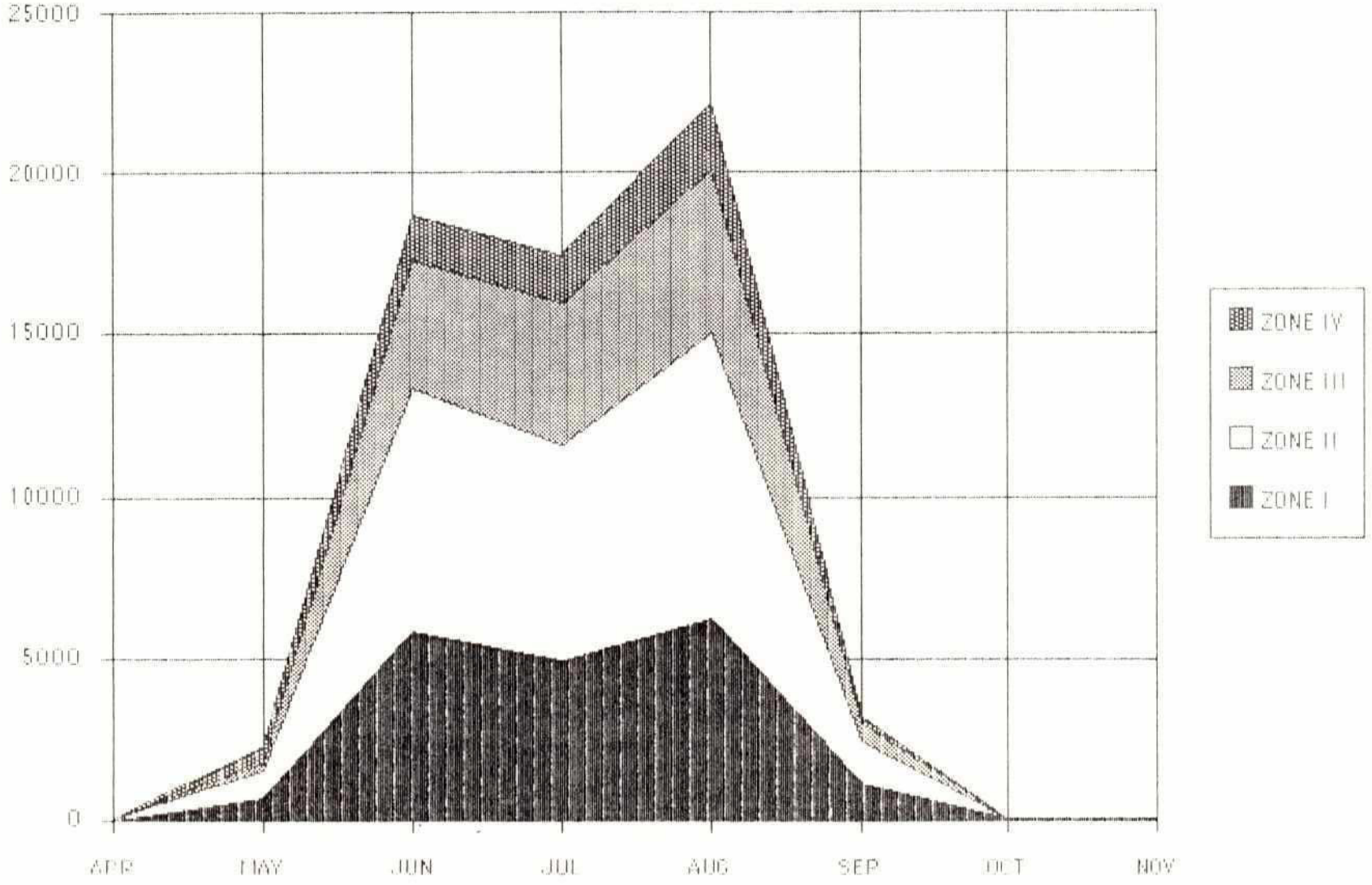
GRAND TOTAL

	GILL			SEINE			CAST			LIFT			TRAPS			LINE			KATA				
	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%	AVG CPU	TOT	%
ROH	3	12%	0.1	16	12%	0.1	13	11%	0.1							2	31%	0.1	5	16%	0.2	10	13%
CATLA	11	22%	0.2	29	10%	0.1	9	0%	0.1										3	10%	0.1	8	10%
MRIGAL	1	4%	0.0	11	4%	0.0	3	2%	0.0										1	3%	0.0	2	3%
KALBAUU	3	5%	0.0	10	3%	0.0	1	1%	0.0										1	0%	0.0	3	2%
CHANNA																							
BOAL	11	18%	0.2	65	22%	0.2	6	5%	0.1				8	80%	0.8	1	21%	0.1	64	27%	0.3	175	21%
AIR	11	18%	0.2	40	13%	0.1	3	2%	0.0													53	7%
PANGAS				10	3%	0.0																10	1%
SILON																							
GHOL				2	1%	0.0	8	7%	0.1										7	12%	0.3	17	2%
SHITAL																							
EOI							2	1%	0.0	1	6%	0.1				1	13%	0.1	1	1%	0.0	5	1%
SIBOR				1	0%	0.0				1	5%	0.1				1	15%	0.1				3	0%
BAR PUNTI																							
B. SHRIMPS																							
M. SHRIMPS				9	3%	0.0	4	3%	0.0													13	2%
OTHER	3	7%	0.1				1	1%	0.0													4	1%
MISCELLANEOUS	10	17%	0.2	66	24%	0.3	70	59%	0.6	13	69%	0.9	2	20%	0.2	1	21%	0.2	87	24%	0.3	251	31%
TOTAL	61	100%	1.1	290	100%	1.0	110	100%	1.0	15	100%	1.0	10	100%	1.0	5	100%	1.0	30	100%	1.0	81	100%
Number in sample	5			18			65			11			2			1			1			11	
% of spec	2%			6%			25%			4%			13%			7%			5%				
Total in use	54			88			251			36			6			2			54			43	
Fishermen/FU	2			38			142			20			2			2			54			55	
Sample size	17%			13%			26%			31%			13%			50%			13%			26%	
Est. Fishermen	72			568			6538			184			15			4			760			156	
Catch/fisherman	0.85			1.56			0.03			0.26			1.92			1.25			2.9			1.4	

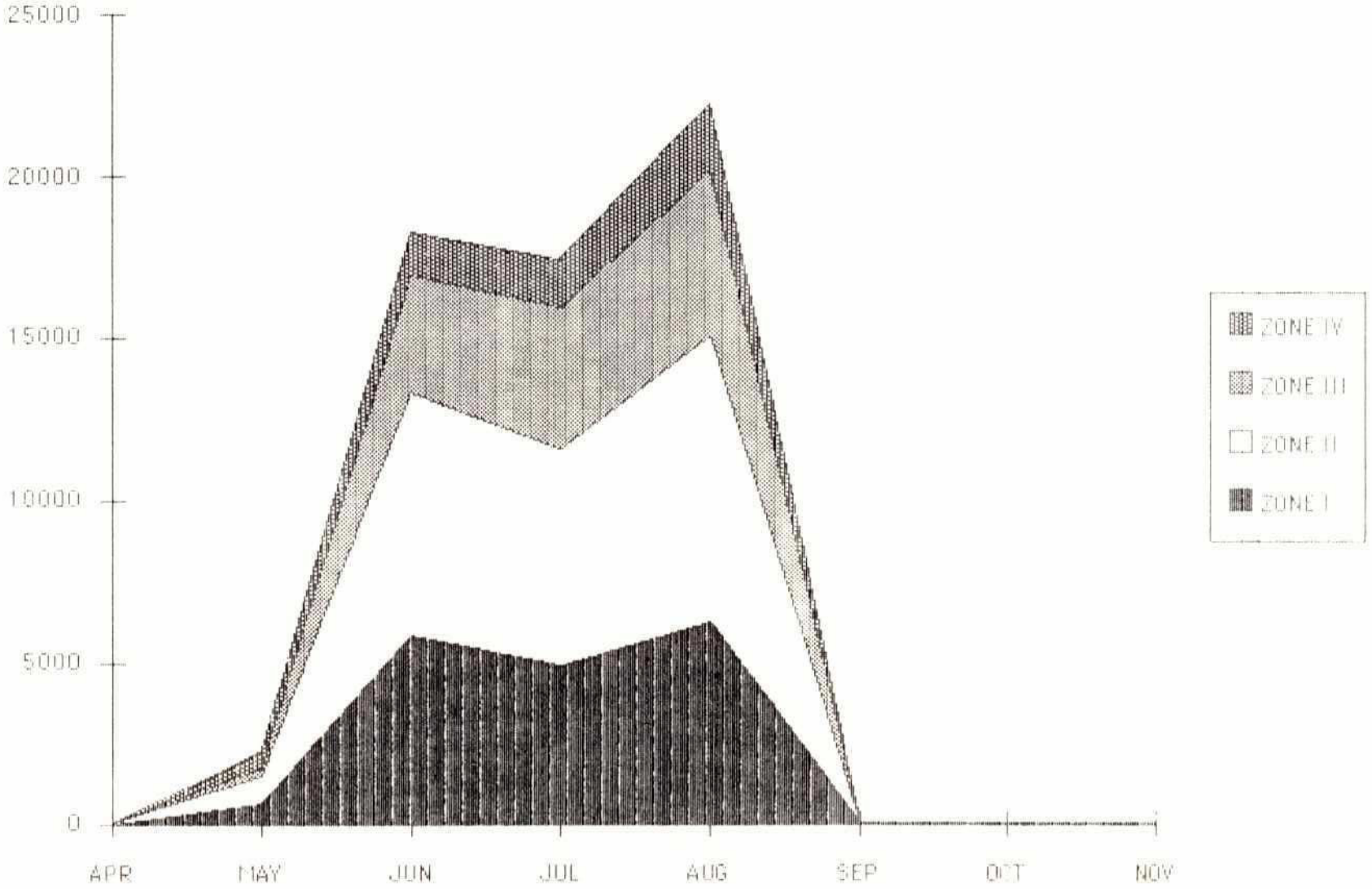
Appendix - C

Coarse Model Results

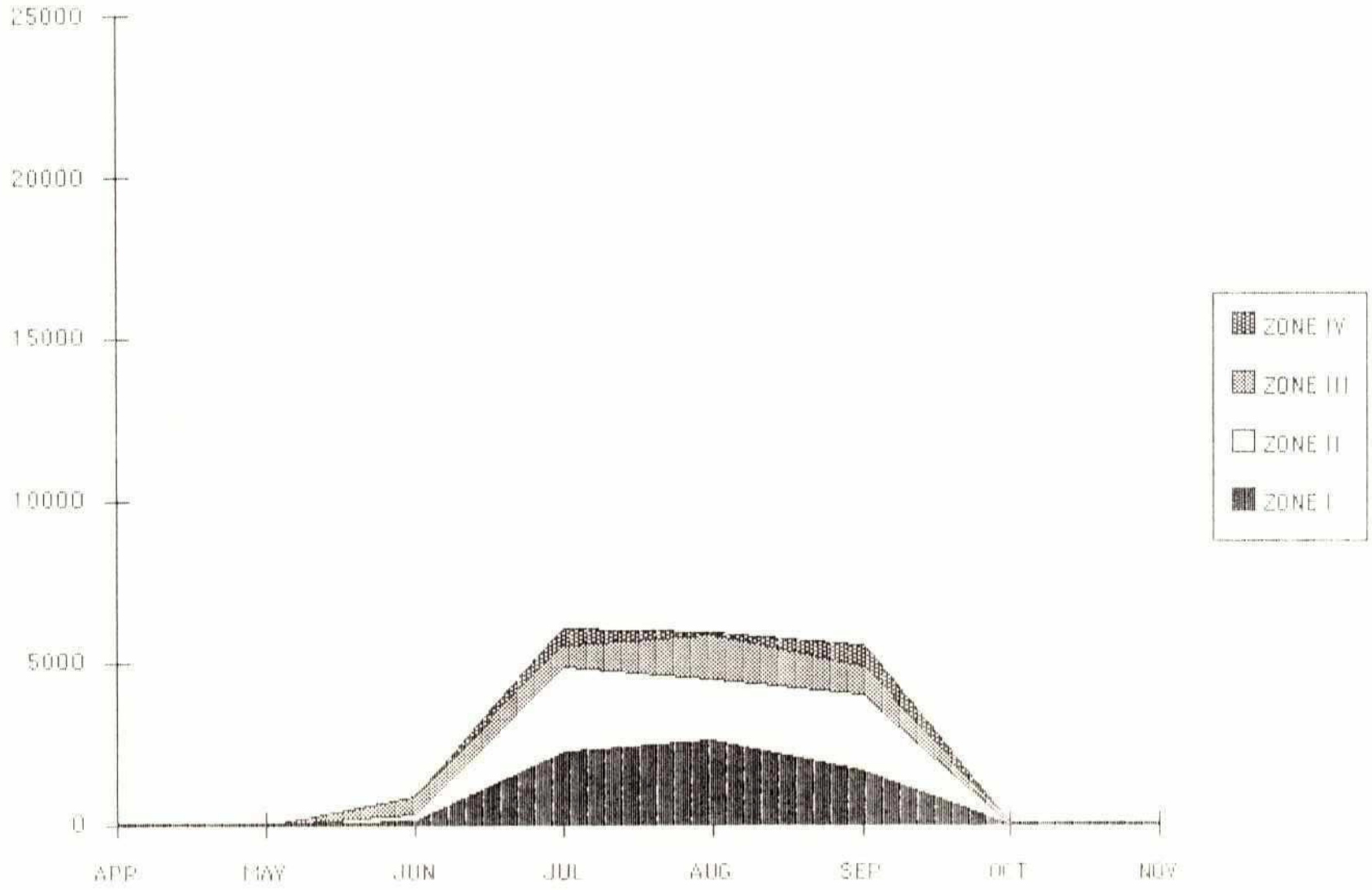
AREA PER DEPTH RANGE - WITHOUT PROJECT



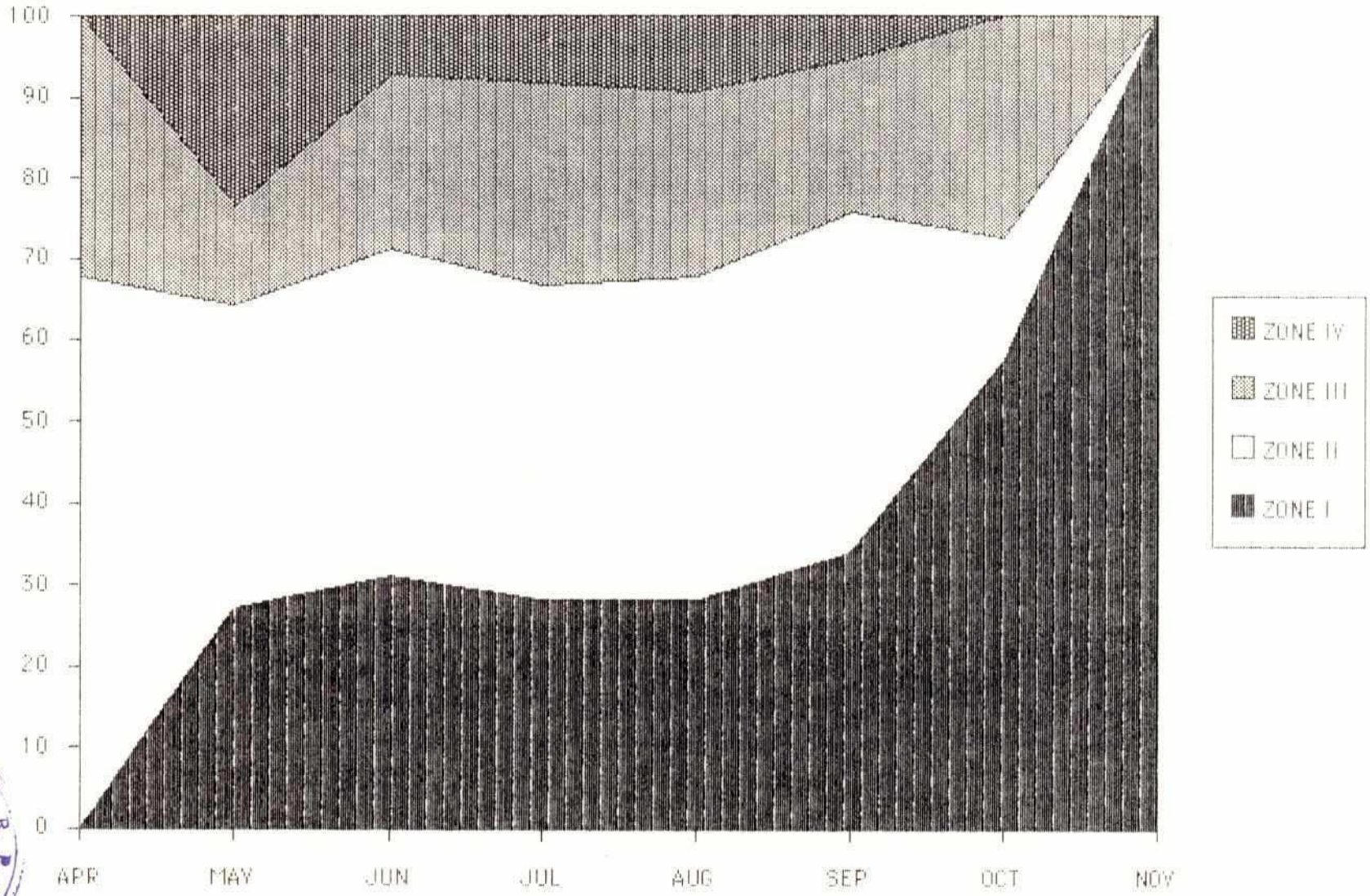
AREAS PER DEPTH RANGES - SCENARIO A



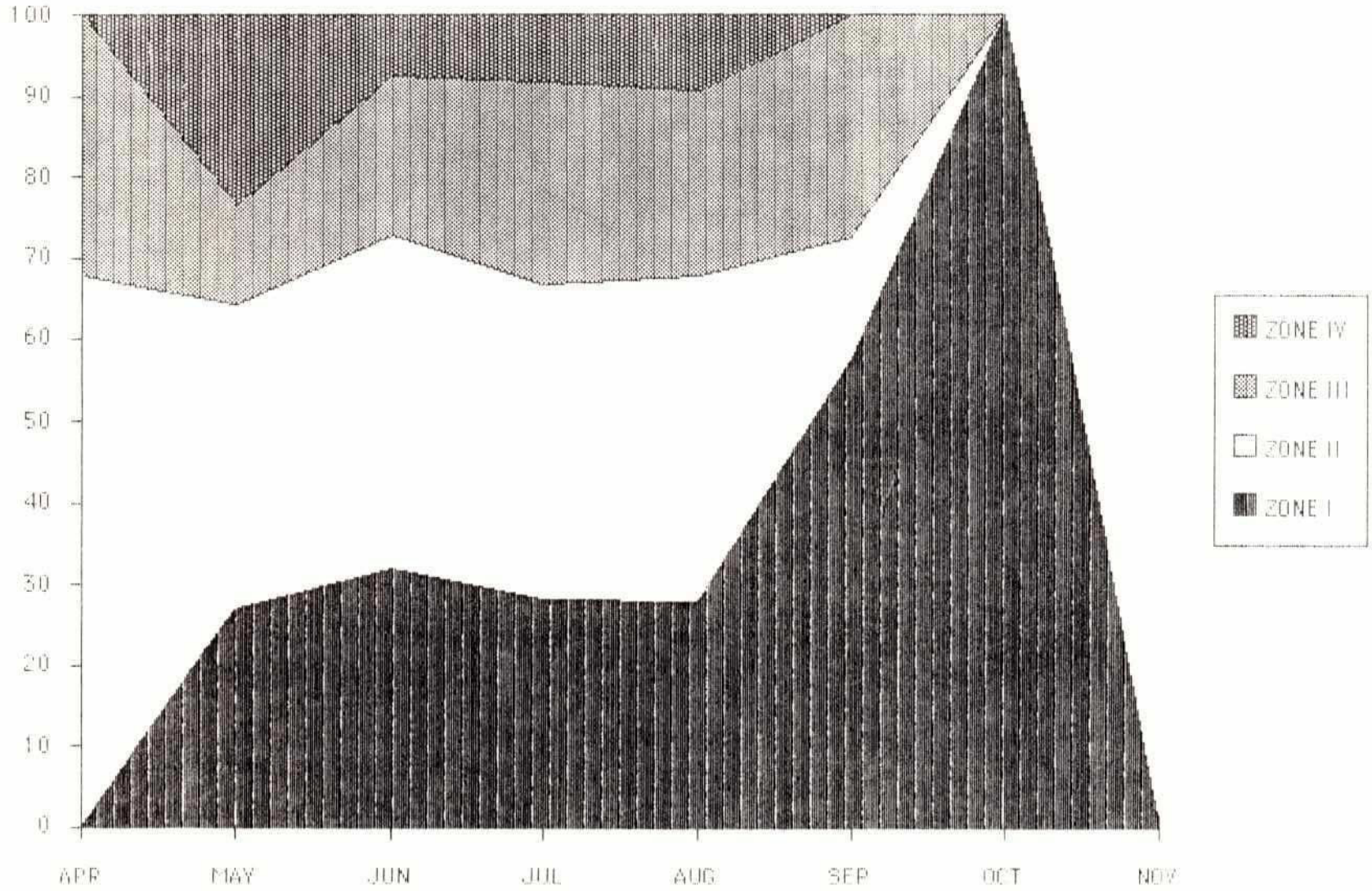
AREAS PER DEPTH RANGES - SCENARIO B



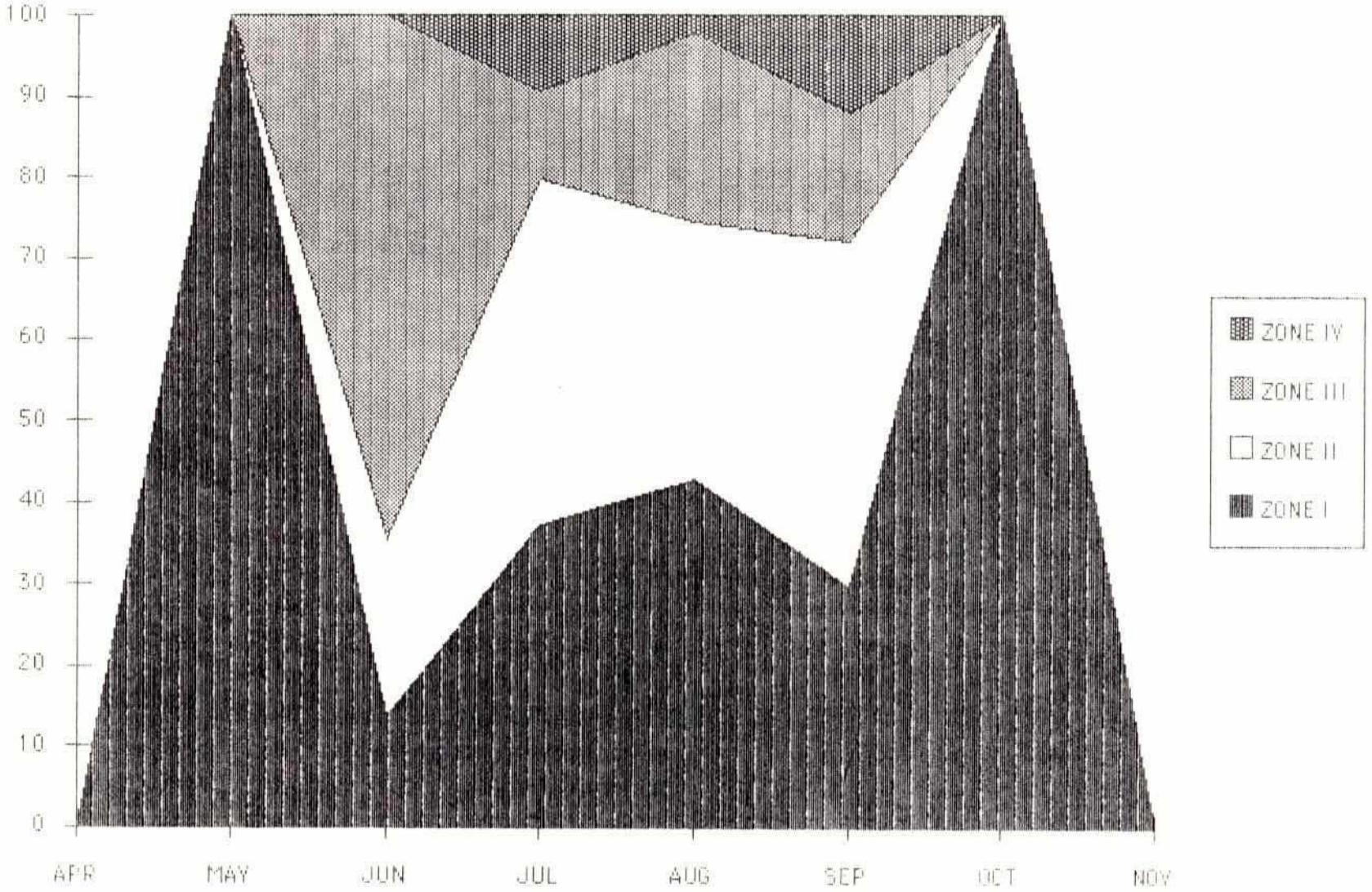
% AREA PER DEPTH RANGE - WITHOUT PROJECT



% AREA PER DEPTH RANGES - SCENARIO A



% AREA PER DEPTH RANGES - SCENARIO B



BY FISHING HH TYPE – 5YR ANALYSIS

PRODUCTION AND VALUE IN FIRST PROJECT YEAR Y5. [W0] SITUATION PER HH TYPE

PRODUCTION (Tons)

W0

	FT/PT	OC	F.FARM.	TOTAL
MR	1445			1445
OR	391	117		508
FL	541	361		902
B	814	286		1100
P		355	958	1313
TOTAL	3191	1118	958	5268
	61%	21%	18%	100%

W/A

	FT/PT	OC	F.FARM.	TOTAL
MR	1445			1445
OR	372	111		483
FL	511	340		851
B	746	262		1008
P		355	958	1313
TOTAL	3073	1068	958	5100
	60%	21%	19%	100%

W/C

	FT/PT	OC	F.FARM.	TOTAL
MR	1445			1445
OR	124	37		161
FL	211	141		352
B	207	73		280
P		355	958	1313
TOTAL	1987	605	958	3551
	56%	17%	27%	100%

W/B

	FT/PT	OC	F.FARM.	TOTAL
MR	1445			1445
OR	259	78		337
FL	364	243		607
B	301	106		407
P		355	958	1313
TOTAL	2370	781	958	4109
	58%	19%	23%	100%

W/D

	FT/PT	OC	F.FARM.	TOTAL
MR	1445			1445
OR	11	3		14
FL	22	14		36
B	24	8		32
P		355	958	1313
TOTAL	1501	380	958	2840
	53%	13%	34%	100%
HH	14089	65457	1900	81446

VALUE (M. Tk.)

W0

	FT/PT	OC	F.FARM.	TOTAL	P.avg
MR	79			79	54.51
OR	22	6		28	55.60
FL	25	17		42	46.86
B	45	16		61	55.32
P		23	61	83	63.49
TOTAL	171	62	61	293	55.71
	58%	21%	21%	100%	

W/A

	FT/PT	OC	F.FARM.	TOTAL	P.avg
MR	79			79	54.51
OR	21	6		27	55.32
FL	24	16		40	46.86
B	41	14		56	55.23
P		23	61	83	63.49
TOTAL	164	59	61	284	55.76
	58%	21%	21%	100%	

W/C

	FT/PT	OC	F.FARM.	TOTAL	P.avg
MR	79			79	54.51
OR	6	2		8	51.82
FL	10	7		16	46.86
B	11	4		15	51.82
P		23	61	83	63.49
TOTAL	106	35	61	201	56.74
	53%	17%	30%	100%	

W/B

	FT/PT	OC	F.FARM.	TOTAL	P.avg
MR	79			79	54.51
OR	14	4		18	53.20
FL	17	11		28	46.86
B	16	6		22	53.20
P		23	61	85	63.49
TOTAL	126	44	61	230	56.01
	55%	19%	26%	100%	

W/D

	FT/PT	OC	F.FARM.	TOTAL	P.avg
MR	79			79	54.51
OR	1	0		1	51.73
FL	1	1		2	46.86
B	1	0		1	51.73
P		23	61	83	63.49
TOTAL	82	24	61	166	58.52
	49%	14%	37%	100%	

BY FISHING HH TYPE – 30 YR ANALYSIS

PRODUCTION AND VALUE IN PROJECT YEAR 30 YS. [WO] SITUATION PER HH TYPE

PRODUCTION (Tons)

WO

	FT/PT	OC	F.FARM.	TOTAL
MR	918			918
OR	249	74		323
FL	344	229		573
B	517	182		699
P		1328	3590	4918
TOTAL	2028	1813	3590	7431
	27%	24%	48%	100%

W/A

	FT/PT	OC	F.FARM.	TOTAL
MR	932			932
OR	240	72		312
FL	329	220		549
B	481	169		650
P		1271	3435	4706
TOTAL	1983	1731	3435	7149
	28%	24%	48%	100%

W/C

	FT/PT	OC	F.FARM.	TOTAL
MR	932			932
OR	80	24		104
FL	136	91		227
B	134	47		181
P		355	958	1313
TOTAL	1282	516	958	2757
	47%	19%	35%	100%

W/B

	FT/PT	OC	F.FARM.	TOTAL
MR	932			932
OR	167	50		217
FL	235	157		392
B	195	68		263
P		355	958	1313
TOTAL	1529	630	958	3117
	49%	20%	31%	100%

W/D

	FT/PT	OC	F.FARM.	TOTAL
MR	932			932
OR	7	2		9
FL	14	9		23
B	16	5		21
P		229	618	847
TOTAL	968	245	618	1832
	53%	13%	34%	100%

HH T0	14089	65457	1900	81446
HH T30	25520	116565	3442	147527

VALUE (M. TK.)

WO

	FT/PT	OC	F.FARM.	TOTAL	P.avg
MR	50	0	0	50	54.51
OR	14	4	0	18	55.60
FL	16	11	0	27	46.86
B	29	10	0	39	55.32
P	0	84	228	312	63.49
TOTAL	109	109	228	446	59.99
	24%	25%	51%	100%	

W/A

	FT/PT	OC	F.FARM.	TOTAL	
MR	51	0	0	51	54.51
OR	13	4	0	17	55.32
FL	15	10	0	26	46.86
B	27	9	0	36	55.23
P	0	81	218	299	63.49
TOTAL	106	104	218	428	59.93
	25%	24%	51%	100%	

W/C

	FT/PT	OC	F.FARM.	TOTAL	
MR	51	0	0	51	54.51
OR	4	1	0	5	51.82
FL	6	4	0	11	46.86
B	7	2	0	9	51.82
P	0	23	61	83	63.49
TOTAL	68	30	61	160	57.88
	43%	19%	38%	100%	

W/B

	FT/PT	OC	F.FARM.	TOTAL	
MR	51	0	0	51	54.51
OR	9	3	0	12	53.20
FL	11	7	0	18	46.86
B	10	4	0	14	53.20
P	0	23	61	83	63.49
TOTAL	81	36	61	178	57.13
	46%	20%	34%	100%	

W/D

	FT/PT	OC	F.FARM.	TOTAL	
MR	51	0	0	51	54.51
OR	0	0	0	0	51.73
FL	1	0	0	1	46.86
B	1	0	0	1	51.73
P	0	15	39	54	63.49
TOTAL	53	15	39	107	58.52
	49%	14%	37%	100%	

U. cost	65.08	55.71	46.86
(average price local/market sales)			

PRODUCTION AND VALUE IN FIRST PROJECT YEAR VS. [WO] SITUATION

PRODUCTION (Tons)

WO

	CARPS	OTHER	MISCELL.	TOTAL
MR	101	1040	303	1445
OR	147	198	163	508
FL	0	0	902	902
B	297	440	363	1100
P	1090	223	0	1313
TOTAL	1635	1902	1731	5268
	31%	36%	33%	100%

W/A

	CARPS	OTHER	MISCELL.	TOTAL
MR	101	1040	303	1445
OR	130	193	159	483
FL	0	0	851	851
B	262	413	333	1008
P	1090	223	0	1313
TOTAL	1583	1870	1646	5100
	31%	37%	32%	100%

W/C

	CARPS	OTHER	MISCELL.	TOTAL
MR	101	1040	303	1445
OR	2	87	72	161
FL	0	0	352	352
B	3	151	126	280
P	1090	223	0	1313
TOTAL	1195	1502	854	3551
	34%	42%	24%	100%

W/B

	CARPS	OTHER	MISCELL.	TOTAL
MR	101	1040	303	1445
OR	37	165	135	337
FL	0	0	607	607
B	45	199	163	407
P	1090	223	0	1313
TOTAL	1273	1629	1208	4109
	31%	40%	29%	100%

W/D

	CARPS	OTHER	MISCELL.	TOTAL
MR	101	1040	303	1445
OR	0	6	6	14
FL	0	0	36	36
B	0	18	14	32
P	1090	223	0	1313
TOTAL	1191	1289	360	2840
	42%	45%	13%	100%

VALUE (M. Tk.)

WO

	CARPS	OTHER	MISCELL.	TOTAL	P avg
MR	7	58	14	79	54.51
OR	10	11	8	28	55.60
FL	0	0	42	42	46.86
B	19	25	17	61	55.32
P	71	12	0	83	63.49
TOTAL	106	106	81	293	55.71
	36%	36%	28%	100%	

W/A

	CARPS	OTHER	MISCELL.	TOTAL	
MR	7	58	14	79	54.51
OR	8	11	7	27	55.32
FL	0	0	40	40	46.86
B	17	23	16	56	55.23
P	71	12	0	83	63.49
TOTAL	103	104	77	284	55.76
	36%	37%	27%	100%	

W/C

	CARPS	OTHER	MISCELL.	TOTAL	
MR	7	58	14	79	54.51
OR	0	5	3	8	51.82
FL	0	0	17	17	46.86
B	0	8	6	15	51.82
P	71	12	0	83	63.49
TOTAL	78	84	40	201	56.74
	39%	42%	20%	100%	

W/B

	CARPS	OTHER	MISCELL.	TOTAL	
MR	7	58	14	79	54.51
OR	2	9	6	18	53.20
FL	0	0	28	28	46.86
B	3	11	8	22	53.20
P	71	12	0	83	63.49
TOTAL	83	91	57	230	56.01
	36%	39%	25%	100%	

W/D

	CARPS	OTHER	MISCELL.	TOTAL	
MR	7	58	14	79	54.51
OR	0	0	0	1	51.73
FL	0	0	2	2	46.86
B	0	1	1	2	51.73
P	71	12	0	83	63.49
TOTAL	78	72	17	166	58.52
	47%	43%	10%	100%	

U. cost (average price local/market sales)	65.08	55.71	46.86

PRODUCTION AND VALUE IN PROJECT YEAR 30 Y5. [WO] SITUATION

PRODUCTION (Tons)

WO

	CARPS	OTHER	MISCELL.	TOTAL
MR	64	661	193	918
OR	94	126	103	323
FL	0	0	573	573
B	189	280	231	699
P	4082	836	0	4918
TOTAL	4429	1903	1100	7431
	60%	26%	15%	100%

W/A

	CARPS	OTHER	MISCELL.	TOTAL
MR	65	671	196	932
OR	84	125	103	312
FL	0	0	549	549
B	169	267	215	650
P	3906	800	0	4706
TOTAL	4224	1862	1062	7149
	59%	26%	15%	100%

W/C

	CARPS	OTHER	MISCELL.	TOTAL
MR	65	671	196	932
OR	1	56	47	104
FL	0	0	227	227
B	2	98	81	181
P	1090	223	0	1313
TOTAL	1158	1048	551	2757
	42%	38%	20%	100%

W/B

	CARPS	OTHER	MISCELL.	TOTAL
MR	65	671	196	932
OR	24	106	87	217
FL	0	0	392	392
B	29	129	105	263
P	1090	225	0	1313
TOTAL	1208	1129	780	3117
	39%	36%	25%	100%

W/D

	CARPS	OTHER	MISCELL.	TOTAL
MR	65	671	196	932
OR	0	5	4	9
FL	0	0	23	23
B	0	12	9	21
P	703	144	0	847
TOTAL	768	832	232	1832
	42%	45%	13%	100%

VALUE (M. Tk.)

WO

	CARPS	OTHER	MISCELL.	TOTAL	P avg
MR	4	37	9	50	54.51
OR	6	7	5	18	55.60
FL	0	0	27	27	46.86
B	12	16	11	39	55.32
P	266	47	0	312	63.49
TOTAL	288	106	52	406	59.98
	65%	24%	12%	100%	

W/A

	CARPS	OTHER	MISCELL.	TOTAL	
MR	4	37	9	51	54.51
OR	5	7	5	17	55.32
FL	0	0	26	26	46.86
B	11	15	10	36	55.23
P	254	45	0	299	63.49
TOTAL	275	104	50	428	59.93
	64%	24%	12%	100%	

W/C

	CARPS	OTHER	MISCELL.	TOTAL	
MR	4	37	9	51	54.51
OR	0	3	2	5	51.82
FL	0	0	11	11	46.86
B	0	5	4	9	51.82
P	71	12	0	83	63.49
TOTAL	75	58	26	160	57.88
	47%	37%	16%	100%	

W/B

	CARPS	OTHER	MISCELL.	TOTAL	
MR	4	37	9	51	54.51
OR	2	6	4	12	53.20
FL	0	0	18	18	46.86
B	2	7	5	14	53.20
P	71	12	0	83	63.49
TOTAL	79	63	37	179	57.13
	44%	35%	21%	100%	

W/D

	CARPS	OTHER	MISCELL.	TOTAL	
MR	4	37	9	51	54.51
OR	0	0	0	0	51.73
FL	0	0	1	1	46.86
B	0	1	0	1	51.73
P	46	8	0	54	63.49
TOTAL	50	46	11	107	58.52
	47%	43%	10%	100%	

U. cost	65.08	55.71	46.86
(average price local/market sales)			

PRODUCTION AND VALUE PER HH IN FIRST PROJECT YS. [WO] SITUATION PER HH TYPE

PRODUCTION (kg/hh)

WO

	FT/PT	OC	F.FARM.	TOTAL
MR	102.56			17.74
OR	27.76	1.78		6.24
FL	38.41	5.51		11.07
B	57.78	4.37		13.51
P		5.42	504.47	16.12
TOTAL	226.51	17.08	504.47	64.68

W/A

	FT/PT	OC	F.FARM.	TOTAL
MR	102.56			17.74
OR	26.40	1.70		5.93
FL	36.24	5.20		10.45
B	52.94	4.00		12.38
P		5.42	504.47	16.12
TOTAL	218.14	16.32	504.47	62.62

W/C

	FT/PT	OC	F.FARM.	TOTAL
MR	102.56			17.74
OR	8.80	0.57		1.98
FL	14.99	2.15		4.32
B	14.71	1.11		3.44
P		5.42	504.47	16.12
TOTAL	141.06	9.24	504.47	43.60

W/B

	FT/PT	OC	F.FARM.	TOTAL
MR	102.56			17.74
OR	18.42	1.18		4.14
FL	25.85	3.71		7.45
B	21.38	1.62		5.00
P		5.42	504.47	16.12
TOTAL	168.21	11.93	504.47	50.45

W/D

	FT/PT	OC	F.FARM.	TOTAL
MR	102.56			17.74
OR	0.77	0.05		0.17
FL	1.53	0.22		0.44
B	1.68	0.13		0.59
P		5.42	504.47	16.12
TOTAL	106.54	5.81	504.47	34.87

VALUE (Tk.)

P.avg

WO

	FT/PT	OC	F.FARM.	TOTAL	
MR	5591			5591	54.51
OR	1544	99		1643	55.60
FL	1800	258		2058	46.86
B	3196	242		3438	55.32
P		344	32029	32373	63.49
TOTAL	12130	943	32029	45102	55.71

W/A

	FT/PT	OC	F.FARM.	TOTAL	
MR	5591			5591	54.51
OR	1460	94		1554	55.32
FL	1698	244		1942	46.86
B	2924	221		3145	55.23
P		344	32029	32373	63.49
TOTAL	11673	903	32029	44605	55.76

W/C

	FT/PT	OC	F.FARM.	TOTAL	
MR	5591			5591	54.51
OR	456	29		485	51.82
FL	702	101		803	46.86
B	762	58		820	51.82
P		344	32029	32373	63.49
TOTAL	7511	532	32029	40071	56.74

W/B

	FT/PT	OC	F.FARM.	TOTAL	
MR	5591			5591	54.51
OR	980	63		1043	53.20
FL	1211	174		1385	46.86
B	1137	86		1223	53.20
P		344	32029	32373	63.49
TOTAL	8919	667	32029	41614	56.01

W/D

	FT/PT	OC	F.FARM.	TOTAL	
MR	5591			5591	54.51
OR	40	3		42	51.73
FL	72	10		82	46.86
B	87	7		94	51.73
P		344	32029	32373	63.49
TOTAL	5789	363	32029	38181	58.52

PRODUCTION AND VALUE PER HH IN PROJECT YEAR 30 YS. [WO] SITUATION PER HH TYPE

PRODUCTION (kg/hh)

WO

	FT/PT	OC	F.FARM.	TOTAL
MR	35.97	0.00	0.00	6.22
OR	9.75	0.63	0.00	2.19
FL	13.47	1.93	0.00	3.88
B	20.27	1.53	0.00	4.74
P	0.00	11.20	1043.18	33.34
TOTAL	79.46	15.29	1043.18	50.37

W/A

	FT/PT	OC	F.FARM.	TOTAL
MR	36.52	0.00	0.00	6.32
OR	9.41	0.61	0.00	2.11
FL	12.91	1.85	0.00	3.72
B	18.85	1.43	0.00	4.41
P	0.00	10.72	998.21	31.90
TOTAL	77.69	14.60	998.21	48.46

W/C

	FT/PT	OC	F.FARM.	TOTAL
MR	36.52	0.00	0.00	6.32
OR	3.14	0.20	0.00	0.70
FL	5.34	0.77	0.00	1.54
B	5.25	0.40	0.00	1.23
P	0.00	2.99	278.51	8.90
TOTAL	50.24	4.35	278.51	18.69

W/B

	FT/PT	OC	F.FARM.	TOTAL
MR	36.52	0.00	0.00	6.32
OR	6.55	0.42	0.00	1.47
FL	9.22	1.32	0.00	2.66
B	7.63	0.58	0.00	1.78
P	0.00	2.99	278.51	8.90
TOTAL	59.91	5.31	278.51	21.13

W/D

	FT/PT	OC	F.FARM.	TOTAL
MR	36.52	0.00	0.00	6.32
OR	0.27	0.02	0.00	0.06
FL	0.54	0.08	0.00	0.16
B	0.61	0.05	0.00	0.14
P	0.00	1.93	179.66	5.74
TOTAL	37.94	2.07	179.66	12.42

VALUE (Tk.)

P.avg

WO

	FT/PT	OC	F.FARM.	TOTAL	
MR	1961	0	0	1961	54.51
OR	542	35	0	577	55.60
FL	631	91	0	722	46.86
B	1121	85	0	1206	55.32
P	0	711	66231	66942	63.49
TOTAL	4255	921	66231	71408	55.71

W/A

	FT/PT	OC	F.FARM.	TOTAL	
MR	1991	0	0	1991	54.51
OR	521	33	0	554	55.32
FL	605	87	0	692	46.86
B	1041	79	0	1120	55.23
P	0	680	63376	64057	63.49
TOTAL	4157	879	63376	68413	55.76

W/C

	FT/PT	OC	F.FARM.	TOTAL	
MR	1991	0	0	1991	54.51
OR	163	10	0	173	51.82
FL	250	36	0	286	46.86
B	272	21	0	293	51.82
P	0	190	17682	17872	63.49
TOTAL	2675	257	17682	20614	56.74

W/B

	FT/PT	OC	F.FARM.	TOTAL	
MR	1991	0	0	1991	54.51
OR	348	22	0	371	53.20
FL	432	62	0	494	46.86
B	406	31	0	436	53.20
P	0	190	17682	17872	63.49
TOTAL	3177	305	17682	21164	56.01

W/D

	FT/PT	OC	F.FARM.	TOTAL	
MR	1991	0	0	1991	54.51
OR	14	1	0	15	51.73
FL	25	4	0	29	46.86
B	32	2	0	34	51.73
P	0	122	11407	11529	63.49
TOTAL	2062	129	11407	13598	58.52

PRODUCTION AND VALUE PER HH IN PROJECT YEAR 30 YS. [WO] SITUATION PER HH TYPE

PRODUCTION (kg/hh)

WO

	FT/PT	OC	F.FARM.	TOTAL
MR	65.16	0.00	0.00	11.27
OR	17.65	1.13	0.00	3.97
FL	24.40	3.50	0.00	7.04
B	36.71	2.78	0.00	8.58
P	0.00	20.29	1889.55	60.38
TOTAL	143.93	27.70	1889.55	91.24

W/A

	FT/PT	OC	F.FARM.	TOTAL
MR	66.15	0.00	0.00	11.44
OR	17.05	1.10	0.00	3.83
FL	23.38	3.35	0.00	6.74
B	34.14	2.58	0.00	7.98
P	0.00	19.41	1808.09	57.78
TOTAL	140.72	26.44	1808.09	87.78

W/C

	FT/PT	OC	F.FARM.	TOTAL
MR	66.15	0.00	0.00	11.44
OR	5.68	0.37	0.00	1.28
FL	9.67	1.39	0.00	2.79
B	9.51	0.72	0.00	2.22
P	0.00	5.42	504.47	16.12
TOTAL	91.01	7.89	504.47	33.85

W/B

	FT/PT	OC	F.FARM.	TOTAL
MR	66.15	0.00	0.00	11.44
OR	11.86	0.76	0.00	2.66
FL	16.69	2.40	0.00	4.81
B	13.81	1.04	0.00	3.23
P	0.00	5.42	504.47	16.12
TOTAL	108.52	9.62	504.47	38.27

W/D

	FT/PT	OC	F.FARM.	TOTAL
MR	66.15	0.00	0.00	11.44
OR	0.49	0.03	0.00	0.11
FL	0.98	0.14	0.00	0.28
B	1.10	0.08	0.00	0.26
P	0.00	3.49	325.43	10.40
TOTAL	68.73	3.75	325.43	22.49

VALUE (Tk.)

P.avg

WO

	FT/PT	OC	F.FARM.	TOTAL	
MR	3552	0	0	3552	54.51
OR	981	63	0	1045	55.60
FL	1143	164	0	1308	46.86
B	2031	154	0	2185	55.32
P	0	1288	119967	121255	63.49
TOTAL	7708	1669	119967	129344	55.71

W/A

	FT/PT	OC	F.FARM.	TOTAL	
MR	3606	0	0	3606	54.51
OR	943	61	0	1004	55.32
FL	1096	157	0	1253	46.86
B	1886	143	0	2028	55.23
P	0	1232	114796	116028	63.49
TOTAL	7530	1593	114796	123919	55.76

W/C

	FT/PT	OC	F.FARM.	TOTAL	
MR	3606	0	0	3606	54.51
OR	295	19	0	313	51.82
FL	453	65	0	518	46.86
B	493	37	0	530	51.82
P	0	344	32029	32373	63.49
TOTAL	4846	465	32029	37340	56.74

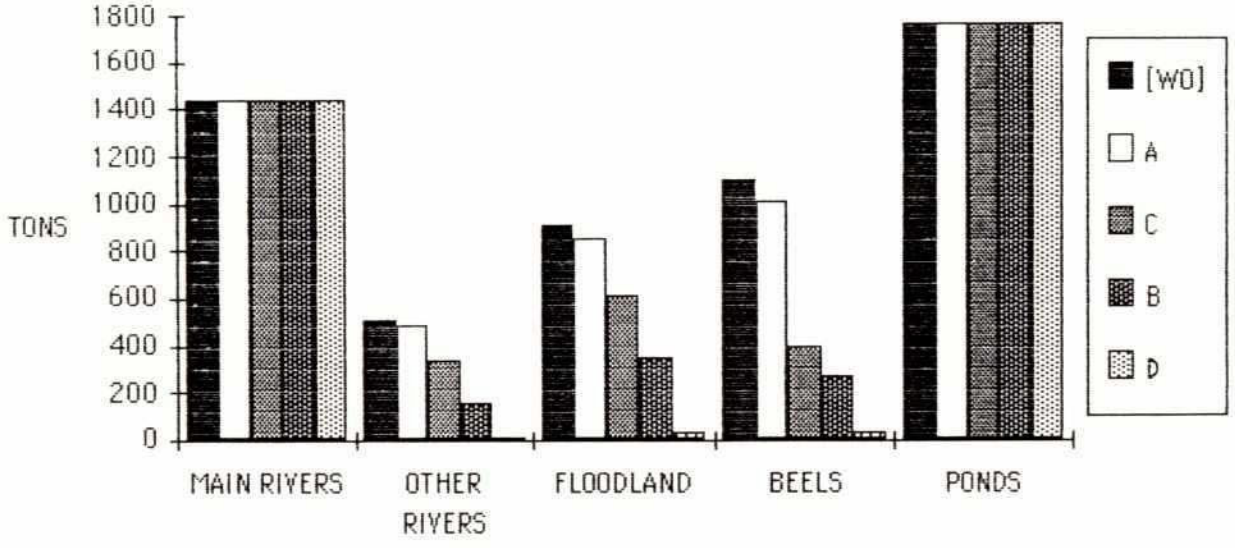
W/B

	FT/PT	OC	F.FARM.	TOTAL	
MR	3606	0	0	3606	54.51
OR	631	41	0	671	53.20
FL	782	112	0	895	46.86
B	735	56	0	790	53.20
P	0	344	32029	32373	63.49
TOTAL	5754	552	32029	38335	56.01

W/D

	FT/PT	OC	F.FARM.	TOTAL	
MR	3606	0	0	3606	54.51
OR	25	2	0	27	51.73
FL	46	7	0	52	46.86
B	57	4	0	61	51.73
P	0	222	20661	20883	63.49
TOTAL	3734	234	20661	24630	58.52

PRESENT PRODUCTION AND POSSIBLE IMPACT IN DIFFERENT FISHERIES PRODUCTION SYSTEMS IN JPPS AREA



Appendix - D

Water Surface Areas
Internal Rivers

Water Surface Area in Internal Rivers
Madardaha and Dadbhanga River

X-Sec No	W.S.Width (M)	Distance (M)	Without Project Area(ha)	Without Project Cum.Area(ha)	With Project W.S.Width at 13m(GTS)	With Project Area(ha)	With Project Cum.Area(ha)
1	20	0	0.00	0	33	0.00	0.00
2	0	1000	1.00	1.00	160	9.65	9.65
3	18	1000	0.90	1.90	23	9.15	18.80
4	21	1000	1.95	3.85	22	2.25	21.05
5	22	1000	2.15	6.00	26	2.40	23.45
6	19	1000	2.05	8.05	30	2.80	26.25
7	36	1000	2.75	10.80	36	3.30	29.55
8	25	1000	3.05	13.85	32	3.40	32.95
9	37	1000	3.10	16.95	50	4.10	37.05
10	90	1000	6.35	23.30	90	7.00	44.05
11	17	1000	5.35	28.65	20	5.50	49.55
12	26	1000	2.15	30.80	26	2.30	51.85
13	24	1000	2.50	33.30	24	2.50	54.35
14	25	1000	2.45	35.75	25	2.45	56.80
15	0	1000	1.25	37.00	0	1.25	58.05
16	0	1000	0.00	37.00	0	0.00	58.05
17	33	1000	1.65	38.65	33	1.65	59.70
18	0	1000	1.65	40.30	0	1.65	61.35
19	33	1000	1.65	41.95	33	1.65	63.00
20	30	1000	3.15	45.10	30	3.15	66.15
21	35	1000	3.25	48.35	35	3.25	69.40
22	40	1000	3.75	52.10	40	3.75	73.15
23	114	1000	7.70	59.80	114	7.70	80.85
24	46	1000	8.00	67.80	46	8.00	88.85
25	0	1000	2.30	70.10	20	3.30	92.15
26	0	1000	0.00	70.10	0	1.00	93.15
27	0	1000	0.00	70.10	0	0.00	93.15
28	0	1000	0.00	70.10	0	0.00	93.15
29	0	1000	0.00	70.10	0	0.00	93.15
30	0	1000	0.00	70.10	0	0.00	93.15
31	0	1000	0.00	70.10	0	0.00	93.15
32	0	1000	0.00	70.10	0	0.00	93.15
33	0	1000	0.00	70.10	0	0.00	93.15
34	0	1000	0.00	70.10	0	0.00	93.15
35	0	1000	0.00	70.10	0	0.00	93.15
36	50	1000	2.50	72.60	50	2.50	95.65
37	109	1000	7.95	80.55	109	7.95	103.60
38	0	1000	5.45	86.00	0	5.45	109.05
39	0	1000	0.00	86.00	0	0.00	109.05
40	53	1000	2.65	88.65	53	2.65	111.70
41	0	1000	2.65	91.30	0	2.65	114.35
42	0	1000	0.00	91.30	0	0.00	114.35
43	60	1000	3.00	94.30	60	3.00	117.35
44	65	1000	6.25	100.55	65	6.25	123.60
45	0	1000	3.25	103.80	0	3.25	126.85
Sub-total:				103.80 *			126.85 **
Grand-total:				232.95 *			665.90 **

Note:

* Water surface area in dry season without project

** Water surface area at 13m(GTS) with project condition

Water Surface Area in Internal Rivers

Jhenai River

Cross-Sec No	Distance (M)	Without Project W.S.Width (M)	Area(ha)	Cum.Area(ha)	With Project W.S.Width at 13m(GTS)	Area(ha)	Cum.Area(ha)
7	1000	27	1.35	1.35	65	3.25	3.25
8	1000	56	4.15	5.50	127	9.60	12.85
9	1000	74	6.50	12.00	110	11.85	24.70
10	1000	70	7.20	19.20	90	10.00	34.70
11	1000	0	3.50	22.70	115	10.25	44.95
12	1000	55	2.75	25.45	90	10.25	55.20
13	1000	69	6.20	31.65	89	8.95	64.15
14	1000	70	6.95	38.60	83	8.60	72.75
15	1000	70	7.00	45.60	80	8.15	80.90
16	1000	43	5.65	51.25	120	10.00	90.90
17	1000	75	5.90	57.15	79	9.95	100.85
18	1000	45	6.00	63.15	140	10.95	111.80
19	1000	41	4.30	67.45	60	10.00	121.80
20	1000	45	4.30	71.75	64	6.20	128.00
21	1000	0	2.25	74.00	100	8.20	136.20
22	1000	68	3.40	77.40	68	8.40	144.60
23	1000	30	4.90	82.30	57	6.25	150.85
24	1000	25	2.75	85.05	57	5.70	156.55
25	2000		2.50	87.55	190	24.70	181.25
26	2500		0.00	87.55	145	41.88	223.13
27	2500		0.00	87.55	130	34.38	257.50
28	5000		0.00	87.55	65	48.75	306.25
29	5000		0.00	87.55	145	52.50	358.75
30	5000		0.00	87.55	35	45.00	403.75
Sub-total:	40000			87.55 *			403.75 **

Chatal River

Cross-Sec No	Distance (M)	Without Project W.S.Width (M)	Area(ha)	Cum.Area(ha)	With Project W.S.Width at 13m(GTS)	Area(ha)	Cum.Area(ha)
1	0	24	0.00	0.00	50	0.00	0.00
2	1000	25	2.45	2.45	50	5.00	5.00
3	1000	52	3.85	6.30	60	5.50	10.50
4	1000	0	2.60	8.90	60	6.00	16.50
5	1000	52	2.60	11.50	60	6.00	22.50
6	1000	25	3.85	15.35	65	6.25	28.75
7	1000	0	1.25	16.60	50	5.75	34.50
8	1000	55	2.75	19.35	75	6.25	40.75
9	1000	55	5.50	24.85	65	7.00	47.75
10	1000	45	5.00	29.85	60	6.25	54.00
11	1000	55	5.00	34.85	65	6.25	60.25
12	1000	0	2.75	37.60	55	6.00	66.25
13	1000	0	0.00	37.60	25	4.00	70.25
14	1000	40	2.00	39.60	40	3.25	73.50
15	1000		2.00	41.60	71	5.55	79.05
16	4000		0.00	41.60	57	25.60	104.65
17	2000		0.00	41.60	57	11.40	116.05
18	5000		0.00	41.60	20	19.25	135.30
Sub-total:				41.60 *			135.30 **

Appendix - E

Basis for the estimate of the rehabilitation/extension cost for the FSMF in Jamalpur