ASSESSING THE IMPACTS OF COMMUNITY-BASED FISHERY MANAGEMENT (CBFM) ON INLAND FISHERY SECTOR IN BANGLADESH

By
Kazi Sabbir Ahmed, Salma Begum and Sajjad Zohir

In association with

Khan Zohirul Islam

August 2006

Economic Research Group
House # 3, Road # 16, Gulshan – 1, Dhaka – 1212
http://www.ergonline.org

This is a work funded by the World Fish Center (WFC), Bangladesh Office. Sabbir Ahmed and Salma Begum are Lecturers at the Department of Economics of North South University, Dhaka. Khan Zohirul Islam is a recent graduate in Economics from the Shahjalal University of Science and Technology. Economic Research Group provided the umbrella for undertaking the research. The research team had worked under the guidance of Dr. Sajjad Zohir, Executive Director, Economic Research Group.

Table of Contents

I. Introduction

The Community Based Fishery Management (CBFM) started operation in 1995 with the objective of testing and assessing alternative models of collaboration and partnerships between government, NGOs and communities to address sustainable use of inland fisheries and to improve benefits for the poor fishermen through their participatory involvement in management. The first phase of CBFM ended in 2000 and is commonly referred to as CBFM 1. The second phase (CBFM 2) began in September 2001 as a continuation of the work of CBFM 1. However, in addition, CBFM 2 also sought to identify and test mechanisms for linking local CBFM arrangements to better manage larger fisheries systems (scaling up) and to inform and influence fisheries policy stakeholders for pro-poor policy formulation.

The CBFM-2 sought to develop fisheries and micro management model by focusing on beneficiaries' participation in resource management. The aim is to assess whether overall management of the water bodies improves overtime. The indicators such as degree of dependence on the resource for economic and subsistence activities, assets and investment in fishing, fishing access, catch size and use, fish consumption, compliance with fishing rules are the criteria that have been commonly used as the basis of the evaluation of CBFM-2.

Even though a number of studies has been undertaken by various institutions and agencies to assess the impact of CBFM -2 at micro level, the importance and contribution of CBFM type of intervention at the macro or national level are yet to be analyzed intensely. This study has been designed as an attempt to fill this gap of measuring macroeconomic benefits and trade-offs of CBFM approaches as well as the consequences of non-management of fishery resources. The study has three components. The first part of the study involved undertaking statistical comparative analysis between project and control households (or water bodies) on the basis of three monitoring data sets on household consumption, income/expenditure and fish catch at water body level. The second component dealt with comparative analysis of Benchmark (baseline) and Impact survey data. Drawing lessons from these two parts, the final component involved developing a suitable model and undertaking simulated projections to assess the contribution of CBFM within a national context.

As part of the final task of the study, a simple model for the fish market has been developed based on the broad framework of demand and supply structure in a multi-market context. Due to data limitations (discussed later in detail), only supply functions at water body level for inland captured fish were estimated. On the basis of these estimates, a number of simulation exercises have been conducted to assess the impact of CBFM 2 on equilibrium solutions using such shock variables as household income and percentage of water bodies under program status. In addition, an attempt has been made to project the impact of CBFM 2 under different assumptions if the program continued till 2020.

Summary results from the first two components of the overall study has been discussed in section II followed by an overview of the inland capture fishery in Bangladesh in Section III. The latter also includes a review of recent literature with respect to multi-market modeling approach in fisheries sector. Section IV describes the general structure of the model while

Section V deals with the estimation process, simulation design and projection scenarios. Results are discussed in Section VI, followed by concluding remarks in Section VII.

II. Summary of Findings from CBFM Data

As mentioned earlier, the three sets of monitoring data on consumption, income/expenditure and fish production were analyzed under the first task of the present study. The second task involved a comparative analysis of benchmark and impact survey data. Detail statistical analyses of the two themes are presented in Annex A, while summary accounts of the results are presented below.

II.1 Summary of Findings on Monitoring Data

II.1.1 Findings on Household Consumption

The consumption data series was analyzed with respect to household average fish production, total fish consumption and amount of fish kept for future consumption. It has been found that in general fish production and consumption (in kg) of project households is higher than control households for **open beel** water bodies. The differences between the production and consumption levels of the two groups are also statistically significant for most of the seasons. Even though project households are found to keep higher amounts of fish for future consumption than control groups for this type of water bodies, the difference, however, is not statistically significant for most of the seasons.

Fish production and consumption are generally lower for project households compared to control households in **closed beel** water bodies. However, the difference between the production and consumption levels of project and control groups is statistically significant for some quarters only. Project households have been also found to keep lower amounts of fish compared to control households. None of the differences between project and control groups are, however, statistically significant.

Since there were no ‘control’ households available in the sample panel for **flood plain beels** and **rivers,** it was not possible to compare the difference across project and control groups for these types of water bodies with respect to fish production, consumption and amounts kept for future consumption.

II.1.2 Findings on Household Income/Expenditure

The income/expenditure data series was analyzed with respect to household food expenditure, non-food expenditure, expenditure on crop production and total expenditure. Analysis for the **flood plain beel** water bodies reveals that food expenditure, non-food expenditure as well as total expenditure of project households is higher than control households for most of the quarters in the sample. The differences between the two groups (project and control) are also found to be statistically significant for most of the seasons. Even though expenditure for crop production in **flood plain beel** water bodies was found to be higher for project households than control households in most of the seasons, none of the differences has been statistically significant.

Food expenditure in **open beel** water bodies has been found to be lower for project households compared to control households for most of the seasons. The difference in total food expenditure between project and control groups is also statistically significant for most of these seasons. Total non-food expenditure has been found to be higher for project households compared to control households for most of the quarters. The difference between project and control groups is, however, statistically significant for some of these seasons only. Even though project households incur higher expenditure for crop production compared to control households, the differences are not statistically significant. Similar results have been found with respect to total expenditure of project households compared to control households.

Similar comparative exercise has not been possible for **rivers** and **closed beel** water bodies due to lack of control households in the panel sample.

II.1.3 Findings on Fish Production

It has been seen that amount of fish caught in the project water bodies is higher than that of control water bodies in all the four types of water bodies and also across all the seasons. As a result, total annual fish production measured in kilograms has been found to be higher for the project water bodies than the control ones for the years 2003, 2004 and 2005.

Analysis of gill-net specific production for **rivers** shows negligible difference between average fish production of project water bodies and control sites, except for the June-November 2005 period when average production is reported to be higher for project than control sites and also the difference is statistically significant. Average fish production of gill-net in **flood plain beel** water bodies is higher for project sites than control ones for most of the seasons. However, the difference between the average production of project and control sites is statistically significant for two seasons only. Similar results have been found for average fish production of gill-net in **open beel** and **closed beel** water bodies.

II.2 Comparison of Benchmark and Impact Survey

When benchmark and impact survey data were compared, it was seen that total annual income of beneficiaries was significantly lower than that of non-beneficiaries in baseline time period (before CBFM 2 scenario) as well as in impact study (after CBFM 2 scenario). However, percentage increase in annual income was about two times higher for beneficiaries than that of non-beneficiaries. Even though total annual income from agriculture, fishing, trade, profession, remittance, self employment, land and equipment rentals increased significantly for both groups, the increase was less for beneficiaries than non-beneficiaries in most of these cases, with the exception of income from fishing.

Regarding sources of income, the contribution of agricultural related activities in total disposable income was found to have decreased for beneficiaries over time whereas it increased for non-beneficiaries. Proportion of income from fishing related activities increased significantly for both groups, but it was about four times greater for beneficiaries than that of non-beneficiaries when “before” and “after” scenarios were compared. In particular, it significantly increased for the direct fishing sector. Direct fishing was found to be the major source of fishing related income for the beneficiary households in both baseline and impact period. Most of the fishing related income for the non-beneficiaries came from fish and fish related trading in baseline, but direct fishing was the main contributor in their fish-related income in the impact period. The contribution of direct fishing in total fishing income stood at about seventy two percent for beneficiaries and sixty one percent for non-beneficiaries in the impact year. Proportion of fishing income from fish labor, fish and fish related trading, selling of fish fry, fish pond/culture and from drying and processing of fish declined for both beneficiaries and non-beneficiaries. Thus, it could be argued that the remarkable increase in total fishing income was mostly due to higher contribution of income from direct fishing rather than due to change in income from other sources.

Total expenditure increased significantly both for beneficiaries and non-beneficiaries compared to the base scenario, but it was found to be higher for the beneficiaries. Both beneficiaries and non-beneficiaries reported lower expenditure on food, clothing, housing, and on travel during the impact period. At the same time, expenditure on health, fuel, loan repayment, savings, land and festival related activities was found to be higher during the impact period for both groups. Importantly, expenditure on education increased for beneficiaries in the impact year whereas it decreased for the non-beneficiaries.

Percentage of households reporting positive expenditure increased significantly for loan repayment, education and land across both beneficiaries and non-beneficiaries. Compared to non-beneficiaries, percentage of households reporting positive borrowing increased significantly for beneficiaries. Proportion of households reporting positive number of dwellings and area of dwellings remain more or less unchanged for both groups. However, the percentage of households with positive responses for number of TVs, radios, bicycles, rickshaws/vans and cattle/buffaloes increased significantly for both groups. A higher proportion of non-beneficiary households responded positively on these expenditures. There were relatively more beneficiary households reporting positive number of goat/sheep than non-beneficiaries during the impact period.

The average area of all kinds of land, except khas land, was found higher for non-beneficiaries both in baseline and in impact periods. Own homestead land, own pond or ditch and land ‘owned but mortgaged out’ increased for beneficiaries, while the corresponding figures had decreased for non-beneficiaries. Land owned and cultivated by the households decreased for both groups. However, own non-cultivated land increased significantly for both groups.

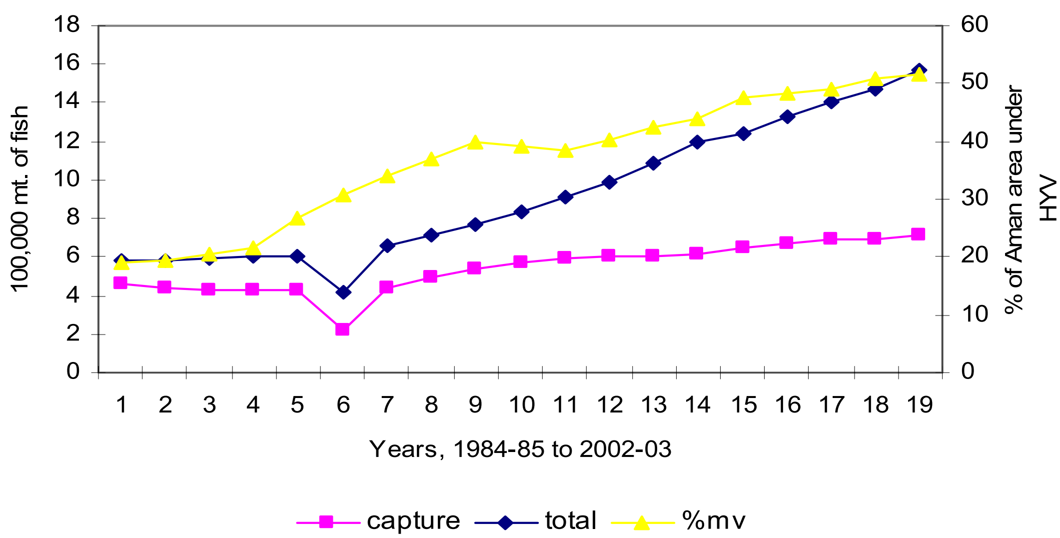
Average years of schooling of children between five and ten years of age marginally changed for both groups. Average years of schooling of children between eleven and fifteen years of age also slightly declined for both groups. However, average years of schooling for adult members (age sixteen or more) increased for both groups. The increase was higher for beneficiary households.

III An overview of Inland Capture Fishery in Bangladesh

III.1 Trends in Fish Production

Fishery is an important sector in the economy of Bangladesh. It is the main source of animal protein and a vast majority of people depends on fishing for their livelihood. The fisheries sources of Bangladesh have been broadly divided into inland and marine fisheries. The inland fishery covers an area of about 4.3 million hectare, while the area of marine fisheries is about 7 million hectare. However, inland fisheries remain the most important contributor to fish production in Bangladesh. Within the inland fishery sector, further distinctions are made between capture (open access) and culture (closed water bodies) sources. While the total capture fish production continues to increase, the Pace of increase falls far short of the pace of population increase – capture fish production failed to double over the last 20 years (1984/85 to 2004/05, see Annex B).

Figure 1: Trends in Inland Fish Production and Adoption of HYV Wet Season Rice



Note: Total' excludes marine fish production.
Source: Statistical Yearbook of Bangladesh, various editions

It is well known that fish and wet season rice are often competing sectors, particularly when High Yielding Variety (HYV) is adopted with increased use of chemical fertilizer and pesticides. It is therefore no wonder that increased adoption of HYV Aman did not permit significant growth in the production of inland captured fish. Figure 1 captures the trends (see also Tables in Annex B), which clearly suggest that the share of captured fish in total inland fish production has persistently declined, especially since the share of HYV in Aman rice took off during late 1980's.

III.2 Brief look into the Projection Exercises on Fishery Sector

Given this scenario of inland fishery sector, various studies have been undertaken to model, estimate and project demand and supply of fish in Bangladesh. A number of such studies have been identified from a survey of recent literature. A summary of the approaches taken in some of the most relevant studies is presented below.

In the paper "Disaggregated Projections on Supply, Demand, and Trade for Developing Asia: Preliminary Results from the Asia Fish Model" by Madan Dey (et. al) an attempt has been made to conduct an impact analysis for fish demand, supply and trade. In doing so, the paper relies on the Asia fish model developed by WorldFish Center under a project of the Asian Development Bank (ADB). The Asia Fish Model has consumer, producer and trade cores. Supply equations for fresh fish are derived normalized quadratic profit functions. The demand equations are Almost Ideal Demand System. These demand equations are developed from a three-stage budgeting process. In the first stage consumption expenditure is divided in to food and non-food spending. The second stage determines household demand for fish. The final stage captures demand for different types of fish using a quadratic form of Almost Ideal Demand System.

In the trade core, the Asia Fish Model follows the Armington approach by assuming that domestic and foreign goods are differentiated products. It follows a constant elasticity of transformation for exports and constant elasticity of substitution for imports. The model is solved/closed by attaining simultaneous equilibrium among the demand, supply and trade cores. The model identifies demand and supply composites for matching fish types and then disaggregates the demand and supply composites based on a constant elasticity function.

Projections for production, consumption and trade were made assuming that the exogenous variables followed some assumed changes. The projections were made using 2 scenarios:

- faster technical progress in freshwater aquaculture
- faster technical progress in high value fish in aquaculture

Results from this study indicate that, with rising population and income, fish demand will continue to grow and supply will also rise, with majority of the increase coming from culture fishing. It has been further reported that Bangladesh is likely to experience a long-term decline in per capita fish consumption, unless reversed by aggressive productivity improvements. This result was supported by the projection and simulation of the alternative scenario with higher productivity growth.

In the paper titled "Globalization and Fisheries: Welfare Implications of Export Trade in Asia" by Roenhlano M. Briones (et. al) studies the impact of export-oriented fisheries on the poor fishers, fish farmers and traditional processors. The authors also rely on the Asia Fish Model and looks at quantitative impact assessment of the effect of rising export price on domestic fish consumption. It expands the framework of the Asia fish model on the supply side by adding different supply functions for capture and culture fisheries. Moreover, processed fish is assumed as a product of fresh fish under fixed proportions technology. In this study, it has been estimated that Bangladesh is expected to have only a slow aggregate consumption growth for fish reaffirming the results from the earlier study. However, this study estimates that consumption would shift away from traditional species such as Indian carps, Pangus, and Hilsha, to newer species such as other carps, high value marine fish and even tilapia.

In the document titled "Fish to 2020: Supply and Demand in Changing Global Markets" by Delgado *et al* of International Food Policy Research Institute (IFPRI) attempts to project production, consumption and trade trends of fisheries items on the basis of IFPRI's IMPACT model. The fisheries component of IMPACT includes 4 types of food fish and 2 types of animal feed items made from fish.

Here culture and capture fisheries have not been differentiated for demand purposes. However, the 4 categories of fish have been sub-divided into separate categories of capture and culture on the production side. Supply (culture, capture) and demand (combined) for these six composites interact together to produce six equilibrium prices in each market. For the model balance across production, consumption and net trade for each country has been impost ex-post for the base year (1997).

Projection scenarios include faster aquaculture expansion, lower production in China, fishmeal and oil efficiency increase, slower aquaculture expansion and ecological collapse (extremely pessimistic scenario for capture fisheries). According to the study findings, global food fish production is likely to increase slightly faster that fish population through 2020. The study also reports that investments in culture fisheries, targeting low-valued fish, are likely to help poor fishers benefit from fisheries development.

IV. The Conceptual Framework

It could be envisaged that CBFM 2 type of intervention has the potential to influence outcomes in both fish and non-fish markets as fish production, consumption, household income and various other factors change. Therefore, the conceptual framework has been developed considering two markets in operation: fish and non-fish markets. A set of demand and supply equations would define each of these two markets and simultaneous equilibrium in these markets would lead to solutions based on which projection analysis for future scenario could be conducted.

IV.1 Fish Market

As with any market, demand and supply of fish characterize the fish market. On the supply side, one needs to distinguish between capture and culture according to production source. Moreover, supply of fresh fish needs to be disaggregated by major fish species groups (*eg*., carp, small fish. tilapia, live fish, other freshwater fish etc.). There would be specific supply functions for capture as well as culture fisheries for various species groups. These supply functions would generate the supply of fresh fish of various categories from capture and culture sources which would be ideally a function of relative price, price of inputs, price of competing and substitute goods in production, environmental factors, management options/policies etc.

On the demand side, distinction between capture and culture would also be necessary as these can be assumed to be imperfect substitutes. Considering fish as a heterogeneous commodity, demand functions should also account for species group/fish type. The very broad framework underlying the empirical work involving simulations in this study includes sets of demand and supply equations for the Fish market, as described below:

(i) Demand and Supply of Fresh Fish from Capture Sources

$$QD_{it}^{cpf} = \alpha_1 + Z_{it1}\beta_1 + u_{it1} \ ;$$

where i refers to categories of fish and QD_{it}^{cpf} is household demand for fresh fish (capture) and Z_{it1} is a set of independent variables which includes relative price of capture to culture fish, relative price of fish to non-fish food items, income, and some socio-economic variables such as program status, types of water bodies, baseline category of fishermen etc.

$$QS_{it}^{cpf} = \alpha_2 + Z_{it2}\beta_2 + u_{it2} \, ;$$

where i refers to categories of fish and QS_{it}^{cpf} is household supply for fresh fish (capture) and Z_{it2} is a set of independent variables which includes relative price of capture to culture fish, relative price of fish to non-fish food items, cost of fishing, size of the water body, percentage time spent using a particular gear, biological stock/growth of fish stock, and some socio-economic variables such as program status, types of water bodies, baseline category of fishermen etc.

(ii) Demand and Supply of Fresh Fish from Culture Sources

$$QD_{it}^{clf} = \alpha_3 + Z_{it3}\beta_3 + u_{it3}$$

where i refers to categories of fish and QD_{it}^{clf} is household demand for fresh fish (culture) and Z_{it3} is a set of independent variables which includes relative price of capture to culture fish, relative price of fish to non-fish food items, income, and some socio-economic variables such as program status, types of water bodies, baseline category of fishermen etc.

$$QS_{it}^{clf} = \alpha_4 + Z_{it4}\beta_4 + u_{it4}$$

where i refers to categories of fish and QS_{it}^{clf} is household supply for fresh fish (culture) and Z_{it4} is a set of independent variables which includes relative price of capture to culture fish, relative price of fish to non-fish food items, cost of fishing, size of the water body, percentage time spent using a particular gear, stock of fish, land price, and some socio-economic variables such as program status, types of water bodies, baseline category of fishermen etc.

IV.2 Non-fish Market

Following similar notions of a market, the demand and supply functions for the non-fish market could be developed. Since the focus of the study is obviously on the fish market, the demand and supply functions in the non-fish market would be in aggregate form. These are:

$QD_{jt}^{nf} = \alpha_5 + Z_{jt5}\beta_5 + u_{jt5}$;

Where, *j* refers to categories of non-fish product and QD_{jt}^{nf} refers to household demand for the jth category of non-fish item at time t and Z_{jt} is a set of independent variables such as relative price of non-fish to fish, general price index, income, and socio-economic variables.

$QS_{jt}^{nf} = \alpha_6 + Z_{jt6}\beta_6 + u_{jt6}$

Where, *j* refers to categories of non-fish product and QS_{jt}^{nf} refers to household supply for the jth category of non-fish item at time t and Z_{jt} is a set of independent variables such as relative price of non-fish to fish, general price index, cost of production, and socio-economic variables etc.

IV.3 General Equilibrium of Fish and Non-fish Markets

Ideally, one would like to estimate the parameters of the system of simultaneous equations defined by the demand and supply functions presented above, and that also, with due to cognizance of the biological aspects of fish reproduction. The endogenous variables of the model would not only include QD^{cpf}, QS^{cpf}, QD^{clf}, QS^{clf} QD^{nf}, QS^{nf}, (P^{cpf}/P^{clf}), P^{nf}, but also stock of various species. The exogenous variables would include income, baseline category, program status, water body type, and percentage of time spent using a particular type of gear. If the values of shock i.e. exogenous variables are changed under a set of assumptions, a new set of equilibrium values would be generated. By comparing the old and the new equilibrium, it would be possible to capture the effect of the change in shock variables on equilibrium values. This mechanism could be employed for the simulation exercise to capture the effect of CBFM since one can argue that CBFM has brought a change in the values of the shock variables which in turn affected the market outcome. Based on the time path of the exogenous variables, projection of the equilibrium outcome over a given time frame could be made to investigate the probable impact of CBFM type intervention.

While the general framework outlined above had been the basis, the exercise undertaken had to be limited to the supply of fish from the various types of water bodies as captured by the catch monitoring data. In only limited ways, other dataset could be made use of, details of which are discussed in the following section.

V The Estimation Process and Simulation Design

The primary objective of undertaking a simulation and projection analysis is to investigate the contribution and importance of inland fishery sector in the national economy of Bangladesh. The projection results are also intended for policy makers to enable them to assess the relative benefits and trade offs of alternative management options. The model presented earlier in the previous section is, indeed, the intended model designed to suit a projection analysis. Unfortunately, this model could not be estimated in its entirety due to lack of data. Since the primary source of data (as outlined under the scope of the study) was the three monitoring datasets as well as the baseline and impact survey, it was only possible to estimate the supply of capture fish (QS_{it}^{cpf}) from the available data. One must acknowledge the fact that the monitoring datasets and the baseline and impact surveys were not designed for simulation or projection purposes. As a result, there were serious deficiencies in meeting data requirements for estimation of the model outlined above. Moreover, bio-economic data on wild fish stock was also needed to undertake a meaningful projection analysis, which was not available at the time of undertaking this study. As a result, data limitation severely constrained the ability to design and estimate a proper model of the fishery sector and the ultimate empirical query under this study became estimating a simplified fish production function for captured fish as a function of variables permitted by parameter estimates from the available data and to conduct simulation exercise on the basis of the estimated supply function.

V.1 Supply of Capture Fish – Estimation

The purpose of the simulation exercise is to be able to project production of inland capture fish. The underlying conceptual framework suggests that supply of fish would depend on its relative price – vis-à-vis cultured fish and (more importantly) vis-à-vis prices of non-fish food. Influence of projects could only be captured by status of water bodies (project and control). Supply would also depend on the extent of extraction, at least in the short term when (possible) depletion of stock is not yet visible in observed outcomes on catch. The extent of extraction shows up in the number of gears that are active on a unit area (ha) of water surface, while the changes in stocks are better captured with time variable. In order to make best use of the three sets of monitoring data, the research team generated a panel data that included year-wise months on the time scale and individual water bodies to represent the cross-sections. Some aspects of this panel data are discussed before presenting the regression estimates on supply of capture fish.

Consumption and expenditure data from household monitoring provided information to group various species into capture and culture. The data also permitted construction of 'non-fish food' price, which is a weighted average of prices of all non-fish food items with shares in consumption being used as weights. Similarly, specie-wise prices were used to generate prices of capture and culture fish for each month in a year. There were missing observations, and these were filled with commonly acceptable statistical techniques.

In the estimated Catch (supply) function of inland capture fish, the **dependent variable** is measured as total catch of captured fish (in log natural of kg). The **exogenous variables** were one dummy variable for project status, three dummy variables for open beel, closed beel and flood plain beel (with rivers as reference), three dummy variables for interaction between project status and water body types, ratio of price of captured fish to price of non-fish food (in log natural), time (in log natural of months), number of active gears per hectare of water body (log natural) and area (in log natural of hectare). The findings are presented in Table 1 below.

The base for comparison in this estimated function is river. The negative sign of the estimated coefficients for the open beel, closed beel and flood plain beel indicate that the production of these types of water bodies is lower than that of river. These are also statistically significant. The positive sign of the coefficients for project open beel, closed beel and flood plain beel imply that fish production is higher in the project water bodies of these types. However, the coefficient for the closed beel is statistically significant at 5% significance level. Interaction terms of area and water body type show that fish production decreases for open beels as (mean) area of a water

Table 1: Regression Estimates, dependent variable: log of catch of capture fish, daily by water body

Description of Variables	Coefficients	t-value	Level of sig.
Constant	0.0882	-0.08	0.938
Dummy, 1 if project (DP)	0.0272	0.09	0.928
Dummy, 1 if open beel (DOB)*	-2.0572	-3.86	0
Dummy, 1 if closed beel (DCB)*	-9.8764	-3.61	0
Dummy, 1 if FPB (DFPB)*	-2.2485	-4.77	0
Dummy, DP x DOB	0.8576	1.85	0.064
Dummy, DP x DCB*	4.268	2.33	0.02
Dummy, DP x DFPB	0.1338	0.28	0.777
Area of Open Beel, cross (AWB1)	-0.0022	-1.27	0.203
Area of Closed Beel, cross (AWB2)*	0.1399	3.06	0.002
Area of FPB (AWB3)	0.0006	0.62	0.539
Dummy, 1 if dry season (DDRY)	-0.0217	-0.08	0.934
Dummy, DDRY x DOB	0.2932	0.79	0.429
Dummy, DDRY x DCB	0.4999	1.08	0.28
Dummy, DDRY x DFPB	0.2707	0.68	0.498
Ratio of price of captured fish to price of non-fish food (log natural)*	0.1775	2.03	0.043
Time, log natural	-0.2018	-1.96	0.051
Number of active gears per ha of water body. Log natural*	1.2121	15.25	0
Area, ha, log natural	-0.1217	-0.78	0.435
Adjusted R-Square	0.51		

Note: Those with * have coefficient estimates that are statistically significant at 5% or less (that is, figures in last column are less or equal to 0.500).

body increases, whereas production is positively related with area for closed and flood plain beel. Here, it is statistically significant for closed beels only. The coefficient for the dry season has a negative sign meaning output is estimated to be lower in dry season. However, it is not statistically significant. When interaction variables are taken between dry season and water body types, it is seen that production is higher in all three types of water bodies during the dry season, though none of these are statistically significant. The sign of the coefficient for the ratio of price of capture fish to price of non-fish is positive and statistically significant. It implies that fish production from capture sources is likely to increase as relative price of capture fish to non-fish items increases. Time fished is negatively related with fish production. Number of active gears is positively related with fish production and it also has a statistically significant coefficient. Area of the water body is negatively related with output, but is not statistically significant.

V.2 Simulation Design

Given the reality of data, an attempt has been made to outline some possible simulation and projection scenarios under a set of assumptions regarding the growth of the exogenous variables. In the simplified supply function, there are several sets of shock variables through which one can try to trace the impacts of CBFM type intervention. These **shock variables** are:

- Percentage growth in total area under different types of water bodies;
- Percentage growth in mean area under different types of water bodies;
- Percentage growth in project area under different types of water bodies;
- Annual growth in active number of gears per hectare;
- Relative price of captured fish to price of non-fish food items (to be affected by changes in income).

Depending on the direction and magnitude of assumed changes in these exogenous variables, a number of alternatives could be generated. It is expected that the relative price of captured fish to price of non-fish food items would be affected by changes in income. Based on adjusted values of expenditure and supply elasticities of capture fishery used in Bangladesh country model of Asia Fish Model (Madan Dey (et. al), it has been estimated that the price of capture fish would increase by approximately 4.368 percent for 6.2 percent rise in income whereas price of non-fish items was estimated to go up by 3.1% for the given increase in income (workings in the annex). This has been treated as the Business As Usual (BAU) alternative. Two other alternative values for the relative price of fish to non-fish presented here are based on scenarios where high productivity growth in culture fishery depresses the increase in the price of capture fish and as a result there would be no change (growth rate = 0%) in the relative price of capture fish. This is the optimistic scenario about fish production in Bangladesh. On the other extreme end is the case of slower technical progress in culture fishing such that the relative price further increases to 2.5% from the business as usual value of 1.41%. A list of some of the alternative values is presented in Table 2.

The business as usual value of total area and mean area of different types of water bodies is obviously zero. The alternative values indicate overall decline in total as well as mean area of water bodies. This scenario is justified by reality where a large area of fish habitat has been gradually removed due to encroachment, construction of embankment, infrastructure and siltation of rivers. Given this situation, it has been assumed that there would be one percent decline in the total area of open beels, flood plain beels and rivers. The assumed decline for closed beels is smaller (0.5 percent) to reflect the possibility that as some water bodies (such as open beels) become smaller in size (due to encroachment or other reasons), these might effectively be considered as closed beel type of water bodies. Due to reasons stated earlier, the mean area of water bodies is also likely decline in future together with the total area. However, the reduction in the mean area might be smaller that the reduction in the total area. This is based on the argument that some water bodies would be completely removed from fish habitat leading to a decline in the total area of water bodies; but the average size of water bodies may remain largely unaffected by this reduction in the total area. The decline in the mean area of rivers has been assumed to be smaller for obvious reasons.

Table 2: Exogenous Variables and their Alternative Values for the Rate of Change

Exogenous variables	Base Scenario (2005)	Assumed Change in the Growth Rate (%)	
		Business As Usual value	Alternative Value
Relative price of fish to non-fish	0.859	1.41	0 (optimistic), 2.5 (pessimistic)
Total area under Open Beel	114315.2 hectare	0	-1
Total area under Closed Beel	5406.48 hectare	0	-0.5
Total area under Flood Plain Beel	2846315 hectare	0	-1
Total area under River	1032271 hectare	0	-1
Mean area under Open Beel	95.08 hectare	0	-0.1
Mean area under Closed Beel	66.13 hectare	0	-0.1
Mean area under Flood Plain Beel	166.22 hectare	0	-0.1
Mean area under River	572.29 hectare	0	-0.5
% of project area under Open Beel	3.41%	0	1
% of project area under Closed Beel	15.90%	0	1
% of project area under Flood Plain Beel	0.15%	0	1
% of project area under River	1.39%	0	0
% area in project (all)	0.24%	0	0.38
Number of active gears per hectare	28.32	10	3

It must be acknowledged here that the assumed magnitude of decline in the total and mean area of the different types of water bodies is rather arbitrary. Not all water bodies are likely to decline/change at the same rate in real life. It is quite plausible that as some types of water bodies decline, it might lead to increase in the number/mean size of other types of water bodies. For instances, homesteads or agricultural land could be increasingly turned into ponds or closed beels as demand for fish rises. The rate of decline of different types of water bodies could be estimated from time series data and correlation matrix of the magnitude of change in the relative size/area of the various types of water bodies. In the absence of such time series data of the size of water bodies and hence lack of a correlation analysis, it has been assumed rather arbitrarily that the total and mean area of the four types of water bodies would decline at the given rates listed in Table 2.

In the business as usual case, the assumed rate of change in the project area under different types of water bodies is also zero indicating the scenario that current trend continues in future. The alternative value reflects the possibility of expansion or scaling up of CBFM 2 type of intervention. As a result, the project area has been assumed to increase at a rate of 1 percent, except for rivers. The share of river under project has been assumed to stagnate. This is based on the understanding that it is difficult to compare across project and control sites in the case of rivers due to the size factor.

The business as usual for number of active gears has been assumed as 10 percent. This has been based on a downward adjusted value of the parameter estimated from gear census to take into consideration the effect of extreme values. The alternative value indicates a slower growth rate in the number of active gears per hectare. This assumption is justified on two grounds. Firstly, it is beyond doubt that capture fishery is already over-exploited and hence it is unlikely that growth rate in the number of gears would accelerate in future. Secondly, data on number of persons per gear shows a declining trend across different types of water bodies (graphs in annex). As a result, it is likely that number of gears per hectare has perhaps reached the peak and the growth would slow down in future as size of water bodies decline.

Given these alternative values of the exogenous and shock variables, a number of simulation and projection scenarios for fish production could be generated by taking a set of combination of these values. Out of many different possibilities, the following four scenarios have been selected for simulation and projection analysis.

Scenario 1
The first simulation exercise is a combination of the business as usual values of the exogenous variables listed in the Table 2.

Scenario 2
The second scenario assumes that relative of price of fish to non-fish grows at business as usual value (1.41 percent) and there is no change in the total area and mean area of the four types of water bodies. However, the rate of growth in the number of active gears has been assumed at its alternative value (3%).

Scenario 3
This scenario reflects the optimistic case of rapid growth in culture fisheries such that the assumed rate of change in the relative price of fish to non-fish is zero. This is combined with alternative values of the other exogenous variables. In other words, total area and mean area of the water bodies declines, project area expands and growth in active gears slows down.

Scenario 4
This scenario reflects the pessimistic case of slow growth in culture fisheries such that the assumed rate of change in the relative price of fish to non-fish is 2.5 percent. This is combined with alternative values of the other exogenous variables as in scenario 3.

Scenario 5
This scenario assumes a higher growth in the share of project in the three water bodies, but a BAU growth in relative prices and a conservative growth in the number of gears per ha.

Table 3 Summary of Scenario Values

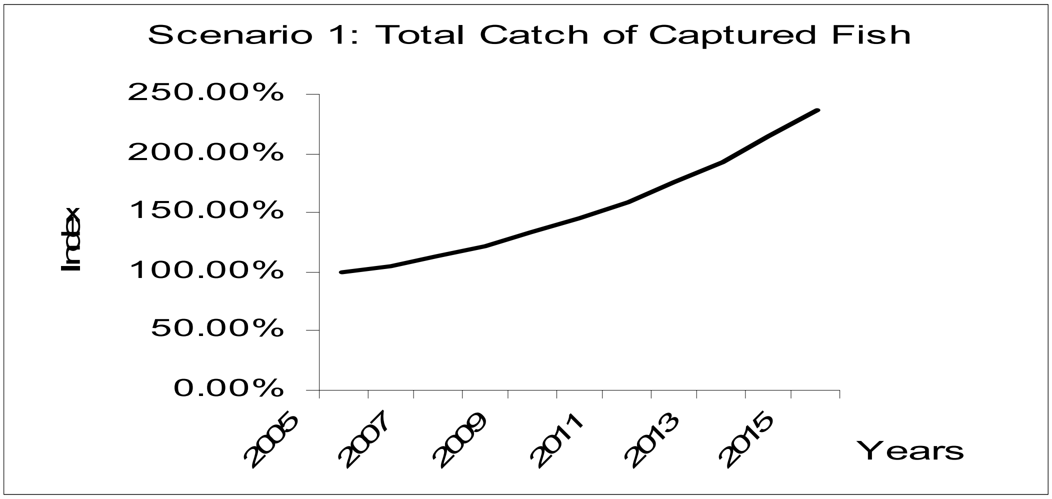
Exogenous variables	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Relative price of fish to non-fish	1.41%	1.41%	0%	2.5%	1.41%
Total area under Open Beel	0%	0%	-1%	-1%	-1%
Total area under Closed Beel	0%	0%	-0.5%	-0.5%	-0.5%
Total area under Flood Plain Beel	0%	0%	-1%	-1%	-1%
Total area under River	0%	0%	-1%	-1%	-1%
Mean area under Open Beel	0%	0%	-0.1%	-0.1%	-0.1%
Mean area under Closed Beel	0%	0%	-0.1%	-0.1%	-0.1%
Mean area under Flood Plain Beel	0%	0%	-0.1%	-0.1%	-0.1%
Mean area under River	0%	0%	-0.5%	-0.5%	-0.5%
Percentage of project area under Open Beel	0%	0%	1%	1%	2%
Percentage of project area under Closed Beel	0%	0%	1%	1%	2%
Percentage of project area under Flood Plain Beel	0%	0%	1%	1%	2%
Percentage of project area under River	0%	0%	0%	0%	0%
Percentage area in project (all)	0%	0%	0.38%	0.38%	0.77%
Number of active gears per hectare	10%	5.5%	5.5%	5.5%	5.5%

VII. Results

Simulation and Projection Results

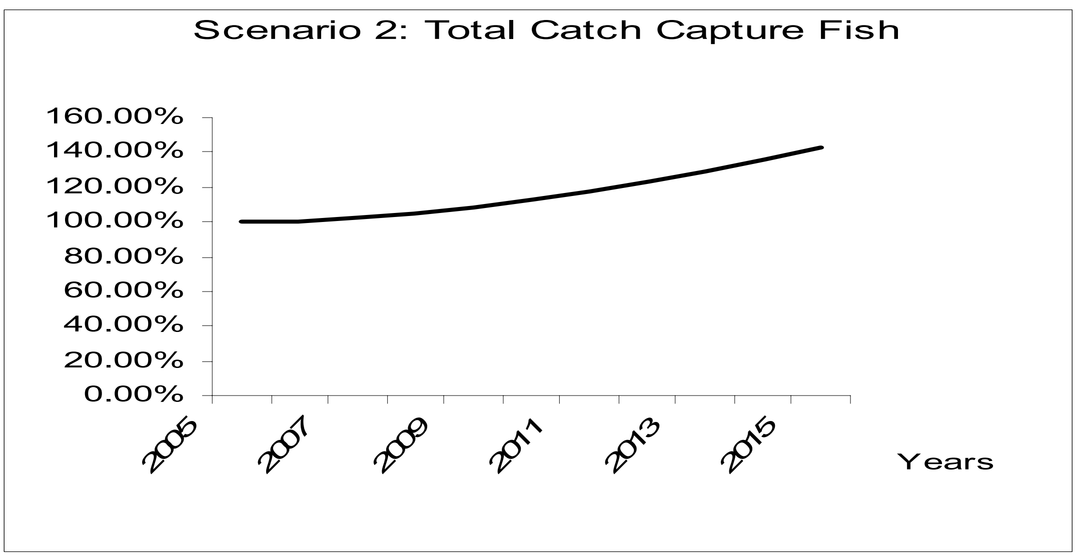
If there is no change in the total and mean area of water bodies as well as CBFM project area, but relative price of capture fish to non-fish increases at 1.41% and number of active gears per hectare grows at 10% per annum, the estimated impact on total catch of capture fish for the four types of water bodies is shown in Figure 2.

Figure 2: Total Catch of Capture Fish (Scenario 1)



It is important to note here that total catch is uniformly increasing across all types of water bodies as relative price of fish to non-fish and number of active gears increase. This result shows that the effect of a change in the relative price is same for all types of water bodies. According to the simulation results, fish catch from capture sources is projected to more than double by the year 2015 compared to 2005 under this scenario.

Figure 3: Total Catch of Capture Fish (Scenario 2)



When the a slower growth in the number of active gears is considered (3%), it is seen that total catch of capture fish first falls below the base year level till 2008 and starts to rise from 2009 onwards. The amount of catch is estimated to be 6.57% higher in 2015 than that of 2005. This result is expected because a sudden slow down in number of active gears used will initially reduce output. This change in assumption has the effect of dampening the increase in total catch as relative price of fish to non-fish increases.

Under scenario 3 (where there is no change in the relative price of fish to non-fish, total as well as mean area of water bodies declines, gear uses increases at a rate of 3% and CBFM 2 project area expands), fish catch from capture sources is projected to go down first, but increase later. The effect is very similar to scenario 2. However, the stagnant relative price of fish to non-fish and the over all reduction in the size of the water bodies have reduced fish production more than it did under scenario 2. Fish catch is projected to rise across all types of water bodies from 2009 and by the year 2015, total catch is estimated to increase by 4.5% in open beels, 3.96% in rivers, and 1.79% in closed and flood plain beels.

Figure 4: Total Catch of Capture Fish (Scenario 3)

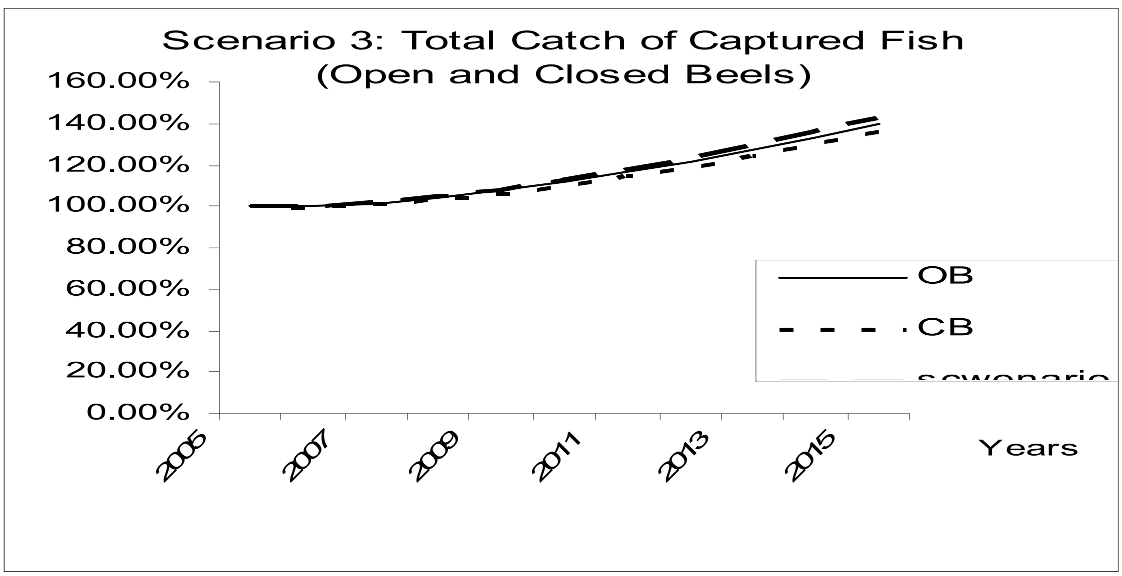
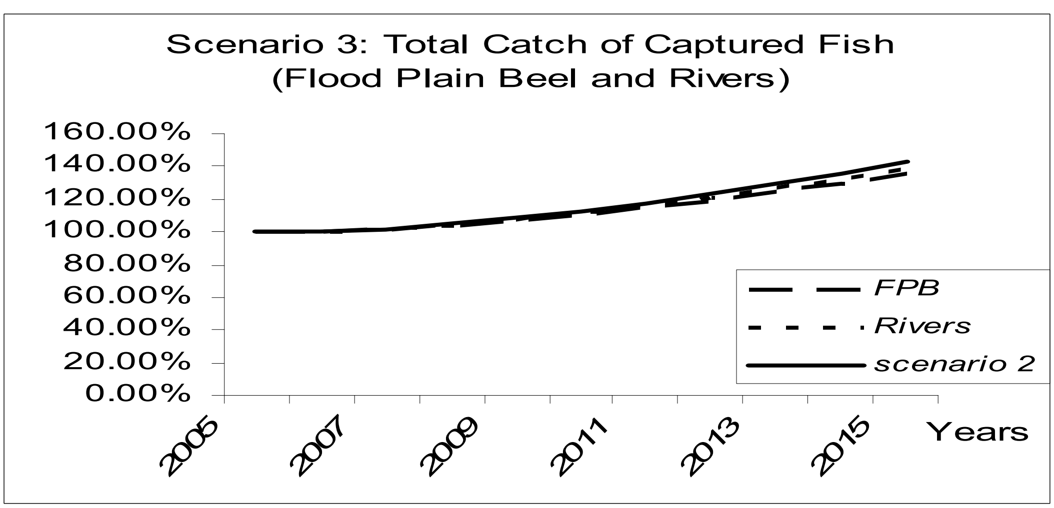


Figure 5: Total Catch of Capture Fish (Scenario 3)



Under the fourth scenario (where higher productivity in culture fishery leads to a rise in the growth rate of the relative price of fish to non-fish), capture fish production declines initially; but the decline is smaller in magnitude compared to that under scenario 3 or 2. The recovery in fish production also happens earlier (in 2008) than those scenarios. By the year 2015, total catch is estimated to increase by 9.18% in open beels, 8.61% in rivers, and 6.35% in closed and flood plain beels.

Figure 6: Total Catch of Capture Fish (Scenario 4)

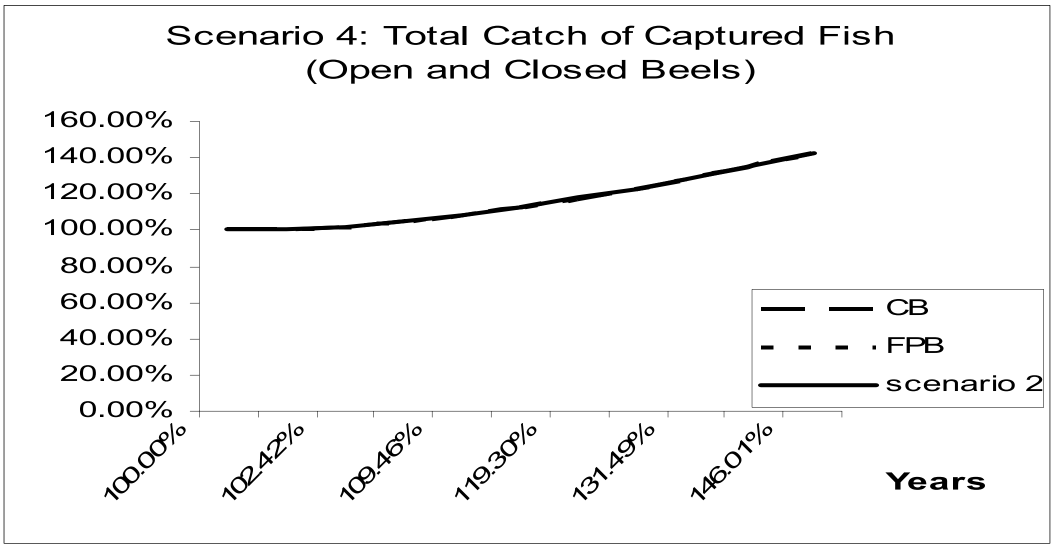


Figure 7: Total Catch of Capture Fish (Scenario 4)

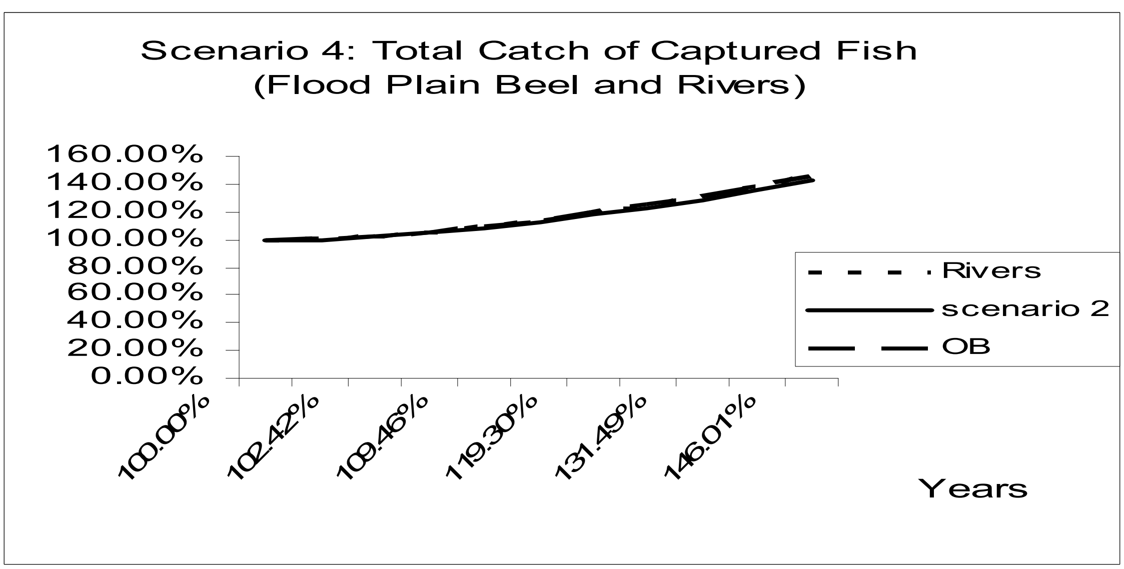
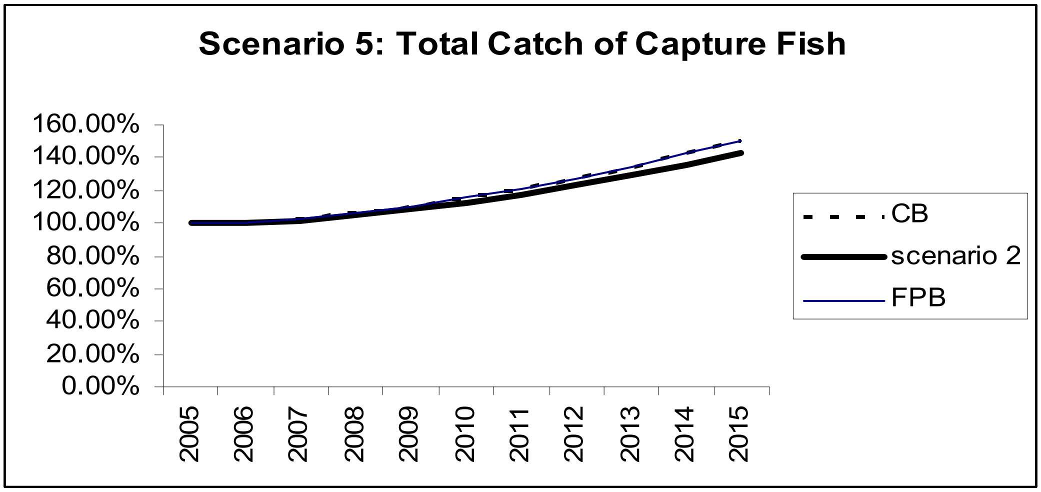


Figure 8: Total Catch of Capture Fish (Scenario 5)



VIII. Concluding Remarks

Even though an attempt has been made here to conduct a projection analysis of inland capture fishery, it must be noted that the task was undertaken in a very simple and partial manner. Limitations of data restricted estimation of a proper model to capture the effect of CBFM intervention and hence an analysis on the demand side of the fish market could not be carried out. As in other simulation studies, the current exercise relied on secondary estimates on demand parameters to derive exogenous time series on prices. In spite of several limitations, the estimated supply function of total catch from capture sources did reveal some interesting features. In particular, it was found that production of capture fish would increase as relative price of capture fish increases confirming the notion that supply of capture fish is not perfectly inelastic. The results also indicate significantly higher productivity of CBFM project water bodies, especially in Closed Beels.

Capture fish is a renewable resource, and its supply over time will depend critically on the extent of extraction. The supply analysis quite explicitly brings the tradeoff on fore. Growth in the number of gears operating on a hectare of water body had increased at great pace in the past – more than 10 percent per year. This was however associated with declines in average number of persons working per gear. Such trends generally reveal that resource extraction may have been poverty-driven, and quite expectedly, there may have been a decline in the potential output (stock) as reflected in a negative coefficient associated with time variable. The future does depend on the measures to replenish stocks, and realizing the right balance between current and future consumptions by influencing the number of operational gears of a given size.

The simulation exercise presented identified a set of probable scenarios and the results need to be judged cautiously because some of the exogenous variables, such as mean size of water body and growth in number of gears per ha, had been set arbitrarily. Projected total fish production from capture sources depends on such factors as growth in number of active gears per hectare, changes in the total and mean area of water bodies, scale of operation of CBFM 2 and changes in the relative price of capture fish to non-fish items. The results show that at least 5.5% annual increase in number of gears (per ha) is necessary to counter the short-term declines (as a result of past resource extraction). Duration of such declines in fish production may however be shortened, along with reduced mean size of water bodies and reduced growth in gear use, provided that relative price of capture fish to non-fish items increase significantly, and there is significant expansion of project area in selected water bodies. The study does not however address the cost of such measures.

Annex A: Statistical Analysis of Monitoring Data

Results on Household Consumption

Table 1.1 Household Average Fish Production (kg)

	Flood Plain Beel	Open Beel					River	Closed Beel				
Season	Project	Project	Control	Project - Control	t-value	Sig.	Project	Project	Control	Project - Control	t-value	Sig.
2002, Q3	10.36	36.58	9.11	27.47	3.88	0.00	38.37	35.37	47.31	-11.95	-1.34	0.19
2002, Q4	38.55	16.30	11.54	4.76	1.03	0.31	26.21	21.59	46.40	-24.80	-2.60	0.02
2003, Q1	12.07	22.29	11.50	10.79	1.87	0.06	67.58	38.25	44.93	-6.68	-0.51	0.61
2003, Q2	15.41	31.62	18.46	13.16	1.76	0.08						
2003, Q3	25.86	68.73	29.56	39.18	2.35	0.02	59.82	58.91	79.37	-20.45	-0.73	0.48
2003, Q4	54.22	66.25	18.55	47.71	3.67	0.00	93.77	44.94	84.35	-39.41	-1.87	0.07
2004, Q1	20.73	44.92	6.16	38.76	3.58	0.00	58.44	33.00	66.47	-33.47	-2.17	0.04
2004, Q2	15.84	46.86	9.96	36.89	3.35	0.00						
2004, Q3	24.36	70.52	9.95	60.57	5.20	0.00	61.06	21.30	68.75	-47.46	-3.51	0.00
2004, Q4	16.31	33.87	13.69	20.19	3.10	0.00	62.78	20.63	30.73	-10.10	-1.94	0.06
2005, Q1	16.54	30.32	5.75	24.58	3.97	0.00	51.83	21.96	24.45	-2.49	-0.44	0.67
2005, Q2	5.69	11.90	6.05	5.85	1.84	0.07						
No. of households	133	140	58				17	13	12			

Note: Q_1 = Jan – Mar, Q_2 = Apr – Jun, Q_3 = Jul – Sep, Q_4 = Oct - Dec
Some Households are missing.
A value of significance (say) less than 0.05 implies that the difference between project and control is statistically significant at 5%.

Table 1.2 Household Total Consumption of Fish (kg)

	Flood P.Beel	Open Beel					River	Closed Beel				
Season	Project	Project	Control	Project – Control	t-value	Sig.	Project	Project	Control	Project - Control	t-value	Sig.
2002, Q3	3.55	8.45	5.70	2.75	2.21	0.03	7.74	23.80	15.29	8.50	3.38	0.00
2002, Q4	9.18	4.79	8.25	-3.46	-3.06	0.00	8.24	16.33	17.66	-1.33	-0.26	0.80
2003, Q1	5.21	8.66	6.59	2.07	1.33	0.19	20.52	19.17	13.31	5.86	1.35	0.19
2003, Q2	5.23	10.65	9.81	0.83	0.39	0.69						
2003, Q3	7.61	14.88	10.37	4.51	1.86	0.06	19.24	33.16	25.06	8.10	1.04	0.31
2003, Q4	11.39	19.24	9.16	10.08	3.50	0.00	26.90	26.52	28.49	-1.97	-0.37	0.71
2004, Q1	6.33	17.02	2.98	14.04	5.59	0.00	19.88	19.73	21.16	-1.43	-0.21	0.83
2004, Q2	3.17	13.51	4.68	8.83	4.01	0.00						
2004, Q3	6.16	12.50	4.99	7.50	4.28	0.00	18.10	14.02	20.75	-6.74	-2.01	0.06
2004, Q4	3.05	7.92	6.43	1.50	1.27	0.21	15.41	13.87	16.41	-2.54	-0.98	0.34
2005, Q1	4.48*	11.20	2.12	9.08	5.69	0.00	14.64	14.95	12.22	2.73	0.73	0.47
2005, Q2	1.66	5.74	2.21	3.53	3.29	0.00						
No. of household	133	140	58				17	13	12			

Note: Q_1 = Jan – Mar, Q_2 = Apr – Jun, Q_3 = Jul – Sep, Q_4 = Oct - Dec
* Some Households are missing
A value of significance (say) less than 0.05 implies that the difference between project and control is statistically significant at 5%.

Table 1.3 Household Kept Fish for Future Consumption (kg)

	Flood Plain Beel	Open Beel					River	Closed Beel				
Season	Project	Project	Control	Project - Control	t-value	Sig.	Project	Project	Control	Project - Control	t-value	Sig.
2002, Q3	0.71	0.72	0.06	0.65	1.57	0.12	0.24	0.00	1.33	-1.33	-1.77	0.09
2002, Q4	1.05	0.88	0.23	0.65	1.50	0.14	0.00	0.00	0.75	-0.75	-1.04	0.31
2003, Q1	0.94	0.99	0.41	0.58	1.81	0.07	4.57	0.17	0.25	-0.08	-0.26	0.80
2003, Q2	0.97	0.49	0.57	-0.09	-0.31	0.76						
2003, Q3	1.11	0.24	0.97	-0.74	-2.56	0.01	0.00	0.00	1.98	-1.98	-1.61	0.12
2003, Q4	2.96	0.78	0.55	0.23	0.55	0.59	1.03	1.15	2.34	-1.19	-0.70	0.49
2004, Q1	1.74	1.10	1.04	0.06	0.10	0.92	4.85	0.00	0.94	-0.94	-1.45	0.16
2004, Q2	0.52	1.70	1.07	0.63	0.41	0.68						
2004, Q3	1.25	12.50	4.99	0.24	1.12	0.26	0.96	0.60	5.19	-4.59	-1.69	0.10
2004, Q4	1.16	0.39	0.75	-0.36	-1.77	0.08	6.91	2.08	6.88	-4.80	-0.95	0.35
2005, Q1	0.89*	2.26*	0.72*	1.54	2.02	0.04	6.37	0.35	1.88	-1.53	-1.14	0.27
2005, Q2	0.08	0.71*	0.49	0.23	0.46	0.65						
No. of Households	133	140	58				17	13	12			

Note: Q_1 = Jan – Mar, Q_2 = Apr – Jun, Q_3 = Jul – Sep, Q_4 = Oct - Dec
* Some Households are missing
A value of significance (say) less than 0.05 implies that the difference between project and control is statistically significant at 5%.

Results on Household Income/Expenditure

Table 1.4
Total Food Expenditure of Household (Tk) for Flood Plain Beels

	Flood Plain Beel				
Season	Project	Control	Project - Control	t-value	Sig.
2003, Q1	6045.38	5120.71	924.67	2.65	0.01
2004, Q1	6002.28	4511.15	1491.13	4.44	0.00
2003, Q2	5932.05	5042.27	889.78	2.37	0.02
2004, Q2	6132.99	5696.04	436.95	1.56	0.12
2003, Q3	5913.74	5223.74	690.01	2.64	0.01
2004, Q3	6510.09	5162.92	1347.17	4.60	0.00
2003, Q4	6822.22	5857.40	964.81	3.42	0.00
2004, Q4	6586.91	6201.53	385.38	1.34	0.18
No. of Household	247	95			

Table 1.5
Total Food Expenditure of Household (Tk) for Open Beels, Rivers & Closed Beels

	Open Beel					River	Closed Beel
Season	Project	Control	Project - Control	t-value	Sig.	Project	Project
2003, Q1	6418.87	10646.12	-4227.25	-2.96	0.00	9423.12	4592.07
2004, Q1	6155.94	6000.66	155.28	0.35	0.73	8285.56	4059.59
2003, Q2	5809.88	5738.34	71.54	0.16	0.87	8029.46	4529.37
2004, Q2	6066.88	7426.76	-1359.88	-2.95	0.00	7843.85	5018.69
2003, Q3	6379.97	8128.85	-1748.88	-2.52	0.01	7412.00	4413.25
2004, Q3	6165.63	7573.78	-1408.14	-2.90	0.00	7385.89	4436.70
2003, Q4	6204.61	7508.58	-1303.97	-2.92	0.00	7559.42	5010.42
2004, Q4	6891.85	7635.03	-743.18	-1.47	0.14	9089.18	5263.51
No. of Household	437	48				60	169

Table 1.6 Total Expenditure on Non-food (Tk) for Flood Plain Beels

	Flood Plain Beel				
Season	Project	Control	Project - Control	t-value	Sig.
2003, Q1	4455.84	1722.15	2733.69	4.39	0.00
2004, Q1	4919.89	4350.24	569.65	0.68	0.49
2003, Q2	4548.78	1365.29	3183.48	3.62	0.00
2004, Q2	4656.27	2930.33	1725.94	1.68	0.09
2003, Q3	3841.32	1856.84	1984.47	2.51	0.01
2004, Q3	6006.71	3457.51	2549.20	2.21	0.03
2003, Q4	3547.83	1608.59	1939.24	3.86	0.00
2004, Q4	4581.31	2745.38	1835.94	2.19	0.03
No. of Household	247	95			

Table 1.7 Total Expenditure on Non-food (Tk) for Open Beels, Rivers & Closed Beels

	Open Beel					River	Closed Beel
Season	Project	Control	Project - Control	t-value	Sig.	Project	Project
2003, Q1	3459.70	3506.20	-46.50	-0.04	0.96	3564.46	3669.87
2004, Q1	3938.25	2524.17	1414.09	1.64	0.10	4229.05	3276.19
2003, Q2	3805.45	2500.59	1304.86	1.68	0.09	2835.45	3245.29
2004, Q2	4356.02	1907.54	2448.48	1.98	0.05	3368.36	2518.17
2003, Q3	3672.29	2202.26	1470.03	1.90	0.06	3271.84	3574.65
2004, Q3	4525.41	1721.40	2804.01	3.63	0.00	2718.98	3446.54
2003, Q4	4189.11	1650.44	2538.67	2.28	0.02	3325.45	3552.53
2004, Q4	3792.30	1773.88	2018.42	2.47	0.01	3669.87	3024.03
No. of Household						60	169

Table 1.8 Total Expenditure of Household (Tk) for Flood Plain Beels

	Flood Plain Beel				
Season	Project	Control	Project - Control	t-value	Sig.
2003, Q1	10501.23	6842.86	3658.37	4.54	0.00
2004, Q1	10922.17	8861.393	2060.78	2.00	0.05
2003, Q2	10480.83	6407.566	4073.26	3.76	0.00
2004, Q2	10789.25	8626.366	2162.89	1.92	0.06
2003, Q3	9755.062	7080.579	2674.48	2.99	0.00
2004, Q3	12516.8	8620.429	3896.37	3.05	0.00
2003, Q4	10370.05	7465.994	2904.05	4.30	0.00
2004, Q4	11168.23	8946.913	2221.31	2.24	0.03
No. of Household	247	95			

Table 1.9 Total Expenditure of Household (Tk) for Open Beels, Rivers & Closed Beels

	Open Beel					River	Closed Beel
Season	Project	Control	Project - Control	t-value	Sig.	Project	Project
2003, Q1	9878.573	14152.32	-4273.75	-2.33	0.02	12987.58	8261.943
2004, Q1	10094.19	8524.824	1569.37	1.44	0.15	12514.61	7335.778
2003, Q2	9615.33	8238.926	1376.40	1.38	0.17	10748.43	7774.655
2004, Q2	10422.9	9334.302	1088.60	0.76	0.45	11169.3	7536.859
2003, Q3	10052.26	10331.1	-278.85	-0.25	0.80	10683.84	7987.9
2004, Q3	10691.04	9295.172	1395.87	1.37	0.17	10237.66	7883.238
2003, Q4	10393.71	9159.013	1234.70	0.94	0.35	10394.87	8562.951
2004, Q4	10684.15	9408.908	1275.24	1.14	0.25	12457.54	8287.534
No. of Household	437	48				60	169

Results on Fish Production

Table 2.1: Total Fish Production (kg.)

Type of WB	PS	December 2002 - May 2003	December 2003 - May 2004	December 2004 - May 2005	June 2003 - November 2003	June 2004 - November 2004	June 2005 - November 2005	2003	2004	2005
River	CBFM 2	74015.16	118315.44	126290.22	210709.68	265193.88	115770.06	284724.8	383509.3	242060.3
	Control	41630.28	54794.46	81593.46	70386.42	67217.76	28011.9	112016.7	122012.2	109605.4
Open Beel	CBFM 2	311291.88	190568.28	77904.54	175632.48	295272.3	60993.9	486924.4	485840.6	138898.4
	Control	15608.34	3375.78	9139.74	10536.06	16600.26	5401.5	26144.4	19976.04	14541.24
Closed Beel	CBFM 2	23223.54	38376.18	27621.18	23554.86	58513.26	8338.74	46778.4	96889.44	35959.92
	Control	366.18	9932.4	2628.48	3508.86	9255.36		3875.04	19187.76	
Flood P.Beel	CBFM 2	5060.04	7979.1	8886.9	19363.38	27141	49049.34	24423.42	35120.1	57936.24
	Control	514.62	1344.6	3557.22	3709.02	8658.06	5231.52	4223.64	10002.66	8788.74

Table 2.2: Weighted Total Fish Production (kg.)

	Project	Control	Difference	DD
2003	311087.4	41497.9	269589.6	
2004	339423.6	46682.4	292741.2	23151.6
2005	131945.7	49471.2*	82474.5	-210266.7

Note: Weighted average without CB

Table 2.3 Average Fish Production (kg) with Gill-Net per man-hour

Types of WB		River				Flood Plain Beel				Open Beel				Closed Beel			
Time Period	Project Status	Mean	CBFM 2 - Control			Mean	CBFM 2 - Control			Mean	CBFM 2 - Control			Mean	CBFM 2 - Control		
			Value	t-stat	Sig.		Value	t-stat	Sig.		Value	t-stat	Sig.		Value	t-stat	Sig.
December 2002 - May 2003	CBFM 2	0.45	0.02	0.28	0.78	0.58	0.27	1.21	0.25	0.35	-0.15	-2.11	0.04	0.41	0.22	1.40	0.16
	Control	0.43				0.31				0.50				0.19			
December 2003 - May 2004	CBFM 2	0.47	0.00	0.04	0.96	0.70	0.59	2.33	0.02	0.79	0.69	1.65	0.10	0.91	0.43	3.24	0.00
	Control	0.47				0.11				0.11				0.48			
December 2004 - May 2005	CBFM 2	0.46	0.06	1.26	0.21	0.87	0.47	-0.32	0.75	0.61	0.36	2.11	0.04	1.12	0.88	1.65	0.10
	Control	0.41				0.41				0.26				0.24			
June 2003 - November 2003	CBFM 2	0.49	0.07	1.19	0.23	0.39	-0.04	1.82	0.09	0.44	0.15	1.15	0.25	0.82	0.57	1.41	0.16
	Control	0.42				0.43				0.29				0.25			
June 2004 - November 2004	CBFM 2	0.41	0.00	0.04	0.97	0.61	0.38	1.50	0.15	0.61	0.48	0.70	0.48	0.72	0.51	1.19	0.24
	Control	0.41				0.23				0.14				0.20			
June 2005 - November 2005	CBFM 2	0.48	0.16	2.91	0.00	0.96	0.69	3.47	0.00	0.45	0.28	4.32	0.00	0.85	0.71	3.60	0.00
	Control	0.32				0.27				0.16				0.13			

Table 2.4 Weighted Average fish production (kg) with Gill Net per man-hour

Year	Project	Control	Difference	DD
2003	0.913820	0.705975	0.207844	
2004	1.319327	0.544723	0.774604	0.566196
2005	1.288627	0.514887	0.773741	-0.000863

Table 3 Average annual income by disaggregated sources (Taka in respective years)

Income Source	Benchmark			Impact Survey		
	Beneficiary	Non-beneficiary	All	Beneficiary	Non-beneficiary	All
Total Agriculture	**4615**	**10219**	**9098**	**10340**	**20491**	**18461**
Agricultural product	457	1653	1413	2219	5334	4711
Agriculture	4157	8567	7685	8122	15157	13750
Total Fishing	**3075**	**1702**	**1976**	**17851**	**5684**	**8117**
Fish labor	357	217	245	1164	258	439
Fish trade	0	0	0	27	91	78
Fisjh and Fish related trading	965	657	719	2787	780	1181
Fish fry selling	34	33	33	111	65	75
Fish pond/culture	394	512	488	490	972	876
Drying/processing fish	71	48	52	349	28	93
Direct Fishing	1255	236	440	12922	3490	5376
Total Trade	**1909**	**3709**	**3349**	**3502**	**6581**	**5965**
Trade & handicrafts	1191	1709	1605	2023	2234	2192
Business/petty trade/handicrafts/cart	718	2000	1744	1479	4348	3774
Total Semi skilled labour	**204**	**177**	**182**	**216**	**260**	**251**
Semi-skilled labor (daily)	135	76	88	162	128	134
Semi-skilled labor (annual)	1	2	2	30	36	35
Making and repairing of fish net/ poultry rearing boxes	68	99	92	24	97	82
Total Profession/ service	**379**	**2885**	**2384**	**1665**	**4951**	**4294**
Low paid daily services/profession	0	12	10	0	66	53
Service/profession(annual)	379	2873	2374	1665	4886	4241
Total Remittance	**773**	**2223**	**1933**	**1865**	**4080**	**3637**
Remittance	0	0	0	225	412	374
Internal remittance	773	2223	1933	1640	3669	3263
Total Other income	**4203**	**5518**	**5255**	**5915**	**7019**	**6798**
Other labor	3562	5236	4901	5282	6580	6321
Other income (domestic service+beggar+other sources)	641	282	354	633	439	478
Self employment	634	1135	1035	2109	2085	2090
Entrepreneur income	84	3	20	29	101	87
Livestock	773	826	815	1131	1243	1221
Dowry received	47	60	57	134	153	149
Samiti income(accrued to individual)	3	9	8	7	37	31
Earning from lendings	5	0	1	0	28	23
Land rented out	199	700	600	297	1436	1209
Equipment rental	58	419	347	385	797	714
Total	**16959**	**29586**	**27061**	**45444**	**54948**	**53047**
% change(impact over benchmark)				167.96	85.72	96.03

Table 4 Percentage distribution of annual income by sources

	Benchmark			Impact		
Income Source	beneficiary	non-beneficiary	All	beneficiary	non-beneficiary	All
Total Agriculture	**27.21**	**34.54**	**33.62**	**22.75**	**37.29**	**34.80**
Agricultural product	2.70	5.59	5.22	4.88	9.71	8.88
Agriculture	24.51	28.96	28.40	17.87	27.58	25.92
Total Fishing	**18.13**	**5.75**	**7.30**	**39.28**	**10.34**	**15.30**
Fish labor	2.10	0.73	0.90	2.56	0.47	0.83
Fish trade	0	0	0	0.06	0.17	0.15
Fisjh and Fish related trading	5.69	2.22	2.66	6.13	1.42	2.23
Fish fry selling	0.20	0.11	0.12	0.25	0.12	0.14
Fish pond/culture	2.32	1.73	1.80	1.08	1.77	1.65
Drying/processing fish	0.42	0.16	0.19	0.77	0.05	0.17
Direct Fishing	7.40	0.80	1.62	28.44	6.35	10.13
Total Trade	**11.26**	**12.54**	**12.38**	**7.71**	**11.98**	**11.25**
Trade & handicrafts	7.03	5.78	5.93	4.45	4.07	4.13
Business/petty trade/handicrafts/cart	4.23	6.76	6.44	3.25	7.91	7.11
Total Semi skilled labour	**1.20**	**0.60**	**0.67**	**0.47**	**0.47**	**0.47**
Semi-skilled labor(daily)	0.80	0.26	0.33	0.36	0.23	0.25
Semi-skilled labor(annual)	0.01	0.01	0.01	0.07	0.07	0.07
Making and repairing of fish net/poultry rearing boxes	0.40	0.33	0.34	0.05	0.18	0.15
Total Profession/service	**2.23**	**9.75**	**8.81**	**3.66**	**9.01**	**8.09**
Low paid daily service/profession	0.00	0.04	0.04	0.00	0.12	0.10
Service(profession)	2.23	9.71	8.77	3.66	8.89	8.00
Total Remittance	**4.56**	**7.52**	**7.14**	**4.10**	**7.43**	**6.86**
Remittance	0.00	0.00	0.00	0.50	0.75	0.71
Internal remittance	4.56	7.52	7.14	3.61	6.68	6.15
Total Other income	**24.78**	**18.65**	**19.42**	**13.02**	**12.77**	**12.82**
Other labor	21.00	17.70	18.11	11.62	11.98	11.91
Other income(domestic service+beggar+other sources)	3.78	0.95	1.31	1.39	0.80	0.90
Self employment	3.74	3.84	3.83	4.64	3.79	3.94
Entrepreneur income	0.49	0.01	0.07	0.06	0.18	0.16
Livestock	4.56	2.79	3.01	2.49	2.26	2.30
Dowry received	0.28	0.20	0.21	0.29	0.28	0.28
Samiti income(accrued to individuals)	0.02	0.03	0.03	0.01	0.07	0.06
Earning from lending	0.03	0.00	0.00	0.00	0.05	0.04
Land rented out	1.17	2.37	2.22	0.65	2.61	2.28
Equipment rental	0.34	1.42	1.28	0.85	1.45	1.35

Table 5 Percentage of household reporting positive income by sources

Income source	Benchmark			Impact		
	beneficiary	non-beneficiary	All	beneficiary	non-beneficiary	All
Agriculture	66.67	75.56	73.78	69.59	76.35	75.00
Agricultural product	9.91	19.03	17.21	26.80	31.59	30.63
Total Agriculture	**64.64**	**74.94**	**72.88**	**70.27**	**78.32**	**76.71**
Fishing	11.04	3.43	4.95	79.73	26.01	36.76
Fish labor	14.19	5.01	6.85	25.90	4.56	8.83
Fish trade	0.00	0.00	0.00	0.23	0.28	0.27
Fisjh and Fish related trading	9.91	4.90	5.90	11.71	3.83	5.41
Fish fry selling	0.90	0.51	0.59	0.90	0.39	0.50
Fish pond/culture	4.28	5.57	5.32	8.11	8.33	8.29
Drying/processing fish	0.45	0.39	0.41	1.58	0.39	0.63
Total Fish	**34.46**	**16.39**	**20.00**	**38.51**	**15.60**	**20.18**
Self employment	6.76	8.84	8.42	14.86	12.84	13.24
Trade & handicrafts	12.61	13.68	13.47	13.51	14.86	14.59
Business/petty trade/handicrafts/cart	4.50	9.18	8.24	10.14	13.06	12.48
Total Trade	**17.12**	**22.13**	**21.13**	**22.30**	**26.58**	**25.72**
Semi-skilled labor	0.23	0.34	0.32	0.23	0.68	0.59
Semi-skilled labor	0.45	0.51	0.50	0.68	0.84	0.81
Net making/repairing/poultry rearing boxes	0.23	0.23	0.23	2.48	0.90	1.22
Total Semi skilled labour	**0.90**	**1.07**	**1.04**	**3.38**	**2.42**	**2.61**
Low paid daily service/profession	0.00	0.17	0.14	0.00	0.51	0.41
Service(profession)	3.15	8.67	7.57	7.88	13.12	12.07
Total Profession	**3.15**	**8.78**	**7.66**	**7.88**	**13.57**	**12.43**
Entrepreneur income	0.45	0.06	0.14	0.45	0.45	0.45
Livestock	51.13	54.67	53.96	58.33	58.73	58.65
Remittance	0.00	0.00	0.00	0.23	0.23	0.23
Internal remittance	3.15	6.59	5.90	6.53	9.12	8.60
Total Remittance	**3.15**	**6.59**	**5.90**	**6.76**	**9.35**	**8.83**
Dowry received	0.68	0.23	0.32	0.90	0.90	0.90
Samiti income	0.23	0.23	0.23	0.23	0.23	0.23
Lend financing	0.23	0.00	0.05	0.00	0.34	0.27
Land rented out	4.05	7.43	6.76	4.73	11.77	10.36
Equipment rental	2.03	5.86	5.09	4.95	6.81	6.44
Other labor	57.66	53.49	54.32	59.01	52.42	53.74
Other income(domestic service+beggar+other sources)	6.76	4.45	4.91	6.31	6.31	6.31
Total Other income	**59.01**	**54.95**	**55.77**	**60.36**	**54.45**	**55.63**

Table 6 Percentage distribution of total annual expenditure by sources

Source	Benchmark			Impact		
	Beneficiary	Non-beneficiary	All	Beneficiary	Non-beneficiary	All
Food	51.10	40.52	42.35	39.40	32.97	34.13
Clothing	6.74	6.83	6.82	5.56	5.77	5.73
Housing(repair + building+ rent)	6.52	7.86	7.63	4.67	7.10	6.66
Education	1.65	4.00	3.59	2.34	3.67	3.43
Health	5.42	6.50	6.31	7.11	6.33	6.47
Fuel	2.25	2.16	2.17	2.47	2.30	2.33
Travel	2.02	2.86	2.71	1.99	2.30	2.24
Loan repayment	4.73	5.82	5.63	8.70	8.30	8.37
Savings	1.54	2.01	1.93	3.63	3.68	3.67
Land(purchase+tax+mortgage)	5.27	7.08	6.77	7.94	9.33	9.08
Livestock	1.61	1.66	1.65	1.77	2.74	2.57
Furniture & equipment	0.50	0.88	0.81	0.96	1.15	1.12
Festival	6.77	7.86	7.68	8.96	8.45	8.54
Fish	0.26	0.08	0.11	0.02	0.35	0.29
Bribe(payment)	0.46	0.09	0.15	0.00	0.07	0.06
Boat	0.07	0.03	0.03	0.00	0.00	0.00
Ornament	0.00	0.01	0.01	0.58	1.17	1.07
Other	3.08	3.76	3.65	3.91	4.32	4.24
Total	27875	33311	32224	40738	46539	45378
Total % change(impact over benchmark)				46.14	39.71	40.82

Table 7 Percentage of household reporting positive expenditure

Sources	Benchmark			Impact		
	beneficiary	nonbeneficiary	all	beneficiary	Non-beneficiary	all
Food	100	99.72	99.77	100	100	100
Clothing	99.77	99.38	99.46	99.32	98.93	99.01
Housing(repair + building+ rent)	59.68	49.07	51.19	53.15	47.10	48.31
Education	50.23	59.15	57.37	57.66	66.03	64.35
Health	97.30	97.13	97.16	98.20	97.58	97.70
Fuel	97.97	96.56	96.85	99.32	98.70	98.83
Travel	81.08	85.30	84.45	91.44	90.93	91.03
Loan repayment	26.80	31.15	30.28	46.62	38.25	39.93
Savings	20.05	18.08	18.48	28.60	20.85	22.40
Land(purchase+tax+mortgage)	10.14	9.13	9.33	23.87	21.92	22.31
Livestock	12.16	13.86	13.52	19.37	25.13	23.97
Furniture & equipment	15.99	16.06	16.04	22.75	21.75	21.95
Festival	95.27	96.51	96.26	96.62	94.25	94.73
Fish	1.13	0.34	0.50	1.13	2.70	2.39
Bribe (payment)	0.45	0.11	0.18	0.00	0.28	0.23
Boat	0.23	0.11	0.14	0.23	0.11	0.14
Ornament	0.23	0.11	0.14	32.21	39.27	37.85
Other	48.42	58.14	56.20	66.67	68.17	67.87

Table 8 Ownership of Asset

	Benchmark			Impact		
Asset	beneficiary	non-beneficiary	All	beneficiary	non-beneficiary	All
Number of dwelling	1.30	1.96	1.83	1.45	1.46	1.45
Area of dwelling (sq. feet)	314.55	371.56	360.16	367.76	439.43	425.09
Number of bed	1.75	2.00	1.95	2.17	2.36	2.32
No of bicycle	0.24	0.39	0.36	0.32	0.46	0.43
No of rickshaw/van	0.05	0.07	0.06	0.10	0.10	0.10
No of cattle/ buffalo	0.94	1.26	1.20	1.11	1.50	1.42
No of goat/ sheep	0.40	0.55	0.52	0.66	0.61	0.62

Table 9 Percentage of household reporting ownership of asset

Source	Benchmark			Impact		
	beneficiary	non-beneficiary	All	beneficiary	non-beneficiary	All
Number of dwelling	99.55	99.21	99.28	99.32	99.55	99.50
Area of dwelling	99.77	98.25	98.56	99.55	99.32	99.37
Number of bed	90.54	91.27	91.13	96.40	96.96	96.85
No of TV	2.93	7.71	6.76	9.23	14.25	13.24
No of radio	16.22	21.57	20.50	22.75	25.17	24.68
No of bicycle	21.85	34.91	32.30	27.93	40.15	37.70
No of rickshaw/van	4.73	6.36	6.04	8.56	9.52	9.32
No of cattle/ buffalo	43.92	51.86	50.27	50.23	59.57	57.70
No of goat/ sheep	18.92	25.68	24.32	29.28	27.76	28.06

Table 10 Average size of land ownership

	Benchmark			Impact		
Source	beneficiary	non-beneficiary	All	beneficiary	non-beneficiary	All
1)Own homestead land	6.75	10.46	9.72	7.71	10.12	9.63
2)Homestead land owned by someone else	0.88	1.08	1.04	1.54	1.20	1.27
3)Own pond or ditch	1.24	4.02	3.46	2.14	3.98	3.61
4)Land owned and cultivated by the household	26.47	76.51	66.50	25.34	71.82	62.52
5)Land cultivated last year but owned by others	29.05	34.94	33.77	35.43	39.10	38.36
6)Land owned but cultivated last year by others	4.49	15.98	13.68	6.09	18.63	16.12
7)khas land	2.34	1.26	1.48	2.84	1.89	2.08
8)Land owned but mortgaged out	4.46	11.29	9.93	5.26	11.11	9.94
9)Own non-cultivated land	0.67	3.29	2.77	11.79	23.82	21.84
Total own land (1+3+4+6+8+9)	44.08	121.55	106.06	47.65	118.51	104.34
% change in total own land				8.11	-2.50	-1.62

Table 11 Percentage of household reporting ownership of land

	Benchmark			Impact		
Source	beneficiary	non-beneficiary	All	beneficiary	non-beneficiary	All
Own homestead land	84.68	87.05	86.58	82.21	86.88	85.95
Homestead land owned by someone else	14.19	12.61	12.93	20.5	14.98	16.08
Own pond or ditch	12.61	22.69	20.68	14.19	26.18	23.78
Land owned and cultivated by the household	45.27	57.15	54.77	41.89	54.5	51.98
Land cultivated last year but owned by others	42.57	44.03	43.74	52.7	48.87	49.64
Land owned but cultivated last year by others	4.73	11.09	9.82	6.31	13.06	11.71
khas land	3.83	2.08	2.43	11.71	5.01	6.35
Land owned but mortgaged out	9.68	18.13	16.44	12.16	18.75	17.43
Own non-cultivated land	3.83	6.64	6.08	100	99.83	99.86

Table 12 Average years of schooling

	Benchmark			Impact		
Education level	beneficiary	non-beneficiary	All	beneficiary	non-beneficiary	All
Education of children (age 5 to 10 years)	0.76	0.88	0.85	0.94	0.86	0.88
Education of children (age 11 to 15 years)	2.22	2.56	2.49	2.05	2.48	2.4
Adult education (age 16 or more)	7.98	8.49	8.39	10.23	8.97	9.22

Table 13 Distribution of total fishing income

	Benchmark			Impact		
Sources	beneficiary	non-beneficiary	All	beneficiary	non-beneficiary	All
Fish labor	11.6	12.73	12.38	6.52	4.53	5.41
Fish trade	0	0	0	0.15	1.59	0.96
Fisjh and Fish related trading	31.38	38.61	36.36	15.61	13.72	14.55
Fish fry selling	1.09	1.92	1.66	0.62	1.15	0.92
Fish pond/culture	12.8	30.07	24.7	2.74	17.1	10.79
Drying/processing fish	2.31	2.81	2.65	1.96	0.5	1.14
Direct Fishing	40.82	13.86	22.25	72.39	61.4	66.23
Total Fishing income	**3075**	**1702**	**1976**	**17851**	**5684**	**8117**
% change in total fishing income				480	234	311

Annex B

Table 14 Quantity of Fresh Fish Caught By Source (Hundred Thousand Metric Tons)

Year	Inland		Marine	Total	Share of Capture fish in total (%)
	Capture	Culture			
1984-85	4.63	1.23	1.88	7.74	59.82
1985-86	4.42	1.45	2.07	7.94	55.67
1986-87	4.31	1.66	2.18	8.15	52.88
1987-88	4.23	1.76	2.28	8.27	51.15
1988-89	4.24	1.84	2.33	8.41	50.42
1989-90	2.24	1.93	2.39	6.56	34.15
1990-91	4.43	2.11	2.42	8.96	49.44
1991-92	4.89	2.27	2.46	9.62	50.83
1992-93	5.33	2.38	2.5	10.21	52.2
1993-94	5.74	2.64	2.53	10.91	52.61
1994-95	5.92	3.16	2.65	11.73	50.47
1995-96	6.09	3.79	2.7	12.58	48.41
1996-97	6	4.86	2.75	13.61	44.09
1997-98	6.16	5.75	3.1	15.01	41.04
1998-99	6.49	5.94	3.34	15.77	41.15
1999-00	6.7	6.57	3.79	17.06	39.27
2000-01	6.89	7.13	4	18.02	38.24
2001-02	6.89	7.87	4.32	19.08	36.11
2002-03	7.09	8.57	4.55	20.21	35.08
2003-04	7.32	9.15	4.75	21.22	34.5
2004-05	8.59	8.82	5.27	22.68	37.87

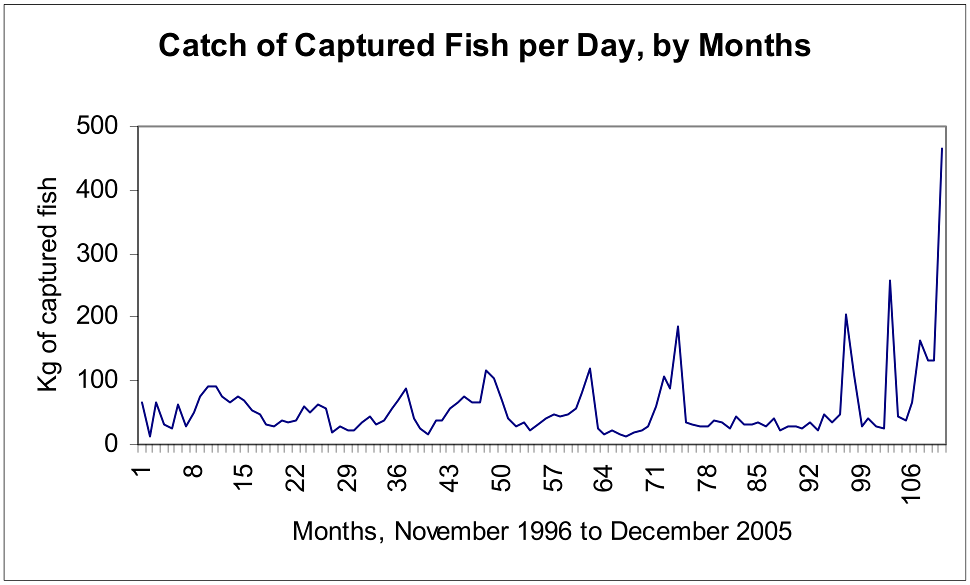
Source: Statistical Yearbook of Bangladesh, BBS, various issues

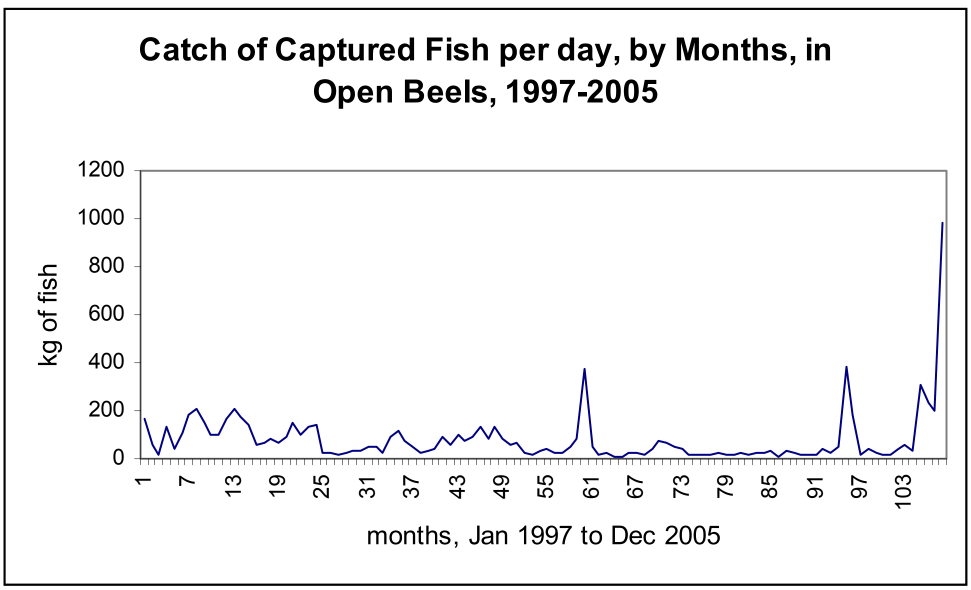
Table 15 Share of HYV Aman in Total Aman Acreage

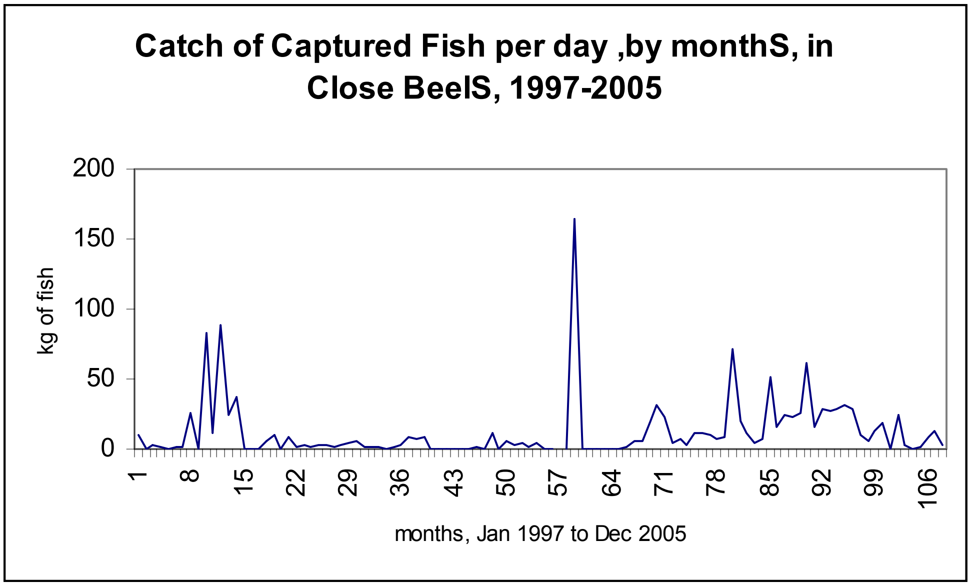
Year	HYV Aman ('000 acres)	Total Aman ('000 acres)	Share of HYV in total Aman (%)	Total Fertilizer use ('000 mt)
1980-81	2376	14918	15.93	823.33
1981-82	2361	14854	15.89	771.38
1982-83	2653	14812	17.91	871.57
1983-84	2329	14845	15.69	1033.02
1984-85	2669	14112	18.91	1260.22
1985-86	2907	14876	19.54	1155.99
1986-87	3085	14958	20.62	1320.94
1987-88	2958	13816	21.41	1515.19
1988-89	3346	12606	26.54	1709.04
1989-90	4354	14095	30.89	2043.18
1990-91	4857	14273	34.03	2107.54
1991-92	5210	14068	37.03	2287.43
1992-93	5759	14441	39.88	2316.18
1993-94	5584	14209	39.3	2217.68
1994-95	5304	13824	38.37	2640.62
1995-96	5606	13953	40.18	3022.69
1996-97	6107	14339	42.59	3036.56
1997-98	6294	14353	43.85	2618.73
1998-99	6087	12762	47.7	2824.92
1999-00	6822	14098	48.39	2826.42
2000-01	6911	14110	48.98	-
2001-02	7079	13955	50.73	-
2002-03	7261	14041	51.71	-

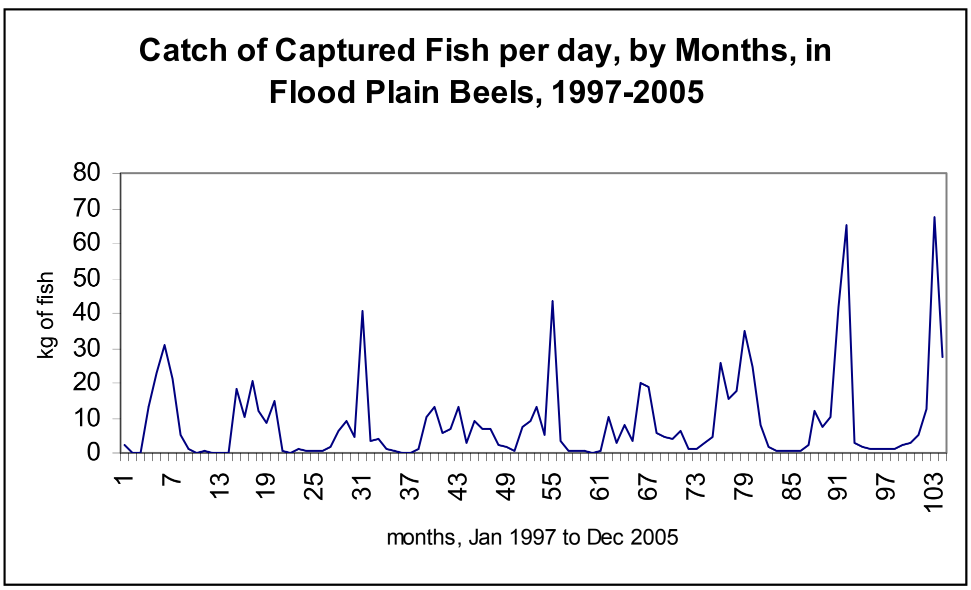
Source: Statistical Yearbook of Bangladesh, BBS, various issues

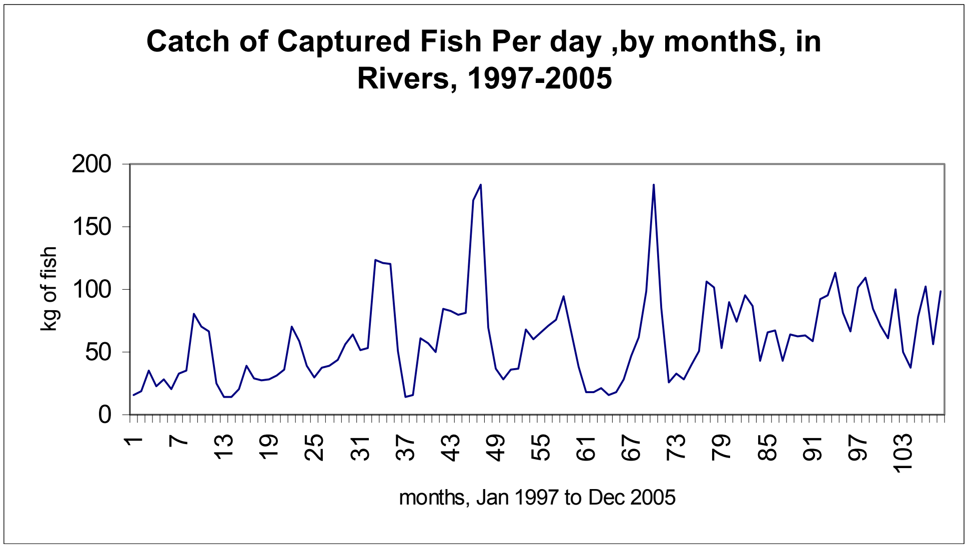
Annex C

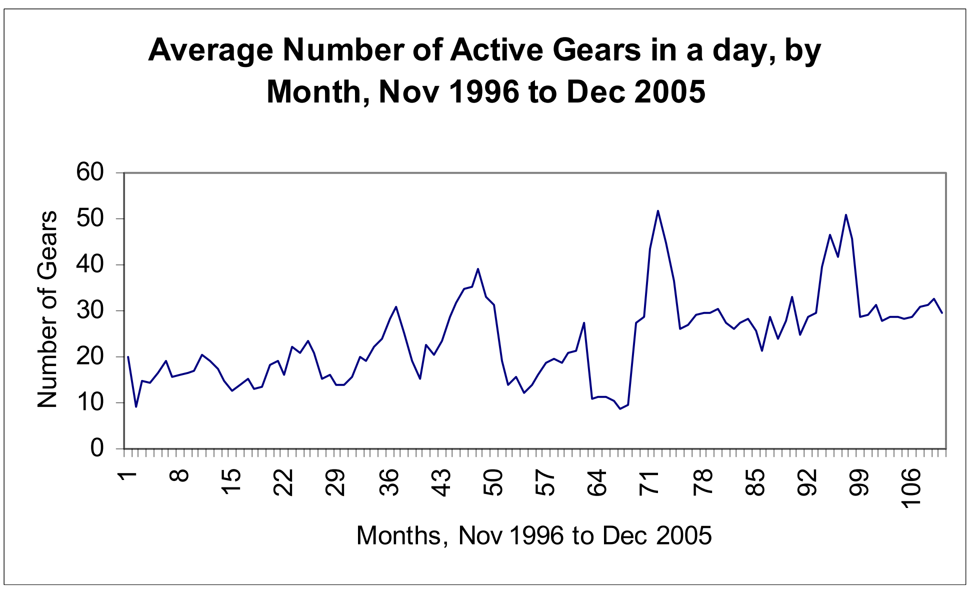

Catch of Captured Fish per Day, by Months
Kg of captured fish
500
400
300
200
100
0
1
8
15
22
29
36
43
50
57
64
71
78
85
92
99
106
Months, November 1996 to December 2005

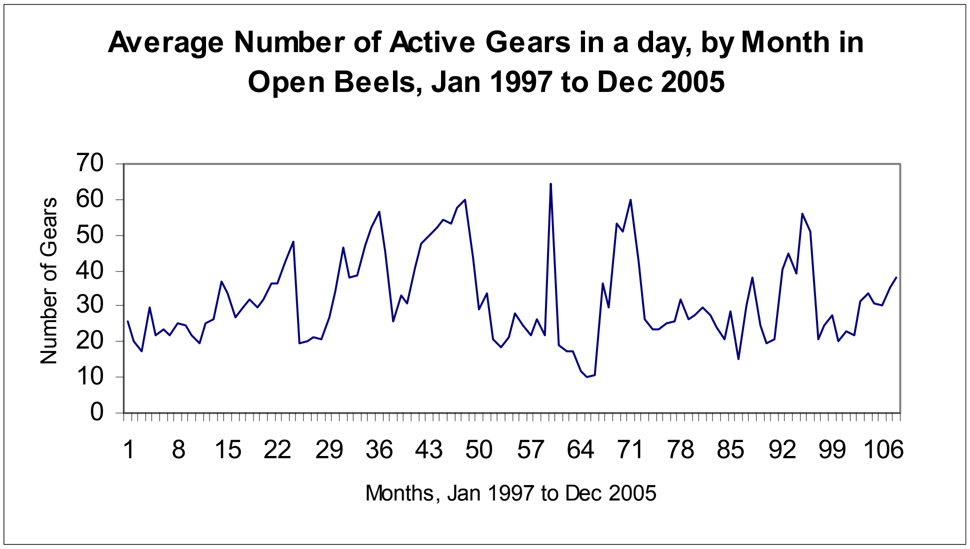

Catch of Captured Fish per day, by Months, in Open Beels, 1997-2005
kg of fish
1200
1000
800
600
400
200
0
1
7
13
19
25
31
37
43
49
55
61
67
73
79
85
91
97
103
months, Jan 1997 to Dec 2005

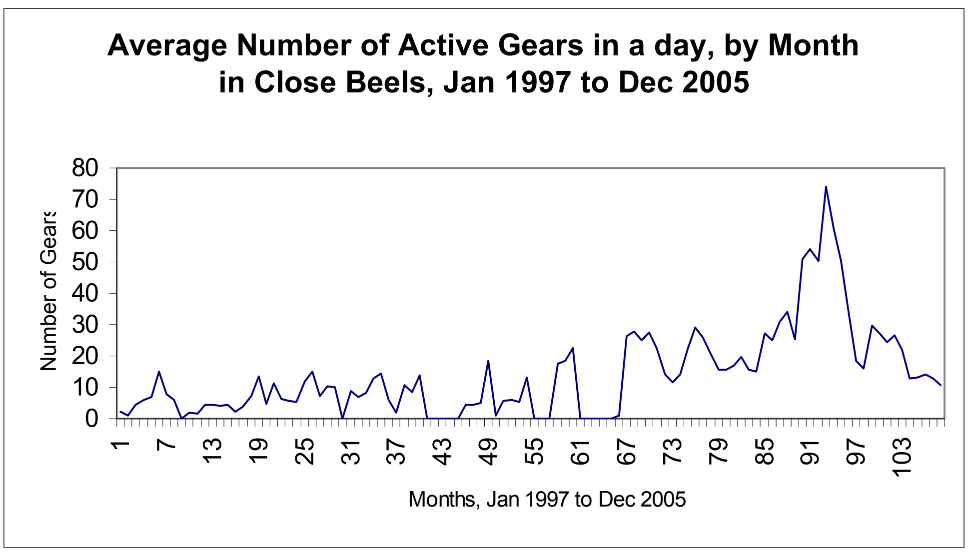

Catch of Captured Fish per day ,by monthS, in Close BeelS, 1997-2005
200
150
100
50
0
kg of fish
1
8
15
22
29
36
43
50
57
64
71
78
85
92
99
106
months, Jan 1997 to Dec 2005

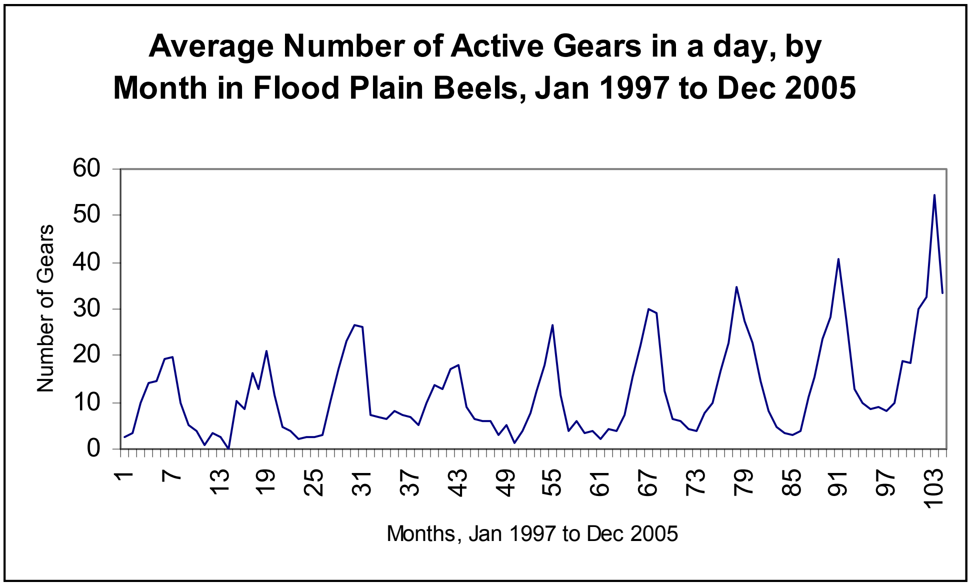

Catch of Captured Fish per day, by Months, in Flood Plain Beels, 1997-2005
80
70
60
50
40
30
20
10
0
kg of fish
1
7
13
19
25
31
37
43
49
55
61
67
73
79
85
91
97
103
months, Jan 1997 to Dec 2005


Catch of Captured Fish Per day ,by monthS, in Rivers, 1997-2005
kg of fish
200
150
100
50
0
1
7
13
19
25
31
37
43
49
55
61
67
73
79
85
91
97
103
months, Jan 1997 to Dec 2005

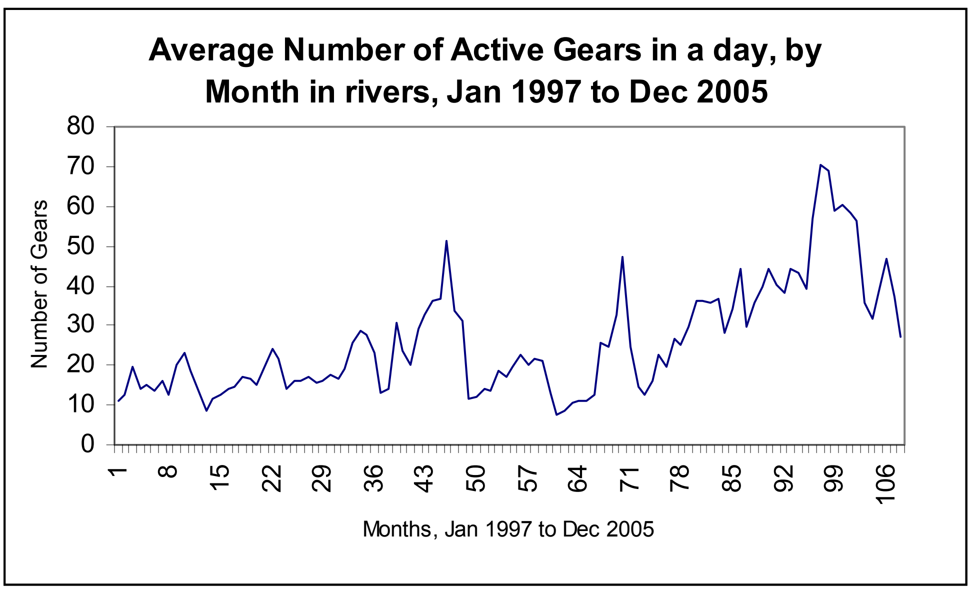

Average Number of Active Gears in a day, by Month, Nov 1996 to Dec 2005
Number of Gears
60
50
40
30
20
10
0
1
8
15
22
29
36
43
50
57
64
71
78
85
92
99
106
Months, Nov 1996 to Dec 2005


Average Number of Active Gears in a day, by Month in Open Beels, Jan 1997 to Dec 2005
Number of Gears
Months, Jan 1997 to Dec 2005

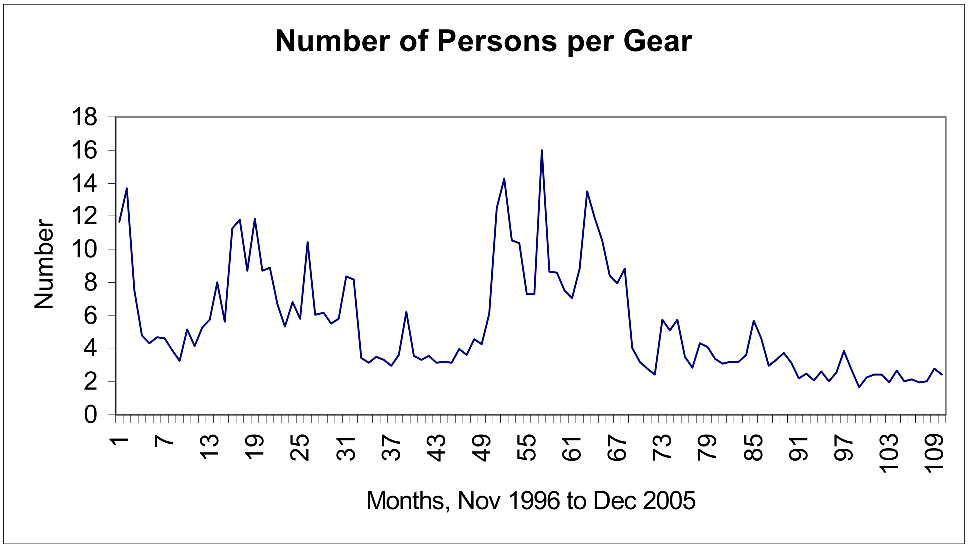

Average Number of Active Gears in a day, by Month in Close Beels, Jan 1997 to Dec 2005
Number of Gears
Months, Jan 1997 to Dec 2005

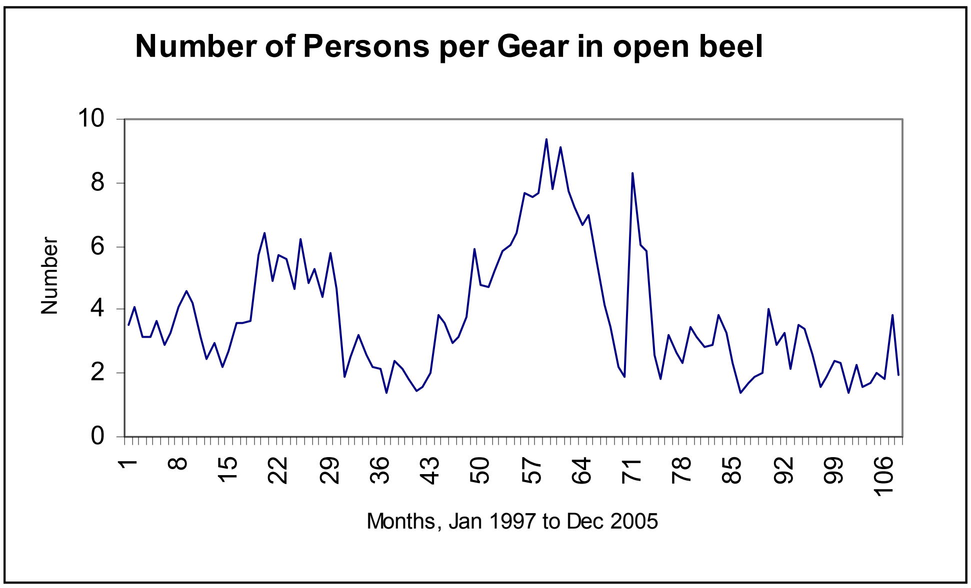


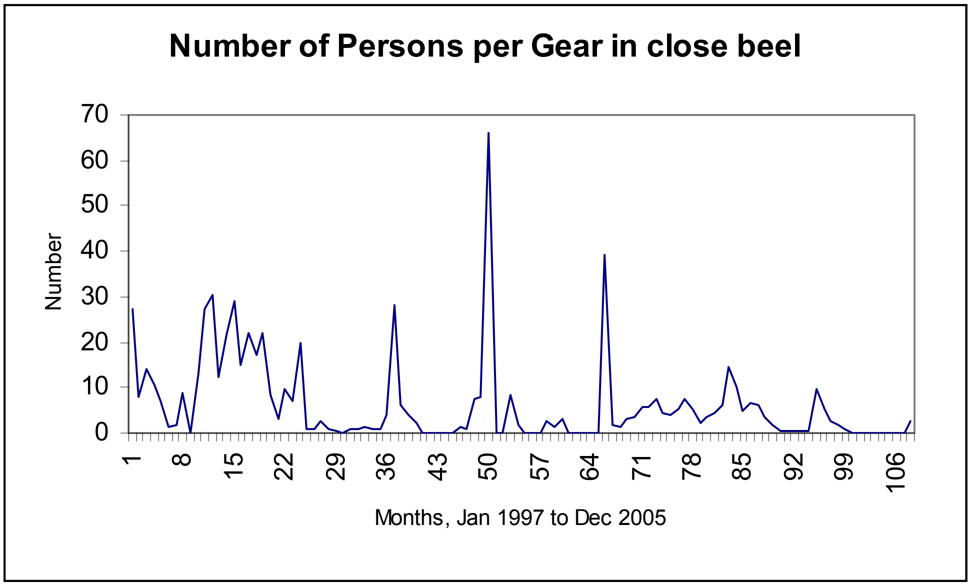
Average Number of Active Gears in a day, by Month in Flood Plain Beels, Jan 1997 to Dec 2005
60
50
40
30
20
10
0
Number of Gears
1
7
13
19
25
31
37
43
49
55
61
67
73
79
85
91
97
103
Months, Jan 1997 to Dec 2005

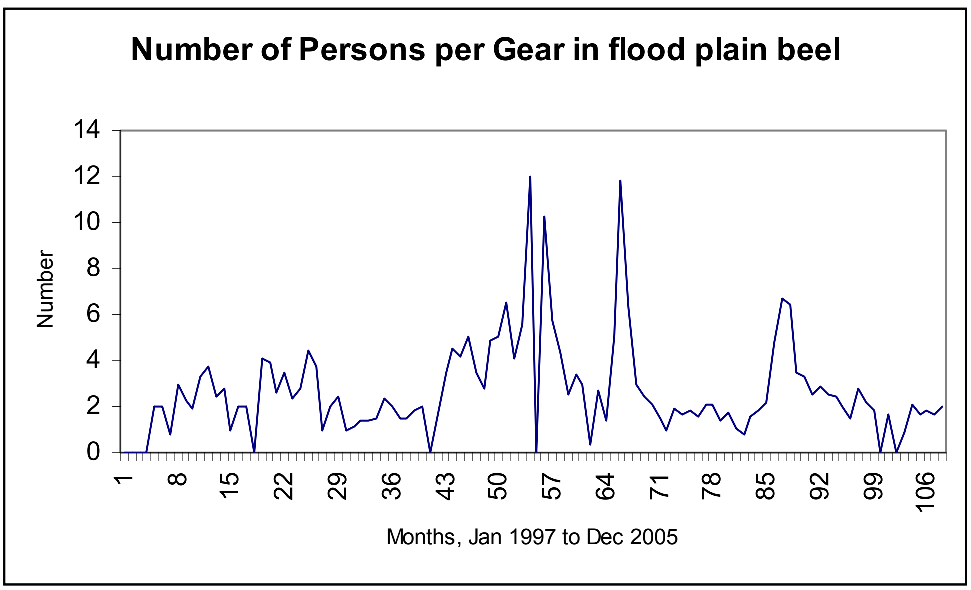


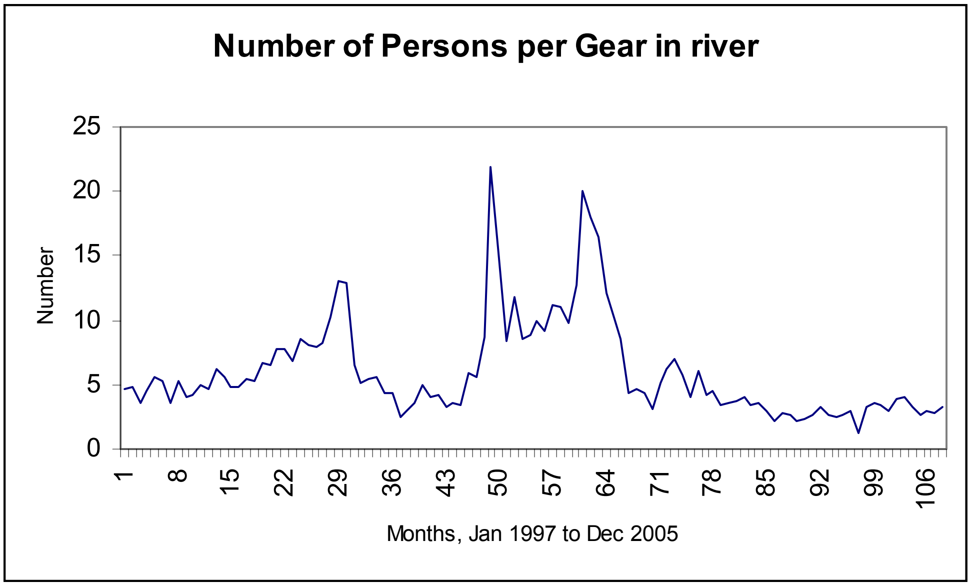
Average Number of Active Gears in a day, by Month in rivers, Jan 1997 to Dec 2005
80
70
60
50
40
30
20
10
0
Number of Gears
1
8
15
22
29
36
43
50
57
64
71
78
85
92
99
106
Months, Jan 1997 to Dec 2005


Number of Persons per Gear
Number
18
16
14
12
10
8
6
4
2
0
1
7
13
19
25
31
37
43
49
55
61
67
73
79
85
91
97
103
109
Months, Nov 1996 to Dec 2005


Number of Persons per Gear in open beel
Number
10
8
6
4
2
0
1
8
15
22
29
36
43
50
57
64
71
78
85
92
99
106
Months, Jan 1997 to Dec 2005


Number of Persons per Gear in close beel
70
60
50
40
30
20
10
0
Number
1
8
15
22
29
36
43
50
57
64
71
78
85
92
99
106
Months, Jan 1997 to Dec 2005


Number of Persons per Gear in flood plain beel
14
12
10
8
6
4
2
0
Number
1
8
15
22
29
36
43
50
57
64
71
78
85
92
99
106
Months, Jan 1997 to Dec 2005



Annex D
Changes in the relative price of fish to non-fish (based on the study by Madan (et. Al))

Price Elasticity of demand for fish = 0.6%
Expenditure elasticity of demand for capture fish = 1.2%
Elasticity of supply of capture fish = 0.47%
Percentage increase in income = 6.2%
Percentage increase price of non-fish items = 3.1%
Percentage change in the price of fish = 4.368%
Assuming there is no excess demand, the ratio of percentage change in the price of capture fish to non-fish = 4.386%/3.1% = 1.41%.

Annex E
Projection Path of Total Catch of Inland Capture Fish, 2005=100

scenario 1										
	Total Catch of Captured Fish									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OB	100.00	105.34	112.79	121.96	132.75	145.17	159.32	175.34	193.39	213.68	236.46
CB	100.00	105.34	112.79	121.96	132.75	145.17	159.32	175.34	193.39	213.68	236.46
FPB	100.00	105.34	112.79	121.96	132.75	145.17	159.32	175.34	193.39	213.68	236.46
Rivers	100.00	105.34	112.79	121.96	132.75	145.17	159.32	175.34	193.39	213.68	236.46
All	100.00	105.34	112.79	121.96	132.75	145.17	159.32	175.34	193.39	213.68	236.46
scenario 2											
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
scenario 2	100.00	100.14	101.93	104.77	108.41	112.71	117.59	123.02	128.98	135.48	142.52
CB	100.00	100.14	101.93	104.77	108.41	112.71	117.59	123.02	128.98	135.48	142.52
FPB	100.00	100.14	101.93	104.77	108.41	112.71	117.59	123.02	128.98	135.48	142.52
Rivers	100.00	100.14	101.93	104.77	108.41	112.71	117.59	123.02	128.98	135.48	142.52
All	100.00	100.14	101.93	104.77	108.41	112.71	117.59	123.02	128.98	135.48	142.52
Scenario 3											
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OB	100.00	99.94	101.52	104.15	107.56	111.60	116.20	121.33	126.97	133.10	139.75
CB	100.00	99.64	100.93	103.25	106.34	110.04	114.28	119.03	124.25	129.95	136.13
FPB	100.00	99.64	100.93	103.25	106.34	110.04	114.28	119.03	124.25	129.95	136.13
Rivers	100.00	99.89	101.42	104.00	107.34	111.31	115.85	120.90	126.44	132.49	139.03
All	100.00	99.88	101.41	103.99	107.33	111.30	115.83	120.88	126.43	132.47	139.01
scenario 4											
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OB	100.00	100.38	102.42	105.53	109.46	114.07	119.30	125.11	131.49	138.46	146.01
CB	100.00	100.08	101.82	104.62	108.22	112.48	117.33	122.73	128.68	135.18	142.23
FPB	100.00	100.08	101.82	104.62	108.22	112.48	117.33	122.73	128.68	135.18	142.23
Rivers	100.00	100.33	102.31	105.37	109.24	113.78	118.93	124.66	130.95	137.82	145.25
All	100.00	100.32	102.31	105.36	109.23	113.77	118.92	124.64	130.94	137.80	145.23
scenario 5											
	Total Catch of Captured Fish										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OB	100.00	100.22	102.09	105.03	108.77	113.17	118.17	123.74	129.85	136.52	143.74
CB	100.00	100.57	102.84	106.23	110.49	115.50	121.20	127.57	134.62	142.36	150.82
FPB	100.00	100.57	102.84	106.23	110.49	115.50	121.20	127.57	134.62	142.36	150.82
Rivers	100.00	100.14	101.93	104.77	108.41	112.71	117.59	123.02	128.98	135.48	142.52
All	100.00	100.17	102.00	104.89	108.58	112.93	117.88	123.38	129.43	136.03	143.18