Poverty and Policy in Inland Capture Fisheries in Bangladesh

Alexander Richard Kremer

PhD thesis submitted to the University of London

Abstract

The thesis's objective is to describe the relationship between inland capture fisheries management and the welfare of the poor in Bangladesh. Existing economic models of fisheries management do not address issues of income-distribution, concentrating instead upon rent-maximisation. The thesis therefore aims to develop new models of the distributional impact of management interventions, based upon a qualitative and quantitative understanding of the social, institutional and economic processes whereby fishery incomes are created and distributed.

The study site is Hail Haor, a 13,600 ha floodplain in N.E. Bangladesh. Descriptions of its physical ecology, fishing technologies and fishing communities are given. There follows a detailed explanation of the social, institutional and economic transactions whereby fishing incomes are distributed between fishing labour, lessees, sub-lessees, government officials and the government.

Estimates of yields, sales and employment levels are presented on a per hectare basis. Sales are divided between labour income, fishing costs and tolls. Tolls are in turn apportioned to the various groups of recipients. Fishermen's access to profitable fishing activities is shown to be a function of religion and social and economic status. Poor fishermen tend to operate with low-yield, labour-intensive gears, in shallow water and during the flood season. They therefore do not perceive themselves to benefit from policies that enhance the dry-season, capital-intensive fishery.

Simulation and analytical models demonstrate how current policy interventions benefit rich people at the expense of poorer fisherfolk. They raise rents, which accrue to rich people, by reducing employment, upon which the poor depend. They also postpone the catch from the labour-intensive flood season fishery to the capital-intensive dry-season fishery. It is concluded that existing policy is regressive and that fisheries assessments should address the issue of income-distribution as well as that of rent-maximisation. Appropriate assessment methodologies are proposed.

Contents

Tables

Figures

Acknowledgements

I carried out this study as part of the project *Poverty, equity and sustainability in the management of freshwater capture fisheries in South and South-East Asia.* It was financed by a grant from the Overseas Development Administration (Project R4791). The interviews with fishermen were assisted by Shamsul Haque Mandal and Zulfiqar Ali from the Bangladesh Institute of Development Studies. The biological assessment of the Hail Haor fishery was led by Dr Daniel Hoggarth of the Marine Resources Assessment Group, with myself, Shamsul Haque Mandal and Zulfiqar Ali handling the fish. Most of the text in this thesis has been commented upon by Professor Christopher Heady, Dr Allister McGregor, Dr Adrian Winnett and Dr Clare Hall from the University of Bath's Centre for Development Studies. In particular, Professor Heady suggested the first bio-economic model in chapter 11 and went over the algebra of chapters 12 and 13.

Introduction: the challenge of floodplain fisheries management in Bangladesh

---

Contrary to popular belief, Bangladesh is not among the poorest of countries. At an equivalent of US$1,160 p.a., its mean per capita purchasing power is higher than India's or Zambia's and more than twice as high as Tanzania's, Niger's, Mali's or Malawi's (World Bank 1993, p.296). Bangladesh does have, however, a large number of poor people. 45% to 60% of the population does not consume sufficient calories to maintain a healthy life (Rahman and Haque 1988) and 60% of children under 5 are malnourished (World Bank 1993 p.292).

Moreover, the number of Bangladeshis in search of a livelihood is growing rapidly. The increase in Bangladesh's population between 1981 and 1991 was more than the entire population of Malaysia. Even on the optimistic assumption that population growth will fall to replacement reproduction only by 2015, Bangladesh's population is set to rise by an equivalent of four Malaysias by 2025. This is in a country which already has a population density of 741/km^2, over three times higher than India's.

Over the next 30 years, therefore, the challenge to development in Bangladesh will be to provide better livelihoods for the half of the population that is currently hungry and then to make new livelihoods for the four new Malaysias that are on the way.

Over a third of Bangladesh's surface area, or around 14.5 million hectares, is under fresh water for at least part of the year. Bearing mineral-rich alluvium from the Eastern Himalayas, these waters support one of the world's most productive freshwater food-chains. At the top of this chain sits the Bangladeshi population, extracting around 600,000 tonnes of fish and shrimp per year. Inland fisheries may be divided into three types: aquaculture, riverine capture fisheries and floodplain capture fisheries. Although most policy and research attention has focused until now upon aquaculture, the floodplain fishery, which is this study's concern, is also of huge importance, being responsible for around half of inland fish production (BBS 1992, p.221).

The Government of Bangladesh and its donors have adopted as their floodplain fisheries management policy a combination of artificial stocking, effort controls and property rights reform. Upon this policy's effectiveness, however, there has been very little formal research. This is partly because inland capture fisheries have only recently become a fashionable research topic for social scientists and partly, perhaps, because there has been no lack of unsubstantiated assertion upon the subject.

This conjunction of population growth, a huge resource and an untested management stance therefore poses an important policy problem: is the current floodplain fisheries policy environment beneficial to the rural poor? More generally, how can the floodplain fisheries of Bangladesh be managed so as to sustain as many livelihoods as possible? The purpose of this study is to use empirical observation and economic analysis to evaluate current and alternative fisheries management policies.

Chapters 1 to 4 will set out the study's aims and methodological approach. Chapter 2 reviews our existing understanding of Bangladeshi rural development in general and of inland fisheries in particular. It finds a lack of information upon fishery economies and the distributional impact of fisheries policy. Chapter 3 reviews the theoretical literature upon fisheries management and concludes that the established approach to fisheries assessment does not take account of distributional issues. Chapter 4 describes how this study plans to analyse the economics of a floodplain fishery, placing emphasis upon the practical difficulties of collecting reliable primary data.

Chapters 5 to 7 will explain how value-added is created and distributed in the Hail Haor fishery of N.E. Bangladesh. Chapter 5 describes its physical ecology and fishing technologies. Chapter 6 introduces the fishing communities and discusses their social systems. Chapter 7 covers the social, institutional and economic transactions whereby factors of production are brought together to create and allocate fishery benefits. They are described in some detail because the analysis of fisheries policy will eventually be based upon them.

Now that the resource flows have been described, chapters 8 to 10 will quantify and analyse the outcome. Chapter 8 estimates production, sales and employment on a per hectare basis and allocates net sales between various factor shares. Chapter 9 shows how fisherfolk's incomes are determined by their social and economic position. Chapter 10 builds upon chapter 9 to identify the particular position of poorer fisherfolk in the fishery, concluding with an account of their perceptions of fisheries policy.

Chapters 11 to 13 use micro-economic theory to analyse the distributional impact of fisheries policy. All the models are based upon the preceding qualitative and quantitative description of the Hail Haor fishery. Chapter 11 presents two simulation models of artificial stocking, closed seasons and effort limitation programmes. Chapter 12 describes three micro-economic theorems upon the effects of artificial stocking. Chapter 13 is a model of income distribution by factor share under different property right regimes.

Chapter 14 brings the thesis's conclusions together. It argues that current policy interventions in inland capture fisheries are regressive, tending to benefit rich rentiers at the expense of fishing labour. On a more positive note, it proposes some poverty-oriented methodological approaches to fisheries assessment.

Bangladesh's fisheries were fascinating to study. Muddy, crowded, beautiful and often violent, Hail Haor was a colourful illustration of many key debates in economic development. Is there a trade-off between growth and equity? How do social structures and markets inter-relate? How should renewable natural resources be managed? Why does poverty persist? Hail Haor's fishermen are acting out these issues daily among the gill-nets and water-hyacinths and it is hoped that the reader will pick up some of the fishery's drama between the lines of this thesis.

Chapter 2

Inland capture fisheries in Bangladesh: a policy-oriented research framework

This section starts by reviewing the existing social science literature upon inland capture fisheries in Bangladesh. It finds an absence of work upon the micro-economic and social relations surrounding the fishery. It reviews the preoccupations of current inland fisheries policy and identifies specific policy decisions that should be guided by a micro-level study of the fishery.

Existing social science publications.

Although the literature upon various aspects of aquaculture or pond fisheries is comparatively abundant, little has been published upon the economics, sociology or anthropology of freshwater capture fisheries in Bangladesh. This in part reflects officialdom's lack of interest in inland capture fisheries until the mid-1980s, when the growing interest in environmental resources, exasperation with the performance of agriculture and donors' interest in marginalised communities led to the "discovery" of inland capture fisheries. In fact, whilst none of the literature upon inland capture fisheries in Bangladesh referenced in this study was published before 1985, no fewer than 4 economists are currently preparing Ph.D. theses on the subject with UK universities alone!

Rural society in Bangladesh

Starting with Bangladeshi rural society in general, the social sciences literature is unanimous in highlighting social and economic inequality as its outstanding feature. Rahman (1985) finds that a household's future life-chances are determined by its current wealth-holdings, that the distribution of assets tends to become more concentrated over time and that the lowest strata of society have become poorer. He concludes that Bangladesh's rural classes may be delineated in terms of ownership of the means of production, principally land. Hartmann and Boyce (1979 and 1983) concluded from a period of participatory observation that an élite appropriates the rural surplus by means of rents, interest, trading margins and plunder whilst the poorest 85% of the population grows poorer. Jansen (1987) argues that a high ratio of labour to productive resources induces households to compete for rents rather than create productive assets. He shows how land moves from poorer to richer households and predicts that economic polarisation will be exacerbated by population growth. He forecasts that before the century's end

Bangladesh will contain more than 20 million unemployed landless paupers, dependent upon charity and crime for their livelihoods.

Whatever their ideological standpoint, many writers studying social structures in rural Bangladesh have observed strong vertical segmentation and an absence of horizontal co-operation, an outcome that Scott (1976) considers typical of peasant societies. Wood (1981) writes of class-formation in Bangladesh, "Vertical solidarities of the patron-client type become the form of class relations under conditions of agrarian development in Bangladesh." Maloney (1986) argues that the patronage system has behavioural origins: a craving for bounty from others is inculcated in Bangladeshi children from birth. Jansen (1987) finds wealthy "élites" maintaining factions through patronage in the form of credit, physical protection and political support in return for mortgaged land and votes. He suggests that the nature of factional politics ensures that patronage services are supplied monopolistically: "The rural landscape can easily be conceived of as a place where many patrons, with their separate groups of clients, can co-exist and live next to each other and only clash over limited and specific events" (p.149). Herbon (1988) seeks co-operative institutions but finds an atomistic, segmentary rural society with diffuse patterns of leadership and collectives managed by the élite for the élite.

Neo-classical economics suggests that competitive capital markets can mitigate income inequality by allowing poorer households direct access to the means of production. According to this model, borrowers as a group receive from their investments the average revenue product of capital but pay as interest in a competitive capital market the marginal revenue product of capital. They thus receive a "consumer surplus" as users of capital. A body of writers has questioned whether this occurs in rural Bangladesh. Ahmed (1989) argues that the short-term, low-value credits required by poor rural households are rendered inaffordable in the formal sector by high transactions costs. Rahman (1992) finds that informal lending covers 2/3 of the credit market by value. Where the lender takes his income as interest the modal rate is 10% per month. McGregor (1988, 1989a and 1992) shows credit to be part of the patronage system. Within the village, informal moneylenders restrict credit to their own political supporters, creating "monopolistic credit fiefdoms" (my phrase). The same moneylenders use bribes and political influence to appropriate the supply of formal-sector credit. The consensus of these writers is that access to credit is wealth-related and does not therefore tend to mitigate pre-existing disparities in economic status.

The Bangladeshi state, which concerns us as the fisheries manager, is seen as the upper part of the patronage chain. Its "Development Policy" aims to satisfy the demands of rural patrons rather than the needs of the rural poor. Jansen (1987) shows how the patrons of the rural poor are in turn the clients of the state, supplying bribes and political support to government officers in return for state resources and legal judgements. McGregor (1989a) shows how patrons compete for state aid for their own factions. Hartmann and Boyce (1979 and 1983) show that foreign aid and co-operatives are managed by the élite in their own interests; their solution is revolution. The Like-Minded Group (1990) and Kramsyo and Wood (1992) argue that development aid in Bangladesh should therefore concentrate upon the distribution, rather than the productivity, of resources: "Interventions which have been advanced as a means of combating poverty have, in practice, usually failed to recognise that poverty is grounded in a lack of access to resources...Without tackling these issues, an increased supply of resources in itself will be of little help to the poor because the poor have no access to them" (Like-Minded Group 1990, p.199.). Substitute the phrase "fish stocks" for the word "resources" and one has the basis for a critique of fisheries management policy.

Sectoral studies of freshwater fisheries

The World Bank (1991) reviews Bangladesh's fisheries at the sectoral level. The number of professional fishermen has risen from 0.8 million to 1.25 million since 1972. With population growth at 2.4% p.a. (1987-9), real GDP per capita growth of 1.2% p.a., an income elasticity of demand for fish around unity and an increase in production of 1.8% p.a. (1983-8), the terms of trade of fish against rice have risen by 75% in 12 years (1979-91). However, output from inland fisheries is falling by 2.7% p.a. (1983/4-1987/8). This is attributed to pollution, siltation, over-fishing and flood control. (Aguero 1986, Planning Commission 1991, World Bank 1991). The World Bank recommends artificial stocking to restore yields and a shift from leasing to licensing (i.e. the New Fisheries Management Policy) to redistribute incomes away from middlemen in favour of fishermen. One could argue, however, that the value of these recommendations is contingent upon the economic and social relationships that govern the fishery at micro-level, a topic not addressed in the World Bank's review.

Many writers are concerned about the effects of flood control measures upon the inland fisheries sector. Ali (1989) estimates that flood control reduced total floodplain area by 814,000ha to 1985 and that a further 2,000,000ha will be lost by 2005. Sklar (1992) warns that planned flood control embankments will block fish migration routes. Majumder and Durante (1993) fear that 800,000 fisherfolk stand to lose all or part of their livelihoods as a result of flood control. In their analysis, floodplains are an open-access resource, "open to anyone with a net", so the poorest of the poor stand to lose from flood control.

On the consumption side, conference papers quote as a matter of course the proverb "Mach-e bhat kai Bangalee" (Bengalis eat fish and rice). The World Bank (1991) emphasises the nutritional importance of the inland fisheries sector with the oft-quoted statistic that fish provides 71% of the country's animal protein. Contrary to popular belief, however, fish are not a particularly important part of the average Bangladeshi's nutrition. Rahman and Roy (1990) and FAP17 (1993) estimate that fish contributes only 12% or 6% of total protein consumption. Official statistics (BBS 1992 p.592) show fish to provide 2% of calories, 7% of protein and 4% of fat intake. One suspects that the 71% figure is cited so often by the fisheries lobby in order to strengthen the case for development aid.

The income elasticity of demand for fish is around unity for all groups (Rahman and Roy 1990) with per capita daily consumption of 18g and 28g for landless and "high income" households respectively (FAP17 1993).

Fishing and socio-economic class

Huq and Huq (1985), Ullah (1985), Rahman (1986) and Jensen (1987) are pre-occupied with the economic stratification of fisherfolk. Huq and Huq report that labour and capital use accounts for more than 50% of variation in floodplain fishing revenues. They and Jensen concur that more than 80% of fishermen's income is produced by fishing. Ullah classes fishermen as protocapitalist, upper artisanal or lower artisanal according to their expenditure upon labour hire and rents. Rahman argues that fishermen are an underclass associated with landlessness and powerlessness, a prey to political bosses and exploitative credit contracts. Jensen describes fishermen as separated from the rest of society by a caste identity and a disparaging attitude to agricultural work. Economic status within the fishing community is related to gear-ownership.

Profitability studies

Several authors have attempted to estimate actual or potential fisheries rents from freshwater fisheries.

Ullah (1985) finds that all classes of fishermen produce a high rate of return upon capital. His explanation is that the lessee incurs sunk costs by acquiring the lease and employing water-bailiffs. He is therefore confident of retaining the lease for several years and restricts effort so as to maximise its long-run profitability. Ullah's argument has three weaknesses: first, a lessee has no incentive to conserve fish stocks if fish move between lease units; secondly Ullah high rates of profit may be normal profits rather than rents depending on the opportunity cost of capital; thirdly, Ullah does not show why the fishermen, rather than the rational lessee, appropriate the resource rents.

Rahman (1989) uses survey data to calculate the profitability of inland fisheries. Rahman, observing positive profits and a 6-month payback period, concludes that the leasing system prevents the dissipation of fishery rents. Another possible reason is that Rahman's imputed costs were well below market rates: an opportunity cost of capital of 10.5% p.a. instead of 10%-15% per month and a shadow wage of 15% of the market wage for casual labour.

Aguero and Ahmed (1990) compare rates of return on capital under different management regimes. They conclude that licensing is superior to leasing although only three water-bodies per regime were studied and the summary table of results shows no regime to be clearly superior.

Ahmed (1991) has created a programming model of effort restriction riverine fisheries in Bangladesh. He argues that the government should tax fishing effort to maintain fishery rents. The analysis contains important flaws: it assumes that the Government of Bangladesh has the bureaucratic capacity to tax fishing, omits to mention existing effort-limitation by leaseholders and does not take account of the biological constraint upon fish production (p.60).

The socio-economics of fishing

Anthropologists Blanchet and Talukder (1992) offer a tantalisingly brief insight into the social and economic relations that surround the Shanir Haor fishery in N.E. Bangladesh. Professional and subsistence fishermen contract and compete with the leaseholder for fishing rights. The leaseholder makes massive profits by charging tolls during the flood and restricting fishing to his own "corporation" during the dry season.

Résumé

The sociological literature upon inland capture fisheries in Bangladesh is largely preoccupied with class; either it is trying to define fisherfolk's class status within rural society as a whole or trying to sub-divide fisherfolk themselves into economic classes. Such an approach, however, is of little use to fisheries managers who want to predict the economic effects of different regimes upon the fisherfolk. Indeed, if fishing communities' response to project interventions is expressed, not through Marx's "class for itself", but through vertically-aligned factions, then the horizontal class-based analysis has little to say about the political economy of fisheries management either.

The economics literature, on the other hand, assesses inland capture fisheries according to whether they produce economic rents or not. What these profitability studies have in common is that they make rent-maximisation the implicit policy objective. This casual assumption is of devastating importance. The choice of rent-maximisation as opposed to employment has clear regressive distributional implications in a society where many poor people depend upon the sale of their labour and most resource rents flow to the wealthy.

Given the recent surge of interest in the sector, one might assume that the "grey" literature generated by projects for internal use would contain analyses of the economics of fisheries management. Unfortunately for the fishermen, and fortunately for my Ph.D. prospects, this is not the case. Micro-economic studies were not used for project preparation and policy-formation, at least two fisheries development projects are currently subject to a government "gagging" order and, with the exception of the Third Fisheries Project, no ex-post policy or project evaluations have been performed.

In brief, the existing literature tells a pessimistic tale. Bangladesh's inland fisheries are set into an unequal, patronage-bound society where the tendency is towards greater inequality and worse poverty. Writers lament the power of the leaseholder and also note economic stratification within the fishing community itself. Formal capital markets are closed to the poor and informal capital is too expensive to be a means of advancement. Development policy works for, not against, the patronage system. The number of people dependent upon inland fisheries is increasing but output is falling. Professional fishermen form a distinct group that derives most of its income from fishing and are therefore presumably vulnerable to a drop in production.

With one exception (Blanchet and Talukder 1992) the literature does not describe the micro-economic and social relations that surround the fishery itself. Without understanding these relations, however, one cannot predict the effect of policy interventions upon income, employment and income distribution.

Inland capture fisheries policy

From a reading of the Fourth Five-Year Plan (Planning Commission 1991), the official version of the state's development policy, it appears that inland capture fisheries are the "poor relation" of the fisheries sector. Although they produce around half of the annual fish catch by weight, they rate only 2 out of 27 paragraphs in the Plan's sector-by-sector discussion (pp5-8) compared with aquactulture's 16. The Plan envisages that the "main research thrust" should be into fish and shrimp culture (p.9).

The Plan's strategy for inland capture fisheries may be summarised in 5 words: "stocking, effort-controls and licensing." The stocking of inland open waters, it is claimed, will raise the beel, haor and floodplain catch by one third from 208,000t to 305,000t between 1990 and 1995. Effort controls, consisting of a "vigorous implementation of the Fisheries Protection and Conservation Act" and "heavy penalisation to the users of current jal" (monofilament gill-nets) are to maintain fish-stocks (p.5). Licensing is to ensure "the biological management of jalmohols (lease units) by providing fishing rights to the genuine fishermen and gradual replacement of existing leasing system" (p.5). On paper at least, the official policy could be described as biological intensification with social redistribution.

In practice the Government of Bangladesh, foreign donors and NGOs have initiated the following policy interventions that will affect the inland fisheries sector directly or indirectly:

Fishing right allocation

Bangladesh's fisheries were established as a source of government revenue under the British Raj by the *Permanent Settlement Regulation 1* (1793). Lands and waters were registered as "mohols" or "sairat mohols" in the name of zamindars (landlord-cum-tax-farmers), who paid annual tribute to the British Indian Government. The zamindar would obtain a profit by leasing them to jotedars. The mohols were re-assumed by the government under the *State Acquisition and Tenancy Act* (1950) and re-codified in the *Estate Manual* (1958). They are now leased out by government. Only ponds and a very few small water-bodies, the property of private individuals (*maurasi jalkar*) or Hindu temples (*deboltar*), are exempted.

The leasing system was designed and is maintained as a source of revenue, not as an instrument of fisheries development. It gives the Ministry of Land alone an estimated Tk90 million p.a. (US$3.6 million) (Ali 1993). Apart from 1980-3, when the Ministry of Fisheries and Livestock administered the leasing system, the government officers that allocate fishing rights have been those responsible for revenue collection and not for fisheries development. The jalmohols were created according to administrative, not ecological, criteria. Similar lease auctions raise revenues from agricultural land, market-places, bridges, ferries, boulder-collection, sand-collection and car-parks.

Current regulations are as follows:

i) Private agricultural land becomes *de jure* an open-access fishery if it is flooded. In practice, however, landowners are increasingly claiming exclusive fishing rights over their flooded fields.

ii) Fishing rights in permanent water and flooded government (*khas*) land are vested in the government. These waters are divided into some 13,000 leasing-units (*jalmohols*). Leasing arrangements are defined by Ministry of Land (1991) and described by Ali (1992):

- Jalmohols under 20 acres, around 70% by number, are administered by the Thana (previously Upazila) Parishads of the Ministry of Local Government. 1% of lease revenue is paid to the Ministry of Land and the remainder is collected by the Thana Parishad.
- Jalmohols over 20 acres are administered by the Deputy Commissioner (DC) for the Ministry of Land. The lease is awarded by a Tender Committee consisting of the DC, Additional Deputy Commissioner, District Fisheries Officer, District Co-operatives Officer and Revenue Deputy Collector. The Committee should only award leases to registered Fishermen's Associations but they may waive this rule if a 25% increase upon the previous year's lease price is not forthcoming. 50% of revenue is taken by the Ministry of Land. The remainder is distributed by central government to the Thanas.

The lease to each *jalmohol* is sold by auction in the Bengali New Year (April-May) just before the onset of the monsoon. Riverine *jalmohols* and non-riverine *jalmohols* are leased for 1 and 3 years respectively. A Ministry of Land order (Ministry of Land 1991) made it possible to leases of 4-10 years to be awarded to a prospective lessee who produced a written "production-oriented development plan." This option was little-known until it was officially encouraged for lease year 1993-4. At the time of writing nobody in the DOF's Head Office was able to say who should approve the plan and according to what criteria. It is likely that the power to award 10-year leases will fall to the Ministry of Land, "because they have the power, the manpower and the money" (Mokhomel Hussein *pers.comm.*).

Auctions were supposed to be conducted in public until 1992. Closed bids were then adopted on the grounds that the previous system encouraged public disorder. The successful bidder should pay 50% of the lease price on announcement of the auction result and the remainder within 7 days.

iii) In 1973 the new Bangladesh administration replaced *jalmohol* leases with fishing licences. The old system was re-adopted in 1976 because of administrative difficulties and ex-leaseholders' control over the licensing process. Under the New Fisheries Management Policy (NFMP) of 1986 fishermen were again to be licensed. The official aim of the NFMP is to transfer the lessees' income to the fishermen by giving them direct access to the water ("jal jaladar" - "water to the fisherman" - was the slogan).

Under the NFMP fishing licences (*adhika patro*) are awarded directly to fishermen. Fishermen's eligibility is determined by the *Thana Nirvahi Committee*, consisting of the Thana Fisheries Officer, a representative of the JMS (the official national fishermen's association) and the Thana Revenue Officer. (One notes that the alliance between the Fisheries Association bosses and the Revenue Office that undermined the licensing of 1973-6 has been incorporated into the *Thana Nirvahi Committee.*) Licence fees were initially to maintain the average of the previous three years' lease revenues and to rise by 10% per year thereafter. *Adhika patro* fees were to be collected by the Department of Fisheries, <u>not</u> by the Ministry of Land.

It was envisaged that BKB (Bangladesh Krishi Bank, a state-owned agricultural bank) would lend to licensed fishermen for *Adhika patro* costs. Few loans materialised; the Department of Fisheries blames fishermen's lack of collateral and low repayment rates. At the time of writing it was enlisting 4 NGOs to supply credit to fishermen's groups in 21 NFMP *jalmohols*.

The Ministry of Land opposed the NFMP from the start. It (Ministry of Land 1988) modified the NFMP in 1988, transferring control of NFMP jalmohols to the Thana Nirvahi Officer (TNO) instead of the Thana Fisheries Officer (TFO). It also decreed that NFMP license revenues should be credited to the Land Revenue Account of the Ministry of Land. The NFMP scheme was then frozen in 1991 after only 264 *jalmohols* had been transferred to it. (Another 36 await the resolution of legal disputes.) Moreover, officials of the Department of Fisheries (DOF) in Dhaka revealed in September 1993 that the Prime Minister had decided to abolish the NFMP. The DOF protested against this decision but does not expect it to be reversed because of opposition to the NFMP from the Ministry of Land.

Despite the NFMP's moribundity, it continues to excite donor interest as a possible future alternative to leasing. The Ford Foundation/DOF's Experiments in New Approaches to Management of Fisheries (ENIMOF) project (1987-9) attempted to evaluate the success of the NFMP. It was succeeded in 1991 by the Improved Management of Fisheries (IMOF) project which intends to evaluate the NFMP in 19 jalmohols, of which 10 will receive NGO support.

A compilation of discussions of the New Fisheries Management policy was published in 1989 (ed. Aguero, Huq, Rahman and Ahmed 1989). Naqi (1989) compares the NFMP with the leasing system and concludes that middlemen dominate both arrangements in equal measure. Siddiqui (1989) applauds the NFMP's intentions but observes increased illegal fishing and over-fishing in the absence of a lessee's supervision. This contrasts with the popular assertion (e.g. Ali 1993, Haque 1993) that leasing leads to the over-exploitation of fish stocks because of the lessee's rapacity.

Fisheries legislation

The *Protection and Conservation of Fish Act* (1950) authorises the government to regulate fishing in the interests of stock conservation. It is forbidden under this act:
- to catch major carp shorter than 9 inches (23 cm) between July and December (the growing season)
- to catch snakeheads (*Ophicephalus* spp./*Channa* spp.) between April and June inclusive, their breeding season
- to use barrier nets across rivers or monofilament gill-nets. Monofilament gill-nets are banned "because they are invisible in the water and entangle everything that touches them."
- to catch boal catfish (*Wallago atu*) shorter than 12 inches (30 cm)
- since 1985, to use any net with a mesh size lower than 4.5 cm
- to catch fish by dewatering

The law prescribes confiscation of gear and a Tk500 fine for the first offence and one year's imprisonment for subsequent offences. However, the Thana Fisheries Officers, who are charged with enforcement of the *Protection and Conservation of Fish Act*, are not empowered by law to confiscate gear or make arrests. In reality, the regulations are enforced as and when political pressure is placed upon local officials.

The *Tanks Improvement Act* (1937), *Fish and Fish-Products Ordinance* (1983) and *Marine Fisheries Rules* (1983) cover aquaculture, quality control and marine fisheries respectively and are therefore not of relevance to this study.

Open-water stocking

Open-water stocking has been promoted as a means of countering the perceived fall in fish recruitment resulting from over-fishing, siltation and flood control.

The Third Fisheries Project (TFP) and the Second Aquaculture Development Project (ADPII) are currently stocking open waters with the fry of major carps in the west and east of Bangladesh respectively. The TFP has stocked three water-bodies totalling 53,680ha annually since 1991. Project documents envisage that 50% of the costs of stocking will be recovered via the leasing system, that 50% of incremental yields will be caught by "part-time fisherfolk" and that stocking will cover 100,000 ha. The project hopes to produce an ex-post economic evaluation of stocking.

The ADP stocks "nursery beels" at the start of the monsoon and relies upon the rising floodwaters to disperse the fry. It has attempted ex-post evaluations of its stocking but they are weakened by a lack of baseline data and of a reliable method for distinguishing between stocked and wild carps. The Government of Bangladesh has forbidden the ADP to release information about its work.

Both the TFP and the ADP have been accompanied, in the words of the TFP's Director, by a "vigorous application of the Fisheries Act." This forbids the catching of major carps during the six months to December. The stocking programmes have also prompted the banning of *current jal*, nylon monofilament gill nets.

An evaluation of the TFP (Leterme and Chisholm 1993) found that poor professional fishermen and subsistence fisherfolk lost 36% and 54% of their fishing incomes respectively, probably as a result of stocking. The main causes were a reduction in stocks of non-stocked species, increased controls on fishermen by officials and landowners and an increase in the number of landowners' kuas (trap-ponds). In one water-body, kuas took 90% of the catch of stocked species. The DOF's official line, however, is that, "The NFMP is taking care of equity aspects" (Director TFP, *pers. comm.*), meaning that the moribund NFMP will transfer profits from lessees to fishermen.

Despite open-water stocking's poor performance, there is pressure for it to continue. First, many fisheries experts in donor agencies, being fisheries biologists by training, remain impressed by the rate of biomass growth on offer. Secondly, it is an open secret that senior officials in the Department of Fisheries have made personal profits from the procurement of fry.

Flood control and drainage

Flood control and drainage (FCD) schemes have long been an integral feature of the Bangladeshi landscape. The official arguments for such schemes are two-fold. There is the economic argument, as in the case of USAID's Coastal Embankments Project, that they increase rice production by converting floodplain into irrigated paddy land. Secondly, there is the humanitarian argument, that they prevent death and damage to property from flooding. Until the late 1980s there was little interest in the effects of flood control upon freshwater fisheries.

Then, in 1988, a heavy monsoon produced an abnormally high flood. Whilst its economic impact is still under debate, donor organisations adopted a plan in 1988 itself to prevent its recurrence by canalising rivers and empoldering floodplains. The resulting vast programme, known as the Flood Action Plan, is split into more than 20 component projects. Most are funded by bilateral agreements with foreign governments. FAP 17, the fisheries component, has set itself the task of estimating *ex-ante* the effects of flood control and drainage works upon the fisheries sector. A team of biologists is collecting length-frequency data and studying fish life-cycles in order to assess how flood control will affect fish recruitment. A socio-economic research programme intends to describe the effects of flood control by comparing conditions inside and outside existing polders. However, the FAP has been phased in such a way that much engineering work will already have been planned by the time that FAP17 and other appraisal components produce their recommendations.

NGO group-formation

Starting with relief operations in the post-liberation period after 1971, NGOs, or private development organisations, have become a distinctive part of the aid sector in Bangladesh. Supporters of NGOs argue that, by working directly with the rural poor, they avoid having their assistance appropriated by patronage networks, which is the fate of official aid. Others (e.g. Kramsyo and Wood 1991), more radically, see in NGOs a force that could lay the foundations for social revolution by weaning the rural poor away from the patronage networks and instilling class-consciousness into the rural proletariat, making a "class for itself". The NGOs' coverage, however, is limited by their recurrent costs and flexible bureaucratic style. Maloney (1986) notes that they reach less than 2% of the population and doubts their capacity for rapid expansion.

A recent survey (FAP17 1993) found that 100% of NGOs working in Bangladesh were involved with the fisheries sector. Their involvement in capture fisheries, however, is recent and restricted; 57% of NGOs have no involvement in capture fisheries at all. BRAC, Bangladesh's largest NGO, only has 4% of its fisheries Area Officers working in capture fisheries (Choudhury 1993 pp. 6,7).

The NGOs' standard mode of intervention, whatever the sector, is first to form "target groups" of poor people, next to encourage them to create a development plan and a group savings fund and then to provide the credit, training and political support to put the plan into action. Choudhury (1993), Rahman (1993), and FIVDB (1993) describe how this approach has been transferred to the capture fisheries sector. Capture fisheries target group development plans tend to focus on gear purchase, lease acquisition and the development of non-fishing activities, predominantly aquaculture.

When choosing how to use their access to NGO credit, capture fishermen groups show an overwhelming preference for gear purchase. For example, Proshika, one of Bangladesh's largest NGOs, manages a Revolving Loan Fund for target groups; 72% of its capture fisheries disbursements were for boat, engine and net purchase (Rahman 1993, p.10).

A special case of NGO involvement in capture fisheries is the Beels and Baors project, implemented by BRAC with funding from IFAD and DANIDA. Under this project BRAC organises target groups in the standard manner but with the specific aim of managing a NFMP baor (ox-bow lake). The group uses a BRAC credit line to acquire fishing licenses for the baor, to stock it with major carps and to fish it.

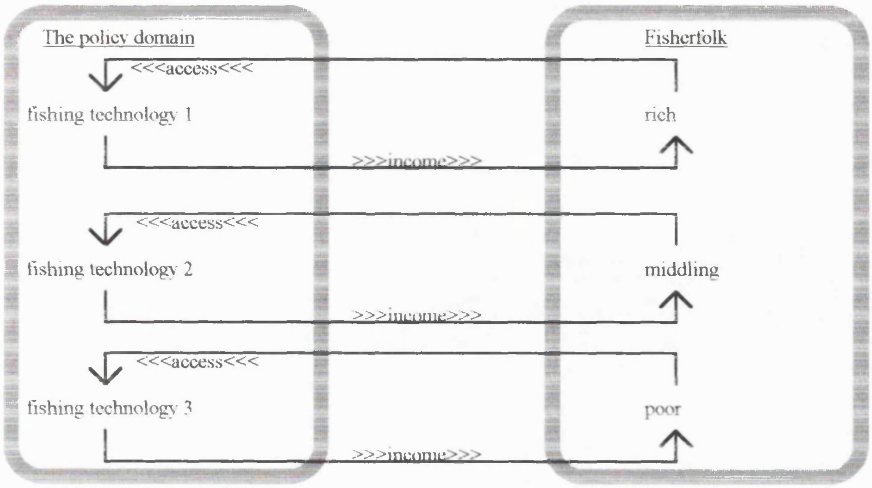
Fishermen have received net incomes of around Tk15,000 per head per year when the scheme has operated as planned. Encouraged by the project's success, BRAC is expanding its coverage, assisting other groups to acquire leases for non-NFMP baors.

Policy-oriented research needs

Policy-makers in the Government of Bangladesh and donor organisations are therefore committed to adjusting fishing activity by means of eumetric controls, gear restrictions, a transfer from leasing to licensing, artificial stocking, flood control and credit promotion. A review of past research (and the "grey" literature), however, reveals a lack of information upon <u>the relationship between fishing activity and economic welfare</u>. In an unequal society this relationship is two-sided, as a household's economic status determines which fishing activities it can practice and a household's fishing activities generate the income that determines its economic status. In order to predict the likely effects of these policy instruments, therefore, it is necessary to know the transmission mechanisms, that is how economic status determines fishing activities on the one hand and how fishing activities sustain economic status on the other.

Figure 2.1 illustrates this analytical framework. Economic status determines access to the fishery and use of fishing technology. Fishing technology in turn generates the income that determines economic status. Policy-makers who adjust the conditions of access and the range of available technologies (the Policy Domain on the left-hand side of the diagram) need to predict how they will affect households' economic status (on the right-hand side).

Figure 2.1. The determination of fishing incomes



Referring specifically to current fisheries policy, a policy-oriented micro-economic study of inland capture fisheries in Bangladesh could answer the following questions:

a) What are the effects of effort management upon incomes, employment and the distribution of income?

b) Licensing is intended to transfer fishing rents from the lessee to the fisherman. Does this occur? Is the lessee's current share high enough to justify the programme administrative costs?

c) To what extent does leasing encourage or prevent over-fishing?

d) What are the effects of artificial stocking upon incomes, employment and the distribution of income?

e) If flood control embankments reduce the area of the floodplain, how will this affect fishing income and employment?

f) What role could NGOs' Target Group approach play in fishery development?

g) Lastly, procedures for the assessment of marine fisheries are already well-established. But what research procedures are appropriate for a policy-oriented assessment of an inland open-water fishery in Bangladesh?

This study aims to investigate and answer the policy questions above. Various qualitative and quantitative methods will be used to examine the linkages between fishery and household. It will then explore how the household might be affected when the instruments of fisheries management are applied and thus evaluate the efficacy of current fisheries policy. The study's theme and principal conclusion will be that government policy increases fishery rents at the expense of fishing labour's welfare.

Fisheries management: a review of the social sciences' contribution.

This review has two goals. It attempts to summarise as briefly as possible the social sciences' insights upon fisheries management and then to assess the extent to which they illuminate the decisions faced by the managers of freshwater fisheries in a country like Bangladesh. Of course, every detail of fisheries management theory cannot be described within a single chapter. It is possible, however, to identify which broad approaches to the question of fisheries management have been addressed and which have not. Indeed, it is the central theme of this review that the social sciences have picked over one issue in minute detail whilst leaving another equally important theme almost untouched.

For ease of exposition, the literature has been grouped into two broad schools. The first, the economic modelling approach to fisheries management, attempts to use neo-classical micro-economics to identify the optimum pattern of fishing effort for fisheries managers to enforce by regulation. The second school, the Community Resource Management approach to fisheries management, aims to build upon the observation that local communities can manage renewable resources effectively themselves.

The core argument of this review chapter is that neither of these two approaches addresses the problem of how fisheries management can alleviate or aggravate poverty - which is the key problem of fisheries management in Bangladesh. The economic modelling approach and the Community Resource Management approach both concentrate upon the issue of increasing economic efficiency in the fishery by controlling levels of fishing effort. This goal of economic efficiency is certainly related to the goal of poverty-reduction but, as this thesis will eventually show, it requires a completely different approach to fishery analysis and policy-formation.

The economic modelling approach to fisheries management

In the 1950s, Gordon (1954) and Schaefer (1957) established an enduring paradigm for the economic study of fisheries. In their analysis, rent-maximisation was the objective and rent-dissipation, produced by unrestricted effort, was the problem. This analytical framework was refined by later writers, but has never been discarded and is probably still what most people understand by the phrase "fisheries economics." Models of the 60s, 70s and 80s added price effects, labour scarcity, discounting, lags, stochasticity and computerised algorithms, but did so largely in order better to identify the same two points, rent-dissipation under open-access and rent-maximisation under regulatory control. If models of the fishery have been restricted to descriptions of fishing effort, it is unsurprising that models of fisheries management have concentrated upon analyses of effort reduction. Similarly, empirical economic studies of the fishery have attempted to identify the shortfall of observed rents below potential rents.

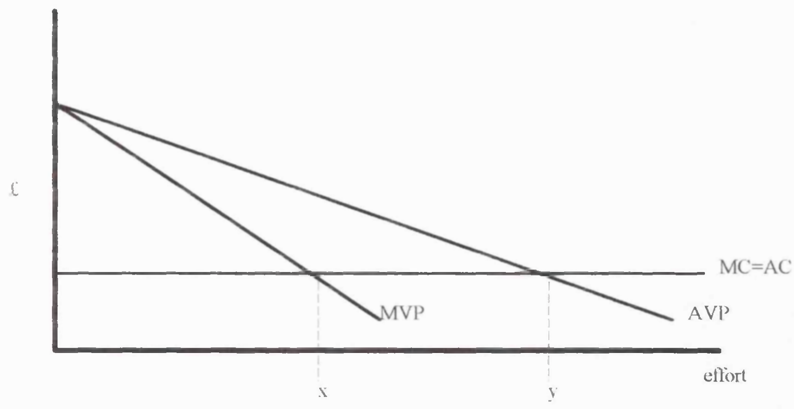
Within this framework, the fishery economist's task is twofold:
i) Diagnosis, the identification of the potential economic gain from effort management and
ii) Optimisation, ensuring the pattern of effort required to maximise rents.
We will start by looking at the economic theory of these two operations.

Diagnosis - identifying the potential gain from management

The application of neo-classical economic theory to fishing, and with it the emergence of the discipline of fisheries economics, began with H. Gordon (Gordon 1954). His intention was to derive a theory of economic behaviour "applicable generally to all cases where natural resources are owned in common and exploited under conditions of individualistic competition" (p.124). He complained that the debate about the advisability of fishing controls had hitherto been conducted entirely in biological terms without any reference to human values or human behaviour and argued that one should therefore identify the economic gains to society from management and then work out the interventions most likely to produce them.

Gordon's bio-economic model of the fishery is illustrated in Figure 3.1. The cost of fishing (MC=AC) is a constant multiple of the amount of fishing effort. Revenue from fishing, however, is a positive function of fishing effort with a negative second derivative. The revenue curve possesses this property because of a biological limit upon total yield. The optimum level of effort from the point of view of allocative efficiency is represented by **x**, where marginal value product (MVP) is equal to marginal cost and resource rents (total revenue less total cost) are at a maximum.

Figure 3.1. Gordon's (1954) theory of the fishery



Under open access, however, positive factor rents are unsustainable. The existence of factor rents will induce fisherfolk to increase the level of effort applied to the fishery, and this increase will continue until **y** is reached, where all rents are dissipated as costs. This state of affairs is frequently referred to as "The Tragedy of the Commons", a phrase first used in Hardin's (1968) lecture on population growth. Gordon concludes that the only fisherman who becomes rich is one who makes a lucky catch or one who participates in a fishery that is put under a form of social control that creates restricted property rights.

Schaefer (1957) also analysed fisheries exploitation under open access, but did so on the basis of a more realistic depiction of fish ecology. He notes Ricardo's reference to rents generated by the "original and indestructible powers of the soil" and remarks that the reproductive powers of fish, by contrast, are highly destructible. More specifically, the growth of a fish population is a function of the current fish population. When the population is extremely low, population growth is zero or negative, owing to scarce spawning capacity and the difficulty of finding mates. When fish population approaches a certain level, population growth is also low, owing to a lack of supplementary food and habitats. Beyond this ecologically-determined maximum, population growth is negative. For population levels between zero and the ecologically-determined maximum population, however, there is a positive natural rate of population growth.

Schaefer derived the following model of natural fish population growth from experimental fisheries data:

$$f(P) = k_1 P (M - P)$$

where:

P is the fish population
f(P) is fish population growth

M is the zero-growth fish population
k_1 is a constant.

and

$$L = k_2EP$$

where:

L is landings
E is fishing effort
k_2 is a constant, the "catchability coefficient."

In equilibrium, the fish population is neither growing nor decreasing. In other words, landings are equal to population growth:

$$L = f(P)$$

By substituting for P into the first equation, one obtains equilibrium landings as a quadratic function of effort. This model agrees with Gordon's description of the fishery, but not with his diagrams, where the total product curve is always upward-sloping.

$$L = k_2E(M - k_2E/ k_1)$$

So long as the demand for fish is elastic, total revenue is always a positive function of landings. It is therefore maximised at the level of effort that maximises total landings. If not, there is a possibility that total revenue will exhibit two maxima with respect to effort. Usually, however, one biological stock is a small portion of the total market supply, so one is justified in assuming demand for the stock to be elastic.

The resulting bio-economic model is specified as follows:

$$L = \alpha E(b - E)$$
$$V = \beta L$$

$$C = \gamma E$$

where:

α is equivalent to $k_2{}^2/k_1$

b is equivalent to $M(K_1/K_2)$. It is the level of effort that reduces population growth to zero.

ß is the price of fish

γ is a constant representing marginal cost

Further useful expressions may be derived by combining the basic equations:

Catch per unit effort (average product) = $\alpha(b - E)$
Value per unit effort (average value product) = $\beta\alpha(b - E)$
Marginal value product = $b\beta\alpha - 2\beta\alpha E$

From this point Schaefer's argument corresponds exactly to Gordon's; an allocative optimum exists where marginal value product equals marginal cost, but the open access equilibrium exists where average value product equals marginal cost. He noted that the privatisation of fisheries may lead to an allocative optimum, since a private owner would attempt to maximise resource rents.

Bell's (1972) model of the U.S. northern lobster fishery is frequently cited as evidence that Schaefer's surplus production model can be applied in practice. Bell calculated that a 50% reduction in lobster-pot days would equalise marginal costs with marginal revenues and that this would raise CPUE by 2.4kg/lobster-pot and concluded "the only solution to the market failure is government intervention" (p.157). Conrad (1989) attempted a similar exercise for the bowhead whale, but without the benefit of empirical catch-effort data. Conrad concluded that the current catch quota for bowhead whales was well below the maximum sustainable yield and therefore too low.

Copes (1970) relaxed Schaefer's assumption of perfect demand elasticity to show that the supply curve for fish from a specific fishery would be backward-bending for a certain range of price levels. His derived cost function is illustrated in Figure 3.2. A certain level of effort (a) generates both a certain cost (b) and a certain yield (c). If the marginal cost of effort does not decrease with respect to effort and the catch/effort function is the inverted-U described by Schaefer, then the yield/total cost function will bend back, giving two values of total cost for some levels of total yield. Copes then goes on to adopt Gordon's statement that under open access effort will be increased until total cost is equal to total revenue, which is also when average cost is equal to price. Referring back to the north-east quadrant of Figure 3.2 one can see that the quantity supplied will first increase and then decrease with respect to average cost, which is indicated by the gradient of a ray from the origin to the curve. Under open access average cost is equal to price, so supply will first increase and then decrease with respect to price. This gives rise to the possibility of a spiralling destabilisation of the market for fish. If the market is on the backward-bending portion of the supply curve, an exogenous shock in the form of a rise in demand or a fall in the fishery's productivity can create an unstable disequilibrium: demand is greater than supply, leading to a rise in price. The rise in price induces fisherfolk to apply more effort to the fishery. The increased effort reduces the productive capacity of the fishery, leading to a further fall in supply, a further rise in price and so on. Copes concludes that policy-makers should consider price controls as an alternative to the effort controls recommended by Gordon (1954).

Clark and Munro (1975) and Clark (1976) refined Schaefer's (1957) description of the optimally-managed fishery by pursuing Clark's (1973) notion of fish stocks as a capital investment. Schaefer had defined optimal management as the maximisation of fishery rents in a single time-period in which the fishery is in equilibrium. Clark and Munro, however, sought to define the management rule which would maximise the present discounted value of the stream of fishery rents from the present onwards.

The arrived at the intuitively attractive expression:

$$\frac{dr}{dx} = d\,[p-c(x)] \qquad \text{(Clark 1976, p.42)}$$

where: r is equilibrium, long-term fishery rents
- d is the discount rate
- p is the price of fish
- $c(x)$ is the cost of catching fish with fish population x
- x is the fish population

This expression says that the fisheries manager can maximise rents by running down the fish stock until the incremental annuity from investing the proceeds of one more fish (right-hand side) would be cancelled out by the stock-depletion effect upon profits (left-hand side). If the discount rate is infinite, then the open-access solution of zero rents is optimal. If the discount rate is zero, then it is optimal to maximise recurrent annual profits. The real life optimum, Clark (1976) argues, lies between these two extremes.

Copes (1972) identifies another divergence between Gordon's (1954) rent-maximising solution and the social optimum. He states Gordon's position as being that a private owner would maximise social welfare at the same time as private profits, by equalising marginal private income and marginal private costs. Copes' disagreement is that a number of divergences between social and private costs and benefits are likely to exist. If the fisheries owner is a monopolist, his marginal benefits are given by the marginal revenue function, whereas social benefits are related to output by the average revenue function, or demand curve. If fishermen command quasi-rents because of the scarcity of their skills, then the private marginal cost of employing fishermen is higher than the social opportunity cost of taking them out of alternative employment. Copes concludes that a privately-owned fishery will tend to be under-exploited.

Although Schaefer's stock recruitment model has dominated theoretical economic analyses of fisheries management, it is necessary to describe an alternative model, the "yield per recruit model" (Beverton and Holt (1957), Tyler and Gallucci 1980). Although it is mathematically more complex than the Schaefer model, it is based upon observable biological parameters such as natural mortality and growth rates, and modern microcomputer technology permits it to be used for rapid fishery simulations.

The number of hatchlings, or recruits, to the fishery in question is determined outside the model by environmental factors such as water temperature and currents. It is not dependent upon the existing fish population as in Schaefer's model.

The model starts with the Von Bertalanffy Growth Formula for fishes:

$$L_t = L\infty \ (1-e^{-k(t-t^*)})$$

where:

L_t is fish length at age t.
$L\infty$ is the putative maximum length that the fish would attain if it lived for ever.
t is the fish's actual age.
k is a constant
t^* is a putative "age at birth".

This expression may be simplified to:

$$L_t = L\infty(1-e^{-kt})$$

In words, the fish is approaching its maximum length asymptotically. The fish's weight is a simple cubic function of its length.

$$W_t = wL^3$$

where:

W_t is fish weight at age t.
w is the "weight for age" constant.

In words, the fish is the same shape irrespective of its size.

The Baranov catch function describes a fish population that is being thinned out simultaneously by fishing and by natural mortality. The total mortality rate is given by:

$$Z = (1 - e^{-(F+M)})$$

where:

Z is the instantaneous total mortality rate
F is the instantaneous fishing mortality rate
M is the instantaneous natural mortality rate

The instantaneous rate of fishing mortality is itself a function of fishing effort:

$$F = 1 - e^{-f}$$

where:

f is the level of fishing effort

Since total mortality is the product of the total mortality rate and fish population, and catch is fishing mortality's share of total mortality:

$$C = F \frac{(1 - e^{(F+M)})N}{F+M}$$

where:
C is the catch
N is the fish population

The model may now be made operational by simulating the yield of an age cohort across its multi-period lifespan with fish size, total mortality rate and catch in each time-period determined by the equations above. It is usual for this to be done by means of micro-computers (Pauly 1980). Economists such as Lipton and Strand (1992) and Onal, McCarl, Griffin, Matlock and Clark (1991) use the yield-per-recruit outputs to identify the Gordon/Schaefer divergence between the rent-dissipating and rent-maximising loci.

Flaaten (1983) presents a variation upon the yield per recruit model that is of particular relevance to Bangladesh's inland open-water fisheries since it describes a fishery with seasonal growth but no linkages between consecutive seasons. The fishery's rate of biomass growth is a function of time. Under open access, there is no fishing until biomass reaches the level at which average revenue reaches average cost. Any tendency for biomass to rise above this level thereafter is immediately countered by an increase in effort. Under optimal management, the manager will only exploit the fish stock when it no longer generates a rate of growth superior to the discount rate. The onset of fishing therefore occurs later and the fishing season is shorter and more intense than under open access.

Allen and McGlade (1987), Beddington and May (1977)and May, Beddington, Clark, Holt and Laws (1979) introduce lags, stochasticity and predator-prey relationships to show the importance of dis-equilibrium analysis. Schaeferian equilibrium only exists when the biomass growth curve has been unaffected by ecological or economic variation throughout the lifespan of the fish, which is normally 8 to 12 years in temperate maritime fisheries. This is effectively impossible. On the economic side, fisherfolk base their actions, not only upon current profits, but upon the expected actions of other fisherfolk.

Allen and McGlade (1987) produced a stochastic simulation of the Newfoundland haddock fishery. Without any ecological variation, it took their model around 40 years to settle upon a bio-economic equilibrium "for all reasonable parameter values." When ecological variation was represented by variation in fish reproduction, it was found to be amplified by the lagged effort adjustments of fisherfolk. The fishery no longer tended towards equilibrium, but flip-flopped between levels of high and low catch. The writers concluded that bio-economic equilibrium is a worthless concept which should be abandoned in favour of computerised simulations.

Beddington and May (1977) explore the inter-action between ecological variability and management. If biomass growth is an inverted-U function of population plus a noise term and an increase in effort leads to a fall in population, then the variability of biomass will increase with the level of effort. Higher levels of effort are also associated with lower rates of biomass growth and therefore with longer recovery periods after a stochastic fall in biomass. If quotas exist a second "amplifier" is built into the system, since fisherfolk will respond to a stochastic fall in biomass by increasing the level of effort. The authors conclude that maximum sustainable yield quotas are not tight enough to prevent a collapse of fish stocks due to overfishing.

May, Beddington, Clark, Holt and Laws (1979) consider the predator-prey relationship within a fish population. If species A predates on species B, fishing for B will reduce yields of A for any level of effort. Fishing for A will increase yields of A and of B up to a certain point, after which it will reduce yields of A and still increase yields of B. When political and economic considerations are admitted "the consequences and management implications defy crisp summary" (p.275).

Welcomme (1985, pp.212-227) argues from multi-country empirical data that freshwater multi-species fisheries are relatively immune from over-fishing. As effort increases, large, valuable species are fished out and their ecological niche is taken by "r-selected" species. These tend to be small, with high fecundity, high productivity and a short life-span. Therefore, although a single species may collapse as effort rises, the fishery as a whole will produce similar yields for a high range of effort levels. This is most likely to be true for fisheries (such as a Bangladeshi floodplain) where large nutrients are abundant at lower trophic levels. Welcomme's ecological hypothesis provides an important challenge to fisheries policy; if total output is invariant with respect to effort then the accent of fisheries policy can be shifted away from yield-optimising effort management towards the redistribution of the benefits from a fixed yield.

The aforementioned models are based upon stock externalities, the negative effect of one fisher's effort upon another fisher's catch via a reduction in fish stocks. One should note, however, the existence of crowding externalities, whereby one fisher's effort interferes physically with another fisher's gear. Examples of crowding externalities would be the tangling of nets, the frightening of fish or congestion in fishing ports. Crowding externalities are likeliest to be of importance in fisheries, such as Bangladesh's inland waters, with a high density of fishers per square kilometre. The effect of crowding externalities is to create an upward-sloping marginal cost of effort curve for the fishery as a whole; one extra unit of effort creates ever increasing interference costs for all gear-users.

Optimisation: ensuring the pattern of effort required to maximise rents.

The theories of the fishery above described the gains to be obtained from managing fishing effort. Whether surplus production or yield per recruit models, they posited the existence of a stable or fluctuating inverted-U relationship between effort and catch. Given a positive relationship between effort and costs, there is a divergence between the open-access result, to which fisherfolk are supposed to tend, and the optimum, to which the manager is supposed to wish to return them. All implicitly assume the fisheries manager to be able to control the level of fishing effort. This effort control is analysed by another body of theory.

Hartwick and Olewiler (1986) set privatisation aside as impractical for most fisheries and review the remaining range of management instruments available. They list unallocated quotas, allocated quotas, catch taxes, effort taxes and co-operatives. Under an unallocated quota regime, the authority monitors total landings and declares the fishing season closed when they reach the pre-set quota. Under an allocated quota regime each fishing unit, usually a boat, is given the right to catch a certain amount. This quota is usually tradable. Under a co-operative regime, a fisherfolk's association determines the level of effort to be applied.

Hartwick and Olewiler's (1986) Schaeferian exposition of catch taxation is presented in Figure 3.3. The open-access equilibrium without taxation is defined by the intersection of the total cost (TC) and gross total revenue (TR) curves at a level of effort AA. This outcome produces zero rents. The manager, however, knows that rents could be maximised at a level of effort BB, where the TC and TR (gross) curves are parallel. The manager therefore imposes a tax on fish sales, depressing the total revenue curve to TR (net). Fisherfolk are driven to reduce the level of effort from AA to BB. It should be noted, however, that the fisherfolk are no better off. Their total revenue is still equal to their total costs. The government is the beneficiary.

A Schaeferian model of effort taxation is presented in Figure 3.4. Before the tax, fisherfolk expand effort until total costs (TC) are equal to total revenue (TR) at aa. This outcome produces zero rents. The manager knows, however, that rents could be maximised at a level of effort bb, where the TC and TR (gross) curves are parallel. The manager therefore taxes fishing effort, raising the TC curve. Fisherfolk are driven to reduce the level of effort from aa to bb. Once again, however, the open-access regime denies fisherfolk the newly-created rents.

Panayotou (1982) argues that unallocated quotas are invariably worthless. Under open access, fisherfolk will always apply inputs until rents are exhausted. This remains true when a global quota exists. In effect, fisherfolk, knowing that time is restricted, will substitute other inputs for time until total cost equals total revenue. This argument is repeated by Hartwick and Olewiler (1986).

Karpoff (1989) analyses the economics of an allocated quota regime. He describes fishing licenses as an option. They permit, but do not oblige the holder to fish, so their value is always positive. If one knew the mean and pattern of variation of fishing profits one could estimate the present value of the permit. He evaluates a permit's expected net present value at the time of allocation as:

$$V = \sum_{t=0}^{t=t^*} \left[\frac{\{E(R_t):R_t>0\} \times P(R_t>0)}{(1+r)^t} \right]$$

Where:

V is the value of the permit
t is time
t* is the time of expiry of the permit
E is the expectations operator
R_t is fishing profits for one licence-holder
P is the probability operator
r is the rate of discount

One could moreover derive from this analysis the observation that, if fishing permits are being traded in a perfect market, where the price is equal to V, all the expected benefits of the permit system will accrue to the original holder. Subsequent holders will pay V for an income stream with net present value V and thus earn no fishing rents.

Panayotou (1982) notes that governments have frequently attempted to raise fisherfolk's incomes by following the opposite course, subsidising fish prices and effort. He argues that such policies are counter-productive. Under open-access fisherfolk will simply expand effort until private profits are exhausted. Moreover, he could have added, total social costs are now higher than total social benefits, making the fishery of negative value to the economy as a whole.

Pessimistic reviews of the effectiveness of effort controls have been written by Scott (1979), Wilen (1979) and Panayotou (1982). All three writers argue that effort control is ineffective because fisherfolk react to the control of one element of effort, for example boats, by increasing another, for example time, to produce again a rent-negating level of effort. Meary (1979) observed this process in the W. Australian crustacean fisheries. Scott (1979) draws upon the North American experience to argue that exclusion clauses concentrate fishing revenues within a smaller population without altering the degree of overfishing. Rather than effort controls, Scott (1979) recommends "eumetric" controls, regulating mesh size and setting aside closed seasons and areas for breeding. However, both Wilen (1979) and Panayotou (1982) doubt that government regulation can ever raise fisherfolk's incomes. Wilen puts this down to it being the nature of fisherfolk to exhibit "share-focused behaviour", seeking to improve individual, rather than group, incomes. Panayotou (1982) recommends that governments wishing to aid fisherfolk should promote non-fishing employment in fishing communities.

Campbell and Lindner (1990) show, however, that Scott, Wilen and Panayotou's assertion that effort regulation will always be ineffective is an over-simplification. Figure 3.5 illustrates their model of effort control. The graph plots revenue and costs against effort. The initial marginal cost of effort is represented by the line MCE1. Fisherfolk have unrestricted access to the most efficient factor combination so marginal cost does not rise with effort; it is always equal to average cost. Under open access, fisherfolk adjust the level of effort until marginal cost (MCE1) is equal to the average revenue product of effort (ARE). When effort applied is at **a**, they have no further incentive to adjust. At this point the fishery is generating zero rents; the dead-weight loss from over-fishing is represented by the triangle **avz**. The fisheries manager then attempts to increase rents by restricting the use of one input, for example time. Fisherfolk substitute other inputs for the restricted input, and an upward-sloping marginal cost of effort curve (MCE2) is generated beyond the point where substitution becomes necessary (v). Fisherfolk approach a new equilibrium level of effort (c) where the new marginal cost of effort (MCE2) is equal to the average revenue product of effort (ARE). This adjustment reduces the dead-weight losses from overfishing (by **axyz**) but a new dead-weight loss is created by the use of inefficient fishing technology (**vwy**). The authors conclude that effort restrictions are likely to prove most beneficial if there is inelastic substitution for the restricted factor; under these circumstances effort will be greatly reduced and only a small amount of inefficiently-composed effort will be applied to the fishery.

Weitzman (1974) questions the supposed welfare benefits from controlling effort, noting that labour, as a variable factor of production, will always be better off under open access than under a controlled regime. He proves this by assuming rising marginal labour costs and falling marginal returns to labour:

$$\frac{d^2C}{dx^2} > 0$$

$$\frac{d^2R}{dx^2} < 0$$

where:

C is total cost

x is employment of the variable factor (labour)

R is total revenue

These two relationships logically imply that for any potentially profitable fishery (where R can be higher than C) rents (R-C) are maximised by a level of x lower than that employed under open access (C=R). Although apparently trivial, this result should make one question the Common Property School's assertion (see below) that community management will tend to be *equitable* as well as efficient. It confirms Charles' (1988) observation that models of fisheries management need to be multi-dimensional; they should predict the effects of intervention upon output and employment because fisheries managers are responsible for both.

Johnson and Libecap (1982) note that fishermen are the first to oppose the effort restrictions that economic theory since Gordon (1954) has stated to be in their interest. They then ask why effort restrictions are so resented. They find the answer in the heterogeneity of fisherfolk. Figure 3.6 illustrates their analysis. (Their article uses other more complex diagrams to make the same point.) The horizontal axis shows effort **per fishing unit**, assuming with Johnson and Libecap no variation in the number of fishing units. The curves TC1 and TC2 represent the total costs of efficient and inefficient fishermen respectively. If the fishery were composed entirely of efficient fisherfolk, the rent-maximising level of effort would be **b**, where a line parallel to TC1 (T1) can be tangential to the total revenue curve (TR). Similarly, if the fishery were composed entirely of inefficient fishermen the rent maximising level of effort would be **a**, where T2 is tangential to TR. If the manager chooses a compromise level of effort, however (c), the efficient fisherfolk will consider it excessive and the inefficient fisherfolk will consider it too lax - the restriction will be opposed and possibly collapse. Johnson and Libecap conclude that the only solution is to apply differential quotas, which are difficult to elaborate and politically unacceptable. They concede that self-regulation is superior to regulation by government, but only because fishermen "will internalise the cost of regulation"; in other words, they will choose a low-cost administrative regime because they are paying for it themselves.

Anthropologists Emmerson (1976) and Acheson (1981) echo Johnson and Libecap's pessimism. Fisheries management, Acheson argues, always produces disputes because it always produces losers as well as winners. Emmerson concludes from a study of a management dispute in Indonesia that any redistribution of benefits is likely to offend local people's attachment to the status quo.

Adasiak (1979) provides a detailed account of the performance of effort control through licensing in Alaska. In brief, although effort controls by no means created an efficient fishery, they achieved their political objective, which was to preserve the identity of traditional fishing communities. Gear-specific permits, substitution away from boats towards fishing time, substitution away from limited towards unlimited fisheries and a possible bias in license allocation towards older fishermen may all have allowed Alaskan fisheries to be technically inefficient, but the programme was adjudged a success inasmuch as it prevented social disruption. Adasiak notes, however, that the licensing scheme was seen by many to be unjust, creating a "rich man's club."

Studies of community resource management.[1]

Gordon's (1954) analysis of over-fishing assumed that fisherfolk did not co-operate when determining the level of effort to be applied to the fishery. Their individual profit-maximising decisions led to the total dissipation of fishing rents. As preceding sections of this review have shown, fisheries economics literature tends to analyse the divergence between this open-access equilibrium and a putative societal optimum; fisheries management economics literature tends similarly to analyse how regulation could shift the fishery from the former state to the latter.

However, a number of writers have challenged the assumption that the only alternatives to rent-dissipating open access are private ownership and regulation. They have argued that a fourth option is logically conceivable, theoretically predictable and empirically observable. This fourth option is variously referred to as "self-regulation", "common property" or "community resource management". All these terms refer to a situation in which those who exploit the natural resource manage it collectively without government regulation. It should be noted that this debate uses the terminology of environmental management to restate an ancient concern of political philosophy, the question of whether coercion is required to establish social harmony, with Plato's Republic and Hooker's Laws of Ecclesiastical Polity having posited the same enlightened co-operation as a possible solution. The Common Property School's case may be broken down into the following arguments:

a) The empirical argument that local communities are observed to manage renewable resources effectively

b) The cultural ecology argument, that societies must manage renewable resources effectively or become extinct

c) The populist argument, that it is right for local people to manage resources themselves

d) The micro-economic argument, that co-operation can be the outcome of rational, egoistic decision-making

---

[1] A note on terminology: The phrase "common property" tends to mean "not private property" when used by economists and "communally-managed property" when used by social anthropologists. This review therefore uses the terms "open access" and "community resource management" to avoid confusion .

e) The institutional argument, that Community Resource Management is administratively efficient

These will be described in turn below.

a) The empirical argument

Several writings (Berkes, Feeny, McCay and Acheson 1989, Feeny, Berkes, McCay and Acheson 1990, Gibbs and Bromley 1989, Grima and Berkes 1989, McGranahan 1991, Ostrom 1987) present an identical line of argument. They start by considering the over-exploitation of resources under open-access known, since Hardin's (1968) lecture on population growth, as "The Tragedy of the Commons". They then state that government regulation and private property are not the only alternatives to open-access, common property being a fourth possibility. They go on to describe observed examples of common property management systems (see below) and suggest that they are both more efficient than regulation or open access and more equitable than private property. They do not, however, offer hypotheses as to why human decision-makers might not act in the individualistic manner described by Gordon (1954) and Hardin (1968). Neither do they substantiate the pleasingly optimistic notion that local communities create equitable outcomes.

b) The cultural ecology argument

Norgaard (1984) provides a concise exposition of a "cultural ecology" explanation of the efficiency of community resource management; societies evolve to manage their environment in a sustainable manner. Those that do, survive. Those that do not, die out: "...information with considerable survival value becomes incorporated in culture as traditional knowledge in ways which individuals do not understand or even perceive." (Norgaard 1984 p.875). Since this hypothesis proposes that local people are successful environmental managers, it follows that the strengthening of "community management" systems would constitute a promising fisheries management policy. One weakness of the "cultural ecology" hypothesis, however, is that it does not explain how individuals are motivated to act in the interests of "society". Another is that it cannot be applied to communities whose natural or socio-economic environment has recently changed, i.e. to most societies of the late twentieth century.

Buck (1989), however, describes culture as an exogenous variable. In this analysis "organisation" and "view of nature" are the aspects of culture of relevance to environmental management. A society's level of "organisation" is in turn defined in terms of the degree of group cohesion and the complexity of its cultural prescriptions. For "community resource management" to be feasible a society must have a high degree of group cohesion and an understanding of nature's limits. Buck therefore concludes that an enquiry into the likelihood of successful "community resource management" should begin, not with an enquiry into incentive patterns, but with ethnographic studies.

c) The populist argument

Rather than restricting the case for "community resource management" to the quality of the community's management systems, Redclift (1992) asks bluntly for whose benefit natural resources should be managed. He states that they should be managed for the benefit of local people and that local people should manage the resources themselves because they are more likely than outsiders to attend to their own needs. Redclift's approach differs from that of other Common Property School writers in that it stresses that some people, in this case outsider capitalists, will lose from "community resource management."

d) The micro-economic argument

None of the theories above explain how egoistic individuals might be motivated to co-operate. Another body of writing uses micro-economic theory to show how the egoistic decision-making of rational individuals could produce a degree of collective action. Olson (1965) applied the analytic tool of Nash-Cournot equilibrium to demonstrate that egoists would contribute to collective action because they received a share of the resultant marginal benefits. The larger the group, the smaller any one individual's share of the marginal benefit from collective action and therefore the greater the tendency to under-cooperation. Sandler (1992) expanded Olson's basic model to allow for a wider range of scenarios. He separates the agent's utility function from the technology of public supply, by which resources are transformed into public goods, allowing both to vary and uses leader-follower (Stackelberg) equilibria as well as Nash-Cournot equilibria. In Chapters 3 and 7 he applies the resulting models to a range of real-life problems. One of these is the case of open-access fishing, which is represented by the basic Olson/Cournot model. Fishers over-exploit fish stocks because they only receive a share of the marginal benefit of stinting. The exception is where there is only one resource-user, the case of private ownership, where the marginal benefit of stinting is fully internalised and therefore provides an allocatively efficient incentive. Sandler analyses two second-best cases, where oligopoly or risk-aversion could lead to under-fishing and the open-access fishery's tendency to over-fishing exerts an allocatively efficient corrective influence. The significance of these theories is that they show limited collective action to be a possible outcome of uncooperative selfishness. Unfortunately, however, this result only applies to resources with a quite small number of users.

A parallel strand of literature has used game theory to show how cooperative develops out of egotism. Sen (1967) distinguishes between two types of game, the "isolation game" and the "assurance game". In the isolation game, an individual is always better off if he pursues an unco-operative strategy. The "Prisoners' Dilemma", "The Tragedy of the Commons" and Gordon's (1954) model of overfishing are examples of unsatisfactory outcomes produced when egotists play this type of game. In the assurance game, an individual is better off co-operating so long as at least a certain number (critical mass) of other players do likewise. For an individual egoist to co-operate he only needs to be assured that others will do likewise. Runge (1986) applies this distinction to natural resource management, arguing that communities often create resource management rules to transform the pattern of incentives from an isolation game into an assurance game. Runge again makes the romantic assertion that local communities will manage resources equitably. Axelrod (1981) used computer simulations of a Prisoners' Dilemma to explore the survival rates of different strategies in competition. An ALWAYS DEFECT society resisted invasion by a TIT-FOR-TAT ("do unto others as they did to you last time") individual, but succumbed to a group of them. In other words, a critical mass of TIT-FOR-TAT created an incentive structure that turned an isolation game into an assurance game.

Ostrom (1990) views community resource management as a modified Prisoners' Dilemma. The original Dilemma assumes no communication between the participants. Ostrom argues that communicating participants can create a different game by binding themselves by new rules. The game then becomes a "meta-game" in which participation in the game leads inevitably to the co-operative outcome; the only remaining decision is then whether or not to participate. Ostrom infers from a review of case-studies that players move from the non-co-operative to the co-operative equilibrium by a process of incremental change; the new rules cannot be implemented instantly because nobody believes that others will obey them. Players must first communicate that they are mutually unhappy with the present situation and then agree a "constitution", a set of rules that determines how operational rules will be determined. The trust that will eventually permit co-operation is created during this period. Ostrom's review of the empirical literature upon community resource management confirms this prediction.

e) The institutional argument

A further group of writings, however, argues that a society's choice of resource management regime is, or should be, driven by the relative costs of property-right enforcement under different systems. They follow Becker's (1968) thesis that a law should not be enforced unless the benefits of the deterrent effect outweigh the costs of enforcement. Alchian and Demsetz (1973) go on to argue that a society will tolerate open access so long as private ownership is too expensive to enforce. According to this analysis, the "Tragedy of the Commons" can be an efficient outcome; it is permitted to exist because the gains from restricted access are less than the cost of the restriction. Field (1985) and Bromley (1989) use graphical methods to define the conditions under which private property is superior. In Field's analysis, exclusion costs and resource rents are increasing convex-downwards and decreasing convex-upwards functions of the rate of exclusion respectively. The optimal commons is located by maximising resource rents less exclusion costs. However, although this literature has posited the importance of enforcement costs, it has only applied its insights to a choice between open access and private property; the costs of enforcing common property are not considered. More importantly, it has not shown how individuals might be motivated collectively to adopt the low-cost solution.

Empirical studies of Community Resource Management

The case for community resource management may therefore be summarised as follows: it prevents over-exploitation, it is somehow equitable, it is cheap to implement, it is sensitive to the local environment and it serves the interests of local people. Publications advocating community resource management tend to cite a common pool of empirical studies. They will be briefly reviewed below as illustrations of the key issues.

Netting (1976 and 1978) analysed the land management systems of Torbel, an Alpine village in Switzerland. Low land, held as private property was under cereals and fruit. The uplands, not private property, were grazed. The first paper argues that "land use by and large determines land tenure" (Netting 1976 p.137); private tenure was appropriate to the lowlands because it rewarded tree-planting, manuring and irrigation, but inappropriate to the high pastures because it would have entailed high fencing and surveillance costs. The second paper (Netting 1978) concentrates upon the regulation of access to the upland pastures. Netting explains that outsiders had been excluded from Torbel's pastures since 1483 and they were only permitted to graze as many animals during the summer as they could maintain during the winter with hay from the lowlands. Competition for land was mitigated by opportunities for outside employment, first in mercenary regiments, then in road construction and now in tourism.

Although Netting's observations have been used in support of the case for common property, they also illustrate its limitations. The resource was sustained, but in an economy where alternative sources of income were abundant. Villagers' access was not equitable. It was a function of their ownership of lowland meadows. Presumably land-owners gained at the expense of seasonal fatteners. The Torbel example does not therefore suggest that common property will benefit the poorer members of a labour-surplus society. It does demonstrate, however, that common property is a means by which the powerful may corner a resource without incurring the costs of privatisation.

Forman (1967) studied the raft-fishers of Coqueiral on the north-east coast of Brazil. Fishers found good fishing sites by a combination of triangulation and spying. Forman argued that over-fishing did not occur because information about fishing sites was not shared, individualistic behaviour fortuitously producing a successful outcome. This study should not, therefore, have been adduced in support of communal resource management.

Bromley and Chapagain (1984) discuss the forest of Nepal. They argue that nationalisation in 1957 created a situation of open-access. Villagers were interviewed. Two-thirds of respondents claimed that if control over the forests were transferred to their village they would stint for the common good. The authors conclude that the transfer of the forests from government to community ownership would lead to an equitable and sustainable use of the resource. Their argument is weak; <u>even</u> if the two-thirds stinted as they said they would, one wonders whether they would continue to do so when the one third failed to do likewise.

Ruddle (1989) described the Fisheries Collective Associations (FCAs) of Japan. Japanese law had codified tradition in 1901 by conferring control over coastal fishing upon the authorities of the nearest village. Control was officially transferred from the village to the FCA in 1949. Disputes within the FCA are resolved by the FCA. Disputes between FCAs are resolved at prefectorial level. Ruddle concludes that traditional management, backed by the state, ensures that the "Tragedy of the Commons" does not occur. Ruddle finds noteworthy, however, the cohesion of the FCAs. Decisions are almost always reached by consensus and fisherfolk are prepared to join waiting-lists of up to 30 years for FCA membership. The question of the system's replicability hinges on whether its success is attributable to the state's support or to the specific character of Japanese society.

Moorehead (1989) describes how, since the arrival of the French in 1893, the "Dina" system of resource management of the Peul Empire of Macina has been supplanted by the Malian state. Under the Dina, the Niger's inland delta was parcelled out between pastoralist Peul clans. Non-Peuls paid tribute in return for access to agricultural land and fisheries. Moorehead argues that the state has destroyed the Dina without providing a new source of authority and that this has led to resource degradation. He argues moreover that élites are now in a position to appropriate the best resources. However, one could say the same of the "Dina" under which one ethnic group, the Peul, levied tribute from other ethnic groups, the Bozo and Songhai. Indeed, Toulmin (1991) has argued that slave-wars and tributes, rather than collective management, were the Malian village's pre-colonial resource control strategies.

Fikret Berkes has studied community resource management in fisheries. In 1976 the right to fish for whitefish and crisco in certain parts of Hudson Bay was allocated to the Cree Indians. Berkes (1977) measured catch per unit effort and found that the resource was not over-exploited. Effort was restrained inasmuch as the Cree were only fishing for consumption. Berkes concluded that community self-regulation had created a well-adapted system. However, the publication does not show whether effort was restrained by social control or by the unprofitability of increases in effort. Berkes' observation that fisherfolk left the fishery when CPUE was low suggests the latter; as Gordon (1954) outlined, the individual's decision as to how much effort to apply was made on the basis of the average return to effort. This is turn implies that the "adaptedness" of the fishery might have been fortuitous, a general possibility emphasised by McCay (1978).

By contrast, Berkes' (1986) study of five Turkish coastal fisheries produced concrete instances of successful community resource management. The Turkish government leased the Ayvalik/Haylazi lagoon to a co-operative. The co-operative only admitted wageless people who had lived in a local village for six months or more. By restricting access to 100 fishermen it maintained fishing profitability. A local businessman created the Tasucu Bay fishing co-operative. By banning dynamite fishing, restricting access to the bay to 140 fishermen and enlisting political support against illegal inshore trawling it again ensured fishing profitability. The fishermen of Alanya prevented competition for fishing spots by defining territories and rotating them amongst themselves. In the Bay of Izmir and Bodrun fisheries, however, self-regulation did not prevent over-exploitation. In each of these cases, it was possible to create co-operation between users of the same gear, but not between users of different gears, an outcome predicted by the theory of Johnson and Libecap (1982).

Watson (1989) and Chapman caution against an unquestioning endorsement of community resource management. Chapman (1985) calls the support of traditional practices a "New Orthodoxy". Her review of the literature upon traditional practices in the South Pacific, however, suggests that traditional custom only tends to be beneficial to the environment when the environment is extremely harsh; elsewhere tradition tends to control the distribution of benefits rather than the level of exploitation. Watson examines traditional swidden agriculture in Sarawak, Malaysia and finds that a combination of traditional agriculture and population growth has damaged the soil, the forests, fisheries and wildlife to the point that human welfare is impaired. Watson therefore calls for government to intervene against traditional land tenure systems in favour of private property. The common property school is accused of romanticism: "A Neroistic tendency among academics - perhaps combined with a reluctance to acknowledge that the actual functioning of traditional systems may not be as egalitarian or idyllic as is often portrayed

- may contribute to the current fashion of promoting a return to traditional community-based management (p.67)."

Conclusion

As this review has shown, writings upon fisheries management divide into two distinct schools of thought, which may be labelled the "control theory" and "community resource management" approaches. The control theory school seeks to create quantitative models of the fishery's ecology, specifying fishing effort as an exogenous variable. It then identifies the pattern of effort that produces the optimum (i.e. rent-maximising) outcome and seeks to bring about this pattern of effort through regulation. Implicit in this approach is the belief that unregulated fishermen would produce a sub-optimal pattern of effort. This assumption is rejected by the community resource management school, however, which has observed the sustainable management of fisheries by local communities. It therefore recommends the devolution of power over natural resources to the communities that use them.

The next stage is then to ask what use each approach is to fisheries managers in Bangladesh. The answer is: they do not address the distribution of benefits from the fishery, which is crucial to the design of policy and projects in Bangladesh. Existing control theory models of fisheries management only mention the issue of income-distribution as an obstacle to implementation, if at all. The control theory approach to fisheries management also assumes that fisheries managers have the power to identify and implement the optimal pattern of effort. In Bangladesh, however, their ability to do so is limited not only by the heterogeneity of the fishery but also, more importantly, by the lack of funds and the lack of a culture of impartial regulation. The community resource management approach, on the other hand, asserts that village society, left to its own devices, will produce a satisfactory outcome, which, for the purposes of this study, is defined as one which serves the interests of fishing labour. As will be shown, however, community fishery management in Bangladesh, reflecting the pattern of economic power in rural society, serves the interests of lessees rather than of fishing labour.

There is therefore a need for a third approach to fisheries management, one which takes the middle ground between the technocratic and community approaches. Unlike the technocratic approach, it should accept that the range of policy instruments is restricted and that those that do exist are not direct in effect but mediated through the economic decisions of the lessee and fishermen. Unlike the community development approach, it should accept the importance for fishing labour of external policy initiatives. If the technocratic model is a system wherein the policy-maker's decisions determine the pattern of effort and the community development model is a system wherein local agents determine the pattern of effort, then the required model is a system wherein the policy-maker affects the pattern of effort by influencing the behaviour of local agents.

To describe such a system, one first needs a qualitative understanding of the biological and economic processes that make up the fishery. The final policy model can draw upon the bio-economic models described above for its structure, but it should display additional features: First, differences between fish types, gears and seasons will be shown to be crucial features of the fishery and must therefore be disaggregated in the model. Secondly, as well as the government and fishermen of the bio-economic models above, it must feature the lessee as a decision-maker. Thirdly, it should make the benefits accruing to poorer fisherfolk, rather than economic surplus, the target variable.

Figure 3.2. Copes' (1970) backward-bending fishery supply curve

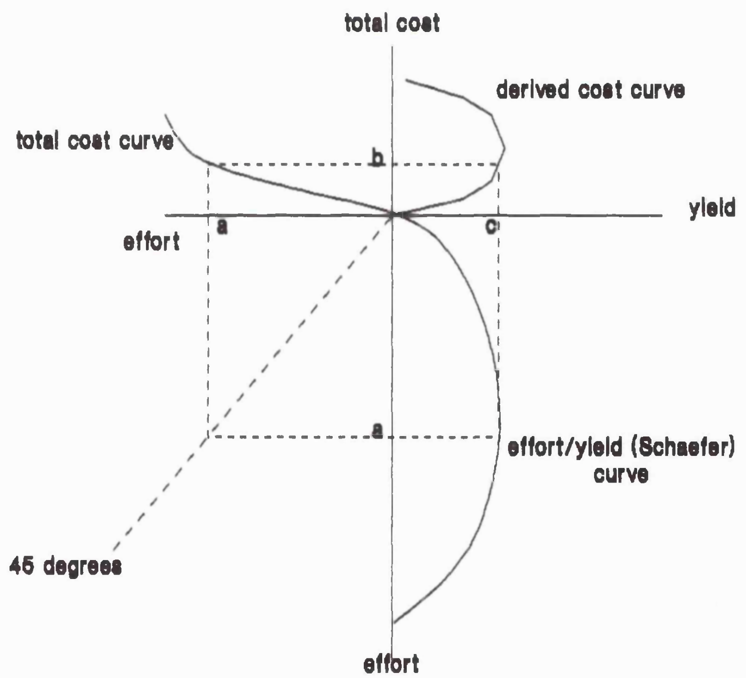


Figure 3.3. Schaeferian model of catch taxation

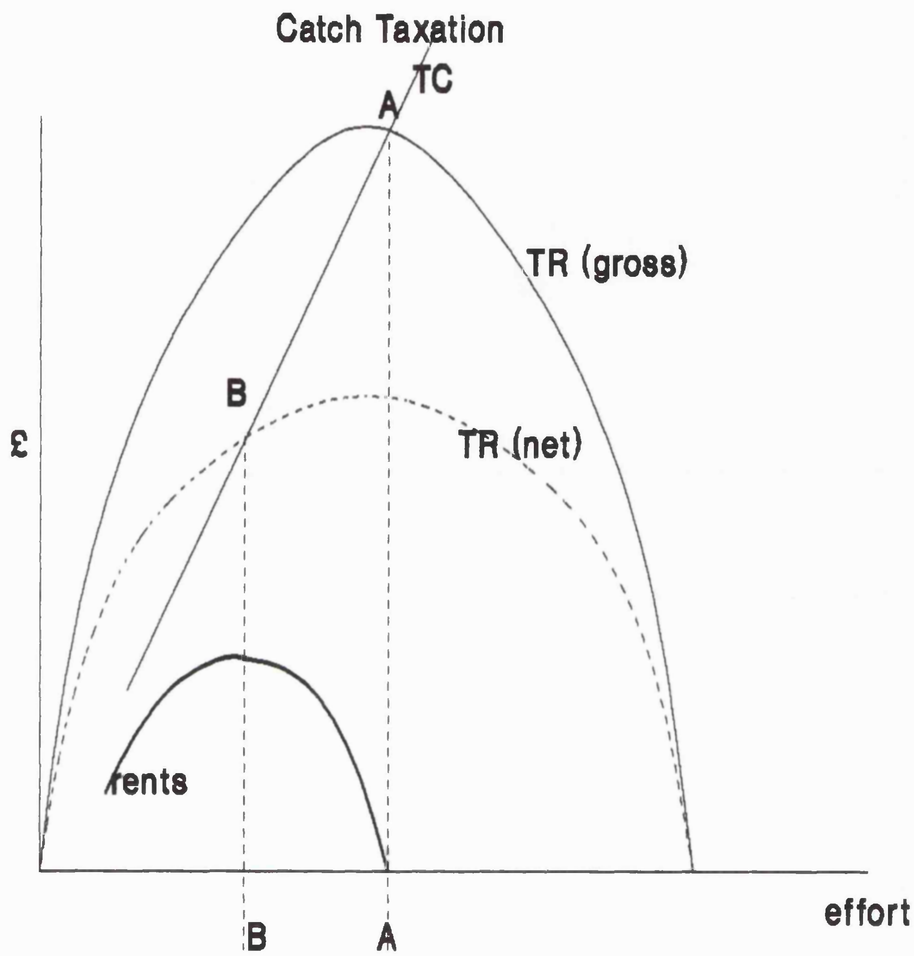


Figure 3.4. Schaeferian model of effort taxation

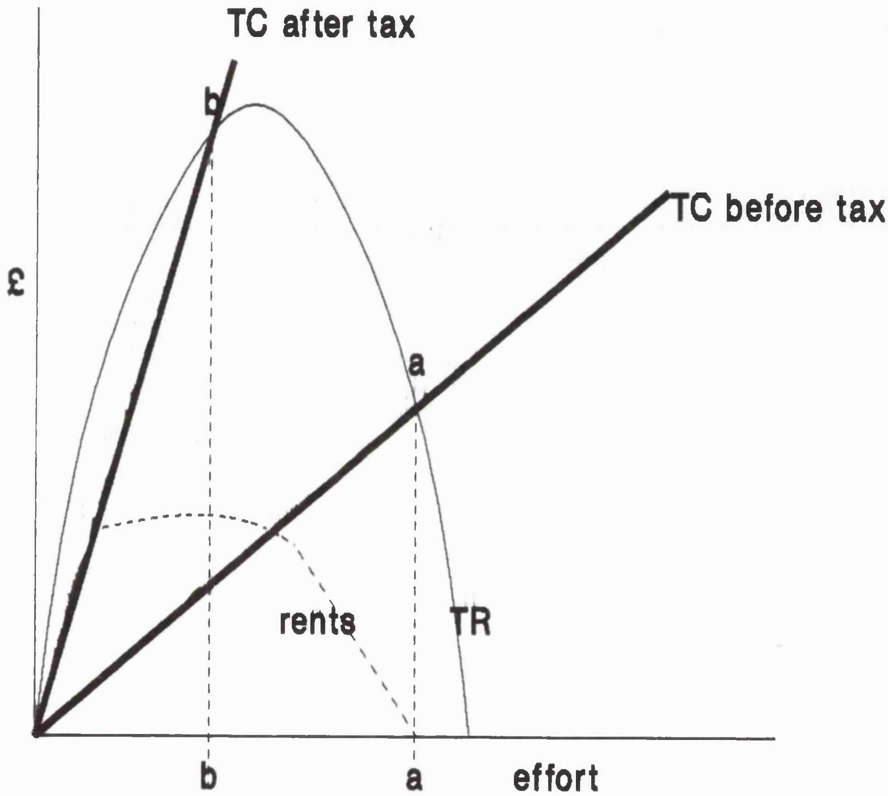


Figure 3.5. Campbell and Lindner's (1990) model of effort regulation

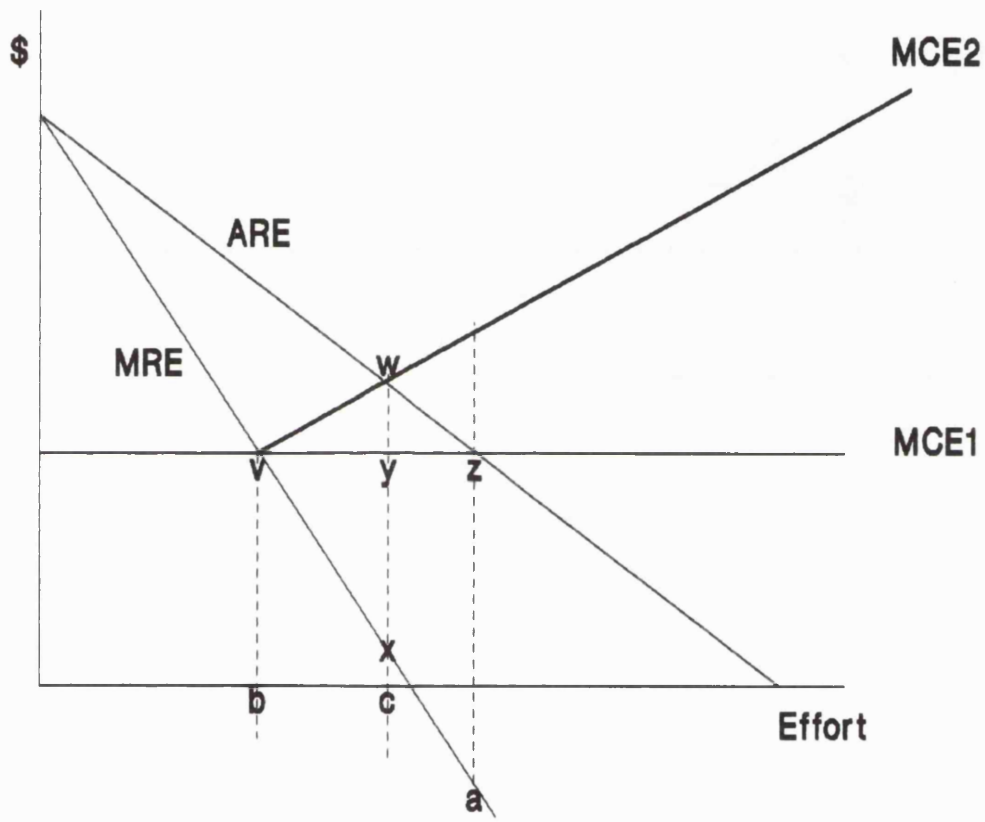
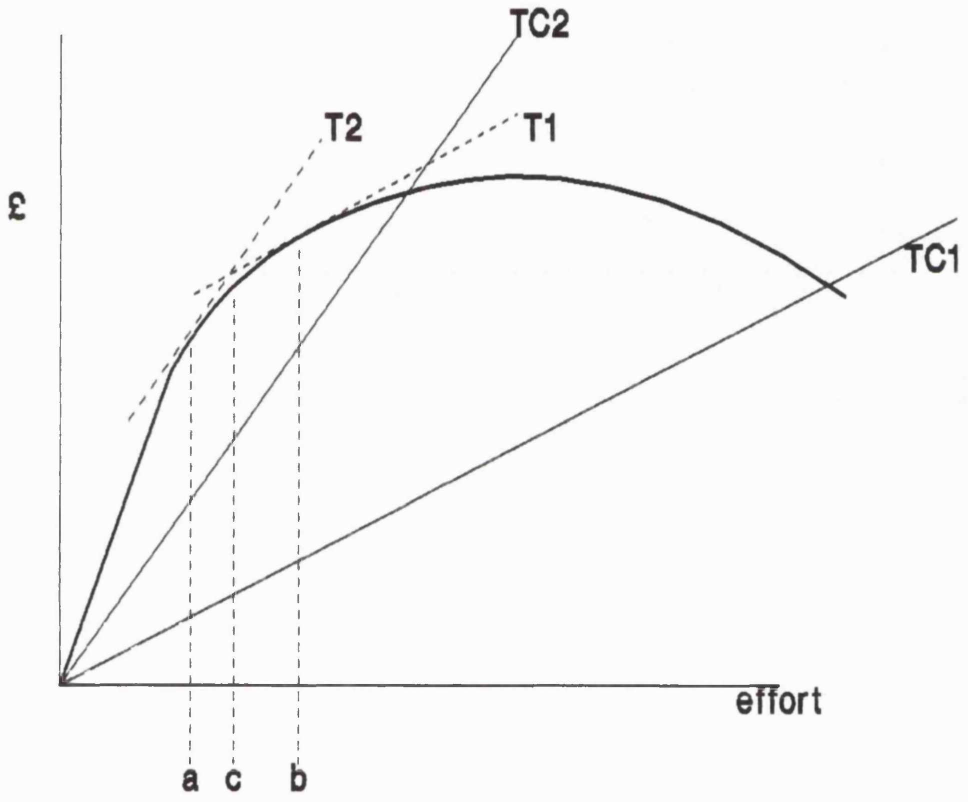


Figure 3.6 Johnson and Libecap's (1982) model of effort restrictions



Chapter 4

Research methodology

It is an unfortunate fact that aid organisations, with the exception of the relatively powerless NGOs, are systematically misinformed about the nature of the development process in Bangladesh. The author's own interviews with fisheries officials and donors in Dhaka corroborated the Like-Minded Group's (1990) analysis of the sources of misinformation: firstly, foreign "experts" import inappropriate fisheries development models from countries whose access to resources is less skewed and, secondly, official government statements "have paid lip-service to the critical importance of rural development and poverty elimination since well before independence" (Like-Minded Group 1990 p.113), whilst actual interventions have continued to support the patronage system.

There is therefore a need in Bangladesh for social scientists to shift information from the fishery, where the reality of development policy is known, to the aid community, which is acting from a standpoint of ignorance. Many writers have attempted such an "information shift" for rural society in general. The previous chapter noted Hartmann and Boyce (1979 and 1983), Wood (1981), Jansen (1987), Herbon (1988), McGregor (1988, 1989a and 1992), the Like-Minded Group (1990) and Kramsyo and Wood (1992), and they doubtless constitute a small part of the whole; Jansen (1987) had counted 25 English-language village-level anthropological studies published up to 1983 alone.

This study's purpose, then, is to tell the aid community what those who deal in fisheries management, from the fishermen to the Director of Fisheries, probably know already. It is a modest task, inasmuch as it involves shifting, rather than creating, information.

The research agenda

The aim of this study was first to understand the socio-economics of a floodplain fishery and then to evaluate current fisheries policy in the light of what had been learnt. What then was the knowledge requirement - the research agenda?

The Marshallian neo-classical theory of the firm assumes a particular stylised production function. The Schaeferian theory of the fishery assumes another. The floodplain fishery, of course, will have its own special technological characteristics, changes in the water-level, fish movements, fish growth and so on. It is therefore necessary to work out from first principles what is the form of the technical production function of the floodplain fishery. Even if it finally proves impossible to put numbers to the parameters, the form of the production function will tell much about how it will respond to policy interventions.

The scope of an economic policy research project should depend upon the social system which it is studying. An economist looking at a developed western economy can make certain implicit assumptions about the economic system: that property rights are maintained, that the state obeys and enforces the law and that economic decisions are not influenced by non-economic considerations. The economy in this case consists of a network of voluntary contractual exchanges, the free market as described by orthodox economics. This study, however, cannot assume *ex ante* that the Bangladeshi floodplain fisheries' inputs and outputs are allocated in a free market. It must first observe and describe the system of allocation. This is not to say that one needs a full anthropological study of Bangladeshi society; as Jansen (1987) writes, there are plenty of them already. All that is necessary is an understanding of how Bangladesh's own particular system of resource allocation, as described by earlier writers, applies to the floodplain fishery.

The floodplain's particular production function and Bangladesh's particular allocative system combine to produce a specific floodplain economy. An important element of this study will be a quantitative description of the economic outcome.

Lastly, in order to make predictions about the likely effects of fisheries policy, one needs policy models. The specific economy of the floodplain fishery will determine the appropriate form of its own specific models.

The knowledge requirement therefore includes four elements:
a) The fishery's physical environment
b) Social, economic and institutional relationships in the fishery
c) The form, value and distribution of value-added in the fishery
d) An understanding of how policy interventions will affect (c).
One could describe this research agenda as a "production line" approach. The "raw materials", the first principles, are a knowledge of the technology and markets in a Bangladeshi floodplain fishery. With technology and the markets together making the floodplain fishery economy, the first stage of refinement is a quantitative analysis of that economy. With fisheries policy changing the floodplain economy, the second stage of refinement is to model their operation. The final product is then an evaluation of current fisheries policy.

Methodological options and constraints

In choosing a research methodology, the principal concern was not intellectual but logistical, of making 14 months and one interpreter stretch to a study of a major fishery in all its seasonal variety. To this were added the difficulties of working at a distance from Dhaka, the project's source of funds, communications, unadulterated fuel and vehicle spares. The monsoon season presented an extra challenge, cutting roads and transforming villages into islands.

The sample questionnaire survey has traditionally been the research method most commonly favoured by sociologists and economists in developing countries (Casely and Lury 1981). Various random sampling techniques can be used to ensure that the respondents are representative of the population at large. A panel survey, in which several repeat visits are made to the same respondents, enables the researcher to follow the population's activities over an extended period. Panel surveys are particularly useful when key variables follow a seasonal pattern.

One disadvantage of questionnaire surveys is their inflexibility. The fixed, pre-specified questions cannot probe subtle qualitative issues. The responses can only incorporate the issues that preoccupied the researcher when the questionnaire was framed. It is therefore advisable to launch a questionnaire survey <u>after</u> obtaining an understanding of the key qualitative relationships by some other means. A second disadvantage of questionnaire surveys is their cost. Census data may be unreliable, communications may be poor and developing country respondents rarely follow a predictable routine, all of which makes contact with a representative sample a time-consuming and precarious task. If one takes resource-saving short-cuts, the representativeness of the sample may be compromised, negating the supposed superiority of the questionnaire survey.

One resource-saving research technique that has recently achieved respectability is Rapid Rural Appraisal (RRA). It recognises the time and resource costs of research and aims for "optimum ignorance" rather than "academic rigour" (Carruthers and Chambers 1981). By means of focused interviews with "key respondents" and village groups the RRA researcher can obtain an accurate impression of the study area's physical, social and economic environment. The principal advantage of RRA is that it offers high coverage for low cost. Like an anthropological study, it obtains local people's perceptions. Like a sample survey, it can cover a wide geographical area. However, one mission typically takes only 5 to 20 days, consuming only a fraction of the manpower of a full-blown anthropological study or sample survey.

Unfortunately, the nature of local society is such that RRA is less productive in Bangladesh than in many other countries. There are several reasons for this:

a) The social science literature upon Bangladesh is awash with unsubstantiated assertion. The reader may have difficulty recognising the superiority of RRA reports over such low-grade material.

b) Villagers see access to the interviewer as a means of access to external aid. More powerful people exclude less powerful people from the dialogue. Members of one faction exclude members of the opposing faction. The researcher therefore meets an unrepresentative sample of respondents.

c) Respondents bias their responses in the hope of receiving more aid. One general tendency is to exaggerate their own poverty and the wealth of others. Another is to explain their own behaviour in terms of the official development rhetoric (collective action, co-operatives, conservation) and to exaggerate the misdemeanours of others (violence, bribes, over-fishing).

d) Public discussions are frequently disordered, noisy and confusing.

e) RRA often interprets the recommendations of the respondent as beneficial to society; this is "participatory evaluation". In Bangladesh, however, where there are many zero-sum conflicts over access to resources, the recommendations of one respondent are frequently detrimental to another party who has been excluded from the dialogue (see b above). Zero-sum recommendations are likely to be especially frequent in the fisheries sector, where output appears already to be close to its biological limit.

f) The state is regarded by many poor people as a hostile, threatening force, known more for its exactions than for its services. They are not likely to be candid with an outside interviewer, who will automatically be identified with the government service.

There is a complementarity between RRA and questionnaire surveys: RRA can reveal the <u>structure</u> of the fishery economy but is very unlikely to give an unbiased account of its <u>dimensions</u>. Questionnaire surveys cannot show the fishery's <u>qualitative</u> aspects but can give a representative picture of the <u>size</u> of the resource flows. Moreover, a bonus of sample surveys in Bangladesh is that sampling provides an introduction to <u>informal</u> interviews with those who were systematically excluded from the RRA.

This study therefore made eclectic use of qualitative and quantitative research methods. For ease of exposition, one can divide the research into the series of *operations* below:

a) A **Literature Review** covered Bangladeshi rural society, sectoral studies on inland fisheries and policy interventions in the inland fisheries sector.

b) A **Reconnaissance RRA** studied the ecology, geography and allocation systems of the Hail Haor fishery.

c) **Opportunistic Interviewing** subsequently provided further information upon the same topics

d) A **Preliminary Survey** prepared the way for a year-round panel survey and provided initial information upon the fishing population.

e) A **Catch, Effort and Cash-flow Survey** provided a quantitative picture of resource flows for one year.

f) **Ancillary Data Collection** validated the Catch, Effort and Cash-flow survey.

The field research methods are described in detail below.

Reconnaissance

Hail Haor was chosen in October 1992 as the principal study site. In selecting a water-body, the following criteria were used:

- to aid comparison with the project's sites in Thailand and Indonesia, the water-body had to be a seasonally-flooded depression ("beel" or "haor") of at least 2,500 ha, with some permanent water.
- to facilitate a bio-economic assessment of the water-body, it had to be clearly-defined, even during the flood. Many of Bangladesh's fisheries merge at this time.
- for regular survey work to be possible, the fishing communities on the water-body's shores had to be accessible for most of the year by four-wheel drive vehicle or poled boat.
- the water-body should be within an hour of reasonably comfortable accommodation and a reliable supply of electricity for the project's computer.

Hail Haor met these conditions. It should be admitted, however, that many water-bodies in Bangladesh do not and that this study's methodology may therefore not be universally replicable.

At the start of the study in October 1992, no information was available upon Hail Haor's physical geography, fishing population, fish, fishing gear, social organisation or management systems. The first two months of the study were therefore devoted largely to informal discussions upon these topics with fishermen, both individually and in groups, with lessees, sub-lessees and government officials and project officers. Bearing in mind that the study's goal was to describe a Bangladeshi open-water fishery in terms of a model relevant to the issues facing policy-makers, these discussions served three distinct purposes:

a) They provided a good understanding of the ecological, social, economic and institutional relations surrounding Hail Haor.

b) They indicated which kinds of survey would and would not prove practical and valid.

c) They provided sufficient information upon the biology and economics of fishing in Hail Haor for appropriate, new bio-economic models to specified.

Several practical difficulties were encountered during this operation:

a) It was conducted at a time when fishermen building brush-piles or operating gill-nets or traps were living twenty-four hours a day upon their boats. These fishermen were therefore under-represented in the interviews.

b) The customary restriction upon women's talking to male outsiders prevented the study from obtaining first-hand accounts of their fishing-related activities.

c) Many fishermen were initially unwilling to speak candidly, fearing that they would incriminate themselves or others. The bribery of government officials, the use of force against rival claimants to water, the sub-leasing of water-estates, fishing with monofilament nets and the landing of under-sized major carp are all illegal, yet they constitute the reality of fishery management in Hail Haor. Fishermen tended to conceal the truth until they were confident that the study was not conducted by or reporting to the Department of Fisheries. This highlighted the importance of developing a long-term relationship between interviewer and respondent.

d) Government officials, with two welcome exceptions, described the rhetoric rather than the reality of fisheries policy.

It was not easy to gain an understanding of the topography of Hail Haor. An engineering map of the haor's embankments (FAP6 1992) was found to bear little relation to reality and was discarded. BBS (1990) gave administrative boundaries only. A satellite image of the haor in February 1992 was obtained but it proved difficult to distinguish between the two principal land types, water with floating aquatic vegetation and rice fields. A central area of permanent clear water was observable, however. A physical map of the haor (Anon., undated) showed the extent of monsoon flooding in a way that corresponded largely to the study team's observations. A comparison with the satellite image, however, showed that siltation at the Gopla's entry to and exit from Hail Haor had created extensive areas of dry land since the physical map's drafting. Early in the study (01/11/92) a group of Hazipur fishermen were asked to sketch Hail Haor. The resultant "participatory map" showed what the *fishermen* believed to be the haor's most important features. It was especially useful for identifying the position of Hail Haor's principal beels and embankments, neither of which appeared on the satellite image or physical map.

In brief, therefore the study's map of Hail Haor was compiled as follows:

direct observation: monsoon flood, dry-season water, embankments
Anon., undated: roads, railway, monsoon flood
BBS (1990): towns and villages

satellite image: new dry land, dry-season water, embankments
Hazipur map: embankments, beels

Monsoon and dry-season areas under water were calculated from the study's own map. For this purpose it was necessary to choose a northern limit to the Haor. The 200m "bottleneck" adjacent to Pachaon village was selected because it is an obstacle to fish migration, is known to all fishermen and is easily recognised from the satellite image. The phrase "Hail Haor" in this study always denotes the water south of this point.

Opportunistic interviewing

The author conducted around 900 one-on-one quantitative data collection interviews with fishermen and it was common to wait 1-2 hours to meet a single respondent. The author had used waiting time for guided interviews in other countries. In Bangladesh, however, this proved difficult, for the reasons given earlier in the discussion of RRA. The waiting time was spent in informal conversation with other villagers which occasionally produced useful insights. Some of the best information, however, was obtained from boatmen during boat-trips around the haor, for the simple reason that it was physically impossible for other people to enter the conversation.

Preliminary survey

In order to assess the pattern of gear use and the distribution of the proceeds from fishing, the study was going to interview a representative sample of fishing households at fortnightly intervals around the year. However, no list or population estimate of Hail Haor's fishing households was available. The Agricultural Census and the Census of Non-Agricultural Activities were consulted, but neither covered fishing. A preliminary clustered sample survey of fishing and non-fishing households was therefore taken in November 1992.

The objectives of the exercise were as follows:

a) **As preparation for the Catch, effort and Cash-flow study**, to construct a sampling frame from which a sample of fishing households could be selected, to estimate the maximum practical sample size and to learn when, where and how it was most convenient to interview representatives of fishing households.

b) **As a survey of fishing and non-fishing households together**, to establish whether fishing households possessed any obvious economic or demographic characteristics which distinguished them from non-fishing households, to establish the extent to which fishing households engaged in other occupations and to establish the pattern of gear ownership around Hail Haor.

A list of the fishing communities around Hail Haor was drawn up from the informal interviews of the previous month (see above). Time and a restrictive transport budget did not permit every community to be covered, especially in view of the need to start the collection of catch/effort data within three weeks of the start of the fieldwork so as to cover an entire year. Respondents' initial mistrust of the study made it moreover advisable to build a closer relationship with a smaller number of villages than to attempt total coverage. It was therefore decided that only six villages should be included.

The informal interviews had made it clear that the twin villages of Buruna and Hazipur dominated the fishery by virtue of the number of their fishermen, their access to deep water and their comparatively high rate of ownership of seine nets and gill nets. It was therefore decided that Buruna/Hazipur should be included "*ex officio*" in the survey. Four additional villages were selected by lottery. They were Monargaon, the twin villages of Alisherkul and Badialisha, Vimshi and Mirzapur. This selection gave the study a good geographical spread, since Buruna, Hazipur and Monargaon are on the Haor's eastern shore, Alisherkul/Badialisha is to the south, Vimshi and Mirzapur are to the west and the northern shore has no permanent communities, being subject to flooding. The sample included three Muslim and three Hindu fishing communities.

After some negotiation and persuasion, the District Electoral Office at Moulvi Bazar made available the sample villages' electoral rolls for the 1991 General Election. These lists had been compiled by local schoolteachers in 1990 and were supposed to give the voter number, name, age, father's name, occupation and village of all residents aged at least 18 at the time of compilation. Male and female voters were listed separately. The voters' occupation was given, but this information was useless: under the heading "occupation", fishermen were labelled "farmer".

A GW-BASIC random number generation programme was used to select names from the male voter list. Duplicate selections were replaced. The numbers chosen were as follows: Buruna/Hazipur 60, Monargaon 27and Mirzapur 40. Each village was then visited in turn and village elders gave the name, father's name and age of the household head of each selected voter. Where the name on the voter list was fraudulent or the random number generator had selected two members of the same household, the elder chose another name from the same page of the voter list with his eyes shut. The resultant lists of household heads were adopted as the survey sample.

For Vimshi and Alisherkul/Badialisha, however, this procedure had to be abandoned. Vimshi's voter list contained another village and Alisherkul/Badialisha's fishing households constituted such a low proportion of the total population (approximately 1 in

40) that a massive survey would have been required to turn up a statistically valid number of fishing households. For these villages, therefore, village elders compiled a list of household heads, their ages and fathers' names. The Alisherkul/Badialisha list only covered the fishermen's quarter (para). The survey sample was drawn publicly from a hat in the village itself by a small boy, to the delight of all present.

Each household head within the survey sample was interviewed once. The responses were recorded on a standard form, checked and tabulated on paper, captured as a SUPERCALC4 spreadsheet, saved as an ASCII file and analysed by means of INSTAT[1]. The entire procedure, from obtaining the voter lists to completing the statistical analysis, took three weeks.

Several limitations were imposed upon the survey by the need for rapid results. They are described below, as they are likely to have affected the quality of the data:

a) The number of clusters (villages) in the sample was limited to 5. The initial informal interviews revealed significant between-village variation with respect to gear use, water access and income, an impression which will be confirmed by the data. The question therefore arises of the relationship between the parameter estimates produced by the sample and the true population values. Confidence intervals for cluster-sampled parameters can in theory be derived by summing the within- and between- cluster sample variances (Casely and Lury 1981), but this is not recommendable in this instance, where the between-cluster variance is estimated with only 4 degrees of freedom. The compromise approach taken by this study shall be to disaggregate survey data by village whenever appropriate. When aggregation is required, as in the subsequent calculation of total catch and total effort parameters for Hail Haor, it is hoped that the forced inclusion of Buruna/Hazipur as the sole "strong" village will decrease the sampling variance by effectively stratifying the sample.

b) Mistrust of the interviewers is likely to have led to some false responses. Where it existed, this mistrust stemmed from a suspicion that the sample was not the product of a lottery but of deliberate choice and that the study would report to government, which was either planning an aid project[2] or looking for illegal fishing practices. It is therefore likely to have led to the understatement of assets and the concealment of illegal gill nets. As the project's aims and programme were explained to each respondent, however, suspicion usually turned to co-

---

[1] available from the University of Reading

[2] We were dogged in several villages throughout the study period by the rumour that we intended to empolder Hail Haor, run it as a fish farm and take on our respondents as salaried employees. Many non-respondents begged us to put them on our list and one respondent, leaving Hail Haor to work in Qatar, begged repeatedly that his brother could replace him. Maybe a lessee was trying to discredit our research in the eyes of the fishing population or a middleman was trying to sell places on our sample list.

operation. This positive response to familiarity confirmed that the selection of a small number of study villages had been correct.
c) The sampling method described above introduced a systematic bias in favour of larger households, since the probability of a household's being selected was directly proportional to the number of males eligible to vote in 1991. The unweighted mean sample household size was 6.54. An unbiased estimate, however, obtained by weighting each observation by the reciprocal of the number of male voters, gives mean household size as 5.59. A correct response from the point of view of statistical validity would have been to draw a second sample from the existing sample, giving each household a corrective probability of selection proportional to the reciprocal of the number of male voters, and this procedure was used in selecting the sub-sample for the Catch, Effort and Cash-flow (see below). Time, however, did not permit the selection of a corrected sample for the initial survey. In order to assess the validity of the survey data, therefore, it was necessary to test it for correlations between key indicators and the number of male voters. The results are displayed in Table 4.1 below. They indicate no apparent correlation between the number of male voters and the economic status of the household. There is no immediate reason, therefore, for rejecting the survey results as unrepresentative.

Table 4.1. Correlations between economic indicators and number of male voters.

Indicator	r-squared
Participation in fishing(yes/no)	.0012
School enrolment (%)	.0075
Land owned (acres)	.1490
Gill net owned (yds)	.0013
Luxury goods owned (no.)	.0989
Boats owned (no.)	.1418
Tin roof owned (yes/no)	.0751

The distribution of sample households by village and reasons for non-returns are given in tables 4.2 and 4.3 below. Overall, the response rate is high for a survey of this nature, with an average contact rate of 85% and the contact rate rising to 90% when those households that have left their villages since 1990 are excluded. It should be noted, however, that 12 households, or 7% of the sample, had still not been contacted after 3 visits and were abandoned. This gave rise to concern that the survey results might be biased away from full-time fishermen, whose occupation keeps them away from their village, so in Buruna, Hazipur and Monargaon other villagers were asked to state the excluded household's principal occupation. In these 3 villages, 5 out of 9 non-respondents were not fishermen. This permitted confidence in the survey sample.

Table 4.2. Preliminary survey - sample households.

Village	H-holds in sample	Non-respondents	Contact rate (%)
Buruna	45	5	89
Hazipur	15	2	87
Monargaon	27	4	85
Alisherkul	10	0	100
Vimshi	20	4	80
Mirzapur	40	9	78
TOTAL	157	24	85

Table 4.3. Reasons for non-response.

Village	Left village	False name	Afraid	Unobtainable
Buruna	1	1	0	3
Hazipur	0	0	0	2
Monargaon	0	0	0	4
Alisherkul	0	0	0	0
Vimshi	1	0	2	0
Mirzapur	6	0	0	3
TOTAL	8	1	2	12

Catch, effort and cash-flow survey

Sampling

The household, defined as a group of people eating together, was selected as the sampling unit. Local people are familiar with this definition. They frequently describe a village's population in terms of the number of households (*poribar*), refer to a household head (*prodam*) and describe brothers as together in the same household (*ekshonge*) or separate (*alada*). The fishing group had originally been intended as the sampling unit, but was rejected when the reconnaissance revealed how fishing groups were likely to coalesce and fragment as different fishing gears became appropriate. The individual was rejected because such a sample would have offered a smaller coverage for the same number of interviews and would have generated no meaningful information upon household incomes.

The Preliminary Survey had covered 133 randomly-selected households from 6 randomly selected villages. The next stage was to select from them a representative sample of 60 fishing households who might serve as respondents for the collection of catch, effort and cash-flow data across a period of twelve months. (A "fishing household" is here defined as a household which admitted that at least one family member fished for sale, at any time, whether as the principal or a subsidiary occupation.) It was decided that the twin villages of Buruna and Hazipur formed a single geographic and social unit and could be treated as a single sampling pool, that 20 respondent households should be selected from them and that each of the other four sample villages should supply ten respondent households each.

It will be remembered that the initial sample from Buruna, Hazipur, Monargaon and Mirzapur was taken from the male electoral roll by means of random numbers. In Alisherkul/Badialisha and Vimshi, however, it was taken from a list of fishing households supplied by villagers themselves. For the first group of villages, therefore, the probability of inclusion in the initial sample was directly proportional to the number of males eligible to vote in the previous general election. There was thus a tendency for large households to be over-represented. So that this bias might be eliminated, a SUPERCALC-4 spreadsheet allocated probabilities of inclusion in the second sample that were proportional to the reciprocal of the number of males aged 20 or over. A GW-BASIC random number generator programme then made the final selection.

The names for the second sample in Alisherkul/Badialisha and Vimshi were again selected out of a hat by a small boy in public view.

Data collection

The sixty households were visited twenty times during the year December 1992 - November 1993, making a total of 1,200 interviews. Two visits were made per month, except during the monsoon months of June, July, August and September 1993 when travel was much more difficult and one visit had to stand for a whole month.

Interviews were conducted face to face in fish markets or in the fishermen's compounds. If the household head was not available, another adult male from the same household might be interviewed. If no suitable interviewee was available, another visit to the village was made.

A specimen interview form ("VISIT SHEET") is attached as Appendix 2. The form changed according to the requirements of the season. For example, three interview forms asked about household agricultural yields by crop and all forms for the first four months of 1993 had a section covering brush-pile fishing. Each form was identified by the respondent's identification number, which was carried over from the preliminary survey, and by the interview date.

The interviews were generally conducted as follows. First the interviewee was asked what he and the household's other workers did the previous day. The response was coded into the column "Activity x hours". For example, "Lx9(dol)" meant that the worker was serving as hired labour on a brush-pile for nine hours. If some cash income could be directly attributed to this work, which was usually the case for hired labour, fish-trading and crafts, the daily amount was written in the column "Income L/FT/C". If a hired labourer was given food by his employer, another Tk5/meal was added to this amount.

The household's fishing activity was then recorded under "D.". Each fishing group was recorded separately, as was each gear used by each fishing group. So, for example, if two household members fished with dori and faron in two separate groups, four lines would be recorded. Each line stated the type and quantity of gear, the hours it was set in the water, the number of household group members and the total number of group members, the principal species caught, the <u>total</u> estimated weight of fish caught in kg, the household's share of the proceeds and the income received by the household.

The household's fishing expenses were then recorded under "B.". "Lumpy" expenses included gear purchase, gear repair, boat purchase, boat repair and brushwood and bamboo for the construction of brush-piles. Respondents were asked to recall how much had been expended under these headings since the previous interview. This they did without difficulty, since the expenditure items invariably represented more than a day's earnings. "Daily" expenses included hired labour, boat hire, kerosene and batteries. Because such items were more difficult to sum over the previous fifteen days, respondents were only asked how much had been expended under these headings on the previous day. All expenses were recorded as the cost to the household, not as the cost to the fishing group.

Fishing toll payments were recorded under "Permits:(since LAST VISIT)". Each cash transaction was given one line and each line recorded the cost to the household of the toll, the leasing area, the permitted gear, the month of payment ("monthstart") and the duration of the permit. Most permits were granted until the specified gear became unusable or until the end of the Bengali year. In this case the word "season" was recorded under the column "duration".

Finally, domestic fish consumption was recorded under "E.". Respondents were asked whether their household had eaten fish on the previous day, whether the fish was "caught" or "bought", what species they had eaten and the actual or estimated value of the fish in Taka. (Fishermen were able to state the value of caught fish without any hesitation.) Species that never exceed 5cm, such as puti, boisa, koia, chingree, darkina and chanda were recorded as "small" fish.

The "VISIT SHEET" differs from most rural survey forms by reason of its flexibility. It is standard practice for enumerators to record interview responses in row-and-column tables or, as for this study's Preliminary Survey, response panels in structured questionnaires. The responses can then be copied directly from the interview form into a data matrix for computerised analysis. However, a flexible questionnaire was better-suited to this survey for several reasons:

a) The range of appropriate questions was likely to change according to the seasonal pattern of respondents' activities.

b) With the raw effort and expense data being reported by fishing group and tabulated by household, they frequently had to be transformed before they could be tabulated; it was better that this transformation should be done after the interview since fishermen were often in a hurry to return to their boats.

c) The enumerator was skilful and accompanied by the team leader, so the discipline of a closed questionnaire was not required.

d) There was little risk of inconsistent interviewing because there was only one interviewing team.

Data tabulation

Interviews were recorded on an "attendance sheet" by household and reporting period to aid the planning of visits.

Responses were recorded manually as four data tables in preparation for computerisation. A <u>Labour Use/Income/Expenses Table</u> recorded labour use and cash-flow by occupation by household by reporting period, giving a total of 15,600 data points. A <u>Catch/Effort Table</u> recorded catch and effort by gear type by household by reporting period giving a total of 32,400 data points. Two Cost tables were created. One recorded leasing payments by household by month from May 1992 to December 1993 (1200 data points). A second categorised costs for the sample as a whole by type by month (84 data points).

It was necessary to transform some data between the "VISIT SHEET" and the data tables.

- Incomes from fishing and agriculture were not recorded under "A." and were derived from other parts of the form. Income from fishing was obtained by summing fish sales ("D.") and home consumption of caught fish ("E."). Income from agriculture was obtained by multiplying reported total yields by the current wholesale price. Yields were recorded in January 1993, June 1993 and November 1993. In January 1993, respondents were asked to report yields of aman rice, this being the only major crop to come to harvest in December. In June 1993, respondents reported "all dry-season crops". In November 1993 they reported "all crops harvested since the beginning of the monsoon." For all agricultural products the value of output was recorded gross of costs and gross of home consumption. For livestock, however, it was deemed too difficult to obtain an output measure and only gross sales were recorded.

- Fishing expenses were transformed into a daily estimate; "Lumpy expenses" were divided by fifteen and added to "daily expenses."

- When household members were fishing in a group, the number of household participants was expressed as a fraction of the number of group members. The group's catch and effort units were multiplied by this fraction before being tabulated. The resultant totals could then be multiplied by the number of fishing households around Hail Haor and divided by the number of households in the sample to give an estimate of total catch and effort.

- Brush-piles (dol) produce large quantities of fish but are managed by a small number of fishing groups. There was therefore a risk of an unacceptably high sampling variance. It was therefore necessary to request a one-week recall for dol catches and divide the response by seven before tabulation.

The data was specified in this manner in order that the following analyses could be performed, both in aggregate and broken down by wealth class.

- Total gear use in Hail Haor by month.
- Total catch in Hail Haor by month.
- Catch per unit effort by gear.

- Total employment by occupation by month.
- Total gross income by source by month.
- Division of catch value between fishermen's income, costs, government and lessees/sub-lessees/bribes.
- Total expenses by type by month.

Problems

The fishermen of Hail Haor prove hard to find. They may be away from dry land for periods of five to ten days, particularly when fish-trapping or gill-netting. Members of a fishing-group take turns to sell the catch, so a meeting with a specific group-member requires several visits to the fish-market. One solution to this problem might have been to replace the most elusive respondents. This option was rejected, however, because a principal objective of the study was to elicit the pattern of employment and a respondent's elusiveness is correlated with his occupation and choice of gear. Gill-netters and fish-trappers were therefore found by means of repeated visits to fish-markets. Other elusive respondents were interviewed by oil-lamp at night.

By the end of December 1992, after the first two rounds of data collection, most respondents appeared to accept that their responses were not going to bring them any impositions from the government on the one hand or any financial benefits on the other. Their responses, although offered sullenly by a minority, were therefore candid. More troublesome, however, were the fishing entrepreneurs and sub-lessees who wanted to be the focus of attention and wished to know what conspiracy had excluded them. The research team correctly devoted more time to informal chat and to explaining its aims and methods than to the research itself. However, with the male population of the survey villages exceeding 3,000, there was an stream of disgruntled enquirers throughout the fieldwork period.

It should be noted in passing that the Hindu Nomosudras and Sarkers were markedly less likely than the Muslim Maimals to perceive the survey as an opportunity for personal gain or avoiding government impositions. They were therefore more likely to respond candidly. Blanchet and Talukder (1992) observed similar behaviour on Shanir Haor and attributed it the importance of deference to one's hierarchical superiors in Hindu religion and culture.

One weakness of this catch-effort data collection method is that it produces only two observations per household per month. It therefore offers no meaningful estimate of day-to-day variation in catch per unit effort (CPUE). Also, although the estimates of catch and effort remain unbiased, their variance would have been lower with a higher number of observations. The recording of daily catch-effort data by the fishermen themselves was ruled out by their illiteracy. More frequent visits were ruled out by the project's budget. Longer recall of catch-effort data was ruled out on the grounds that it would create bias by increasing the scope for invention. Two catch-effort data points per household per month were therefore accepted as the "least worst" solution. The 30 observations per gear-type per month recommended by Tsai (1991) were unaffordable.

Biologically and financially, the fishery's year starts in May. This is when spawning and in-migration generate the year's fish stocks, when the previous year's sub-leases expire and the next year's leases are granted. By collecting data between December 1992 and November 1993, therefore, this study obtained an incomplete picture of two seasons rather than a complete picture of one. This impaired the analysis and interpretation of data in the following ways:

- Systematic seasonal variation could not be distinguished statistically from stochastic annual variation. This proved particularly important as 1992-3 gave a late flood and a high incidence of ulcerative fish disease whilst 1993-4 gave an early flood. The study therefore relied upon fishermen's accounts of seasonal and annual variation.

- A specific households' rate of return on investment for the year could not always be meaningfully calculated because some were earning income during the study from investments made before it or earning income after the study from investments made during it. The solution was to present instead case studies of selected fishing activities of selected households.

Ancillary data collection

Certain questions could only be answered by means of additional data. They were obtained from an ancillary data collection programme.

Fishing population estimation.

The catch-effort and cash-flow study followed a sample of 60 fishing households; in selecting the sample a "fishing household" was defined as a household that fished for sale, whether or not this was its primary occupation. So as to apply its results to Hail Haor as a whole, it was necessary to know the ratio of households fishing in Hail Haor to the number of households in the sample.

BBS (1990) reports the number of households in Srimangal Thana but the breakdown is by Mauza, an administrative unit with boundaries that link disparate communities and cut through villages. The voters' roll lists fishermen's occupation as *"krishok"* - farmer. Bangladesh's two rural census series, the *Agricultural Census* and the *Census of Non-Agricultural Activities*, make no mention of fishing as an occupation. The Thana Fisheries Officer and villagers themselves supplied estimates of the number of fishing households in each village around Hail Haor but such large discrepancies existed between the two that both were dismissed as unreliable. Official statistics being of limited use in this case, an ancillary study estimated the number of fishing households by village.

For the villages of Buruna, Hazipur, Monargaon and Mirzapur the following method (Method 1) was used. The Preliminary Survey provided estimates of the number of male voters per household and fishing households as a percentage of total households. The estimated total number of households was the number of male voters divided by the estimated number of male voters per household. The estimated number of fishing households was the total number of households multiplied by the estimated percentage that were fishing households.

For the villages of Alisherkul/Badialisha and Vimshi the number of fishing households was low enough for them to be listed directly (Method 2).

A Fishing Population Survey (Method 3) was implemented during the 1993 monsoon season. The electoral roll compiled in 1990 was obtained for the villages of Srimangal Busti (Lalbagh Para), West Baraura, Rustumpur, Bolashi, Bonabir, North Pachaun, Shohostri and Shulpur. Twenty male names per village were selected by means of a GW-BASIC random number generator. A meeting was then held in each village during which the project's work was explained and the household head of each sample name was identified. The twenty sample household heads were asked to report the occupations of their household members. If fishing was reported, the household head was asked to list the gears used during the fishing year May 1992 to April 1993. It was thus possible to estimate the ratio of fishing households to all households for each village and to assess whether the pattern of gear use in the six sample villages was representative of the situation in Hail Haor as a whole.

Every time the study team visited the village of Uttosur it was taken to a somewhat hostile local shopkeeper, possibly a lessee's "agent". It was clear that survey work in Uttosur would produce a low return to effort and it was therefore decided to extrapolate the estimated number of fishing households from the number of male voters (Method 4), using the mean of the ratios from the other villages.

Catch composition estimation.

In the Catch-effort and Cash-flow Survey, fishermen were able to name the species they caught but not to apportion the catch by species. The catch composition was therefore estimated by direct observation at three landing sites, Buruna, Hazipur and Bilashirpar. Initial estimates were validated by means of a spring balance. Later estimates were made by eye alone. With weight of fish by gear reported by fishermen and species of fish by gear observed directly, it was then possible to estimate weight of fish by species.

Households fishing for consumption only.

The Catch, Effort and Cash-flow sample only represented households that fished for sale; it excluded households that fished for consumption only. Moreover, households who fished for consumption only saw no reason to participate in the study's informal group interviews. In order to understand the importance of fishing for consumption only, all respondents in the Fishing Population Survey who never fished for sale were asked whether they ever fished for consumption. Some of those who did were followed up with an informal interview.

Conclusions

This chapter has explained the study's approach to the assessment of inland capture fisheries policy in Bangladesh. It is based upon a progression from a qualitative understanding of the fishery's technologies and relations of production, via the collection of quantitative data, to analytical models of the impact of policy interventions. By moving from field observation to micro-economic analysis, it was hoped to redress the lack of information upon how income-creation and -allocation that was identified in chapter 2 and the lack of theoretical models of the distributional impact of policy that was identified in chapter 3.

A detailed description of the study's data-collection methods has been presented. This chapter showed how they were largely determined by logistical constraints and identified a number of ways in which the statistical power of the data was impaired by limited resources. Rapid Rural Appraisal was discussed as a possible means of reducing the resource-cost of data-collection but its application to a Bangladeshi fishery was found to be fraught with difficulties. The use of RRA in fisheries is a topic that will be expanded in chapter 14.

An important theme of this chapter was how the study's data-collection methods were determined by the social organisation of the fishery. Households were used as the sampling unit instead of fishing groups because they were more stable, the importance of familiarising fishing communities with the researchers meant that a small number of clusters was used for sampling, the different distributions of self-employed fishermen, brush-pile owners and people fishing for consumption only necessitated three separate sampling procedures and the village-based methods adopted by the study would have been impossible if migratory fishing had been practiced in Hail Haor. The finding of this study, which is backed up by the author's experience in Thailand and Indonesia, is therefore that no single data-collection methodology is likely to be appropriate to a range of fisheries. The research protocol should be tailored to the fishery's social structures after they have been outlined by preliminary reconnaissance.

Chapter 5

The Hail Haor fishery: topography, fish ecology and fishing technology.

This section, which describes the physical context of the Hail Haor fishery, shows how the environment, fish stocks and fishing gear combine to produce a saleable good. The neo-classical theory of the firm is based upon a standardised production function, a stylised description of how inputs are combined to make output. Similarly, this analysis of the economics of a Bangladeshi floodplain fishery will rest upon the fishery's own production function, where the inputs are fishing space, fish stocks, fishing gear and labour and the output is, of course, landed fish.

The Meghna Basin

Hail Haor lies in the north-east corner of Bangladesh. This region, sometimes referred to as "Greater Sylhet", is a triangular wedge of low-lying alluvial plain that protrudes into the foothills of north-east India. Rivers flow into the lowlands of Greater Sylhet from three sides, from Assam to the north, Meghalaya to the east and Tripura to the south. All of these rivers feed eventually into the River Meghna, which discharges into the Bay of Bengal at a peak rate of 5 million cubic feet per second, making it, with the Amazon and Orinoco, one of the world's largest rivers.

The climate of Greater Sylhet is sub-tropical, with a marked cool season from December to February. Rainfall in the Meghna basin's catchment area is heavy; Zafflong, 50km north of Sylhet town, records on average a staggering 12,700mm per annum. Table 5.1 presents the more reasonable rainfall figures for Srimangal beside Hail Haor. There is a pronounced monsoon season, with 93% of rain falling between April and October.

Table 5.1. Mean monthly rainfall in Srimangal

Month	Rainfall (mm)
January	13
February	33
March	81
April	229
May	389
June	561
July	338
August	338
September	285
October	218
November	25
December	3

Source: White (1984)

The Meghna Basin acts as a funnel for the monsoon run-off from Assam, Meghalaya and Tripura. The River Meghna breaks its banks, creating a patchwork of floodplains ("haors") in the triangle between Sylhet, Habiganj and Mymensingh. These water-bodies, known collectively as the "Haor Belt", support one of Bangladesh's principal inland fisheries. Greater Sylhet contains 29% of Bangladesh's beels by area (DOF 1986) and contributed 14% of the beel and floodplain catch in 1987/8 (DOF 1988). Fisheries provide around 2% of Greater Sylhet's Gross Regional Product (BBS 1992).

Hail Haor: physical geography

Hail Haor itself is on the southern edge of the "Haor Belt", five miles north-west of Srimangal town (24^{o}23'N, 91^{o}50'E), in Srimangal Thana (Sub-District) and Moulvi Bazar Zila (District). Figure 5.1 shows the Haor's principal features.

Hail Haor is on the northern edge of the Tripura foothills and is bounded to the east, south and west by low, lateritic hills. These are mostly wooded or under tea cultivation but recent years have seen increases in the area of exposed soil, which the Thana Fisheries Officer (TFO) and Thana Nirvahi (Executive) Officer hold responsible for accelerated silt deposition in the Haor.

Accounts of Hail Haor's area under water vary. FAP6 (1992) gives a dry season area of 2,800 ha and a monsoon area of 9,400 ha whereas Srimangal's TFO gives a flooded area of 9,000 ha. This study estimates that Hail Haor covered 1,800 ha during the 1992/3 dry season and 13,600 ha at the height of the flood in June 1993.

Hail Haor's water-level during the flood season is around 4m above the dry-season minimum. Number 1 Beel, for example, was around 0.4m deep in February 1993, 4.5m deep in June 1993, 3.5m deep in September 1993 and 3.0m deep in October 1993.

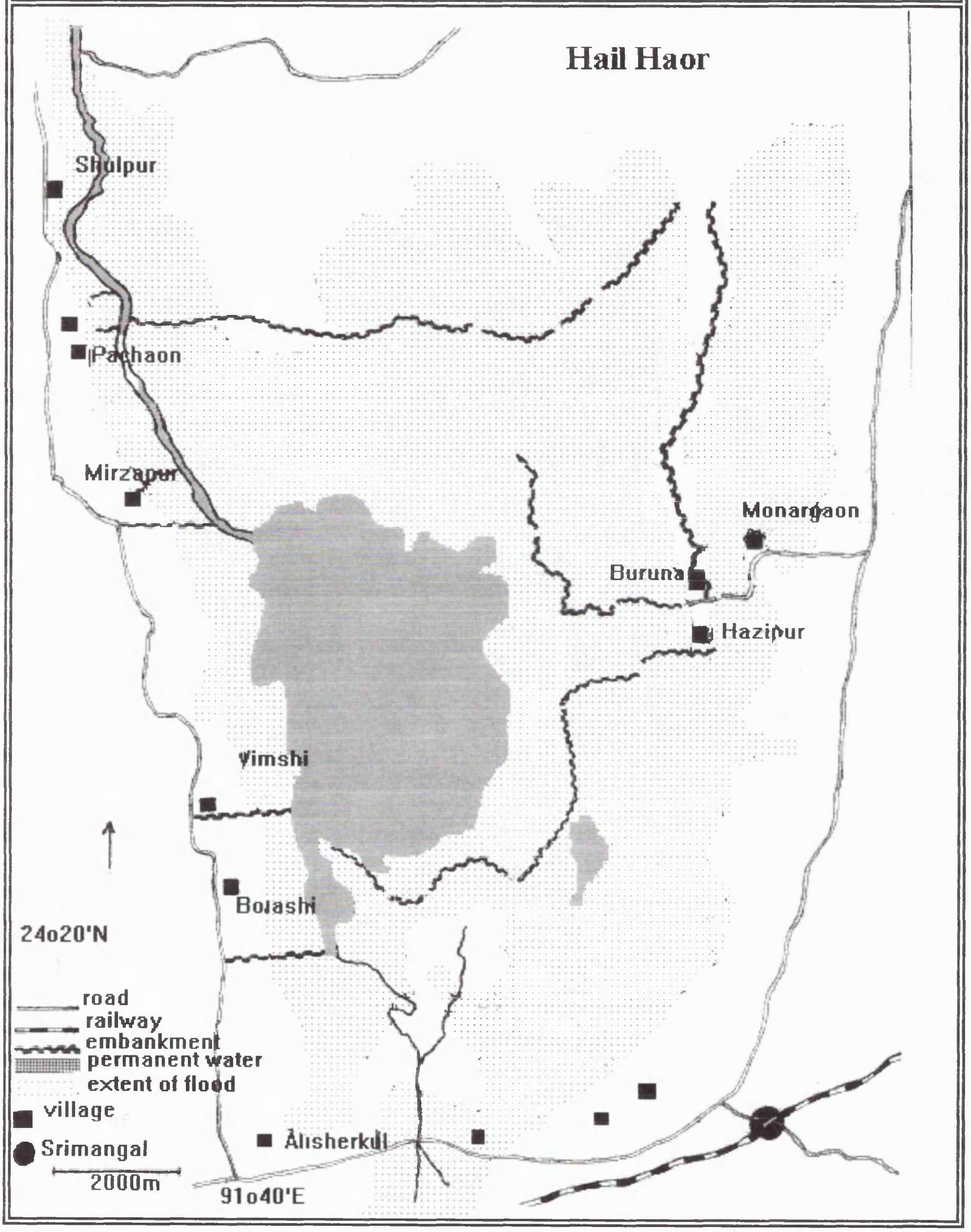
Hail Haor is fed by at least 352 choras, creeks that drain the surrounding hills. Their banks are well-defined, cutting down as deep as 3 metres into the laterite. After rain they become rapid torrents and their water becomes cloudy with rust-coloured sediment. Hail Haor's most important feeder is the Gopla Nodi (or Lungla Nodi), a permanent river running through the depression from south to north. Its catchment area goes back into the hills of Tripura.

The haor only has one outflow, at its north-west edge, whence the Gopla flows through another haor, Manik Haor, towards the Manu River. The Manu joins the Kushiara River north of Moulvi Bazar and the Kushiara flows into the Meghna River.

The link with the main river system downstream is very narrow. As it leaves Hail Haor, beside Pachaon, the Gopla River passes through a "bottleneck". During the flood season this nexus is around 5m deep and 500m broad, narrowing to 200m between the Pachaon embankments. During the dry season the Gopla River is only 15m broad as it leaves Hail Haor.

The flow of water in Hail Haor is almost always from south to north. Flooding in the Kushiara only causes the Gopla River to back up into Hail Haor around one year in five and then only for three or four days. The outflow at Pachaon is imperceptible during the dry season and rises to around 2km/h during the monsoon. Hail Haor's water-level, however, reflects that of the Kushiara and Meghna. If, as in March 1993, there is heavy rain in the Gopla Nodi's catchment area alone, the water-level in Hail Haor rises, but falls to its original level overnight.

Figure 5.1. Hail Haor.



A number of embankments have been constructed in Hail Haor. Many, protruding from dry land into the floodplain, serve to improve access to paddy land and the haor itself and are frequently used as fish landing sites. A large artificial embankment runs close to the haor's southern and eastern shores. It was constructed before 1947, possibly in order to improve access to paddy land. Fishermen, however, complain that it has accelerated the siltation of 62 Beel on its southern side. Local people have cut several openings through the embankment for boats to pass through and this no doubt eases fish movement.

The Gopla River has a levee on each side throughout its length. They are scarcely noticeable in the southern half of the haor but are as high as 3m adjacent to Mirzapur and Pachaon. Local people have made several cuts on the eastern levee to improve boat access to the beels.

During the flood season Hail Haor is an unbroken expanse of water. Between October and February, however, its features appear, first the south-eastern embankment and then the Gopla River's levee. By December a number of depressions, or beels, become apparent. By late February, only the Gopla River and the haor's three largest beels, 62 Beel, Number 1 Beel and Beri Beel, hold water.

Any water shallower than around 1m supports water-hyacinths and water-lilies. By January only the Gopla River is not covered. The gradient on the eastern side is steeper than that on the western side. It is on the east, therefore, that there is most macrovegetation.

The land between the lines of maximum and minimum flood is used as paddy and pasture during the dry season. Land that appears before September may grow aus (floating rice) and/or aman (autumn rice). Land that appears between October and December may support boro (winter rice). Most rice cultivation is on the eastern side of the haor because of its shallower gradient.

The 1980s saw a rapid increase in the use of chemical insecticides on boro rice around Hail Haor. The Department of Fisheries and its donors have expressed concern about their toxicity to fish on a national level. FAP 17 has found low concentrations of pesticide residues in floodplain water but is uncertain as to their importance. (B. McCarton *pers. comm.*)

Hail Haor: the study period

Running as it did from October 1992 to November 1993, the study period covered the second half of the 1992-3 flood season and the first half of the 1993-4 flood season. Both of these seasons were abnormal in different ways.

The 1992 monsoon was unusually late and dry. The FAP 6 project, responsible for flood monitoring in Greater Sylhet, described 1992-3 as a "one in ten year drought" (G. Bernaczek, *pers. comm.*). Between December 1992 and January 1993, moreover, a serious outbreak of ulcerative fish disease reduced stocks of *Puntius* spp. and snakeheads. If caught alive, infected fish could be sold, but only at a discount of around 50%. Fish catches and sales were therefore lower than average in 1992-3.

The 1993 monsoon was unusually early and heavy in Greater Sylhet and was described as "a one in twenty-five year flood." More than 90% of Hail Haor's aus rice crop was destroyed by the flood in June 1993. By the same month, however, fishermen and fish-traders were predicting an excellent fishing season. By late October 1993, high yields and the unseasonable appearance of large *Labeo rohita* in the catch made it clear that their predictions were correct.

Hail Haor: The fish

Table 5.2 shows the fish species found in the catch from Hail Haor. Dhaka dialect equivalents are given when the local fish name is different.

Table 5.2. Species of fish observed in the catch from Hail Haor, 1992-4.

Local name	Scientific name	
baim	*Mastacembalus* spp.	x
baliara, baila*	*Glossogobius giuris*	xxx
bera, mini*	*Nandus nandus*	xx
boal	*Wallago atu*	
boisha	*Colisa* spp.	xxx
carpo, carfu*	*Cyprinus carpio*	
chanda	*Chanda nama*	xxx
chingri,issa*,gungi	**shrimp**	xxx
darkina	*Rasbora rasbora*	xxx
gojar	*Ophicephalus* (*Channa*) *marulius*	
gonia	*Labeo gonius*	
kakiya, kaika*	*Xenentodon cancila*	x
kalbaush, kaliara*	*Labeo calbasu*	
kalna, kangla*	*Notopterus notopterus*	x
katla, katol	*Katla katla*	
kawa*	*Chaca chaca*	xx
koi	*Anabas testudineus*	x
koia	*Colisa* spp.	xxx
magur	*Clarias batrarchus*	
mokha, mola	*Amblypharyngodon* spp.	xxx
mrigal	*Cirrhinus mrigala*	
pabda	*Ompok pabda*	x
potka	*Chelenodon fluviatilis*	xxx
pupul	*Ophicephalus* (*Channa*) *barca*	xx
puti	*Puntius* spp.	xxx
rui, rohu	*Labeo rohita*	
shing, shingi*	*Heteropneustes fossilis*	x
silver	*Hypophthalmichthys molitrix*	
shol	*Ophicephalus* (*Channa*) *striatus*	
taki, sheng*, lati*	*Ophicephalus* (*Channa*)*punctatus*	x
tengra	*Mystus vittatus*	xx

* denotes regional name
x denotes small fish, usually caught at 10cm-20 cm
xx denotes very small fish, usually caught at 5cm-12 cm
xxx denotes tiny fish, usually caught at 2cm - 8cm

Scientific names from Rahman (1989)

In contrast to the huge literature upon aquaculture biology, very little is known of the floodplain fish species' life-cycles. (FAP 17's fish migration research will produce new results in mid-1994.) For the purpose of this study, however, a few key points will suffice:

a) Most fish species spawn only at the start of the flood in May and June.

b) The snakehead species (*Channa*/*Ophicephalus* spp.), which are physiologically capable of spawning all year round, also produce most of their fry at the start of the flood.

c) At the start of the flood non-snakehead fish migrate upstream into the haor from the Gopla River.

d) Between June and November, when Hail Haor is an unbroken expanse of water, fish can move between auction units.

e) Fish growth is fastest during the flood.

f) Whereas small fish species are dispersed evenly across the haor, large fish species concentrate in deep water.

The bio-economic models will show how these aspects of fish ecology inter-act with the leasing system and fisheries policy to determine the distribution of fishermen's incomes.

Artificial stocking in Hail Haor

The Department of Fisheries' Second Aquaculture Development Project (ADPII) stocked Hail Haor with Chinese and Indian carps in 1991, 1992 and 1993. Tables 5.3 and 5.4 show the stocking rates for 1991 and 1992 (32 tonnes of carp fingerlings were stocked in 1993).

The 1992 stocking was delayed until September by late rains and delays in the procurement of fingerlings. High temperatures, shallow water and low oxygenation (15 ppm on the 21/9/92) led the DOF to abandon it before the programme was complete. The 1993 stocking was again delayed until September, this time by delays in procuring fish poison for the removal of predator species.

Table 5.3. Stocking of Hail Haor 1991

Species	%	Survival rate (%)	Mean sale weight(g)
Katla	10.7	13.5	705
Rohu	12.6	17.2	505
Mrigal	8.2	8	367
Grass Carp	.8	.9	n/a
Common Carp	4.1	6	n/a
Silver Carp	63.8	14.1	430

Source: Aquaculture Development Project II

Table 5.4. Stocking of Hail Haor 1992

Species	Fingerlings (kg)	(number)
Katla	2,000	100,000
Rohu	4,600	291,000
Mrigal	4,400	299,000
Grass Carp	1,000	82,000
Common Carp	400	18,000
Silver Carp	7,000	490,000

Source: Srimangal TFO

The ADPII also stocked a pond in Hazipur village in 1992. The project cut a ditch from the pond to Hail Haor so that the fingerlings would enter the haor. However, a government officer closed the channel and leased out the pond to a private individual.

The stocked species, Chinese and Indian carps, are large, fast-growing fish and, with one exception, tend to concentrate in deep water. It is therefore relatively easy to enforce rights over them and to catch them with brush-piles and pumps. The exception is the Silver Carp (*Hypophthalmichthys molitrix*). Because this fish does not settle in deep water it is easily caught by poorer fishermen's faron traps and gill-nets as early as November. It was removed from ADPII's stocking programme in 1993 on the grounds that it was being caught too early.

Fishing gear in Hail Haor

The fishermen of Hail Haor use a variety of nets, hooks and traps. Along with boats, they constitute the fishermen's capital stock. Their catching efficiency, cost, working-life, water requirements, boat requirements and labour requirements are factors that influence fishermen's choice of technique and thus the pattern of effort applied to the fishery.

1 Gill nets

Two types of gill net (fash jal/fai jal) operate in Hail Haor, those made of spun nylon thread (sometimes known as "parachute") and the illegal current jal, made of nylon monofilament thread. Both come in stretched-diameter mesh sizes of 3/4", 2" and 3". The mesh size determines the catch composition; large fish are more likely to brush off the smaller mesh sizes and small fish can swim through the wider meshes. Hail Haor's fishermen travel over 50km to Chadpur or Boirob to buy both nets.

The study team estimated by direct observation that around 90% of the gill-nets used in Hail Haor are illegal current jals and of these 80% have a stretched diameter mesh-size of 3/4". The price of current jal is approximately Tk1,000/lb, which covers 75 yards at a mesh size of 3/4". Current jals only last for six months after which the household may use it as fencing for poultry.

The price of the spun nylon gill net is Tk 340/lb for narrow mesh and Tk 240/lb for wide mesh. 1lb of this net stretches for 75 yards and 125 yards for narrow and wide mesh respectively. The fishermen of Buruna and Hazipur, who are relatively rich and therefore most likely to buy new nets, sometimes sell them by the mut (60 yards) onto a second-hand market after six months or one year of use. The price is three-quarters and one half of the new price respectively. As gill-nets age and holes appear they lose their ability to catch large fish, although some repairs can be made. The spun nylon gill nets are said to be useless after two years.

Some fishermen set these gill nets for twelve hours a day, checking the net at four-hourly intervals. Others leave the net set for two or three days at a stretch, after which it is brought onto land for drying and repairs. The smallest gill net fishing team consists of the net itself, one person and a boat, but it is possible for up to 8 fishermen with gill-nets from different households to form a fishing group.

Migratory Siberian waterfowl visit Hail Haor between December and February. A small minority of fishermen stretch 2" mesh current jals above the water between bamboo poles and scare birds into them.

2 Cast net

The jhaki jal or ural jal is a cast net worked by one person. Its mesh size varies from 0.5" to 3". The advantage of a narrow-mesh net is that nothing escapes between the filaments; the advantage of a wide mesh is that the same throw covers a larger area. It is estimated that the stretched diameter mesh size of 80%-90% of cast nets is no greater than 1". Hail Haor's fishermen buy them cast nets in Srimangal or Moulvi Bazar, where a 3.5 yard net sells for approximately Tk 540. The metal weights attached to the rim of the net sell for Tk 40/kg and the net requires 5kg of weights to function. The net itself usually lasts for one year, but the weights are good for ever. A boat is required for cast-netting in deep water.

3 Lift nets

The bel jal is a net spread within a triangular bamboo frame and mounted upon a bamboo scaffold in shallow water. The frame pivots like a see-saw so that the fisherman can raise the net by climbing onto, or pulling a rope attached to, one corner of it, which he does every five to fifteen minutes. Two fishermen usually work a bel jal together; the work is laborious and more efficient if broken into shifts. A boat is often required to reach the net and transport the catch.

The net itself sells for Tk 3,500 to Tk 5,000 and lasts for three years if repaired after two years. Tk 300 of bamboo is required to construct the mount, but this quickly rots and must be replaced after 6 months. Fishermen explain that they can usually construct a bel jal in paddy land free of charge, but must pay a fee to construct one in one of the Haor's jalmohols.

The smaller dhormi jal is operated from dry land by a rope. It is therefore more suited to the steeper banks of canals, boro pits, ditches and rivers and was not observed in Hail Haor.

4 Hooks

Two hook-fishing techniques are used in Hail Haor. They are both called "hook-giving", but their catch composition and economics are very different.

Long lines are by far the most common hook-fishing technique. Fish hooks are attached to nylon threads around 10cm long which are in turn tied 3 to 5 yards apart on a coarse jute line that is usually more than 500 yards and can be up to 3000 yards long. The long line is set beneath the surface, either slung between bamboo poles or resting on natural aquatic vegetation. It takes around two hours to place, is set for between 2-8 hours and takes another three hours to lift. Long-liners usually follow one of two timetables: either they set the hooks in the late afternoon and lift them at dawn for the morning market or they set them at down and lift them in the early afternoon for the evening market. The catch composition is similar in each case.

Towards the end of the flood season, however, another practice occurs. Large hooks, baited with 3cm live-bait, are suspended in the evening from 10-20 metre lines an inch <u>above</u> the water's surface. The bait's spasms attract large boal, shol and gojar. Bait purchase constitutes the major cost of this technique: the cost of snakehead fry is around half the value of the fish it will catch.

The hooks come in various sizes and qualities. The small Korean hooks most commonly used in Hail Haor sell in Srimangal for Tk 14 per 100. They rust and break, however, after only 15 to 20 days. The hooks, nylon thread and jute line are sold in every fish-market and retail market around Hail Haor. Some fishermen buy a small amount every day. A boat is almost always necessary.

Earthworms and shrimp are the most common bait for long lines. Froglets and small fish (*Chanda nama*, *Puntius* spp.) are used for the larger hooks on long-lines. Adult frogs and snakehead fry are used for over-water hooks.

Male household members dig up the earthworms with hoes. If small fish or shrimp are used as bait, the fisherman either buys them from retail fish-markets or operates a small number (6-12) of dori traps. Male household members catch froglets and adult frogs in paddy fields with push-nets. The fishermen either buy snakehead fry from fish-markets or catch them themselves with push-nets.

It takes around 40 minutes to bait 100 hooks. Most fishing households bait their own hooks. Others hire men, women or children for this task at a going rate of Tk 5 per 100 hooks. Female participation in baiting is noticeably higher in Hindu households.

5 Tana jal (mokha jal)

The tana jal (called a mokha jal on the N.W. side of Hail Haor) is a seine net, typically 45 yards by 9 yards with a stretched diameter mesh size of 7mm-9mm.

During the flood season tana jals are used to encircle fish in deep water. Each end of the net is towed by one boat or, in rough weather, by swimmers. During the dry season, however, the water is often too shallow for the net to be dragged. The fishermen then set the net in an arc between 2 boats. 3 or 4 other boats lie about 10 metres distant on the concave side. At a given signal the outlying fishermen start circling the net, thrashing the water with their poles, shouting and banging metal pots to scare the fish into the net. Meanwhile the two inner boats come together and the catch is hauled.

Hail Haor's fishermen travel to Boirob or Chadpur to purchase tana jals. They typically cost Tk30,000.

6. Brush piles

A brush pile, or dol, or dol kata, is a type of fish aggregating device (FAD). Like pump-fishing, it is one of the most profitable and capital-intensive fishing techniques used on Hail Haor.

Brush-piles are constructed in deep water between November and December. First, a rectangular area of up to 0.5ha is marked out with bamboo stakes around 8m apart. Then brushwood is submerged within the rectangle and pinned to the bottom mud with bamboo. Water-hyacinths are brought to float above the brushwood. The resulting artificial fish habitat attracts fish, especially the larger species such as carps, *Channa striatus* and *Channa marulius*.

The dol is fished between January and April in an operation that lasts between two and ten days. First, the brush-pile is enclosed by a seine net (dol jal) attached to the bamboos on its perimeter. The dol jal's stretched diameter mesh size is 1/2" below the water and 2" above the surface. Then, starting at one side of the brush-pile, the brushwood is removed and the net is moved up against what remains. When all the brushwood has been taken out, the dol is fished out by repeated tana jal passes.

Sometimes the dol jal is not tightened at the end of the day after the day's brush has been removed. The dol-owner may then use a practise known as "tepwal" or "tepi" whereby a cast-net fisherman fishes in the part of the dol without any brushwood. Tepwal cast-netting is said to help the dol-owner by scaring fish back into the brushwood whence they are less likely to escape from the dol jal.

7 Taki jal

Taki jal is a seine net of around 20 yards by 10 yards used as a lift net, frequently found in Gopla Nodi. Four bamboo poles are planted in the water and the net's corners are slung from them. The two upstream corners are periodically dropped into the water and pegged back up. At 3", the taki jal's mesh size is comparatively large. This is to permit rapid lifting. Taki jal fishermen frequently have days when no fish enters the net that is large enough to be held by the wide mesh.

8 Push nets

When interviewed, fishermen and "non-fishermen" frequently omit to list their push net (felun jal, plen jal, mokha jal) as fishing equipment, perhaps because it is such a common household tool as to be beneath mention. The push net is suited to paddy, submerged pasture, ditches, and puddles and even filters mud. It sells for Tk 175, of which Tk 25 covers the triangular bamboo frame, and lasts for around 6 months. The mesh size is usually in the range 7mm - 9mm.

The push net is either operated by one person, sometimes a child, without a boat or by two people, one poling a boat and the second holding the net in the bow. A third method is to use the push net with a thick rope. Two people agitate the water with the rope, driving fish into a push net held by a third. This combination is called "gusa jal".

9 Fish traps

The smallest, most common trap is the dori, a box made from slivers of split bamboo 2mm apart, with a slit on two opposite vertical faces. The fish enter the slits by pushing through a V-shaped straw "valve" which closes again behind them. The fishermen remove the catch through a square hole in the top surface. Dori are sold and used by the dozen. Their price varies according to demand, from Tk120/dozen during the monsoon to Tk200/dozen in November. They last for around 3 months.

The faron is a larger version of the dori with a 1cm mesh size. It costs Tk 40 per piece and lasts for around 6 months.

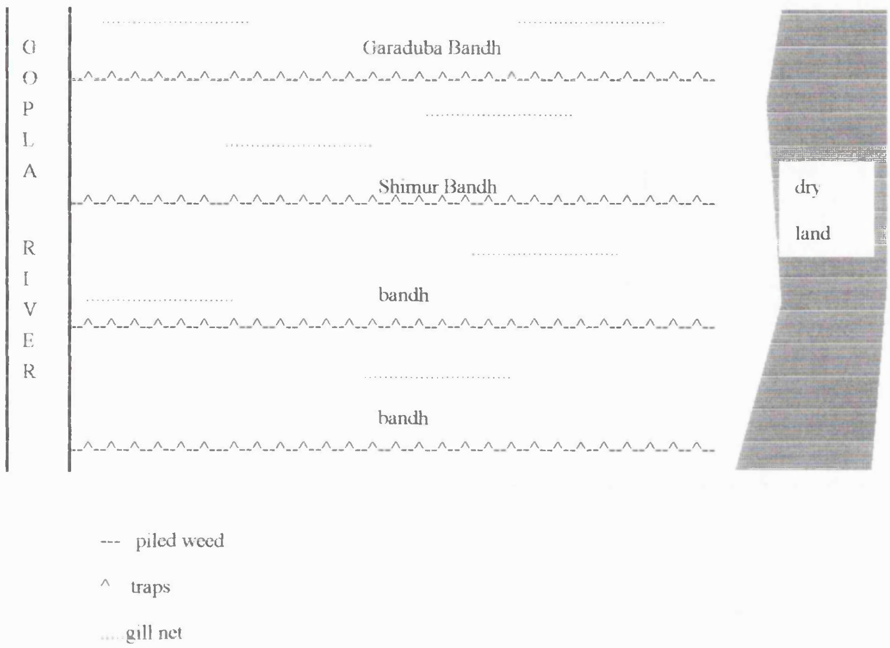
The boshni trap is a 90cm by 60cm envelope made from slivers of split bamboo 2mm apart. Each of its two faces contains six openings with an o-shaped straw "valve". It sells for Tk 200 per piece.

The lunga and koin traps are bell-shaped with an circular valve at one end. Of the two, the wider koin is more suited to catching larger fish. Both are comparatively rare and it was impossible to obtain a market price.

The traps are not baited. There are two systems of trap placement, in paddy field embankments or in mid-water barricades:
Paddy field embankments: Plots of paddy land are surrounded by 5cm-15cm mud embankments. When the flood falls below the level of the embankment, water and small fish are trapped inside the plot. Some fishermen and farmers then fit dori or bosni traps into breaches in the embankment. The fish are caught as the current drawns them out of the plot. This technique does not require a boat.
Mid-water barricades: As the flood recedes fishermen build barricades (bandh) of aquatic vegetation up to 1km long across the water. Each barricade location has its own name and is allocated by the lessee or sub-lessee to a specific group of fishermen. They make gaps in the barricade and set dori, bosni and faron traps into them. When fish

attempt to pass the barricade they are caught. Figure 5.2 below illustrates the placement of large barricades in Number 1 Beel.

Figure 5.2. Barricade-trapping in No. 1 Beel.



Fish traps are manufactured locally by Hindu fishing households. To produce a dori, a faron and a boshni takes around 8 hours, 14 hours and 30 hours respectively. Usually, however, the household adopts a "production-line" system, performing each stage of the manufacturing process for batches of 1-3 dozen traps at a time. A boat is necessary for barricade-trapping.

10 Dewatering by pump

It is sometimes possible to empty a depression (beel) by raising a mud embankment around it and removing the water by means of a diesel pump ("machine"). Carps and small fish are removed from the surface of the mud. Larger snakeheads (shol, gojar) and catfish are dug out. The resulting pit may be over two metres deep and creates a prime fish habitat for the following season.

11 Dewatering by hand

Groups of 3-5 men with scoops remove the water from an embanked paddy field and collect fish from the mud. Farmers use this technique to bring forward the date of planting. Labour (Tk20-40/person/day) is the main cost.

12 Fishing by means of macrovegetation

A manual fishing method known as "panga" is practised in shallow water. Groups of 4 or 5 fishermen make a circular embankment of water weeds. It is initially around twenty metres in diameter. They then walk around the embankment many times, pushing the weeds towards the centre as they go. When the circle is three metres in diameter it is fished out with a push net (felun jal). Small fish such as boisa, chanda and shrimp are caught. A group is said to be able to build and fish one panga embankment per day. The felun jal is the only gear required.

13 Basket-fishing

A *polo* is a large, conical wicker basket with a 2" mesh size and a hole at the pointed end. It is dropped wide-end-down in shallow water. The fisherman inserts his arm through the hole and gropes for any large fish that have been trapped between the basket and the mud.

Gear selectivity

The composition of the catch by species varies by season and gear. Table 5.5 presents an account of gear selectivity in Hail Haor for November 1992-November 1993. It shows that small species dominate the catch of hooks, gill-nets, traps and tana jals, the gears most commonly used by fishermen. Only the relatively expensive brush-piles have a high proportion of carps, the stocked species, in their catch. After the brush-pile season has finished in March, carps almost completely disappear from Hail Haor's catch, suggesting that they have been fished out. Although cast nets appear to have caught large non-carp species between March and May, these observations relate to tepwal fishing and could therefore be included with the brush-pile catch.

Table 5.5. Gear selectivity by category of species. Hail Haor, November 1992-November 1993.

	Large species		*	**	***		
	Carps	others	small	v.small	tiny	total	n
Jun-Aug							
Bosni	-	-	-	-	-	-	
Cast	-	-	-	-	-	-	
Dol	-	-	-	-	-	-	
Dori	0	0	0	3	98	100	4
Dry	-	-	-	-	-	-	
Faron	-	-	-	-	-	-	
Felun	0	29	3	3	65	100	14
Gill	13	3	56	7	21	100	17
Hook	0	9	80	9	1	100	23
BHook	0	99	1	0	0	100	7
Lift	-	-	-	-	-		
Tana	17	1	8	2	73	100	8
Spear	-	-	-	-	-	-	
Taki	-	-	-	-	-	-	
Sep-Nov							
Bosni	-	-	-	-	-	-	
Cast	-	-	-	-	-	-	
Dol	-	-	-	-	-	-	
Dori	0	0	1	0	100	100	4
Dry	-	-	-	-	-	-	
Faron	-	-	-	-	-	-	
Felun	1	13	15	0	70	100	8
Gill	5	3	49	23	20	100	15
Hook	0	10	75	8	7	100	14
BHook	0	100	0	0	0	100	7
Lift	1	0	4	1	95	101	5
Tana	0	0	2	0	98	100	7
Spear	-	-	-	-	-	-	
Taki	-	-	-	-	-	-	
Dec-Feb							
Bosni	-	-	-	-	-	-	
Cast	-	-	-	-	-	-	
Dol	60	5	0	2	33	100	1
Dori	0	0	1	2	96	100	12
Dry	1	24	45	6	24	100	13
Faron	17	2	48	8	24	100	8
Felun	0	5	30	5	60	100	
Gill	17	7	44	6	26	100	22
Hook	0	7	93	0	0	100	13
BHook	-	-	-	-	-	-	
Lift	0	0	19	6	75	100	3
Tana	37	17	9	2	35	100	
Spear	32	42	25	0	0	100	5
Taki	-	-	-	-	-	-	
Mar-May							
Bosni	0	0	8	4	88	100	1
Cast	0	100	0	0	0	100	2
Dol	-	-	-	-	-	-	
Dori	0	0	3	1	96	100	9
Dry	-	-	-	-	-	-	
Faron	0	1	88	5	6	100	4
Felun	0	0	0	0	100	100	5
Gill	1	3	32	16	48	100	5
Hook	0	3	97	1	0	100	7
BHook	-	-	-	-	-	-	
Lift	-	-	-	-	-	-	
Tana	-	-	-	-	-	-	
Spear	25	38	37	0	0	100	2
Taki	0	0	0	0	100	100	2

Notes to Table 5.5:
-The data for dry fishing is provisional.
-All observations are weighted equally, irrespective of the weight of the catch.
-Species categories are as defined in Table 5.2.

Fisheries specialists in Bangladesh, however, frequently underestimate the importance of small species, dismissing them as "trash fish", "commercially less important" (Tsai 1991 p.2) or "miscellaneous fish". Coulter and Disney (1987) state that most small fish in the catch are the juveniles of larger species, which is patently untrue. This bias exists for several reasons:

a) the DOF and projects often use catch data from the operators of deep beels (e.g. Aquatic Farms Ltd 1992) where larger fish congregate and are caught.

b) the senior civil servants and expatriates who design fisheries policy are less familiar with small fish species because they do not eat them.

c) fisheries policy-makers have often been trained in carp aquaculture.

d) there is little demand for small fish in the rich countries where fisheries science and management models have been developed.

e) most importantly, the poorer fishermen who depend upon small fish species cannot communicate their situation to policy-makers.

It is a major theme of this study that the underestimation of the economic importance of small species has a regressive distributional impact when it is translated into policy.

Seasonality in the Hail Haor fishery

By contrast with the temperate marine fisheries for which orthodox fisheries management economics was developed, the fishery ecology of Hail Haor is highly seasonal. Figure 5.3 below shows how seasonal flooding and fish movements produce a seasonal pattern of gear use.

Figure 5.3. The seasonal fishing ecology of Hail Haor

```
                   May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr
hydrology
Rain               <----monsoon------>
Water level           <------high------><---------falling----><low>
No.1 Beel depth(m) 0.5 4.5 4.5 4.5 4.5 3.5 2.5 1.5 1.0 0.5 0.5 0.5
-------------------------------------------------------------------
fish
life-cycle         <spawning><--rapid growth--><slower growth>
Large carps/Channa    <--dispersed-->    <--in depressions-->
Small fish         <------------------dispersed------------------>
-------------------------------------------------------------------
rice-growing
aus                    <plant>     <hvst>
aman                               <plant>    <hvst>
boro              <hvst>                      <plant>
-------------------------------------------------------------------
fishery access
type of access     <open or territorial><----lessee control------->
-------------------------------------------------------------------
gear use
Gill nets          <------------------------------------>
Paddy-field traps                  <--------->
Mid-water traps                         <----------------->
Push nets         <------------------------------------------------>
Tana jal                <--drawn through water-><-noise-fishing->
Lift nets               <---------------------->
Long lines              <------------------------------------------>
Over-water hooks                  <---------->
Brush-piles                             <built><-fished->
Pump-fishing                                   <-------->
-------------------------------------------------------------------
Fishing wages      -----------Tk40/day----><-Tk 50/day><Tk40/day--
Credit            <---borrowing high------><--repayment high-->
Fish prices        ---------high-----------><-----low-----><--high-
Fishermen's income <-------low-------><----medium--><-high-><falls>
-------------------------------------------------------------------
```

Fishermen describe the beginning of the monsoon as the most difficult part of the year. At this time the Haor is almost devoid of fish, the weather is unsuited to fishing and there is no demand from agriculture for hired labour. As the Haor's waters rise fish migrate upstream from the Kushiara and Manu Rivers and push nets, lift nets, traps and gill nets are brought into use. In November the demand for labour rises as the aman rice crop is harvested and brush-piles and grass barricades are constructed. The prevailing wage rate rises as a consequence. By December the water has receded to the point where the fish are concentrated in depressions such as No. 1 Beel and Gopla Nodi. Between December and April these depressions are fished out by means of seine nets. Smaller beels may be encircled by wicker fences and pumped dry. The intensity of activity peaks in January and gradually diminishes until the end of April. The majority of fishermen, however, state that they take no part in the fishing of depressions.

Conclusion

This chapter has described the ecology and fishing technologies of the Hail Haor fishery. A salient feature is the degree of heterogeneity; the fishery is effectively composed of a number of sub-fisheries, different combinations of season, gear, fish species and location, each with their own particular production function. In this, Hail Haor is distinctively different from temperate marine fisheries, where fishing activity has approximately the same character irrespective of the season, location or target species.

A conspicuous feature of the Hail Haor system is therefore its asymmetry. There are large species with a high affinity for deep water and more dispersed small species. There is a flood season of dispersed fry and a dry season of concentrated adult fish. There are cheap gears producing small catches of small species on the floodplain and expensive gears catching spectacular quantities of larger species in depressions. The key to understanding the distributional impact of inland capture fisheries policy in Bangladesh is to know how these physical asymmetries inter-act with the no less pronounced socio-economic asymmetry of rural society.

Chapter 6

The Hail Haor fishery: the fishing population

Introduction

One purpose of this chapter is to introduce the reader to the people who fish in Hail Haor. A knowledge of the social structures within which they operate will be essential for an understanding of the subsequent discussion of benefit allocation. This chapter will therefore describe fishing groups, fishing communities, fishing households and the fisherfolk's distinctive identity in rural Bangladeshi society.

The second purpose of this chapter is to discuss a sociological issue which bears directly upon the operation of fisheries management policy. Put bluntly, there is a popular generalisation, frequently found in the fisheries literature, that fisherfolk are an underclass, homogeneously poorer than the rest of rural society. The supporting theory is that assetless people can take up fishing as an occupation of last resort because fisheries are open-access. If it were so, then fisheries policy-makers could conceivably be exonerated from considering the distributional impact of their policies; whatever was good for the fishery would be good for the poor because all fisherfolk would be poor people. If it is not so, on the other hand, then the distributional impact of fisheries policy is indeed crucial. This chapter will assess whether the concept of fisherfolk as an underclass is applicable to the Hail Haor fishery.

The communities around Hail Haor

The four Unions around Hail Haor, Kalapur, Srimangal (excluding Srimangal town), Bonabir and Mirzapur, have a combined population of 68,247 (BBS 1990) and a surface area of 178km^2, giving a population density of 383 persons/km^2. This is low compared with the national population density of 768 persons/km^2 (BBS 1992), but largely because these four unions include Hail Haor itself and the relatively lightly-populated tea gardens. In fact, the level of population congestion in the villages beside Hail Haor is as high as the national average. In the mid-1980s there were 4 people per acre of agricultural land (Jansen 1987) for Bangladesh as a whole. For our 6 sample villages around Hail Haor there were 5 people per acre of agricultural land in November 1992.

A satellite image of Hail Haor shows an almost unbroken band of human settlements on the eastern, southern and western sides of the haor, between the line of maximum flood and the foot of the surrounding hills. Most houses (ghor) are grouped into yards (bari) which are grouped into quarters (para). Because there are often no open spaces between quarters, the "village" has no objective physical boundaries. The government has defined revenue villages (mauza) and administrative villages (gram) but local people have their own conceptual village (gram) boundaries, which are often little more than footpaths running between two yards. The village names used in this study refer to the villagers' own village definitions.

Only 49.5% of the population of Srimangal Thana is recorded as Muslim, as opposed to 85% (Jansen 1987) for Bangladesh as a whole. This exceptionally low figure can be attributed to 2 factors: the employment of Hindu labour in the tea-gardens and the in-migration of Hindus seeking refuge from Muslim "pogroms" elsewhere. Out-migration after Partition and Independence reduced Bangladesh's Hindu population from 33% of the total in 1901 to its current level of 12% (BBS 1992). This process was less marked in Greater Sylhet, where Hindus are now 18% of the population (BBS 1992). Some border areas within Bangladesh, like Srimangal, became "safe havens" for Hindu migrants and received net in-migration of Hindus. It is one of very few regions with a growing Hindu population (3% p.a. 1974-81, BBS 1992). The next chapter will explain how the Hindus' strong numerical presence is of great importance for fishery management as Hindu and Muslim factions compete for access to fishing rights.

Srimangal must be one of Bangladesh's most vibrant Thana towns. It has an unusually high number of retailers, warehouses, wholesalers and vehicle repairers. Migrant remittances are one source of the town's prosperity; 90% of Bangladeshis in Great Britain are from Greater Sylhet. Srimangal also serves as the railhead for all of Moulvi Bazar Zila and as a market for the tea-gardens of the Balisera and Satgaon valleys.

The haor is provided with comparatively good communications. The Dhaka-Sylhet trunk road serves the villages on its east and south banks. The west bank is linked to the main road by a smaller metalled road. Although the road is in poor condition, a regular bus runs as far as Mirzapur. Srimangal has a main-line station and the Gopla River carries freight, including fish, during the monsoon.

A note on terminology

The word "fisherman" must be used with caution, as its meaning varies according to the speaker's intentions. Caste fishermen use it to distinguish themselves from other fishermen when asserting the greater legitimacy of their fishing rights. Non-caste fishermen use it to distinguish caste fishermen from themselves to stress their own separate status. People who finance fishing or market fish define themselves as "fishermen" in order to benefit from fishery support projects. They are frequently supported in this assertion by government officials. The poverty-oriented NGO BRAC defines a fisherman as anybody who catches fish with his own hands. The Department of Fisheries' NFMP defines a "professional fisherman" as one who devotes 9 months of the year or receives 90% of his income from fishing, apparently ignoring the fact that many fisheries hold water for less than nine months in the year.

Similarly, the phrase "non-fisherman" has entered the Bengali language to denote somebody who does not catch fish, who is not a caste fisherman or to whom the speaker simply wishes to deny fishing rights. Bangladesh thus has hundreds of thousands of "non-fishermen" who catch and sell fish.

The phrase "subsistence fisherman" is equally ambiguous. People who catch fish for consumption only are called "subsistence fisherfolk" or "non-fishers". Moreover, the phrases "part-time fishermen" and "subsistence fishermen" are used interchangeably for those who do not qualify as "professional fishermen" but catch fish for sale.

This study uses "fisherman" to mean a person who catches fish, or himself goes onto the water to supervise the catching of fish, for sale at any time during the year. (The "-man" suffix is appropriate in this case because only males fish for sale in Hail Haor.) The word "fisherfolk" shall refer to all the members of fishermen's households. To avoid ambiguity, the word "subsistence" will be avoided and replaced by the ungainly phrase "people who catch fish for consumption only".

The number of fisherfolk

Even where fishermen camp on their boats or beside the haor, their villages are always within 2km of the Haor, the camps being to minimise travelling time and to guard nets and fishing grounds. Fishermen say that their number is growing, but only because of population growth in the fishing community. They say that there is no in-migration of fishermen to Hail Haor and no adoption of fishing by other households.

The fishermen live in recognised fishing communities. These are 17 in number. The Thana Fisheries Officer (TFO) provided estimates of the number of fishing households in each community (Table 6.1).

Table 6.1. Estimated distribution of fishing households around Hail Haor

Community	No. of fishing households		
Shulpur	1000	(2000)	M
Pachaun	500	(300)	M
Mirzapur	500	-	M
Bolashi	150	(40)	H
Bonabir	100	(175)	H
Vimshi/Goshnogor	50	-	H
Rustumpur	200	(500)	H
Uttosur	50	(200)	H
Udnarpar	200	Not fishing in Hail Haor	
Bilashirpar	100	Not fishing in Hail Haor	
Amarnathpur	150	-	?
Srimangal Busti	1500	(650)	M
Baraura	1000	(500)	H/M
Monargaon	200	(200)	H
Hazipur	1500	(8000)	M
Buruna	2000		M
Shohostri	(n/a)	(500)	M

Source: Srimangal Thana Fisheries Officer (TFO)
(The village's own estimate of the number of fishermen is in brackets.)

H = Hindus
M = Muslims

Given the huge disparities between the estimates of the TFO and the communities themselves, neither was accepted as reliable. Instead, fishing population estimates calculated from the Fishing Population Survey are presented below in Table 6.2.

Table 6.2. Estimation of households fishing for sale in Hail Haor.

Village	Method *	Male voters	Male Voters /h-hold	Estim. no. h-holds	% of h-holds fishing	Estim. fishing h-holds
Buruna	1	1187	1.75	678	73	492
Hazipur	1	654	2.08	314	69	218
Monargaon	1	197	2.22	89	70	62
S.Busti	3	494	1.95	253	65	165
Baraura	3	331	2.15	154	85	131
Uttosur	4	917	1.85	495	50	250
Rustumpur	3	310	1.80	172	55	95
Alisherkul	2	N/A**	1.50	N/A	N/A	30
Bolashi	3	780	2.26	345	20	69
Bonabir	3	699	2.05	341	10	34
Vimshi	2	656	1.94	338	20	69
N. Pachaon	3	181	1.53	118	35	41
Mirzapur	1	489	1.63	300	48	145
Shohostri	3	403	1.30	310	20	62
Shulpur	3	350	1.75	200	85	170

Total	2033
Catch-effort sample	60
Total/sample	33.9

(* See earlier section for definition of methods.)
(** No voter-list was available for Alisherkul.)

It was thus estimated that just over 2000 households were fishing for sale in Hail Haor either as their primary occupation or as a subsidiary occupation. The Catch-effort and Cash-flow sample contained 60 households. Assuming the sample to be typical, the sample results can be multiplied by 33.9 to represent the whole Hail Haor fishery.

Household labour

The concept of a household (poribar), being a group of people who eat together food cooked on the same hearth, is recognised and used in village conversation. Most production and consumption are organised at household level. The oldest male of the household's oldest generation is recognised by his household and others as the household head. Unless he is incapacitated by age or sickness, he acts as the household's spokesman. In a fishing household, the household head is usually able to describe household members' catch, income and expenses even if he does not go onto the water himself.

Households were classified according to the relationships between their married male members. The breakdown of households by composition is given in Table 6.3. Of the 133 household heads interviewed, 132 were male. Even though one would expect the sample to be biased towards larger households, given the sampling method, the overwhelming majority of households are nuclear, in the sense that they contain a single married couple. This explains the need for fishing households to combine into fishing groups.

Table 6.3. Classification of households by composition

Household type	Frequency
Household head and no other married males	85
Household head and married brother(s)	18
Household head and married sons	26
Household head, married brothers and married sons	4
TOTAL	133

The Catch-effort and Cash-flow Survey reveals how work is distributed between household members. Males enter the workforce around age 9 or when they leave school and leave it when they are incapacitated by age or disease. When a household's males are split between different activities it is the younger men that tend to fish. For example, a household head in his 50s with adult sons may market their fish, do agricultural work or tend livestock. One household head in Mirzapur supervised the hired labourers fishing his brush-pile - one of whom was his own son. When more than one male is fishing, any adolescents are more likely to collect frogs or worms for bait or to fish with low-value gears like hooks or push-nets. Fishermen of all ages frequently take rest-days because of sickness or exhaustion, especially between March and June.

Although females do not catch fish, both married and unmarried women do contribute labour to the fishery by baiting hooks, making nets and, most importantly, making and repairing traps. Their rate of participation is much higher among Hindus than among Muslims for several reasons:

a) The Koranic prohibition against men and women working together
b) Only Hindus manufacture traps. Women skilled in trap-making double several households' incomes in Alisherkul.
c) Purdah confers high status and poorer, Hindu households are less able to afford it.

We noted that fishermen's wives sometimes knew more of fish sales and fishing costs than the household's male members. It is possible that women in fishing households have more knowledge of and discretion over the household budget than their agricultural counterparts. During the dry season, when male household members are absent for up to a week at a time, they are left to maintain the supply of food. Fishing households also tend to buy rice for cash rather than grow it or receive it in kind. If, as Jansen (1987) writes, the household's senior female is responsible for managing its stock of rice, fishermen's wives will be more involved in managing the household's cash balances.

Fishing groups

As the foregoing discussion of fishing techniques indicated, some gears, especially seine nets, traps and gill nets, are operated most effectively by more fishermen than most households can provide. It is common, therefore, for fishermen from different households to band together into groups of 2 to 12 members.

The group's catch is sold collectively and the proceeds are shared among the members, after deductions for indivisible team expenses such as kerosene or large boat hire. It is usual for groups to avoid disputes by insisting that all group members provide the same gear. In the few tana jal (small seine net) groups where an outside net is used, a share is allocated to the gear. Again to prevent disputes, all group-members must contribute the same amount of labour. If illness or the need to travel forces a member to withdraw temporarily, he supplies a relative or hired labourer to take his place.

The most important criterion for gear membership is a fisherman's ability to bring along his share of fishing gear. It is unheard of for a fisherman to be included through family or social ties alone. Fishermen tend to join groups with people from their own bari, para, religion and village but all of these preferences are subordinate to gear-ownership.

In some cases, fishermen make a deliberate effort to recruit group-members from different paras in order to benefit from a combination of each para's skills and political status. The Buruna Maimals say they recruited Nomosudras because only they can work with fish-traps; the Hindus say they work with Muslims because otherwise their fish-traps would be stolen. In the words of a Muslim fish-trader, "They need our security." In most mixed groups the Hindus and Muslims come from neighbouring villages, but some Hindus are recruited in from Nabiganj, 40 miles away. The Muslims generally retain control over a mixed group's marketing and accounting.

Groups do not have leaders, but rely upon a strict sharing of labour, costs and revenues to maintain cohesion. Every opportunity is taken to shift responsibility from the group to the individual. For example, many trap-groups only own the barricade in common, owning the traps and lifting the catch individually. Tana jal groups rarely own their net in common. Each member usually brings his own section of net, to be sewn onto the others at the start of the season and unstitched at the end. Group membership is fluid. They form and dissolve seasonally as different gear types are used and set aside. When last year's group re-forms it will simply replace any old member who cannot contribute his share of the group's costs (poisha).

Fishing groups, in short, are nor social organisations but an opportunistic means of obtaining economies of scale from labour. Within the group, social relationships are subordinate to commercial relationships. So far as a household's life-chances are concerned, therefore, the primary determinant is not its relationships with its fellow-fishermen but its access to gear and then to water. This theme will be developed in the chapters upon unequal access and the position of poor fisherfolk.

Fishing society

Underlying fisheries policy, and justifying its interventions, there is a quasi-official version of the fisherfolk's place in Bangladeshi society. It can be condensed into two statements:

a) "Genuine fishermen", also known as "professional fishermen" or "full-time fishermen", are recognisably distinct from "non-fishermen."

b) "Genuine fishermen" constitute an underclass that is exploited by "non-fishermen". In the words of a DOF socio-economist, "They live sub-human lives at the mercy of the arotdar (wholesaler) and lessee" (Chowdhury 1993).

These assertions follow a powerful body of literature that sees fishing as an activity of last resort and a refuge for the marginalised. Pollnac, for example, starts a discussion of fishermen's organisations with the statement, "Small scale fishermen, who are frequently among the poorest of the poor in developing countries..." (Pollnac 1988, p.1). Kurien (1980) similarly proposes that the nature of fishing causes fishermen, whatever their ethnic group, to be relatively poor. He argues that fishermen are inward-looking, bound to nature rather than to local society, and therefore particular vulnerable to the depredations of middlemen and local politicians. Rahman (1986) asserts that inland fishing in Bangladesh is associated with landlessness and powerlessness, low-caste Hindus and failed Muslim peasants.

The view that fishermen are a socially distinct and exploited underclass serves to justify current fisheries policy, giving the impression that any foreign aid to the fisheries sector will be to the benefit of the very poor. If fisherfolk are an underclass, then the allocation of fishing rights through Fishermen's Associations will be equitable, artificial stocking becomes an exercise in poverty-alleviation and the eventual biomass gains from effort controls will reach those who need them most.

This study will contest, however, that this simplistic class analysis of fisherfolk's position is not appropriate because they do not constitute a homogeneous underclass. It will be argued that they are separate but not subordinate to the rest of rural society and that fishing communities exhibit socio-economic structures which are in many ways a mirror image of their agrarian neighbours'.

The fishing identity

Those who catch fish in Hail Haor for sale fall into five social groupings:

a) Some villages contain Muslim communities specifically associated with fishing. They call themselves, and are called by others, "Maimal" or "motshojibi" (fisherman).

b) Some Hindu villages contain communities of Nomosudras, a fishing caste.

c) Some Hindu villages contain members of the Sarker agricultural caste who fish for sale. In at least one case, that of Alisherkul village, the shift from agriculture into fishing took place in the last 30 years. Residents of this village had farmed land to the north of Moulvi Bazar and fled to Hail Haor to escape the Muslim pogroms. In the words of one man, "Since we were next to water we studied fishing." The Sarker fishermen are recognised as "motshojibi" rather than "non-fishermen" by the Maimals. They are frequently referred to as "Nomosudra", suggesting that the fishing caste identity has touched them.

d) Some Muslim villages contain households that have recently taken to fishing for sale with gill-nets. The Maimals and Hindu fishermen call them, rather confusingly, "non-fishermen", implying that the gill-netters have neither a Maimal identity nor a place in the leasing system. Although "non-fishermen fishermen" are an important feature of other floodplains (e.g. Blanchet and Talukder 1992), and some, from villages on the northern edge of the haor, set gill-nets in the Gopla Nodi north of Pachaon and in adjoining Manik Haor, they do not operate in Hail

Haor proper. This is because the northern jalmohols are operated by Buruna village which is strong both numerically, financially and politically. In the words of one Buruna fisherman, "They are frightened to come near us. They know that we can beat (marte) them."

e) Those who fish for consumption only are drawn from all the communities around Hail Haor.

The phenomenon of migratory fishermen, though widespread in Bangladesh, is not found in Hail Haor: all those who fish there live there.

It is common for uneducated villagers who have not taken in the official line on Bangladeshi nationalism to make a distinction between Maimals and Nomosudras on the one hand and "Bengalis" on the other. Although Maimals and "Bengali" Muslims may live in the same block of houses (bari), they will not inter-marry. The "Bengalis" claim to look down on the Maimals and vice-versa. It is said, however, that the poorest "Bengalis" and Maimals will inter-marry out of necessity. Educated Bangladeshis will not describe the Muslim Maimals as a caste (jati), although they will use this word for the very similar Hindu Nomosudra.

Ehsan (1993), writing of Muslim "Mondol" fishermen in Tangail, argues that Muslim fishermen have no real caste identity. In his analysis, marriage between cousins and between fishing households, both for economic reasons, combine to produce an endogamous group with "no distinct cultural identity." This thesis, however, is contradicted by evidence from Hail Haor and Ehsan's study itself: Both Mondols and Maimals see themselves as distinct from "new" fishing households, even if that household has been fishing for three generations. Mondols themselves believe that they are the descendants of Hindu caste fishermen. A Hail Haor Maimal can give up fishing but he and his children will remain Maimals, seen by themselves and others as different from "Bengalis."

Reinforcing the separateness of the caste identity is the distinctive nature of the fishermen's work. Fishermen relate proudly the indubitable fact that their work is more difficult and dangerous than agriculture. Often immersed in the water for hours at a time, they are prone to skin diseases, leeches and fevers. Although Hail Haor looks to a westerner like a placid lake, the fishermen consider it to be a haunt of pirates and malicious ghosts. (One "ghost" tipped a Buruna fisherman out of his boat in October 1992. The resulting brain damage was seen as possession by evil spirits. Fishermen were frightened of him from then on and felt obliged to support him when he became a beggar.) Unsurprisingly, the fishermen have acquired a reputation for courage and self-reliance. A Catholic Missionary in Srimangal recalls that the Pakistan Army did not dare enter the fishing villages around Hail Haor during the War of Independence.

The five fisherfolk groupings described above are spatial as well as social. Where only some residents of a village are fishermen, they tend to live in a recognised quarter (para) of the village. This is usually the waterside (lama) quarter. Where a village contains both Hindus and Muslims, each again tends to occupy a distinct space in the village. Within any one village there is a strong correlation between occupation and religious affiliation. In Mirzapur, for example, a community of Hindu shopkeepers and traders lives alongside a larger Muslim community of Maimal fisherfolk. In Shulpur a small group of Hindu landless labourers lives alongside the Maimal fishermen. In Monargaon, on the other hand, a community of Muslim landowners, businessmen and local politicians lives alongside a much larger community of Hindu Nomosudra fisherfolk.

As Jansen (1987) has stressed, it is within the para, rather than the village, that people form their most intimate social and economic relationships. It is thus possible for a Vimshi fisherman to point across a rice field to a row of houses 50 metres away and say, "They are not the same people (eki lok) as us." As we will see later, this has important implications for fisheries management because the para becomes the social template through which fisheries rights are allocated.

Sub-dividing the fisherfolk.

The "grey" literature generated by fisheries projects, for example Wood (1990) and BCAS (1992), frequently distinguishes between full-time and part-time fisherfolk and between subsistence and commercial fisherfolk. The rhetoric of the Department of Fisheries and its projects stresses the aid-worthiness of the "professional" fisherman. It is worth investigating whether these classifications are of value as socio-economic indicators.

Although fishermen are drawn from castes traditionally associated with fishing, a household's degree of participation in fishing is determined by opportunism, not by its professional identity. Households are constantly comparing the income to be obtained from fishing with that from other sources. They thus switch in and out of fishing several times during the year according to the catchability of the fish, the restrictiveness of the leasing system and the demand for labour on dry land.

For example, an adult Hindu male without enough land for subsistence might fish the flood from June to October, harvest aman rice as a hired labourer in November, make fish-traps from December to February, fish with hooks in March and April and spend May at home. In this particular case the switches would be caused by the imposition of fishing controls and a rise in the demand for labour in November, a fall in the demand for labour and a rise in the demand for fish-traps in December, a fall in the demand for fish-traps in February and a fall in catch-per-unit effort in May.

A high degree of participation in fishing could either denote the existence of assets and opportunities in fishing or the absence of assets and opportunities on dry land. The phrases "part-time fishing households" and "full-time fishing households" do not therefore identify any social grouping. As an illustrative analogy one could consider the value of classifying office-workers according the proportion of their time spent behind a desk.

For the same reason of opportunism, the households described as engaged in "subsistence fishing" are economically heterogeneous. Any person that fishes for sale, from the brush-pile entrepreneur to the boy of 11 with the push-net, may retain fish for home consumption. Retained fish typically constitute 15-20% of the value of the catch. If a fisherman does not retain fish, this does not reveal the economic or social position of his household; it indicates rather that he does not wish to confuse the accounts of his fishing group or that he does not trust the fish to remain fresh until cooking time. Many households fish for consumption only during the monsoon season when agriculture generates no demand for labour, but these include land-owning, landless, predominantly farming and predominantly fishing households. "Subsistence fisherfolk" are therefore in no sense a recognisable social or economic order.

Indications of economic differentiation among fishing households

Between 57 sample households who received a positive net income from fishing between December 1992 and November 1993 there was a significant variation in recorded income. As Table 6.4 indicates, this holds true for total income, net income from fishing and, taking account of variation in household size, the hourly returns to labour from fishing. The 25% of households who received more than Tk7.5/hour from their fishing labour were certainly not low-paid in Bangladeshi terms, with agricultural labourers in Greater Sylhet earning Tk33/day (BBS 1992). Another indicator of economic differentiation between fishing households is the difference in incomes between villages. ANOVA shows a fishing household's village of residence to be a significant determinant of net fishing income (99% level of confidence), total income (95% level of confidence) and returns to labour from fishing (95% level of confidence). The notion that fisherfolk constitute a homogeneous underclass does not stand the most rudimentary statistical analysis. The subsequent discussions of gear ownership and fishing right allocation will explore how the differences in fishing households' incomes arise and are maintained.

Table 6.4. Income comparisons by quartile for 57 fishing households, December 1992 to November 1993.

	% of total income	% of net fishing income	Return to labour (Tk/hr)
Top quartile	59	50	> 7.8
Lower quartile	12	7	< 3.8

Economic status of fishing households as compared with others

As well as fishing gear and boats, the Preliminary Survey asked villagers to report on ownership of homestead land, homestead roof type, agricultural land, watches, cycles and radios. They were also asked which of their children were attending school. These indicators were used to make a comparison between the economic status of households that fished and households that did not fish. Ownership of each of the three luxury goods, watch, cycle and radio gave the household one luxury good point. A household's school enrolment rate was defined as the number of children between the ages of six and fifteen inclusive in attending school as a percentage of the total number of children in that age group. All means are unweighted.

The results are presented in Table 6.5. It shows that there is no statistically significant difference in these basic indicators between the fishing and non-fishing populations. The only exception is in ownership of agricultural land where non-fishermen, who are mostly farmers, have an unsurprising advantage. The hypothesis that fishing households are distinctly poor is not therefore sustained by this survey.

Table 6.5. Indicators of economic status of fishing and non-fishing households.

Indicator	Households Fishing	Non-fishing	Significance of difference
Homestead land (% owning)	93	88	
Agr. land (mean acres)	1.0	2.0	*
Tin roof (% owning)	34	58	
Luxury good points (mean)	.47	.30	
School enrolment (mean %)	45	56	

* : Hypothesis that population means are the same was rejected at a 95% level of confidence.

Heads of fishing households were asked whether their fathers, grandfathers and great-grandfathers had fished before them. Their responses are presented in Table 6.6. It indicates that the vast majority of fishermen are not "economic refugees" from other occupations but have inherited the profession from their forefathers. The one exception is again Alisherkul. Many of this village's Hindu households were previously farmers in a non-fishing area to the north of Moulvi Bazar. They left this area because "they were tortured by the Muslims" and moved to Hail Haor where a strong Hindu presence guaranteed them relative security. Finding themselves beside a fishery, some experimented with fishing. For most fishing households on Hail Haor, fishing is not an occupation of last resort.

Table 6.6. Length of association with fishing.
(Fishing households)

Village	No. of generations fishing 1	2	3	over 3
Buruna	1	1	0	27
Hazipur	2	0	0	6
Monargaon	3	1	0	15
Alisherkul	3	2	1	3
Vimshi	1	3	0	10
Mirzapur	1	3	1	11
TOTAL	11	10	2	72

There is no significant difference between the labour resources of fishing and non-fishing households. The mean number of persons performing non-domestic work in fishing and non-fishing households was 1.9 and 2.0 respectively. One cannot conclude therefore that fishing acts as an employer of last resort for the surplus labour of larger families.

Rahman (1986) wrote that many Muslim fishing households have come to fishing recently, whereas Hindu fishing households tend to be from low castes specifically associated with fishing. This distinction is not confirmed by the data for Hail Haor. Hindu and Muslim fishing households in the Preliminary Survey sample had been fishing on average for 4.1 and 4.4 generations respectively (Table 6.6). (For the purposes of data analysis, households associated with fishing for 4 generations and more than 4 generations were classified together.)

If fisherfolk were a subordinate part of rural society, one would expect fishing households to invest in non-fishing assets like land as their income rose. There would then be a negative correlation between total income and the share of income received from fishing. In fact, however, the opposite is the case. A regression of the percentage of income received from fishing (%F) upon total annual household income (TY) in Tk'000 for 57 households who made a positive net income from fishing between December 1992 and November 1993 shows a significant positive correlation at a 95% level of confidence.

$$\%F = 49 + (0.6 \times TY)$$

In other words, every thousand taka added to income tends to increase the share of fishing in total income by 0.6 percentage points. This regression again refutes the hypothesis that fishing is an activity of last resort for marginalised people. It suggests that surplus assets are invested in fishing rather than non-fishing diversification and that the worst-off are not full-time fishermen but those too poor to invest in the fishery.

If all these statistics suggest that fisherfolk are not economically subordinate to their agrarian neighbours, the same sentiment is shared by the fisherfolk themselves. In the words of one Maimal, "We think we are better than them and they think they are better than us." Jensen (1987) drew the same conclusion from a study of fisherfolk in Noakhali. If fishing were low-status, one would expect to see rich fishing households marrying into peasant households. In fact, however, the opposite is the case. Maimals say that only poor Maimals will marry "Bengalis." If fishing were low-status, one would expect to see households shedding the fisherman label when they stopped fishing. In reality, rich members of fishing communities, like the owner of Buruna market, Udnarpar's wholesaler and Bilashirpar's late landlord, none of whom catch fish with their hands, continue to assert that they are fishermen. At least three local politicians, the Union

Parishad members for Mirzapur, Pachaon and Shulpur, continue to live in their respective villages' Maimal paras and own brush-piles, living on the water when necessary. They are not ex-members of a subordinate society but senior members of a parallel society.

The allocation of labour to fishing

In the upwardly-biased Preliminary Survey sample, the mean number of people available for labour outside the household was around 2 in every village. (See Table 6.7.) Households were thus divided into those participating and not participating in fishing (Tables 6.8 and 6.9). Alisherkul emerged as a village with high involvement in agriculture and a low involvement in fishing, even though the team had based the sample on a list of fishing households. When a household denied fishing, they were asked several times whether they never fished for consumption, whether they owned no fishing gear and so on. As Table 6.9 indicates, however, the mean number of workers per household fishing as a subsidiary activity is rather low in villages with both higher and lower rates of fishing as a primary activity. In fishing households, moreover, only 19% of workers were reported to practice an activity other than fishing as their primary occupation. In other words, most fishermen are mostly fishermen.

Most fishing households depend upon fishing for most of their income. For 57 households who made a positive net income from fishing between December 1992 and November 1993, 69.5% of total income was obtained from fishing (including the consumption of their own catch). 50% of households took more than 75% of their income from fishing and only 7% of households took less than 20% of their income from fishing.

These findings refuted the initial hypothesis that a large number of households would use part-time fishing as an insurance against the failure of other activities. It suggests another hypothesis, however: when fishermen invest cash and negotiation into obtaining fishing rights and gear, these are sunk costs; the cost of the rights and the gear is more or less the same whether the fishermen use them fully or not. Fishing is therefore economically more attractive as a full-time activity than as a part-time activity because part-timers would be amortising the same fishing costs with a lower fishing income. The sunk cost of fishing access is probably another reason why fishermen have retained their distinct, specialised status rather than blending into the agricultural and petty-trading sectors with the rest of rural society.

Table 6.7. Persons per household contributing non-domestic labour.

Village	Workers/household
Buruna	1.9
Hazipur	2.2
Monargaon	2.4
Alisherkul	1.9
Vimshi	1.4
Mirzapur	2.1

Table 6.8. Number of households reporting fishing as a primary or subsidiary activity.

Village	Households	
	fishing	not fishing
Buruna	29	11
Hazipur	9	4
Monargaon	19	8
Alisherkul	9	1
Vimshi	15	2
Mirzapur	16	17

Table 6.9. Labour allocation to fishing and fish-trading.
(Mean no. of participants per household.)

Village	Most important occupation		Subsidiary occupation	
	Fishing	Fish trading	Fishing	Fish trading
Buruna	1.1	.1	.1	.1
Hazipur	1.3	0	.2	0
Monargaon	1.5	0	0	0
Alisherkul	.7	0	.5	0
Vimshi	.8	.1	.4	0
Mirzapur	.9	.1	.1	0

Conclusions

There is a strong body of opinion that fishermen are a low-status underclass, marginalised and driven into fishing because they are too poor to participate in other activities. The evidence from Hail Haor suggests an alternative view of fisherfolk as a parallel, but not subordinate society:

a) Fisherfolk are not an underclass. They are not significantly poorer than their dry-land neighbours on average and there is a wide range of incomes amongst them.
b) Fishing on Hail Haor is not an occupation of last resort. The fishermen have a caste identity and have been fishing for many generations.
c) Fishing does not absorb the surplus labour of larger households.
d) Fisherfolk cultivate their fishing status rather than trying to shed it. It carries high status within fishing communities. If prosperous, fisherfolk invest in fishing.
e) Subsistence fishing is not exclusively for the poorest. It involves a wide range of economic classes.

The key factor is access. The statement that poverty drives people to fish assumes implicitly that access to the fishery is open compared with access to other income-generating activities. This theory may be applicable to temperate marine fisheries with open access. In Hail Haor, however, as the next chapter will explain, entry is restricted by gear requirements and the operation of the leasing system. The poorest people are not those who fish but those excluded from the fishery.

Chapter 7

The Hail Haor fishery: economic and institutional transactions

The water-bodies, fishing gear and labour, Hail Haor fishery's three factors of production, have already been described. This chapter will now explain the transactions that bind them together and convert them into fishery incomes. Determining the level and distribution of value-added in the fishery, they are the matrix through which policy will affect the livelihoods of poorer people. The chapter will cover the behaviour both of markets and of institutions. Since many economic transactions involve an element of politics and many institutional actions involve an element of commerce, it would be misleading - and difficult - to distinguish between them.

Marketing

Coulter and Disney (1987) and personal observation report that there is a margin of around 40% between the price paid by the consumer and the price received by the fisherman. Economic theory tells us that a trading margin consists of three components: normal profits (compensation for risk taking), trading costs and super-normal profits (produced by restricted competition). From the point of view of the fisheries policy-maker who wishes to increase the share of sales accruing to fisherfolk in general or poorer fisherfolk in particular, the research need is to identify the relative importance of these three components. Coulter and Disney (1987) and the World Bank (1991) have studied the marketing of freshwater fish in Bangladesh. Both identify a multi-level system, where small traders assemble fish for, and are financed by, larger merchants. Both concur that it is the high cost of marketing rather than monopsony that restricts fishermen's share of the retail value of the fish to around 60%. The World Bank argues that any monopsony is created by the smallness and isolation of that particular market. Both conclude by recommending infrastructural investment. However, it is popularly believed and part of official policy rhetoric that monopsonistic fish-markets exploit the fisherman by producing super-normal margins (e.g. Kurien 1980, Nuruzzaman 1993). If this is so, the policy prescription is for marketing reform rather than new infrastructure.

Before examining the marketing of Hail Haor's fish it is first necessary to understand a key feature of the pattern of demand: fish size and consumers' income are positively correlated. Small fish (chingree, puti, koia etc) serve as a daily accompaniment to rice in many households. Households with higher incomes, however, tend to favour larger fish, especially the major carps (rui, katla, mrigal), because they are firmer and less bony. These fish therefore command a higher price in urban areas, which leads to a situation where the length of the marketing chain tends to be a direct function of the size of the fish.

Direct sales

For the majority of fishermen, who catch around 2kg of mixed small fish per person per day, there are two marketing possibilities. Either they can sell their fish to a porter-trader (paiker) or they can retail it directly to the consumer in an evening market. The fisherman's choice between paiker and consumer depends largely upon his individual circumstances:

a) Night fishermen tend to sell to paikers because they land their catch in the morning when there is little consumer demand.

b) Group fishermen tend to sell to paikers because, by making the sale price a single, publicly-known figure, they minimise the risk of being cheated by the group-member on selling-duty.

c) Paikers are used when household labour is in demand, for example during the dry season when there is a high return to working on the water both day and night. Conversely, a household with a "spare" infirm or old adult male often sells its own fish.

The outcome is that paikers buy the majority of fish of the majority of fishermen.

Paikers buy fish from fishermen either in a fish-market (mas bazar) or on the water. The most important fish-markets for Hail Haor are at Srimangal, Hazipur and Buruna. There are two selling-sessions daily, one around 7.00 a.m. for the night catch and another, around 3.30 p.m., for the day catch. In line with the pattern of gear use, the morning and evening markets are dominant in the dry and monsoon seasons respectively.

Buruna's fish market provides a good illustration of how fishermen sell to paikers. The marketplace is owned by a nonogenarian Maimal. He attends every market, collects tolls in kind from each seller, offers judgements on disputes and organises contributions for improvements to the marketplace such as the installation of a water-pump. If small boys are selling fish he advises them what price to accept. His tolls are not onerous: 2kg fish on a turnover of 200-1,500kg per day. The market is competitive, with vigorous haggling. 20-30 fishermen sell unsorted fish to 20-30 paikers and the bargaining sometimes resembles a set of simultaneous open-cry auctions. Paikers often wedge the offered money into the fishermen's clothing and fishermen ask for a higher price by pushing it back. The resulting shoving match is the continuation of haggling by other means. The eventual sale is direct; there is no wholesaler or commission agent.

Arot

Brush-pile (dol kata) and pump groups produce fish, both large and small, in bulk. They sell their fish through an arot market. Hail Haor is served by arots at the Gopla River's inflow, Srimangal and Moulvi Bazar. Between them they contain 30-40 arotdars. The feature that distinguishes a fish arot from a fish market like Buruna's is the extra liquidity injected by the arotdars (arot-agents), who auction off the fish and finance fishermen and paikers in return for a percentage of the sale value. The advantage of an arot as a point of sale for brush-pile and pump groups is that it provides credit for their capital-intensive gears and a large number of liquid buyers for their bulk catch. Some fishermen using smaller gears also sell their catch in an arot because it is nearer or offers higher prices.

The arot where the Gopla River enters Hail Haor illustrates their general function. Fishermen bring baskets of sorted fish to one of the 3 arotdars. His assistant auctions them, basket by basket, to the 30-50 assembled paikers. The paiker pays the auctioneer. The auctioneer retains a percentage of the price and pays the rest to the fishermen. If the seller has borrowed from the arotdar the auction fee is 6% of the sale in cash plus about 4% in kind. If the seller has not borrowed from the arotdar the auction fee is 4%.

Arotdars have two strategies for increasing their turnover. One is dalal, where the seller borrows money from the arotdar in return for a promise to use his auctioneer and pay the higher auction fee. There is competition between arotdars for dalal clients. Fishing entrepreneurs approach several arotdars before committing themselves. Arotdars try to poach other arotdars' sellers. They do this by offering larger loans, not by offering to reduce their percentage. It cannot be concluded, however, that the price of credit is fixed uncompetitively. If the arotdar offers to fund a larger portion of the same project in return for the same percentage of the same output, he is effectively offering an interest rate cut. The arotdars' second strategy for increasing their turnover is to offer buying paikers 24 hours' free credit.

Secondary marketing

Most fish therefore pass into the ownership of a paiker, whether by direct sale or by arot. The paiker's income can be attributed to two functions:

a) He contributes physical labour, carrying two baskets of fish with a combined weight of 10-20kg over 3-15km per day.

b) As the fish's owner, he is taking the risk of speculating on its price. On any one day there is a 5-10% probability of making a loss.

Paikers receive on average a profit of Tk67/paiker household/day from fish-trading (49 observations, s.d.= Tk46), which places them on a par with middle-income fishing households. Many fishermen slip in and out of fish-trading according to the two professions' relative profitability. Somdu Miya of Buruna, for example, gave up fish-trading for fishing and agriculture in November 1992 and then gave up fishing for fish-trading in May 1993. The Maimals of Bilashirpar and Udnarpar converted *en masse* into paikers after their exclusion from Hail Haor 20-25 years ago and now trade as far afield as Chadpur, Habiganj and Sylhet. Indeed, farming communities consider paikers to be a form of fisherman. In the words of one Bilashirpar resident, "They call us fishermen because we buy and sell fish."

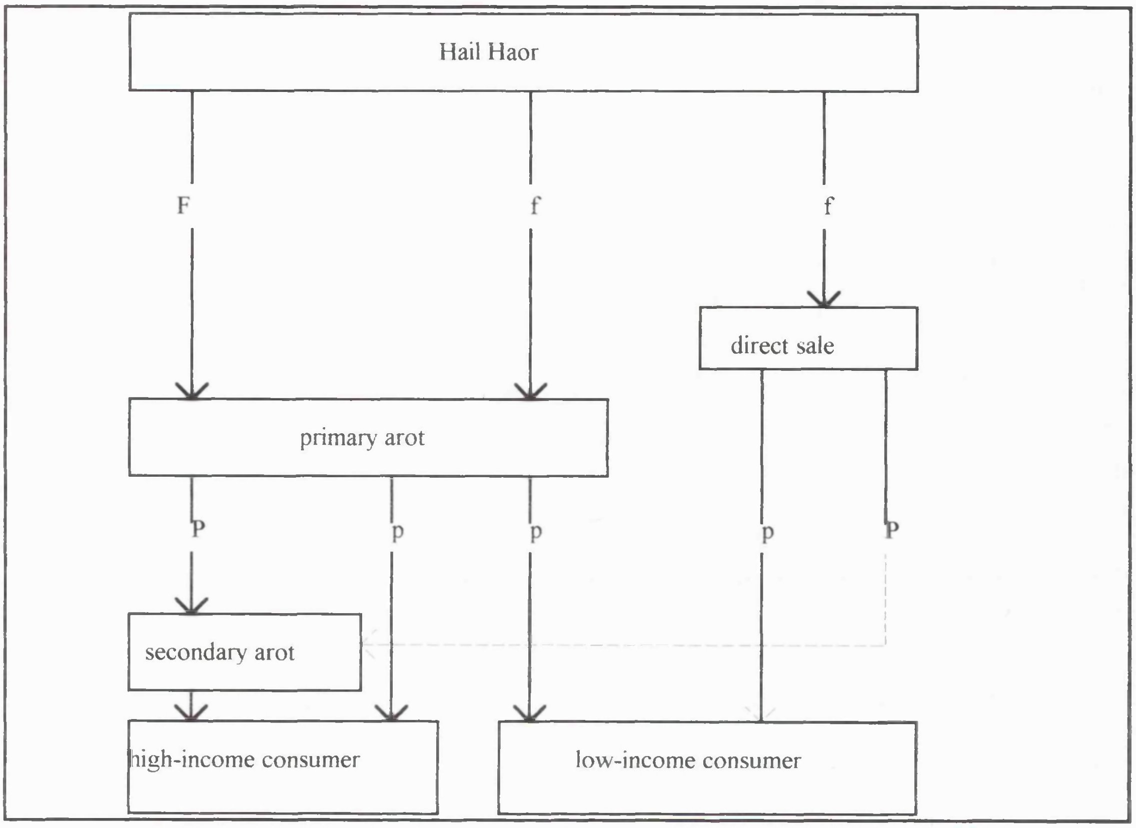
Having obtained his fish, the paiker has one of two possible destinations, a retail market or a secondary arot.

Many villages have a retail markets (bazar) every evening. Some have a larger market (hat) once or twice weekly. Every bazar or hat has a fish section where at least 5 fishermen or retailing paikers (nikari) sell their wares. Because of the high population density, retail markets are rarely further than 3km from each other. Fishermen and nikari often change their market to another in search of higher prices.

A secondary arot resembles a primary arot except that the sellers/dalal-clients are not fishermen but paikers. During the flood season, when the catch of large fish in the Meghna basin falls and the catch of ilish (*Hilsa hilsa*) downstream is high, the flow of fish is reversed. Srimangal and Moulvi Bazar's fish arots become secondary arots for the influx of ilish.

The fish-market at Sherpur is a good example of a secondary arot. Selling paikers bring fish from Azmiriganj district by launch or country boat. As soon as the fish arrives it is taken to one of 8 arotdars. The arotdar auctions it to one of around 50 buying paikers. The auctioneer takes a percentage of the sale for the auction, a further percentage for dalal if applicable, Tk1 for the marketplace and Tk1 for the mosque. He hands the remainder to the selling paiker along with a purchase note showing the sale price, deductions and net price. The buying paiker carries the fish to the Dhaka-Sylhet road for a bus to the next point of sale.

Figure 7.1. The marketing of Hail Haor's fish



Key: f fisherman
F fisherman with dalal
p paiker
P paiker with dalal

Figure 7.1 summarises the channels through which Hail Haor's fish are marketed. Generally speaking, the larger the fish, the more distant the consumer and the greater the number of links in the marketing chain.

Fish prices

Hail Haor's fish are rarely priced by species and weight. (The pump-fishing catch of smaller air-breathing species such as koi, magur, taki and shing is the only exception to this rule. To save time, they are occasionally sold by weight at the arot.) The usual procedure is for a mixed basket to be sold on sight. Rather than calculating price per kg by species, therefore, it was more logical and easier to calculate the price that matters to the fisherman, which is price per kg by gear.

Fish prices were estimated from the following regression equation:

$$y_{it} = p_1 w_{it} + \ldots + p_n w_{it} + U_{it}$$

where: y_{it} is the income in Tk from fishing of household i on day t.

w_{nit} is the weight in kg of fish caught from gear n by household i on day t.

p_n is the price of fish caught by gear n in Tk/kg.

U_{it} is a random term s.t. $E(U_{it})=0$, $cov(U_{it}, W_{it})=0$ for all i,t.

The equation was estimated once for each 3-month season between December 1992 and November 1993. The results are shown in Table 7.1.

Table 7.1. Prices received by Hail Haor's fishermen 1992-3.
(Price estimate and standard error of estimate in Tk/kg)

Period	Dec-Feb		Mar-May		Jun-Aug		Sep-Nov	
Gear	p_n	s.e.	p_n	s.e.	p_n	s.e.	p_n	s.e.
fai	34	4.4	35	2.9	28	1.8	31	1.6
felun	29	10.9	21	2.2	20	2.4	21	4.0
lift	-	-	-	-	-	-	44a	-
tana	19	7.6	35	9.7	13	2.1	10	2.0
taki	-	-	-	-	-	-	28	14.0
hook	37	13.9	44	3.3	33	2.4	28	2.4
big hook	39	15.0	-	-	40	4.7	34	2.7
spear	- b	-	61	16.0	-	-	-	-
dori	27a	-	26	2.2	9	2.6	23	2.4
faron	48	11.7	-	-	- b	-	33	6.0
bosni	- b	29.3	24	7.1	39	18.0	- b	-
dol	44	3.3	83	9.1	-	-	-	-
jhaki	- b	-	24	8.6	- b	-	-	-
kanja	21	4.7	50	4.5	15	2.0	- b	-
pump	>59c	-	-	-	-	-	-	-

Notes: a) High variance because of multiple gear use. Estimate obtained from single-gear observations only.

b) S.e.>$0.5(p_n)$. Estimate too unreliable for presentation.

c) By direct interview.

\- not available.

Table 7.1 shows that the price of fish varies significantly according to the gear used. The highest price per kg is for the brush-piles that aggregate major carps during the dry season, for pump-fishing and for fish-spears, a relatively rare gear that can catch large carps and snakeheads. Middling prices are awarded to gill-nets, farons and hooks. The lowest prices go to the small fish gears, the dori and tana jal. The rise in the price of large fish during the monsoon is well-known (Coulter and Disney 1987). Table 7.1 shows a corresponding collapse in the price of small fish.

Competitive or monopsonistic?

To return to the policy issue, how much of the fish-trading margin can be attributed to monopsonistic super-normal profits? For Hail Haor at least, the answer is, "Very little." Whether at the mas bazar, the arot or the retail market, fishermen and paikers are selling into a competitive market with many buyers and many sellers.

One possible source of confusion about the level of competition in fish-marketing has been the institution of dalal. There is a common belief that the dalal borrower is obliged to sell fish to the lender. In fact this is not true; the borrower sells fish through the lender's auctioneer into an open, competitive auction. Even the lender's rate of return is negotiable and competitive, with the competition being expressed in terms of the principal amount rather than the interest rate.

Finance

Hail Haor's fishermen have four principal sources of credit:

a) Simple interest loans (shudhi)
b) Formal sector credit (loan)
c) Dalal
d) Mortgaged (bondo) land

Their demand for all types of credit follows a seasonal cycle. Drawdowns peak in September and October as they re-equip after the lean monsoon period. This is the time when they commission new boats or travel to Boirob to buy new nets. Repayments peak three months later, between December and February, when CPUE is at a maximum. The quantitative data (n=58) upon credit use by Hail Haor's fishermen refers to November 1993, when amounts outstanding were near their annual peak.

83% of fishing households had some form of credit outstanding at this time. For those with debts, the median value of the principal amounts was Tk3,000 per household. 38% of borrowing households had loans with a combined principal of less than Tk2,000 per household.

Shudhi

78% of households, or as many as 94% of borrowing households, had shudhi outstanding. In 2/3 of cases, shudhi were taken from moneylenders (mohojon) or shopkeepers (dokandar) in the borrower's own village. They are also taken, however, from relatives, households in the same bari or more distant mohojons. Some Buruna fishermen obtain shudhi from Srimangal. Some Monargaon fishermen obtain them from Moulvi Bazar or their Hindu co-religionists in the tea-gardens. One fishing group, requiring a loan of Tk23,000 for a sub-lease, put it together with shudhi from half-a-dozen mohojons from different villages. 23 fishing households in Vimshi, most of whom genuinely worked on the water, had combined into a lending association (somity) with capital of around Tk30,000. They operated commercially, lending to non-members only at the going shudhi interest rate. They say, in so many words, that they associated to in order to benefit from economies of scale.

The cost of shudhi loans is expressed as Tk per Tk1,000 principal per month. Interest accruals depend upon the principal amount, not upon the balance outstanding. The mean interest rate was 12.2% per month, equivalent to 146% p.a.. Although this is much higher than the rate for formal sector credit, it is not far out of line with alternative speculative uses of capital. For example, the price of stocked potatoes in Srimangal rose by 13% p.m. between March and December 1993, while the price of stocked onions rose by 11% p.m. between September and December 1993. Borrowers in different villages faced significantly different interest rates: the average rate was 11% p.m. in Buruna and Hazipur and 18% in Mirzapur. Inter-village interest rate differences were different at a 95% level of confidence (One-way ANOVA and Kruskal-Wallis).

Formal credit

20% of households had formal credit outstanding, with 75% of such loans coming from the NGO Caritas or the Grameen Bank and the remaining 25% from nationalised banks. The Caritas loans were given to women for poultry production. The Grameen bank loan was for house improvements. The nationalised bank loans, around Tk2,000 per household, were obtained through the agency of the Union Chairman. The interest rate of formal sector loans, at 1-1.5% p.m., is effectively insignificant.

Dalal

The institution of dalal has already been described. It is not easy to estimate the arotdar's rate of return upon dalal advances because both he and the borrower will tend to understate their turnover. Table 7.2, however, illustrates the dalal account of one particularly reliable dol-fishing respondent from Mirzapur. On the assumption that the arotdar's cut is 10% of the catch, 6% as cash and 4% in kind, it is estimated that the arotdar's rate of return was around 16% per month. Although this is similar to the shudhi rate, fishermen unanimously believe dalal to be a more favourable contract than shudhi because the lender bears some of the risk of failure. It is in the arotdar's interest, however, to restrict dalal to a few promising prospects, the brush-pile groups, pump-fishermen and sub-lessees. This is because he needs to be sure that the borrower is productive and can be observed by his network of informants. The fishermen's preference for dalal is in clear contrast to the opprobrium with which it is viewed by policy-makers.

Table 7.2. The dalal account of Joinal Abedin's brush-pile group, 1992-3.

	Dalal advance	Group revenue	Arotdar revenue	Arotdar cashflow
October	(15,000)			(15,000)
November	0	0	0	0
December	0	0	0	0
January	0	74,900	6,809	6,809
February	0	182,147	16,559	16,559
March	0	34,258	3,114	3,114
			IRR p.m.:	16.0%

Mortgaged land

Jensen (1987) has described land mortgages as the principal medium of economic polarisation in rural Bangladesh. In his sample, around 30% of households owned land that was mortgaged (bondo) to another household. A key feature of these contracts is that the mortgagee obtains full usufruct rights over the land until the principal amount has been repaid. The mortgagor is therefore generally less solvent after the mortgage than before and usually takes recourse to further mortgages and, eventually, to selling the land.

57% of Hail Haor's fishing households owned some agricultural land and 24%, or about half the landowning households, had mortgaged at least some of it. Overall, 12% of the acreage of fishermen's land was mortgaged. The mortgagors mostly pledged land to other households in the same para, sometimes to their own brothers. The Nomosudra fishermen of Monargaon, however, had made almost all their pledges to the Chairman's bari in the neighbouring Muslim para. The mortgagors had received on average Tk 7,929/acre in credit for the usufruct of their land but the mortgage prices were spread evenly between Tk3,000/acre and Tk13,000/acre. This spread probably reflected variation in the age of the debt and the social relations between borrower and lender.

Credit and patronage

Some writers (Jansen 1987, McGregor 1988, 1989a, 1992) have argued that credit in rural Bangladesh is not marketed to the end-user competitively because a client can only hope for resources, including loans, from his own political patron. If the same situation prevails in fishing communities as in the predominantly agricultural villages studied by previous authors then there are important implications for fishing rights reform. As a later chapter will demonstrate analytically, with fishermen dependent upon the same patron for water-rights and capital, a resource-access reform such as the NFMP will alter the economics of the fisherman-capitalist relationship without severing it and the reform will not produce the intended results.

There are some key differences between fishermen and peasants that make monopolistic credit relationships *a priori* less likely in fishing communities:

a) Fishermen are socially distinct from "Bengalis". When they go to the Bengali mohojon or dokandar for credit they are more likely than peasants to be moving outside their own network of political ties.

b) Although there are of course seasonal peaks and troughs, fishing can produce incomes all the year round. *Ceteris paribus*, fishermen's demand for credit is likely to be lower than that of farmers or agricultural labourers, where income comes in brief spurts.

c) Because fishing skills are <u>relatively</u> scarcer than other labouring skills, an experienced fisherman without capital is in a less parlous position than a "Bengali" without capital and his demand for credit is therefore likely to be lower.

d) One inducement for mohojons to lend money to peasants is the hope of acquiring their land. Also, the land serves as security. Fishermen own less land than peasants and economic rents in fishing derive from their skills and access to water, neither of which can be pledged. Even fishing gear does not constitute a reliable pledge because it is somewhat perishable.

In the absence of firm knowledge of the relationships between lessees and moneylenders, it is unclear whether lessees supply credit to fishermen monopolistically or not. It would probably take a prolonged period of participatory observation to resolve the issue.

Access to gear

Fishermen's means of access to gear can be divided into four categories:

a) User-ownership

b) Gear shares

c) Rental

d) As hired labour

e) Borrowing

These types of access will be described in turn below.

User-ownership

User-ownership is by far the most common mode of access to gear. At any one time, more than 90% of fishermen are working with their own gear. Gill-nets, traps and hooks are almost invariably owned by their users. This contrasts strongly with the agricultural sector, where share-cropping, land-renting and hired labour predominate and "owner-occupied" plots are in a minority. There are several possible causes:

a) Hooks, gill-nets and traps are fragile. The hiring of fragile goods creates a problem of moral hazard.

b) The gear is perishable. With the exception of boats and seine nets, for which a market <u>does</u> exist, artisanal fishing gear usually rots away into uselessness within 6 months. Fish hooks have to be replaced within two weeks. Perishable goods cannot be hired and returned after use.

c) Fishermen have access to simple interest loans.

The predominance of personal ownership contrasts with the view of some fishery policy-makers, who assert in informal conversation that professional fishermen are exploited by gear-owners. It is possible that this view of the fishery, like many others, has arisen because policy-makers have concentrated their attention upon the capital-intensive, deeper-water, major carp fishery. Self-employment is indeed rarer there because the water-rights and gear are more expensive.

Gear shares

The fishermen in a group normally contribute equally to the gear stock and receive equal shares of the revenue. Sometimes, however, a group trades access to gear for a share of the catch, the "net's share" (jalir bag).

The net-share arrangement occurs most commonly between a group of 4-7 fishermen and a tana jal owner, who invariably does not work on the water himself. The net-owner receives the same share as one fisherman. Net-maintenance is the group's responsibility but the owner sometimes pays for the pitch (rong, alcatra) which is used to preserve the fibres. With a 5-man tana jal costing around Tk20,000 and a labour share running at around Tk60/day, the owner would have a rate of return of around 9% for each month that the net was in use. This is in line with the cost of shudhi and other speculative uses of capital.

Lift-nets occasionally offer a net-share. We found one lift-net group of two fishermen, where the net-less fisherman had agreed to work longer hours than his net-owning partner in return for 50% of the catch.

Another category of gear share contracts is as a means whereby brush-pile or pump-groups bring in labour to fish out their enclosures. When a seine net is used, the seine-netters receive as a group between 5% and 10% of the catch, which they must then divide between themselves and any net-owner. When a cast-net is used in brush-piles, the cast-netter gives all fish longer than around 2" to the brush-pile group and keeps the smaller fish himself. This practice is known as tepi or tepwal.

Gear shares are <u>not</u> used for fish-traps, hooks and gill-nets, the gears that most fishermen use most of the time. Even tana jals were labour-owned in 56% of cases (March-October 1993, n=36).

Rental

The most commonly rented item is the fishing boat. The ordinary 4-yard boat rents for Tk300/month, giving the owner a rate of return of around 10% per month which is, once again, in line with the informal money-market rate. Fishing households do not obtain most of their boat-use from rental. On the actual day that they were fishing, 22% of households were using rented boats and 78% were using their own boat, a borrowed boat or no boat at all (January-February 1993, n=144).

Brush-pile and pump groups require larger boats between November and January for carrying bamboo, brushwood or mud or for shoving away surface vegetation. These are hired at Tk600 per month.

As hired labour

Sometimes when fishing labour is hired the hirer provides equipment to the labourer. This is the normal arrangement for the construction of pump and brush-piles. It is rare for other gears, but we found one fish-trader in Buruna who hired two labourers, inserted them into trap-fishing groups, provided them with gear and took their share of the groups' net revenues.

Borrowing

One household sometimes borrows equipment free of charge from another household, often a brother or a member of the same bari. Equipment is usually only lent free of charge for a few days while the lender's household labour is otherwise occupied. Only the lowest-value gears such as felun jals and polos are lent and even these are more commonly rented for Tk5/day.

Theft

The theft of gear from the water by other fishermen is a great worry to the fishermen of Hail Haor. Around 5% of households in the Catch-Effort sample had some or all of their gear stolen between December 1992 and November 1993, a mishap which could led to the abandonment of fishing for several weeks. Many fishermen have to remain on the water even when not catching fish, just to guard their gear. This is, of course, an economically unproductive use of labour.

There is a pattern to the theft. We never heard of any cases of fishermen stealing gear from their fellow-villagers. In most cases the victims were fishermen, usually Hindus, who were fishing outside their village's territory. The blame was invariably attached to the fishermen of Buruna. The fear of gear theft is therefore an important element in fishermen's choice of water-body. The more co-religionists or members of the same para are fishing there, the more secure they will feel their gear to be.

The pattern of fishing gear ownership

Table 7.3 shows the distribution of fishing gears among Preliminary Survey fishing households. It should be noted that this is a "snapshot" of gear ownership in November, and that households adjust their portfolio of gear across the year in line with changing access conditions and catchability co-efficients. In particular, many households purchased fish-traps in early December, after the census. Nonetheless, the distribution of gear ownership provides some valuable insights.

The sample only revealed seine net ownership in one village, Buruna, the wealthiest of the six. Even within that village, only 10% of households reported seine net ownership and part-ownership constituted the most common form of ownership. This indicates that the vast majority of fishermen do not own gear adapted to the fishing of deep water and brush-piles, where large fish tend to reside, which suggests that when the Government and its foreign donors attempt to promote the capture of large fish through a combination of re-stocking with major carps and effort controls, little benefit is likely to reach the majority of fishing households.

Gill nets, push nets and hooks constitute the most widely-dispersed fishing gears. The census interviews did not ask fishermen to describe the mesh size and construction of their gill nets because narrow mesh sizes and the monofilament current jal are illegal. They were instead observed directly from a boat; it was estimated that at least 90% of gill nets were of monofilament thread and at least 90% of gill nets had a mesh size of 1/2". It may be concluded that the majority of gill nets on Hail Haor are illegal and adapted to catching small fish. Push nets may also only catch small fish. The majority of fish caught by hooks, however, are snakeheads or small catfish (shol, shing, magur, taki, gojar, tengra) ranging from 3cm to 25cm.

Table 7.3 confirms that fish-trap ownership is concentrated among Hindu households. In fact, 26 out of 55 Hindu fishing households owned fish-traps as opposed to 1 out of 77 Muslim households. Both Hindu and Muslim fishermen say this is because Hindus are more skilled in the production and use of fish-traps. It is not clear, however, why this should be so, since Maimals have also been fishing for many generations. The most widely-distributed trap was the dori, which can only catch small fish (<5cm) and shrimps. The lunga and koin, which are specifically adapted to catching large fish, were very rare.

At around 40% of all fishing households, a significant minority did not own a boat. There are four ways to overcome this lack. The most common is to hire a boat at a daily rate of Tk10. Otherwise, they are restricted to fishing with a push net from the bank, working as hired labour or working as the less-welcome members of a fishing group. Similarly, 31% of fishing households owned no fishing gear except a push net - not even hooks.

In conclusion, therefore, an "ordinary" Haor fishing household is chasing small fish with low-cost gear adapted to shallow water. About a third of fishing households own only push nets or no gear at all. A very small minority exists with the means to catch large fish in deep water.

Table 7.3. Percentage of fishing households owning each type of fishing gear, November 1992.

	Percentage of households owning:						
	Nets						
Village	Seine	Gill	Push	Lift	Cast	Hook	Boat
Buruna	10	38	52	7	7	38	66
Hazipur	0	67	44	0	0	67	56
Monargaon	0	53	53	5	16	84	74
Alisherkul	0	11	44	0	0	22	44
Vimshi	0	33	33	0	0	67	60
Mirzapur	0	31	75	6	38	56	63

	Traps				
	Dori	Bosni	Faron	Lunga	Koin
Buruna	3	0	3	0	0
Hazipur	0	0	11	0	0
Monargaon	89	47	74	16	26
Alisherkul	56	44	33	0	0
Vimshi	27	7	33	0	0
Mirzapur	0	0	0	0	0

Fishery management (access and effort control)

Official enforcement

Under normal circumstances, enforcement of the *Protection and Conservation of Fish Act* (1950) in Hail Haor is best described as lax. Between November 1992 and August 1993 there was no attempt to enforce the bans on monofilament nets, dewatering, mesh below 4.5 cm, the capture of undersized carps and boal catfish or the capture of snakeheads between April and June. Srimangal's Thana Fisheries Officer knew that these illegal practices were going unchecked but claimed not to be able to control them without additional staff. Fishermen are well aware of the restrictions on current jals and under-sized carps but, for most of the time, pay no attention to them.

However, the stocking of Hail Haor with carp fingerlings in the monsoons of 1992 and 1993 prompted sudden and occasionally violent enforcement campaigns in September and October of both years. In November 1992, when this study was drawing its sample of fishing households, two fishermen reported that they had been beaten by the TFO's assistant for using monofilament gill-nets. One displayed the fresh scars on his back and both reported having to pay a Tk100 bribe/fine to retain their nets. Hail Haor was stocked again in the three weeks to September 10th 1993. This time the accompanying enforcement campaign covered legal push nets and seine nets as well as monofilament gill-nets. The TNO reported that he had lodged 39 court cases and confiscated 130 gears, of which over 100 were monofilament gill-nets, by September 18th 1993. His enforcement patrols appeared to have concentrated upon the accessible southern part of Hail Haor and to have disproportionately affected the fishermen of Srimangal Busti and West Baraura.

The Department of Fishery's (DOF) 1993 enforcement campaign reduced the use of illegal monofilament gill-nets and legal tana jals by fishermen from the south and west of the Haor. As the study's effort statistics will show, however, the fishermen of Buruna and Hazipur continued to use gill-nets with impunity. One may hypothesise that their lessees' strong influence at Thana level ensured their immunity.

The 1993 campaign quickly aroused opposition. In late August a day of protest was organised by the Chairmen of the 3 Unions around Hail Haor (Kalapur, Bonabir and Mirzapur). Fishermen were collected from their villages in buses and trucks and taken to the Thana offices in Srimangal. For Buruna the cost of vehicle hire was defrayed by tolls collected from fishermen. The Moulvi Bazar TFO estimated that 3,000 - 4,000 fishermen attended the protest meeting. This figure seems improbably high but confirms that fishermen did arrive in impressive numbers. Although interviews with fishermen in September 1993 revealed great hostility to gear controls, not all those who attended the meeting knew why they were there. It was thus possible for at least one government official to dismiss the protest as "Awami League (opposition party) activism".

The TFOs were motivated to enforce gear restrictions in 1993 by two sets of incentives, official and unofficial. Officially, their normally dormant responsibilities as DOF employees were awakened by the demands of the Second Aquaculture Development Project (ADPII); the project had paid field allowances and led to the designation of Srimangal's TFO as "Fisheries Officer of the Year." Unofficially, to quote Moulvi Bazar's TFO, "The élites are learning that banning current jal is in their interests." In other words, the lessees and arotdars upon whom the TFO depends for his unofficial income supported gear control because it raised the profitability of leases, pump-fishing and brush-piles. Leterme and Chisholm (1993) noted that the stocking of floodplains in west Bangladesh was accompanied by similar gear control campaigns, even though gear controls were not requested by the stocking project (Keith Fisher, *pers. comm.*).

Another possible cause of the TFO's zeal in confiscating gear was the profit to be made from re-selling it. Srimangal's Executive Officer (TNO) lodged a case against the TFO after the 1993 control campaign on the grounds that the TFO was not legally entitled to confiscate and retain gear. The TNO had the Zila authorities order the TFO to hand in the confiscated gill-nets and now accuses the TFO of altering official documents in order to retain some of them.

One is left with the strong, but not altogether surprising, impression, that the pattern of effort control is determined, not by the wording of the *Protection and Conservation of Fish Act*, but by the balance of political pressures acting upon the TFO. The majority of fishermen are opposed to gear controls and thus the Act is ignored for most of the time. Artificial stocking, however, stimulates in lessees and arotdars a greater interest in stock protection. A gear-control campaign ensues, causing resentment among most fishermen but ultimately raising the profitability of the capital-intensive carp fishery. Why, after all, is the legal tana jal confiscated and illegal de-watering tolerated? It is because the tana jal is labour-intensive and unprofitable whilst de-watering, to quote again the TFO, "Is supported by the Land Ministry and influential persons."

Types of tenure

Hail Haor's area is governed by 3 forms of legal tenure. The dry-season fishing grounds are government property. The outlying floodplain is privately-owned. There is also a small amount of government-owned (khas) agricultural land which is leased out to private farmers. Khas land is not important in Hail Haor and will not be not discussed further.

Fishing over agricultural land

During the high-water season from June to September fishermen avoid the deep water and work the flooded land close to their villages, where low-cost gears are most effective and the danger from storms is smallest. Flooded, privately-owned agricultural land in Hail Haor is in principle an open-access fishery. Landowners only rarely try to restrict access to the water over their land. Several reasons are given for this: the land-holdings are fragmented, fishing is not profitable enough to give tolls, the fishermen are the farmers' friends and relatives and the law prescribes open access over flooded private land.

It is clear, however, that local patrons will create and enforce private property rights over flooded agricultural land if the rents available justify the transactions costs of enforcing control. One example of this is Mahania Beel, a shallow depression of around 2 ha between Buruna and Monargaon villages. Receiving the fish run-off from the surrounding rice fields, Mahania Beel supports gill nets, traps and a small brush-pile in November and December. It provides employment for around 10 fishermen during these two months. Until 20 years ago, Mahania Beel's "owner" (malik) lived in Buruna. It is not clear whether he charged fishing tolls. Around the time of Bangladesh's independence, however, the Union Chairman, a resident of Monargaon's Muslim para, took over the beel, securing his title with a certain amount of physical violence. He now rents the beel back to fishermen from Buruna. The letter of the law, which prescribes free fishing access to flooded paddy land, would not support the Chairman's control over Mahania Beel. Neither does he own much of the paddy-land beneath it. He has simply used force and political influence to create a title[1].

A second example is Garulia Beel, another water-filled paddy land depression. In this case the land consists of many plots that are owned by one landlord. Fishermen explain that he is the beel's "malik" because he owns the land beneath it. The gradual concentration of land holdings is increasingly likely to enable landlords to take control over beels in this way.

Fishermen report that more and more floodlands are being privatised with the passage of time. The fishermen of Rustumpur have an explanation: an increase in the fishing population has increased the amount of competition for fishing spots. The increase in competition has reduced the income that fishermen are prepared to receive and the fall in their income has increased the profitability of privatisation.

Bromley (1989) hypothesised that the degree of private ownership over land is determined by its use. He argues that a community will privatise the most profitable land in order to realise its potential for intensive cultivation. His optimistic theory implies that communities move towards the most efficient land tenure system. The process of fishery privatisation in Hail Haor, however, is rather different from that proposed by Bromley. The tenure system is not designed in the interests of a "community"; there is just one set of people imposing its will upon another. Neither is there any efficiency motive; the floodplain is no more productive than it would be under open access.

Fishermen of one village attempt to prevent other fishermen from fishing over certain areas of flooded agricultural land (Figure 7.2).

Example 1: The Muslim Maimal fishermen of Buruna and Hazipur use the threat of force to prevent the Hindu fishermen of Monargaon from fishing close to the three villages. This territorial pattern was identified by direct

---

[1] Many economic resources in Bangladesh have been unilaterally privatised. Dhaka, for example, has hundreds of unofficial taxi-ranks where rickshaws and baby-taxis pay tolls for using the public pavement .

observation and confirmed by conversation with two Buruna fishermen in September 1993.

Example 2: During the "open-access" season, fishermen from the villages on the haor's southern shore are afraid to fish north of the embankment. As one Baraura fisherman explained, "The Buruna people would send us back."

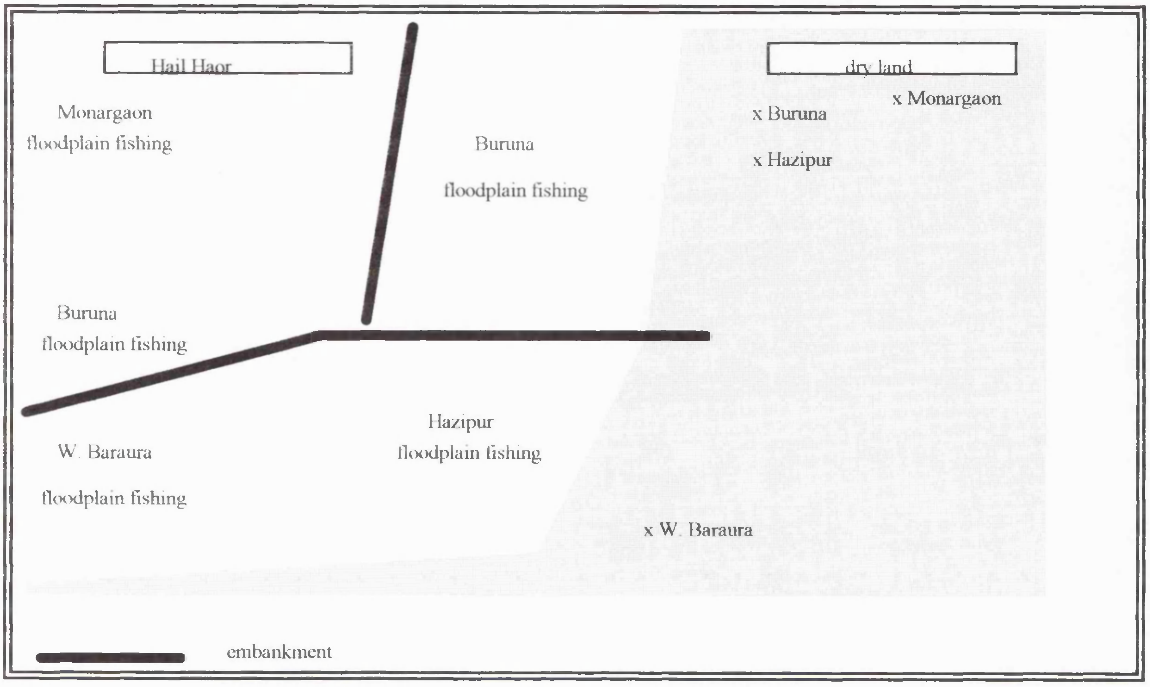
This is one instance of the economic importance of belonging to a "strong" fishing community.

In brief, it is time to rethink the popular, romantic view that the floodplain is one of the few resources open to the poorest of the poor. The most productive parts of the floodplain are gradually being privatised and professional fishing communities have established territorial rights over the floodplain's toll-free remainder.

One normally thinks of tenure as an exogenous variable, determined by law <u>before</u> people start making economic decisions. In the case of the Bangladesh floodplain, however, the degree of private ownership is <u>dependent</u> upon the economics of the fishery; profitability brings about privatisation. The notion of endogenous privatisation has important implications for fisheries management. A strategy of fishery intensification, as followed by the stock-enhancement programmes of the TFP and the ADPII, is likely to increase the degree of private ownership when it raises the profitability of the fishery. This in turn may negate the strategy's benefits to fishing labour. The process of endogenous privatisation will be modelled analytically in a subsequent chapter.

Secondly, the territoriality that fishermen exercise over the floodplain has important policy implications. The popular view that the floodplain is "open to anyone with a net" (Majumder and Durante 1993, p.2) and that fishermen "are the most deprived and poorest class" (Chowdhury 1993, p.8) has long coloured people's thinking about fisherfolk and has provided ammunition against the Flood Action Plan. This way of thinking has been reinforced by the fact that most fisheries research in the west has been upon marine fisheries where access is comparatively open. The unromantic truth is, however, that fishermen, like everybody else in this crowded country, wish to protect their livelihood from others. As the joke says, "Soon the air will have a lessee."

Figure 7.2. A sketch map of the division of "open-access" fishing above paddy land between the villages of Buruna, Hazipur and Monargaon.



Jalmohols

The dry-season (October to May) fishing grounds, however, are vastly more important in terms of the yields and employment that they provide. They are divided into more than 60 water-estates (jalmohols) which are leased out, usually for a period of 3 years. Those over 20 acres are leased by the district (Zila), those under 20 acres by the sub-district (Thana). Jalmohol leases are allocated in May and the government requires payment from the lessee by August. They constitute an important source of local government income. To cite one example, jalmohols under 20 acres provide Tk650,000 p.a. (US$16,250) to nearby Nabiganj Thana, around 50% of locally-collected revenue.

Under British rule and until 1962 control over fishing waters, either through ownership or leaseholding, was largely exercised by Hindus. Nomosudra fishermen remember this as a time when they could fish in the deepest, most productive parts of Hail Haor and the Muslim Maimals were restricted to catching small fish in the shallows. Since the 1962 Land Reform, however, this position has been reversed. Hindus and Muslims alike recognise that a minority of fishermen from the Maimal villages of Buruna, Hazipur and, to a lesser extent, Mirzapur and Shulpur, have best access to the high-yield fishing zones, where they use expensive seine nets (ber jal, thana jal, taki jal, mokha jal, boro jal, urun jal). The others now describe themselves as fishing for small fish in shallow water.

Older fishermen say that the leasing system served them better 20 to 25 years ago. They say that civil servants were less corrupt, that leaseholders employed fewer water-bailiffs and that they permitted fishing for sale with push nets and gill nets without demanding tolls. Fishermen attribute the tighter enforcement of fishing controls to population growth and increased competition for leases.

Lease allocation

Hail Haor's leases were supposed to be allocated until 1991 through an open auction. The auction for each jalmohol would be initially restricted to Fishermen's Associations; if they failed to offer the reserve price the auction would be opened to individuals, so long as they were from the same Thana. In 1991, however, a new system was introduced on the grounds that open auctions created public disorder. Associations and individuals from any Thana now submit closed bids to the government and the government announces a winner. The secrecy increases the scope for bribery and allows government officers to award the lease to the strongest bribe, irrespective of whether the applicant is an individual or a Fishermen's Association, local or outsider and whether the bid is highest. The leaders of Fishermen's Associations complain that lease prices have risen and their access to fishing grounds has been reduced.

A new system of payment was introduced along with closed bids in 1991. The lessee had previously been required to pay 50% of the lease value immediately after the auction in May, followed by 50% a week later. Under the new system, tenders must be accompanied by a bank draft worth 25% of the value of the bid. The bidder must therefore incur the transactions costs of arranging a source of finance and negotiating the banking system before acquiring the lease. This has two effects: it favours literate middlemen over fishermen and, more importantly, creates an additional incentive for the lease to be awarded by a private deal between a bidder and officials.

In practice, however, leases are not awarded to the highest open or closed bids but for bribes. It is normal for lessees to make side-payments to government officials before the lease is allocated. It is also common for side-payments to be made afterwards, to initiate or prevent their re-allocation. Some illustrative examples follow:

» The Rustumpur Fishermen's Association obtained three leases in 1992 at an official price of Tk23,000 per year for three years. However, they also paid a bribe of Tk 375 to the Co-operatives Department for a certificate of audit, a bribe of Tk300 to obtain three tender forms, a bribe of Tk14,000 to the Thana leasing committee and a bribe of Tk15,000 to the Zila leasing committee.

» One Alisherkul Fishermen's Association obtained a lease over Lotwa Kancata for Tk21,000, of which Tk18,000 was in side-payments, mostly to have an appeal against the allocation quashed. They lost the appeal and Lotwa Kancata was allocated to another association from the same village. This second association had paid an official lease price of Tk4,795 per year, a Tk5,000 bribe to the tender committee, a Tk1,500 bribe to a fisheries officer, a Tk1,000 bribe to a co-operatives officer, a Tk500 bribe for a favourable audit and a Tk7,000 to the Zila office. The Thana Fisheries Officer boasted to the research team that he (illegally) kept the seals of the Co-operatives Department and had used them to support the successful association's case.

» In the late 1980s an association from Pachaon village paid Tk90,000 for a jalmohol, of which Tk30,000 was the official value. The Zila office retained the money, but awarded the lease to another bidder.

» In May 1993 the lessee of Hail Haor's most important jalmohol, No. 1 Beel, had his lease term extended from 3 to 8 years, in line with the new regulations, by persuading local officials to classify his jalmohol as a fisheries development project. He boasted that he would not implement the "development plan" that he had submitted. The Thana Fisheries Officer for Moulvi Bazar described such development plans as, "Good on paper but impossible to enforce."

The definition of jalmohols has caused disagreement between the Thana Revenue Office and the Fisheries Officer. The Fisheries Officer argues that corrupt officials in the Revenue Office are defining fishing grounds as pasture land in order to circumvent the requirement that Fishermen's Associations should have priority in the allocation of fishery leases. The revenue per hectare demanded by central government for pasture and arable land is moreover much lower than that required for fisheries, thus increasing the resource rents to be retained at Thana and Zila level as profits for the lessee and bribes for the revenue officials.

It is clear that collusion between officials and bidders is a constraint upon jalmohol revenue. The Land Ministry had issued a guideline that lease prices should rise by 25% per year but it is not always observed. Indeed, is hard to see how lease revenues could rise exponentially indefinitely. Thana officials do not feel that they are under pressure from the Zila to increase jalmohol revenues. They attribute this to the fact that Zila officials are also accepting low tenders when leasing out jalmohols of over 20 acres.

Notwithstanding the level of corruption, for those jalmohols over 20 acres that came up for auction in 1992 the official lease value has increased substantially (Table 7.4). This is attributed to a combination of inflation (the lease prices are reset every three years), restocking, increased demands from central government and the increased acceptability of bids from individuals and outsiders. Jalmohols under 20 acres appear simply to have been revalued by 25%.

Table 7.4. Leases granted for 1992-4 (Tk/year)

Name	Previous lease	Current lease
over 20 acres		
62 Beel	65,000	135,000
Gopla Nodi 3	52,000	96,000
Jirwar Doba	19,000	57,000
Balla Beel	5,200	16,500
42 Dolnetch	49,000	65,000
Dumar Beel	3,500	7,800
Beel Doba	55,000	74,700
Mobarjonoika Poishakali	6,500	15,000
under 20 acres		
Bokbokia	5,100	6,375
Charudoba	1,800	2,350
Patrodobar	375	469
Kunjaberi	675	844
Gurudara	1,725	2,156
Lotwakankata	6,900	8,625
Dolidoba	1,500	1,875

The fishing rights market after lease allocation

The lessee usually parcels out his jalmohol into smaller areas, which are rented on a yearly basis by sub-lessees. This practice is illegal. The lessee and sub-lessee may be an individual, a group (sorik) of fishermen or a Fishermen's Association (Motshojibi Somobaya Somity). The sub-lessee then charges a fee to fishermen for access to water although he may tacitly tolerate the push nets of those fishing for home consumption. Three modes of access allocation may therefore be formally distinguished as follows;

```
Type 1: Government
            V
   individual lessee
            V
 individual/group sub-lessee----------------
            V                              V
        fishing for sale          fishing for consumption


Type 2: Government
            V
     individual lessee
            V
  Fishermen's Association-------------------->members
            V                      V
       non-members            fishing for consumption


Type 3: Government
            V
   Fishermen's Association------------------->members
            V                      V
      non-members             fishing for consumption
```

It is normal for lessees and sub-lessees to sell fishing rights to people in their own communities. This is for several reasons:

a) It reduces the transactions costs of the sale and the collection of tolls.

b) The fishermen will have to band together against poaching and the theft of gear.

c) From the lessee's point of view, the political support of his fellow-villagers is more useful than that of outsiders.

Fishermen can thus say that Number 1 Beel is Buruna's territory, 62 Beel belongs to Srimangal Busti and Baraura, the north of the Gopla River is "the Muslims'" and so on.

If the lessee needs to market fishing rights outside his own fishing community, he may employ an agent to recruit fishermen from his village. The Secretary of the Baraura MSS acts as both agent and front-man for the true lessee in Srimangal. The Buruna lessee of No. 1 Beel has a full-time agent living on the water to recruit fishermen from other villages, collect tolls and exclude unauthorised fishermen. The fishermen are often scarcely aware of the real lessee and will consider the agent to be the jalmohol's "malik".

The time-distribution of payments is a key feature of the sub-leasing market. The lessee incurs the first costs, paying bribes and the lease price during the low-season between May and August. The fisherman, however, pays tolls to the lessee or sub-lessee during the high season, between October and the following March. As one fisherman explained, "The lessee's year begins in May but ours begins in October." The sub-leasing system is therefore effectively a form of seasonal credit delivery provided by the lessee and sub-lessee to the fisherman.

Challenges to lease allocation

Even when a lease or sub-lease has already been allocated, the fishermen's access is not secure unless it is backed by political and/or physical power. The challenge to fishing rights allocation can appear as an open faction fight or as surreptitious poaching. In either case, a fishing right has to be backed by might.

Sometimes a group of fishermen openly challenge the existing allocation of a lease or sub-lease. This will be illustrated by two examples, those of the Baraura Motshojibi Somobaya Somity (Fishermen's Association) and a No. 1 Beel sub-lease.

The Baraura Somity obtained the lease to 62 Beel in 1992. An influential Hindu from the village of Bonabir then challenged Baraura Somity's title to the lease on the grounds that he had held it for the previous three years and had not made a profit. The case was referred by the Assistant Deputy Commissioner to the High Court in Dhaka and is still pending at the time of writing. It is realistic to expect the lease to end before the lawsuit. Legally speaking, fishing is banned in 62 Beel until the case is resolved. In December 1992, however, 62 Beel was still being sub-let by the man from Bonabir and his sub-lessees were building brush-piles. Then, in February 1993, after a certain amount of physical violence, 62 Beel was being fished solely by fishermen from Baraura and Srimangal Busti, all paying subscriptions to the Baraura Somity.

At the end of the 1993 monsoon, a group of 10 fishermen obtained a sub-lease for part of No. 1 Beel. 5 of the group members were from Buruna, the lessee's home village, but 5 were from Mirzapur. In November 1993 some other Buruna fishermen started fishing inside the sub-lease area. The sub-lessees came in a group to Buruna's fish-market and complained that their sub-lease had been violated. A heated argument followed. Many Buruna fishermen took the side of the poachers, arguing that the Mirzapur fishermen had no right to exclude Buruna residents because No. 1 Beel was "Buruna's lease". The Mirzapur fishermen were pushed physically to the edge of the market.

By contrast with other water-bodies such as Shanir Haor (Blanchet and Talukder 1992), the problem of surreptitious poaching by non-toll-payers is relatively infrequent. The Maimals of Shulpur complained in November 1992 that "non-fishermen" from the villages around Manik Haor were setting gill-nets in a Shulpur jalmohol north of Hail Haor. The Buruna fishermen complained in November 1993 that Shulpur fishermen "had paid the fisheries officer to use fine-meshed monofilament nets in No. 1. Beel". Apart from this, however, we found no instances of surreptitious poaching.

The reason for the near-absence of poaching is that the toll-paying fishermen themselves act as the lessees' water-bailiffs. As one Buruna fishermen remarked, "The 'non-fishermen' wouldn't come here. They know how strong we are." In other words, the Buruna fishermen can organise themselves to defend their territory from poachers because they are united in their allegiance to a common lessee. This has very important implications. First, it implies that the toll-paying fishermen's immediate concern is the maintenance, not the weakening, of the leasing system. Secondly, it gives the fisherman another reason to affiliate himself with a strong lessee; the stronger the lessee, the more numerous the fisherman-bailiffs and the lower the risk of poaching.

All these examples show how it is possible to defend or re-allocate fishing rights after lease allocation, by deploying local influence, government officials and physical force. This has important policy implications. Official fisheries policy, from the World Bank (1991) downwards, recommends the re-allocation of fishing rights from lessees to fishermen as a means of producing a more equitable distribution of fishing rents. The problem is that a paper lease has to be backed by local influence to be effective. At the moment, of course, the corrupt nature of the leasing system ensures a high degree of congruence between lease allocation and local influence; those who have the power to obtain a lease will also have the power to defend it. The rhetoric of official policy, however, envisages the allocation of leases to relatively powerless people. Without external support they are unlikely to have the power to defend them.

Gear-specific fishing rights

Within each lease- or sub-lease-area separate contractual arrangements usually exist for each fishing technology. The deepest water is often allocated exclusively to a group of fishermen for the construction of brush-piles (dol, dol kata), artificial fish habitats, or for de-watering by diesel pump. The lessee or sub-lessee will authorise the owners of such rights to prevent all other fishing in the deep water until their own operation has finished. All the clients of the same lessee are expected to defend each others' patches, by force if necessary. Lessees and sub-lessees also specify the permitted gear when selling the right to fish the remainder of the tract of water. Where a tract of water can support fish-trapping with barricades (bandh), the placement lines are known by name and allocated by the lessee or sub-lessee specifically to a group of fishermen. It is customary for fishermen catching small fish for home consumption, usually by push-net, to work free of charge.

There is therefore a hierarchy of fishing rights, as follows, defined in terms of the cost of access:

dol fishing/dewatering

deep water fishing for sale

shallow water fishing for sale

push-net fishing for consumption *or* total exclusion

The activities at the top of the hierarchy are capital- intensive, inasmuch as the expense of deep-water rights, seine nets and dol-construction must be incurred before a short period of work produces a substantial catch of large fish. The activities at the bottom of the hierarchy are capital-saving but offer a low return per unit of labour.

Effort control by leaseholders

The manner in which fishing rights are marketed to the fishermen is of economic significance; it is clear that owners of fishing rights restrict the level of effort applied to the water in order to maintain rents.

The lessees approach or are approached by interested fishermen, sometimes through the lessees' agents. The price of access and the timing of the payments are determined by negotiation. It happens that two groups using the same gear in the same area at the same time are paying different tariffs.

The means by which effort is controlled depends upon the technique being used. A distinction may be made between two types of fishing technique: territorial techniques and mobile techniques. The former include dols (brush-piles), traps and dry-fishing. The latter include seine nets, gill-nets and push-nets.

For the territorial techniques, the right to fish is sold by area. The fishermen are allowed to use as much labour or gear as they wish, so long as they restrict their activities to the specified site. (It will be remembered that trap-lines are individually named.) Effort is obviously restricted by the fact that sites cannot be "double-booked." This is another point of divergence between Hail Haor and orthodox fishery economics. Existing bio-economic models warn that rents will be dissipated under open access because they will always attract higher levels of effort. Hail Haor's combination of cheap labour and fertile water, however, might make it possible for the locational constraint to put a limit on effort increases <u>before</u> rents are dissipated.

For the mobile techniques, fishing rights are sold by "man and a boat" units. The price per unit varies according to the gear used. If a group wishes to take on an extra member during the season, it must pay an additional fee *pro rata*. Fishermen report that the seller may refuse to sell additional access lest his area become less profitable. In this way the margin between total cost and the value of the catch is maintained.

However, the owners of fishing rights make no apparent attempt to maintain the growth and reproduction of the fish stock. Leaseholders and sub-leaseholders are not known to ban monofilament or narrow-mesh gill nets during the flood season, to establish reserves or to maintain a breeding stock for the following season. Because the areas of the jalmohols and sub-leases are small and the fish are mobile between them, especially during the flood-season, the benefits of stock maintenance would be largely externalised.

Fishermen's Associations and lease allocation

The official rationale for the government's awarding preferential auction rights to Fishermen's Associations, and indeed for the New Fisheries Management Policy (NFMP), was that Fishermen's Associations (Motshojibi Somity) would allocate fishing rights equitably among the households of a fishing community. In reality, however, it is difficult to distinguish between Hail Haor's Fishermen's Associations and the cartels of influential individuals that they were intended to replace. In villages where a Fishermen's Association controls a jalmohol, non-members usually outnumber members by about ten to one and within the membership actual control over its finances is exercised by an individual or a small syndicate.

The true nature of Hail Haor's Fishermen's Associations is illustrated by four examples, the Baraura Motshojibi Somobaya Somity, the Jonokolan Motshojibi Somobaya Somity, the Bonabir Motshojibi Somobaya Somity Ltd and the Rustumpur Motshojibi Somobaya Somity.

The Baraura Motshojibi Somobaya Somity has a Chairman, a Secretary, 4 Directors and 89 ordinary members out of an estimated 1,000 fishermen. Its finances are raised by a monthly subscription of Tk10 on all members and a loan of Tk30,000 from a Srimangal moneylender upon which interest accrues at a rate of Tk3,000 per month. In return for their membership fee Somity members receive access to the shallow part of all jalmohols leased by the society. The deep waters are sub-leased. The Baraura Somity is operating the final year of a Tk10,000 p.a. three-year lease over Lota Gang, a two-mile river fishery principally supporting bel jals (pivot lift nets). In April 1992 it paid Moulvi Bazar Zila (district) Tk86,000, being a 50% instalment on the annual lease value of 62 Beel, which adjoins Baraura village. The Somity intended to repay its Tk30,000 loan by sub-letting part of 62 Beel and charging entry fees to non-members, who constitute most of Baraura's fishermen. In the event, a man from Bonobir village claimed 62 Beel for his Fishermen's Association on the grounds that they had owned the lease previously and had not made enough profit at that time.

Jonokalan Motshojibi Somobaya Somity has a Secretary and 210 members out of an estimated fishing population of 1,500 in Buruna, its home village. Ordinary members buy an initial permanent share for Tk25 and pay a membership fee of Tk2/month thereafter. If collected in full, membership fees would provide an income of Tk5,040/year. However, the annual official lease payments for the Somity's three jalmohols, Juduria (120 acres), Chapra Maguria (21 acres) and Morajonka Boishakali (71 acres) amount to Tk20,350. In reality, as the Secretary freely admits, he himself pays the government the lease money and sub-lets the jalmohols to syndicates of 5 to 15 Somity members. It should be noted that fishermen wishing to operate in No.1 Beel, Hail Haor's prime jalmohol, pay fees to the Secretary of Jonokalan Motshojibi Somobaya Somity, even though the lease is held in another name.

The man from Bonabir who temporarily seized control of 62 Beel is called the Secretary of the Bonabir Motshojibi Somobaya Somity Ltd. This Somity had 108 members in 1992, up from 65 members the previous year. Each paid Tk10/month as a membership subscription, but the Secretary is unable to explain what they receive in return, since the Bonabir MSS Ltd had in theory no jalmohol leases that year. In fact, however, the Secretary had obtained *de facto* control of 62 Beel pending the High Court ruling and was charging entry fees to his "members". Although the Bonobir MSS Ltd's "members" are Hindus from the Haor's western shore, it is backed by a Muslim "non-fisherman" mohojon from Srimangal. The mohojon purchased the previous lease and finances the current lawsuit. The man from Bonobir recruits fishermen for him and satisfies the government's requirement that Fishermen's Associations should contain "bona fide fishermen." He is a front.

Some fishermen from Rustumpur village are paying the man from Bonabir for the right to fish in 62 Beel. Because of this, the man from Bonabir is sometimes described by men from other villages as "the Secretary of Rustumpur Motshojibi Somobaya Somity". It is interesting to note how the terminology of community development has been used to describe the sub-leasing relationship.

The Rustumpur Motshojibi Somobaya Somity has 56 members out of an estimated 500 fishermen in Rustumpur. In 1992 they controlled leases for 6 jalmohols totalling over 150 acres. For these they paid bribes totalling Tk45,000 followed by official lease payments of Tk15,000 per year. The Somity attempted to raise this capital through membership subscriptions but failed and resorted to a loan from a fish wholesaler (arotdar). The Somity members must in return sell their entire catch through him, and he receives a 6% commission upon the purchase price, the practice known as dalal. Not all fishing in the Somity's jalmohols is subject to dalal. Fishing between the monsoon and the beginning of December and fishing by Somity non-members are exempt. The Somity's beels contain a number of potential brush-pile sites. These are allocated to groups of 5-6 Somity members, which make a sub-leasing payment to the Somity after the brush-pile catch.

As these examples show, the absence or presence of a Fishermen's Association is not an indicator of the concentration or diffusion of access rights. Management by Fishermen's Association should certainly not be interpreted as "community management" or "common property" and may be more realistically described as sub-leasing by another name. The lessee or his agent is called a "President" and the tolls are called "membership fees" but the flows of cash are the same. The advantage for government is that it can negotiate fees for accepting and registering these palpably fake associations.

Fishing factions

In contrast to the Department of Fisheries' official policy pronouncements, which are uniformly hostile to the leasing system, fishermen's own attitudes are more subtle. The relationship between lessee and fisherman appears to create a patronage system. as typified by Scott (1975): the fisherman, as client, cedes a part of his value-added to the lessee, as patron and the lessee in return assures him a fishing livelihood.

We saw earlier how the lessee usually sells fishing rights to members of his own community or, if he does not, the lessee's agent sells them to members of his own community. This has important implications; fishermen see their access to water as deriving from, as well as hindered by, the wealth and influence of leaseholders. Fishing communities without wealthy leaders cannot obtain direct access to the best fishing sites. Thus the Hindu fishermen argue that they have been excluded from prime spots since the 1962 Land Reform undermined the economic status of the Hindu élite. Thus the Hindus of Bonobir and Rustumpur tried to gain access to 62 Beel by allying themselves with a Srimangal mohojon but were eventually excluded when their patron was out-manoeuvred by the patron of Baraura. Thus the Nomosudras of Monargaon obtain limited access to No. 1 Beel through the sub-lease taken in Buruna by their priest/doctor.

Even after the leases have been allocated, fishermen need a strong patron to make their title effective. Neither leases nor sub-leases are secure from rival factions and poachers unless they can be maintained by physical and political power. Fishing gear will be stolen unless the owner has colleagues on the water who are prepared to protect it. Although access to the floodplain is open in theory, groups of fishermen exercise territorial control over it in proportion to their strength.

In brief, a fisherman's chances on the water depend upon membership of a band of fishermen united by their common allegiance to a lessee, sub-lessee or agent - in other words, a fishing faction. To take the example of Buruna's Maimals, they receive many benefits from the influential lessee in their midst: they obtain access to Hail Haor's best jalmohol, they are better-placed on the floodplain during the "open-access" season, their gear is not stolen and they are relatively immune from gear restrictions. Unsurprisingly, they are comparatively rich, well-dressed, healthy and smug. Compare them with the Nomosudra fishermen of Monargaon who are visibly poorer, worse-clothed and worse-fed. There is no difference in their technological opportunities. Their villages are adjacent and the Monargaon fishermen are, if anything, more experienced and skilled. The difference is that the Maimals have a strong patron and the Nomosudras do not. From the fishermen's point of view, the imminent need is not to avoid "exploitation" - it is to have a strong "exploiter".

Certain fishermen complain bitterly about lessees and the corruption of government officials. It is significant, however, that their complaints are not against the leasing system *per se* but that its operation has deprived them of access to a good jalmohol. Indeed, some fishermen speak with some satisfaction of their position within the leasing system. So, whilst fishermen cede a portion of their incomes to the leasing system in general, they perceive their <u>own</u> lessee as protecting their fishing incomes.

Conclusions

This chapter has examined in some detail the social, economic and institutional transactions that combine labour, fishing gear and the water-bodies in the Hail Haor fishery. It has covered the markets for fish, credit, fishing gear and water-rights, which are of interest because they are what will transmit the effect of fisheries policy onto the fisherfolk. The markets for fish, credit and gear were found to be more or less competitive, as orthodox models of fisheries management assume them to be. The allocation of fishing rights, on the other hand, is dominated by patron-client relationships in which non-economic factors such as coercion, violence, theft and bribery also play a part. The remainder of the thesis will examine the outcomes of these transactions: the value of output, the distribution of value between participants in the fishery and the impact of policy interventions upon them both.

Chapter 8

Benefits and factor shares

Introduction

The Ricardian model of agricultural production describes how value is created and then allocated between labour and landowners. It may be summarised as follows: as *more labour is applied, its incremental productivity decreases. Landowners hire it in until its incremental productivity is the same as the pre-determined wage rate. Total production is the sum of all the labourers' incremental productivities up to that point, all of which are higher than the wage rate. Labourers receive the wage and landowners take the rest in land rent.*

Gordon (1954) applied Ricardo's model to the fishery and Schaefer's (1957) classic formulation refined it by including the possible of biological over-fishing with a negative incremental productivity of labour.

This section uses data collected in 1992-3 to locate the Hail Haor fishery within the framework of a Ricardo-Gordon-Schaefer model. It discusses the fishery's productivity, how rents are generated and the allocation of benefits. All the quantitative results are, of course, only "best estimates", but it is hoped that their orders of magnitude, both absolute and relative to each other, will produce some useful insights into fisheries policy.

Benefits

One reason for studying the total benefit flow from the fishery is as part of an assessment of effort controls. The case for these restrictions rests partly upon the belief that there is a negative relationship between effort and the fish catch. To test this hypothesis, a comparison of the productivity of Hail Haor with that of other tropical floodplain fisheries would permit one to judge the extent to which Bangladesh's higher concentration of fishing effort has led to a reduced catch.

A second reason for studying the haor's productivity is to inform land-use planning. In the land-scarce economy of a country with a population density of 741/km^2, floodplain fisheries like Hail Haor appear to be taking up valuable space. One case for the construction of flood-control embankments, and a case that has come to the fore with the recent down-playing of flooding's destructive effects, is that an increase in the area of agricultural land accompanying a reduction in the area of the floodplain could produce a net increase in output and employment per hectare. For flood control, as for many environmental interventions, a body of opinion warns of the effect upon the poor. Majumder and Durante (1993), for example, argue that the floodplain is an open-access resource, "open to anyone with a net" (p.2), so those without private resources will bear a disproportionate part of the cost. Their case is far from proven, however. The recent flooding of Beel Dakatia, and the impoverishment of local villages as they converted from agriculture to fishing (BCAS 1993, Rahman 1994), suggests that, hectare for hectare, paddy land can support more livelihoods than standing water.

This section will describe the biological and economic productivity of the Hail Haor fishery[1]. It should be emphasised that it refers only to one particular aquatic system, one, moreover, which is hydrologically atypical of Bangladesh's inland fisheries. A particularly important weakness of the estimates presented below is that they only measure <u>locally-caught</u> fish. They do not capture the biomass, derived employment and value of fish that grow in Hail Haor during the flood season, swim north into the Gopla River and are caught elsewhere. The reader is referred to the Flood Action Plan 17 (FAP) project, which is currently preparing estimates of the fisheries' biological and economic productivity nation-wide.

Starting with the catch of households who fish for consumption only, the proportion of riparian households falling into this category was as low as 10% (n=160), with 95% confidence that the population frequency lies between 5.4% and 14.6%. One would expect this figure, however, to be slightly lower for Hail Haor than for many other floodplains, because Hail Haor's relatively steep banks, with gradients as high as 1:350 on the western side, reduce the possibility of fishing in trapped depressions. For these households, the mean catch was 30.8 kg of fish per household per year. With a total riparian population of 3777 households (Appendix 4.1), this suggests as a best estimate that 11.6 tonnes of fish are caught by households who fish for consumption alone.

As for the catch of households fishing for sale, there are an estimated 1,363 such households operating in Hail Haor north of 24°21'N. It is estimated that they caught a total of 0.80 tonnes of fish and shrimp per household (Appendix 4.2) (or 1090 tonnes in total) between December 1992 and November 1993 by all gears except brush-piles[2]. Treating the 50 sample households fishing north of 24°21'N as a single population, the 90% confidence interval for mean catch (excepting brush-piles) is 678 kg to 922 kg per fishing household per year (mean=800kg, n=50, s.e.=516, t{.90,49}=1.68). The area in

[1] All estimates in this section exclude that part of Hail Haor to the south of the main embankment at 24°21'N. This area, which holds 0% and 15% of Hail Haor's area during the dry season and monsoon respectively, was excluded for lack of data upon the local fishing population and the predominant fishing technique, dewatering by pump.

[2] Dry fishing by villages north of the main embankment was excluded because it mostly took place south of the main embankment .

question contained 139ha of brush-piles, producing, at an estimated 600kg/ha (see Appendix 4.9), 83 tonnes of brush-pile fish.

Table 8.1. Total catch from Hail Haor north of 24°21'N, December 1992 to November 1993 (tonnes).

Households fishing for consumption only	11.6
Households fishing for sale with:	
Gill net	245
Push net	169
Seine net	104
Hook	294
Dori	163
Faron	88
Bosni	5
Brush pile	83
Other	21
Total	1184

The total catch of all households fishing either for sale or for consumption only totals 1,184 tonnes per year (Table 8.1). Using dry-season acreage and maximum flood as the denominator, this works out as 658 kg/ha/year and 111 kg/ha/year respectively. Estimating that this portion of Hail Haor supports 77,708 hectare-months of flooding (Appendix 4.6), each flooded hectare produced 15kg of locally-caught edible biomass per month.

It is estimated (see Appendix 4.5) that fishing households spent 3,592 work-hours/household/year, or 4.9 million work-hours in total, in self-employed fishing (Table 8.2). To this must be added activities in support of self-employed fishing, such as fish-selling, trap-building and repairing, net-making and so on. Such work adds a further 380 hours per household per year. Fishing households hired out 115 hours per household per year of labour for fishing or trap-making. Certain items of fishing gear, namely fish-baskets, creels and, most importantly, fish-traps, are produced for sale almost entirely by local fishing households. Fishing households spent an average of Tk1,101/household/year on the purchase of these items. Observing that the implicit wage, gross of production costs, of trap- and basket-makers is around Tk4/hour, this works out as a derived demand for labour of about 275 hours/household/year. This figure is not far off the 320 hours/household/year devoted to trap- and basket-making by the study's respondents. These four uses of labour, accounting for the labour demand generated by the fishery until the catch passes out of the fishermen's hands, sum to 5.9 million work-hours per year, which is equivalent to 3,303 work-hours per dry-season hectare, 561 work-hours per hectare at maximum flood or 77 work-hours per hectare-month of flooding.

No information is available for the labour required by subsequent marketing. It is likely, however, to add around a further 10% to the demand for labour generated by the fishery. Observing that one paiker handles around 20kg of fish in a 10-hour day, and allowing for the fact that fishermen who fish for sale eat about a sixth of the catch themselves, it is possible to estimate that the fishery requires around 0.5 million hours of paiker labour per year.

Table 8.2. Local employment generated by the Hail Haor fishery from gear-production to the first sale, north of 24°21'N only ('000 work-hours per year).

Activity	/fishing household	Total
Self-employed fishing	3.6	4,895.9
Supporting work	0.4	535.2
Hired fishing labour	0.1	156.5
From local gear purchases	0.3	375.2
Total	4.4	5,945.4

(Figures may not sum exactly owing to rounding.)

Considering next the value of the fish catch (Appendix 4.4, Table 8.3), households who fish for consumption only report that their catch consists almost entirely of small fish and shrimp, which are observed to have a value of around Tk20/kg. This suggests that the value of their annual catch is Tk0.2 million for the area in question. To put it in perspective, it is about US$1.54 per riparian household or the equivalent of around one and a half days' wages per riparian household per year.

Table 8.3. The value of the Hail Haor fishery north of 24°21'N (Tk million/year).

	Gross sales
Households that:	
fish for consumption only	0.2
fish for sale	35.1
Total	35.3

The gross value of the catch of households fishing for sale was Tk25,747/household/year or Tk35.1 million/year for the area in question. The total annual value of the catch therefore works out at Tk19,625 per dry-season hectare, Tk3,332 per hectare at maximum flood or Tk454 per hectare-month of flooding.

The Marine Resources Assessment Group (MRAG 1993) has contrasted the productivity estimates above with those of the project's other study sites in Thailand and South Sumatra. The comparison revealed that the fish yields reported above, measured as kg per hectare at maximum flood, were up to three times higher than those of the other two sites and the published yields of over 30 other tropical inland fisheries, despite Hail Haor's density of fishermen being up to ten times higher. It has also compared the composition (Appendix 4.3) and length frequency of Hail Haor's catch with those of the other two sites and concluded that Hail Haor produces higher physical yields, not by exploiting the same large species to a higher degree, but by targeting smaller, fecund, "r-selected" species as well as larger species. MRAG's analysis has three important implications for the relationship between effort and catch:

a) If Hail Haor's yields <u>have</u> been reduced through over-fishing, the reduction is not abrupt enough to be demonstrable by comparison with fisheries in other countries.

b) Because the level of exploitation <u>of any one species</u> is apparently no higher than elsewhere, the higher concentration of fishing effort in Hail Haor is unlikely to bring about a higher risk of recruitment failure and stock collapse, as reported from some marine fisheries.

c) Effort controls aimed at restricting the catch of juveniles will indeed increase the yield-per-recruit of larger species but at the cost of a reduced catch of "r-selected" species.

In brief, the response of total catch to effort is likely to be minimal around current levels of effort (MRAG 1994, p.94).

Factor shares in the fishery

The distribution of revenues by factor share provides a useful indicator in the assessment of management options. Existing normative economic theories of the management of natural resources focus upon the value of resource rents (revenues minus costs). The main theme of this literature is the development of algorithms whereby the manager can adjust the pattern of effort so as to maximise rents. This study, however, is more concerned with another factor share, the benefits accruing to fishermen. Bangladesh's New Fisheries Management Policy aims, ostensibly at least, at re-allocating resource rents away from lessees towards fishing labour. All these approaches are primarily concerned with factor shares.

Fishing revenues since Gordon (1954) have traditionally been divided into three factor shares. Material costs are a loss to the economy. The prevailing wage, which is determined in a clearing labour market as the opportunity cost of labour, is multiplied by the amount of labour applied to produce an implicit wage bill. Since the wage rate represents labour's opportunity cost it is also a loss to the economy; increases in fishing employment do not per se generate any increase in economic welfare. The residual, revenues less material costs and labour costs, constitutes fishery rents.

This simple three-way model, however, fails to capture the economic processes that divide the catch in a floodplain fishery in Bangladesh. It must be refined.

A marginal divergence between the wage and the social opportunity cost of labour

Orthodox fisheries management theories specify economic rents as the target variable to be maximised. Since one is concerned in this case with poverty-alleviation in a labour-surplus economy, however, it is appropriate to treat the social opportunity cost of labour as negligible and thus to include the flow of revenues to labour as part of net benefits rather than an economic cost.

Gordon (1954) defined the optimum management stance as one where a small change in the level of fishing effort would not affect fishing rents. Considering the opportunity cost of labour as negligible, however, one should attempt to seek the point where any marginal increase in rents due to a change in the pattern of effort would be cancelled out by a marginal decrease in the value of labour's remuneration.

A marginal divergence between the wage and the private opportunity cost of labour.

Moreover, the labour market does not clear. For most of the year there is an excess supply of fishing labour at the prevailing wage, or implicit wage, allowed to labour. In the foregoing discussion of the allocation of fishing rights it was observed that there is vigorous competition between fishermen of different communities for fishing rights at the prevailing level of tolls. Communities clearly feel that they have lost out if deprived of the right to fish; in other words, they believe that the private return to fishing is significantly higher than the next best use of labour. There is a clear parallel here with Jansen's (1987) description of an agrarian community, where there was fierce competition for sharecropping contracts at the prevailing labour share.

Copes (1972) has suggested that fishermen's remuneration could be higher than the private opportunity cost of labour because fishing skills are in scarce supply. In his analysis, factor rents are created not only by the scarcity of fish but by the scarcity of people to catch them. There are several pieces of evidence, however, that suggest that Copes' hypothesis does not apply to Hail Haor:

a) If fishermen were in short supply, they would not have to compete with violence and bribes for the right to fish.

b) If fishermen were in short supply, the wage rate for hired fishing labour would be higher than that for hired agricultural labour. As Table 8.4 indicates, however, there is no significant difference between the two rates.

c) Hindu fishermen in general and some Maimal Muslim fishing communities such as Bilashirpar, have been displaced from the fishery by richer and better-connected villages such as Buruna, Hazipur and Srimangal Busti. The resulting presence of non-fishing fishermen strongly suggests that fishing skills are not scarce.

Table 8.4. Wage rates, including benefits in food and in kind, for fishing and agricultural work.

Work	Fishing	Agriculture
Observations	50	18
Mean wage (Tk/day)	39.8	38.1
Median wage (Tk/day)	40.0	32.5
s.d. of wage (Tk/day)	13.6	12.8

(s.e. of difference between means=3.69, t=0.48)

Another possible source of the divergence between the prevailing rate of remuneration to labour and the private opportunity cost of labour lies in the restriction of effort. If effort is restricted to below its open-access, rent dissipating level by regulation, community management or private ownership, then some of the resulting resource rents could accrue to fishermen. There is one apparent problem with this hypothesis, however: with a large number of fishermen competing for the fishing spaces allocated by a small number, an oligopsonistic number even, of lessees, one would expect all the resource rents to accrue to the lessee rather than to labour. The evidence from Hail Haor suggests that some resource rents are indeed diverted to labour and that the source of this divergence lies, not in the operation of a classical competitive labour market, but in the nature of the patronage relationship between the lessee or sub-lessee on the one hand and his fishermen on the other.

Orthodox economic theory assumes that property rights are sacrosanct, being preserved by the state, and goes on to predict the actions if rational agents under this restriction. In Bangladesh's floodplain fisheries, however, property rights can be captured and lost, not only through purchase and sale in the economic market, but also through physical force and political manoeuvring. The foregoing section upon access management noted how bribery, coercion and local influence had more importance in determining *de facto* jalmohol allocation than the official bid. It also demonstrated how jurisdiction over other parts of the floodplain is established through physical coercion. A large body of writers upon rural Bangladesh (e.g. Hartmann and Boyce 1983, Jansen 1987, McGregor 1989b) show how physical security, land and external aid are allocated through force and political influence. Part of Kramsyo and Wood's (1992) case for NGO interventions is that they create a countervailing power by putting physical force and political influence under the control of the rural poor.

If the mobilisation of physical force and political support is a key concern of the rural capitalist, it follows that he wishes to secure the physical and political support of a number of followers. This "loyalty" is obtained by allowing his clients, whether sharecropping tenants, regular labourers, plaintiffs or, in this case, fishermen, somewhat more than the market-clearing private opportunity cost of their labour. This "loyalty" premium is akin to the economist's "efficiency wage", where the employer raises the remuneration of his workers in order to improve their performance. In the floodplain fishery, the "loyalty premium" provides a potent explanation of the non-price rationing of employment through vertical faction alignments in a non-clearing labour market.

The existence of a "loyalty premium" has important implications for a factor-share analysis of the floodplain fishery. It suggests that a portion of the fishery's resource rents will flow to fishermen, even if their skills are not in short supply. If this is so, and there is an accompanying marginal divergence between the fishermen's implicit wage on the one hand and the private opportunity cost of labour on the other, then it is no longer possible, with Gordon, to identify fishermen's remuneration as a cost to the economy. This provides a further argument for treating employment in the fishery as a target variable rather than a cost.

Tolls

The tolls that are paid by fishermen can be conceptually apportioned into five factor shares, between:

a) venal civil servants
b) lessees' and sub-lessees' opportunity cost of capital
c) lessees' and sub-lessees' rewards for risk-taking
d) lessees' and sub-lessees' super-normal profits
and e) government revenues

The official Department of Fisheries view is that toll payments are largely channelled towards (d), lessees' super-normal profits and (e), government revenues, thus creating plenty of scope for a progressive redistribution of rents through the New Fisheries Management Policy. The evidence from Hail Haor, however, suggests that payments to venal civil servants and the lessees' opportunity cost of capital account for a large share of toll payments.

Regarding civil servants' incomes from lease allocation, the evidence presented in the preceding chapter suggests that bribes, or informal fees if one prefers, represent around 40% to 60% of a lessee's official and unofficial outlay upon lease acquisition. This figure rises sharply if a law-suit arises. The importance of bribery is revealed in the huge variability in the per acre value of leases. The 1992 lessee of Gopla River 3's 58 acres, for example, paid Tk96,000 per year while his neighbour in Gopla River 4's 52 acres paid Tk8,300. The 16 large, central and therefore, one would expect, relatively productive jalmohols leased out by Zila officials went for an official price of Tk413/acre (n=16, unweighted average), while those rented out by Thana officials went for Tk1,215/acre (n=13, unweighted average). One possible explanation is that the relative seniority of Zila officials permits more scope for private arrangements.

The importance of bribes should lead one to reconsider the rates of profit made by leaseholders. Many writers (e.g. Blanchet and Talukder 1992) show them making rapid profits by reselling or sub-leasing their jalmohols. Since these calculations invariably use the <u>official</u> lease price as the denominator they are almost certain to underestimate the lessee's outlay and thus overestimate his super-normal profits.

One way of obtaining a rough impression of the leasing system's opportunity cost of capital is to examine the time distribution of lease acquisition payments and toll collection. Table 8.5 presents an estimated account of the flow of lease prices, bribes and tolls for Hail Haor in 1992-3. It shows how the lessees' initial investment in May earns a delayed pay-off, much of which is collected in two bursts, one in October, when lessees impose control, and one in April, at the end of the brush-pile and pump season. Considering this cashflow as a single investment, the internal rate of return would be 10.0% per month, which is more or less the going rate for loan finance in the informal sector. If one ignores away the cost to the leasing system of bribes, the IRR rises to 16.7% per month.

Table 8.5. Estimated leasing system cash-flow for all Hail Haor, 1992-3.
(Tk '000)

Month	Outlay		Tolls(c)
	Price(a)	bribe(b)	
May	-614.1	-307.1	6.8
June	0	0	0
July	0	0	0
August	0	0	37.3
September	0	0	33.9
October	0	0	283.9
November	0	0	415.2
December	0	0	132.8
January	0	0	161.8
February	0	0	487.2
March	0	0	176.5
April	0	0	99.9

(a) Source: Thana Fisheries Office, Srimangal
(b) Low estimate: 50% of official price
(c) Mean tolls per household paid by 60 fishing households, scaled up to the 2,033 households estimated to fish on Hail Haor, May 1993 to November 1993, December 1992 to April 1993.

Of course, this calculation is prone to a number of possible inaccuracies: the allowance for bribery is at best a rough guess and toll payments and the total fishing population are statistical estimates. The point remains, however, that the leasing system's IRR is of the same order of magnitude as the informal sector rate of return upon financial capital. It follows from this that a large portion of the profits accruing to the lessee and sub-lessee are not super-normal profits but the market's standard return for capital investment. This in turn suggests that the NFMP's official aim, which is to shift super-normal profits from lessees and sub-lessees to fishermen, will be of limited effectiveness without a change in the cost of capital and/or a postponement of lease allocation payments.

Distribution of fishery revenues by factor share

Table 8.6 shows the breakdown of Hail Haor's fishing revenues by factor shares from December 1992 to November 1993 (see Appendix 4.8 for data). The share of fishery revenues absorbed by the leasing system, at 3.6%, is strikingly low. If one allows that the labour component of trap and basket sales is around 50%, the share of fishery revenues accruing to fishing labour, either through self-employed fishing, fishing labour hire or trap and basket production, is around 78%. In other words, the leasing system's gross earnings are only around 1/25th of the net earnings of fishing labour. If one subtracts the government's share, Tk614,000 per year, from the leasing system's turnover and allows that another Tk600,000 or so is pocketed by government officials, one estimates that the lessees' and sub-lessees' surplus is only some 1.3% of fishing households' net incomes from fishing and gear-production. Any allowance for the lessees' opportunity cost of capital would have to come out of this 1.3%.

Table 8.6. Breakdown of fish sales: 60 sample households, December 1992 to November 1993.

(per cent of fish sales)

Leasing system:	
Official lease price	1%
Lessees, sub-lessees, bribes	2%
Fishing costs:	
Labour hire	2%
Traps and baskets	4%
Other fishing costs	18%
Fishermen's net incomes	72%
Total: Fishing sales	100%

(Percentages may not sum to 100 because of rounding.)
(Source: Appendix 4.8)

If these figures are accurate, or a least of the right order of magnitude, then they have very significant policy implications. The potential rise in fisherfolk's net incomes from an NFMP-type redistribution of lessees' profits is around 1.3%. Given the administrative costs of a change in procedures, the provision of credit to license-buyers and breaking the venal link between lessees and government officials, one should question whether policies such as the NFMP could produce noticeable or cost-effective benefits to fishing labour.

It remains to be explained, however, how the view has arisen that the leasing system absorbs a high fraction of fishing revenues. Dey (1986), for example, has studied the cash-flow of the haor fishermen of a Nomosudra village in neighbouring Habiganj Zila and estimated that leasing costs were equivalent to 25-30% of fishing groups' total costs. The answer to this problem of perception lies in the asymmetrical nature of the fishery. Around 93% of the catch by weight (see Table 8.1) is produced by low-cost, relatively unproductive gears such as gill-nets, push-nets, tana nets hooks and traps. Since they produce a small surplus over labour's requirements the lessee cannot levy tolls from them at a high rate. The remaining 7% of the catch, however, is obtained from relatively productive brush-piles.

Table 8.7 breaks down revenues from brush-pile fish sales by destination. It shows how their high profitability allows lessees to obtain an important share (34%) of sales. Supposing that one did redistribute jalmohol costs back to the brush-pile owners, they would see a 140% increase in their net incomes, which is very high by comparison with the 4% increase on offer in the fishery as a whole. If, as the NFMP proposed, low-cost credit replaced "exploitative dalal", the brush-pile owners' net incomes would stand to rise by 170%.

It is very probable that it is the highly-visible, capital-intensive and politically well-connected brush-pile and pump fishery that has given the impression that lessees' tolls consume a high proportion of fish sales. Dey's (1986) list of gears, for example, <u>does not mention</u> the existence of gill-nets, traps, hooks and push-nets. It has already been pointed out that policy-makers have drawn their perceptions of the catch composition (dominated by major carps) and fish marketing (exploited by dalal) from this small but powerful sub-sector. It would hardly be surprising if the same were true for tolls.

The observation that tolls cost brush-pile groups proportionally much more dearly than ordinary fisherfolk ought to cast the political economy of the NFMP in a new light. Those who would benefit most are not the marginalised fishing underclass of popular myth but capitalised fishing entrepreneurs. These are, in the case of Hail Haor at least, "genuine fishermen", being members of Maimal or Nomosudra social groupings who live and sleep on the water during the brush-pile season. If implemented in Hail Haor, the NFMP could certainly meet its official goal of helping "genuine fishermen", but the principal beneficiaries would be the richest members of fishing society. One returns to a point made earlier, that an understanding of fisheries policy should start with a conception of fisherfolk as a parallel hierarchy rather than as a homogeneous underclass.

Table 8.7. Distribution of brush-pile sales by factor share

('000 Tk/ha of brush-pile)

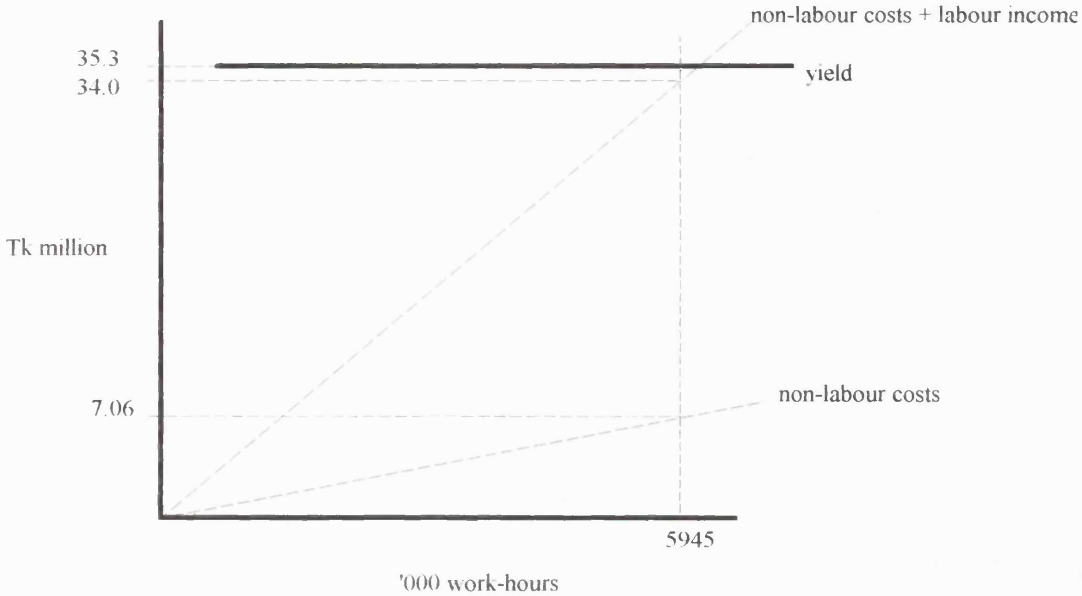
Share	Mean	% of sales
Jalmohol costs	11.7	34
Building costs	5.6	16
Fishing costs	6.1	18
Arotdar's dalal	2.8	8
Net revenue	8.3	24
Total sales	34.5	100

Source: Appendix 4.9

Factor shares and effort controls

It is possible to use this data upon the distribution of sales by factor shares to analyse the possible redistributive effects of a reduction in fishing effort. Figure 8.1 illustrates a Schaeferian model of the Hail Haor fishery. Non-labour costs are shown as a constant multiple of the amount of labour applied to the fishery. The yield curve is represented as a horizontal line, the form suggested by MRAG's (1994) observations upon the probable relationship of catch to effort. Labour's remuneration is a constant multiple of the amount of labour applied. There is no positive relationship between labour use and the implicit wage, in line with the earlier observation that there is an excess supply of labour with fishing skills. The margin between the value of sales on the one hand (Tk35.3 million) and labour remuneration plus non-labour costs on the other (Tk34.0 million) provides tolls, the leasing system's turnover (Tk1.3 million).

Figure 8.1. Schaeferian model of factor-share determination in Hail Haor.



The response of labour's remuneration to a change in the amount of labour applied can be calculated as:

$$\frac{34{,}000{,}000 - 7{,}060{,}000}{5{,}945{,}000} = \text{Tk } 4.5 \text{ per work-hour}$$

The response of tolls to a change in the amount of labour applied can be calculated as:

$$\frac{-34{,}000{,}000}{5{,}945{,}000} = \text{Tk } -5.7 \text{ per work hour}$$

This small illustration brings out an important feature of the political economy of effort management, that it is nearly a zero-sum game. For every Tk1.00 lost to labour because of the reduction of effort only Tk1.27 is taken by the leasing system. To put it another way, one needs to remove Tk3.75 from fishing labour in order to gain Tk1.0 for the economy as a whole. It is therefore likely that a large part of the pressure for gear controls will derive from concern for the leasing system rather than concern for economic efficiency. For policy-makers, the question is whether their social welfare function accords leasing system turnover, of which around two-thirds accrues to lessees and venal government officials, at least 79% of the weight that it accords fishing labour's income. If it does not, there is a case against effort controls.

The question then arises of why lessees and sub-lessees do not reduce the amount of labour applied to the haor and then raise the total value of tolls. The answer probably lies in the fragmented nature of property rights. Once Hail Haor has been divided into jalmohols and those jalmohols have been divided into sub-lease units, the mobility of fish means that the stock-depletion costs of effort are largely externalised. This fits with the observation that independent fishermen are more or less excluded from enclosable units such as the 62 Beels' pump areas and Beri Beel near Sherpur, which are fished almost entirely by sub-lessees' pumps and brush-piles.

Conclusion

This section has presented estimates of the flow and distribution of benefits from the Hail Haor fishery. The analysis attempted to locate Hail Haor within a Ricardo-Gordon-Schaefer model of the creation and allocation of benefits. Having done so, it was possible to make a number of tentative conclusions about the operation of fisheries policy:

a) The fishery generates 15kg of fish, 7 work-hours and Tk454 (US$11.35) of fish sales per hectare-month of flooding. These are the benefits that might be lost to a programme of flood control.

b) The fishery is highly productive by international standards, suggesting that the high density of fishing effort is not significantly depressing yields (MRAG 1994).

c) Because tolls are a relatively small share of sales and government officials and capital costs consume part of the leasing system's turnover, the potential benefits to the average fishing household from a reform of the leasing system may be smaller than previously imagined.

d) The potential benefits to the relatively rich owners of capital-intensive gears such as brush-piles, however, are very high indeed.

e) Effort controls are quite close to being a zero-sum policy. For every Tk100 gained by the leasing system, Tk79 is lost by fishing households.

This kind of fishery assessment, analysis in terms of the value and factor-distribution of benefits at one point in time, provides a complement to more conventional biological assessment methods. In particular, a discussion of the allocation of benefits between fishing labour and "land" has produced valuable insights into the distributional impact of fisheries policy.

Chapter 9

Unequal access to the fishery

Introduction

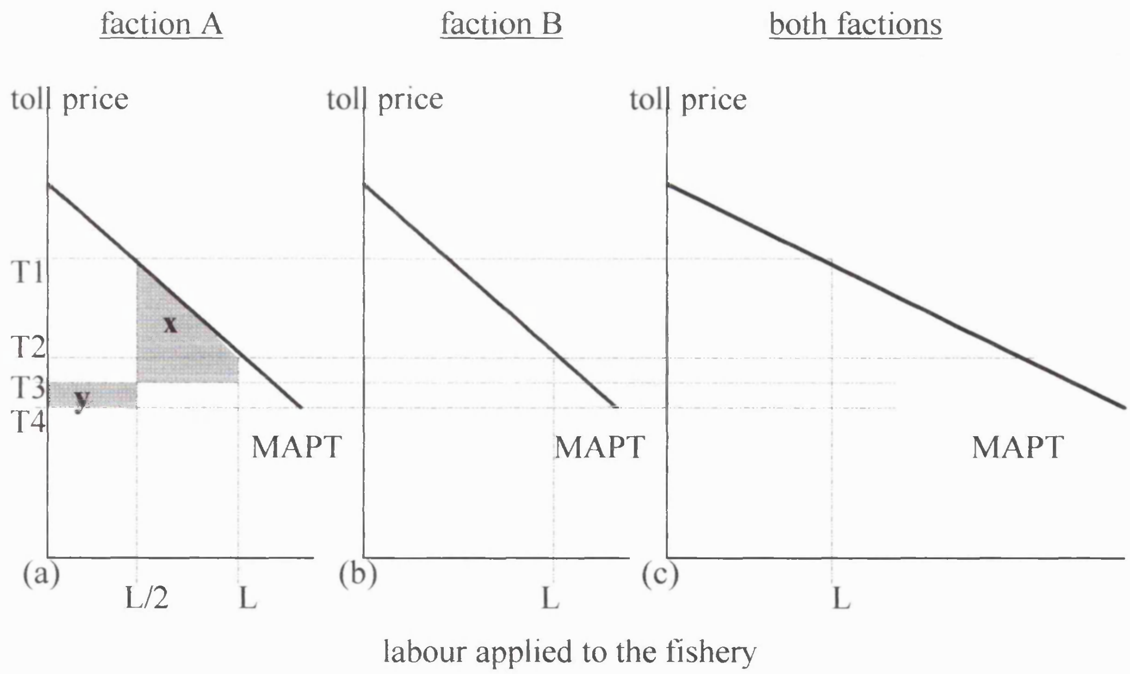
Hail Haor's lessees and sub-lessees break the haor up into thousands of different fishing spots, differentiated from each other by location, season and gear-type. The fisherfolk themselves are also differentiated, by socio-economic status, place of residence and religion. The purpose of this section is to examine how the latter maps onto the former, how a household's physical activities on the floodplain are determined by its place in fishing society. Just as biologists speak of a species' ecological niche within the ecosystem, it will be possible to identify how different groups of fishermen occupy *socio-ecological niches* on the floodplain.

The leasing system

The leasing system allocates access to Hail Haor's fish stocks to some whilst denying it to others. It is possible to study the 1992-3 pattern of allocation and denial and observe what factors determine a fisherman's chances of making a living from fishing on any one particular day. A key issue is whether the main determinant of access is economic, the fisherman's ability to pay the toll, or social, the fisherman's membership of a well-placed fishing community or faction. The distinction is of significance for fisheries policy, as it bears upon the political economy of a shift from leasing to licensing. If the allocation of rights is principally economic, with price competition for fishing space, then one might expect fishermen actively to support a policy that removed the middleman. If, one the other hand, access is restricted to members of a particular fishing faction, the fishermen who currently enjoy access rights would stand to lose from any policy that threatened the privileged position of their lessee patron, which is the professed intent of the NFMP and NGOs.

Figure 9.1 illustrates this theoretical approach. Charts (a), (b) and (c) represent respectively the fishermen of well-connected faction A, excluded faction B and both factions together. The "MAPT" lines represent fishermen's <u>Marginal Ability to Pay Tolls</u> in each chart. They are downward-sloping because the fishermen within each faction have differing abilities to pay tolls, according to their liquidity, fishing skills, access to credit, gear-ownership and so on. Suppose that the lessee has enough fishing spaces for L fishermen. If his goal were to maximise immediate monetary profit irrespective of his need to secure political support within a particular faction i.e. chart (c), he could charge a toll of T_1 and earn revenues of T_1L. If, on the other hand, he behaves as a patron of faction A, he will only charge a toll of T_2 or, making a toll concession in return for political support, T_3. Now, suppose the NFMP or NGO offers the low toll T_4 to all comers. If the lessee had been maximising tolls before the change, subleasing the jalmohol to both factions, the net gain for fishermen of faction A will be their share, say a half, of the gains from the toll reduction, or $\frac{1}{2}L(T_1-T_4)$. If, on the other hand, the lessee had previously been acting as a patron, the net loss in surplus for faction A's fishermen will be shaded area x (representing the gain from lower tolls) minus shaded area y (representing the loss from sharing access with faction B). The smaller the fall in tolls, the more likely it is that a net loss will result, with the exclusion of some effort (area x) outweighing the gains to the remainder (area y) from the lower tolls. Fishermen on the whole, of course, will be net gainers, but this consideration will not weaken faction A's support for its patron's subversion of the NFMP or NGO's policy.

Figure 9.1. Toll reductions with and without patronage factions.



One way of analysing this question quantitatively is to examine seasonal patterns in fishing participation. As Table 9.1 indicates, fishermen work on toll-free flooded rice land during the June-September monsoon season and in the jalmohols during the November-May dry season. The period of most intense control by lessees and sub-lessees is the brush-pile and pump fishing season of January to March. Fishing participation picks up in April and May as this exclusion is relaxed, even though the new season's fish stocks will only start to appear in the catch in early June. One can therefore identify the fishermen who are excluded by the leasing system as those who fish during the monsoon flood and drop out between January and March.

Table 9.1. Fishing participation by month and season, December 1992 to November 1993.

(% of households fishing on any one day.)

	Month	jalmohol	floodplain	total
M	June	7	60	67
M	July	27	55	82
M	August	25	58	83
M	September	27	47	73
M	October	19	59	78
	November	35	25	60
	December	47	3	49
	January	58	1	59
	February	57	3	60
	March	64	2	66
	April	62	1	63
	May	70	4	74

M: monsoon month

Table 9.2 compares the seasonality of fishing participation for rich and poor households. If a household's financial ability to pay tolls were an important determinant of its participating in dry-season fishing, one would expect to see a greater falling-off for poor households than rich households during the dry season. The figures show that a poor household was 35% more likely than another household to be fishing on any one day during the flood between July and October. Conversely, a non-poor household was 26% more likely to be fishing on any one day during the dry season between November and April than a poor household.

Table 9.2. Fishing participation for rich and poor(a) households, December 1992 to November 1993.

(% of households fishing on any one day.)

	Month	Poor	- Other	= Difference
M	June	52	55	- 3
M	July	83	54	29
M	August	70	53	17
M	September	83	66	17
M	October	74	57	17
	November	65	69	- 4
	December	57	76	-19
	January	63	76	-13
	February	54	92	-38
	March	61	65	- 4
	April	63	81	-18
	May	80	55	25

M: monsoon month
(a) Ranked in the poorest 40% on the study sample list by their fellow-villagers.

As the preceding discussion of the leasing system explained, many of the wealthy Hindus who used to obtain jalmohols on behalf of their Nomosudra co-religionists fled Bangladesh after Partition, the 1962 Land Reform and Independence. If the patronage hypothesis is correct, one would now expect to see Muslim Maimal lessees and sub-lessees selling scarce dry-season fishing spaces to Muslim fishermen. Hindu fishermen, on the other hand, would have to withdraw from the fishery at this time. Table 9.3 compares the seasonality of fishing participation for Hindu and Muslim households. It shows that Hindu fishermen are slightly more likely than Muslim fishermen to fish during the flood months of July to November. During the January to May dry season, however, a Muslim household is 30% more likely to be fishing than a Hindu household. The relationship between fishing access and community membership is vividly illustrated by the locational distribution of eastern shore fishermen in early November 1993, just as they were moving back off the floodplain into the jalmohols. Of 12 Buruna Maimal households fishing on one particular day, 9 were already fishing in the jalmohols. Of these, 6 were in No. 1 Beel, Hail Haor's central basin. Of 8 Nomosudra households from neighbouring Monargaon, however, 7 were still fishing over paddy land.

Table 9.3. Fishing participation for Hindu and Muslim households, December 1992 to November 1993.

(% of households fishing on any one day, 3-month moving average.)

	Month	Muslim-	Hindu =	Difference
M	June	73	72	1
M	July	74	78	- 4
M	August	72	83	- 9
M	September	73	83	-10
M	October	67	73	- 6
	November	67	62	- 5
	December	64	52	8
	January	64	47	17
	February	69	48	21
	March	69	49	20
	April	73	58	15
	May	70	63	13

Although the number of participating fishermen falls during the dry season, the total effort and catch applied to the fishery does not show a matching decline. The proportion of households that fish on any one day is 41% higher in July-September than in December-February (Table 9.1). The total value of sales, however, is 8% higher in December-February than in July-September (Appendix 4.4). This clearly represents a high premium for dry-season access.

It is also possible to examine how important access is for fishing households by comparing the returns to labour from fishing with those from a fall-back activity. For many Hindu households, who are rather more likely than Maimals to be excluded, an important fall-back activity is trap- or basket-making. The median net income from trap-making per standard nine hour day is Tk30/day. This result is the same whether one uses household income per year (n=17) or household income per month (n=81) as the unit of observation. The modal range is Tk20-29/day. Even though the distribution is positively skewed (mean=Tk34/day), the mean net daily income from trap- or basket-making is significantly different from Tk40/day, the mean net income from hired fishing labour or self-employed fishing.

A third indicator of the importance of dry-season access to the fishery is provided by the relationship between the labour that a household devotes to fishing between December and May and its total income during the same period. If it were possible for households to substitute out of fishing into another equally remunerative activity, one would observe no relationship, or even a negative relationship, between fishing labour use and total income. If, one the other hand, there are no equally remunerative substitutes for dry-season fishing, one would observe a positive relationship between fishing labour use and total income. The following regression equation was estimated in order to choose between these alternative hypotheses:

$$Y_i = a + (B \times H_i) + U_i$$

where:
Y_i is household i's total income (Tk) from all sources less tolls and fishing costs between December 1992 and May 1993.
B is the propensity of dry-season fishing to increase total household income.
H_i is household i's allocation of labour to self-employed fishing or related support activities between December and May (work-hours).

The regression, which was significant at a 99.9 level of confidence (n=60, regression sum of squares=1.4×10^9, residual sum of squares=3.9×10^9) showed that every hour of labour used in fishing alone led to an extra Tk2.6 for total household income. The regression explained 26% of the variance in total household income. This result is particularly telling in view of the fact that December to May is considered a "fat season" for the agricultural sector, with the aman harvest in December and boro preparation in January. One would therefore expect alternative employment to be relatively abundant at this time.

To sum up, there is a contraction in the number of fishermen participating in fishing at the start of the dry season. For those who can retain access there will be a significant income premium over and above what they could obtain from non-fishing activities. Because there will therefore be more claimants than dry-season fishing places, this premium has to be rationed. The first determinant of premium allocation is the community to which the fisherman belongs. The second determinant is his economic status within that community. The lessee will, of course, only contract with those who can afford his tolls; however, the existence of a sizeable fishing premium after the payment of tolls suggests that social status within the village and ability to mobilise gear are of more concern to the lessee in his choice of client than maximising toll revenue.

The importance of gear purchase as a determinant of fishing incomes will be discussed below.

Gear ownership

Fishermen often describe each others' status in terms of the gears that they operate. With access to the jalmohols, gear-ownership is the second determinant of a household's income from fishing. Gear ownership is itself determined by the fishing household's economic status.

Gear as a determinant of fishing incomes

In order to estimate the importance of gear costs, fishing income was modelled as a Cobb-Douglas function of non-toll costs (mostly gear), toll costs and fishing labour:

$$Y_i = A \,.\, G_i^{B_1} \,.\, T_i^{B_2} \,.\, L_i^{B_3} \,.\, U_i$$

where:
Y_i is the gross fishing income of household i (Tk)
G_i is the non-toll fishing costs incurred by household i (Tk).
T_i is the value of tolls paid by household i (Tk). Zero values were set to Tk1.
L_i is the fishing labour applied by household i (work-hours)
This model was estimated by OLS regression from the total income, costs and labour use between December 1992 and November 1993 of 57 sample households, in the form:

$$\ln Y_i = a + B_1 \ln(G_i) + B_2 \ln(T_i) + B_3 \ln(L_i)$$

The results are presented in Table 9.4.

Table 9.4. Determinants of fishing income

	estimate	s.e.	t	significance
Intercept	3.91	.506	7.73	**
B_1	.35	.067	5.20	**
B_2	.02	.022	1.02	
B_3	.38	.081	4.71	**

** significant at a 99% level of certainty
(Regression sum of squares 29.8, residual sum of squares 6.7, r-squared .82, n=57.)

The co-efficient upon toll expenses (B_2) was not significantly different from zero. This evidence supported the earlier hypothesis that it is not the cost of the toll that inhibits access but non-price rationing, the lessee's choice of client. It is consistent with the existence of a fishing premium. Once again, one is led to question the assertion that fishermen are kept off the water by the exorbitant levies of lessees. With tolls amounting to only 12% of total fishing costs, it would be surprising if they were an important determinant of access.

The co-efficients upon non-toll expenses (B_1) and fishing labour (B_3) are both significantly greater than zero and smaller than unity at 99% levels of confidence. This implies, unsurprisingly, that both are important determinants of fishing income and that if one factor of production were fixed the other would exhibit diminishing marginal returns. The sum of the co-efficients is .729, distributed with a standard error of .148 and a 90% confidence interval of .48 to .98, indicating slightly diminishing returns to scale.

Bearing in mind that there is an excess supply of fishing labour, it is not surprising that the principal effect of investment in gear for most fishermen is to bring their labour into the fishery rather than to increase labour productivity on the water. There is a high degree of correlation between non-toll expenses and labour use; simple OLS regression of fishing labour upon non-toll expenses produces an r-squared of .47 (n=57). Indeed, non-toll expenses alone explain 74% of the variance of fishing income. Simple regression of labour productivity (Tk/work-hour) upon non-toll expenditure, on the other hand, only produces an r-squared of .08. Once again, one returns to the idea that there is a premium just for access to the water and fishermen's economic and social strategy is to obtain and exploit it.

Economic status and gear choice

The neo-classical theory of the firm predicts that producers will choose the unique technique of production that maximises profits subject to the market prices of labour and capital. For Hail Haor's fishermen, however, the opportunity costs of labour and capital vary according to the household's economic status. This means that there will not be a unique best technique but a best technique for each household.

The opportunity cost of capital is likely to be higher for poorer fishing households. They have a higher subjective rate of time-preference because a higher proportion of their income is spent on necessities. They are less likely to hold cash balances or liquid physical assets. The study of the credit market showed that they are less likely to receive credit on dalal or mortgage terms. If McGregor's (1989) analysis of rural power systems applies to fishing communities, poorer households are less likely to receive credit on favourable terms through village patronage networks. Conversely, poorer households are likely to have a lower opportunity cost of labour. Owning less land and having less access to fishing rights, they have fewer alternative opportunities for employment. They are also least able to afford the moral authority that Bengali society confers upon those who abstain from manual labour. One would therefore expect poorer fishing households to opt for capital-saving, labour-intensive techniques of production.

Self-employed fishermen's gross incomes by gear were estimated from two regression equations. The first estimated income as a function of gear use, or value per unit effort (VPUE):

$$Y_{it} = B_1E_1 + B_2E_2 + \ldots + B_nE_n + U_{it}$$

Where:

Y_{it} is the gross income from fishing of household i on day t.
E_n is the use of gear n applied by household i on day t.
B_n is the VPUE co-efficient for gear n.

A second regression equation estimated labour use as a function of gear use:

$$H_{it} = L_1E_1 + L_2E_2 + \ldots + L_nE_n + V_{it}$$

Where:

H_{it} is the fishing work-hours of household i on day t, including support activities.
E_n is the use of gear n applied by household i on day t.
L_n is the labour-for-unit-effort co-efficient for gear n.

The results of these regressions are presented in Table 9.5.

Table 9.5. Value per unit effort and labour per unit effort by gear, Hail Haor 1992-3.

Gear	Effort unit	VPUE (Tk/unit) mean	VPUE (Tk/unit) s.e.	Labour (hrs/unit) mean	Labour (hrs/unit) s.e.
Intercept	-no intercept-				
Gill net	'000 yard hours	5.4	.28	.8	.04
Felun jal	net hours	11.6	1.4	1.9	.18
Tana jal	net hours	36.2	5.4	5.8	.71
Hook	'000 hook hours	6.9	.7	1.1	.09
Big Hook	'000 hook hours	12.2	1.6	2.0	.20
Dori	trap hours	.06	.01	.010	.001
Faron	trap hours	.04	.01	.005	.001
Bosni	trap hours	.18	.01	.010	.010

Regression details:
VPUE: r-squared=.73, n=479
Labour requirement: r-squared=.79, n=473

Table 9.6. Implicit wage by gear, Hail Haor 1992-3.

Gear	Tk/9 hours
Gill net	60.8
Felun jal	54.9
Tana jal	56.2
Hook	55.0
Big Hook	54.9
Dori	54.0
Faron	72.0
Bosni	162.0

The implicit wage for a 9-hour working day for each gear can be calculated as 9 times the value per unit effort divided by the labour requirement (in hours) per unit effort. The results of this calculation are presented in Table 9.6. Apart from the bosni trap estimate, for which the standard error is very high, all these low-cost gears appear to provide a gross income of around Tk55 per 9 hour day.

Table 9.7. The cost of equipping one fisherman with different gears

Gear	Unit	Units needed	Outlay/ unit(Tk)	Outlay (Tk)	6 month income(Tk)
Gill net	'000 yards	1.25	3333	4166	10944
Tana jal	net	1/7th	15000	2142	10116
Hook	'000 hooks	.88	140	123	8092
Dori	'00 traps	100	12.5	1250	9720
Faron	'00 traps	200	40	8000	12960
Dol	hectares	.63	11700	7371	21735

The cost of equipping a single fisherman is presented in Table 9.7. The figures for gill-nets, hooks and traps were the ratios of gear-hours to work-hours derived from Table 9.5 above. It was assumed that one tana net equips 7 fishermen and that one push-net equips one fisherman. The figure for brush-piles is the mean number of brush-pile hectares per group-member. No cost information was collected for big hooks. Bosni traps were removed from the analysis because of the high standard errors in Table 9.5. Felun jals were removed from the analysis because of their use in tepwal fishing within brush-piles. Even after these exclusions, the remaining gears account for 83% of Hail Haor's marketed catch by weight. The 6-month incomes were calculated by multiplying the daily gross income estimates in Table 9.6 by 180 days. Tk10/day is deducted from hook income for hook replacement.

These calculations are summarised in Figure 9.2, which illustrates the different combinations of labour and capital that fishermen can use to catch Tk1,000 of fish. One would expect poorer fishermen to tend towards the labour-intensive techniques to the south-east and richer fishermen to tend towards the capital intensive techniques to the north-west. This hypothesis was tested by comparing the contribution of each gear to the catch of richer and poorer households in Vimshi and Mirzapur (n=20). These two villages were selected because they are the only villages in the sample that practised brush-pile fishing. The six gears in the analysis account for 82% and 84% of the catch of richer and poorer households respectively. The poorest 30% of households (ranking 1 to 3), as identified by their fellow-villagers, caught 74% of their fish by weight from the three most labour intensive gears, hooks, dori traps and tana jals. This compares with a contribution of 45% from these gears towards the catch of the richest 30% of households (ranking 8 to 10). The richer households caught 39% of their catch from the three most capital intensive gears, gill-nets, brush-piles and faron traps. This compares with a figure of 8% for the poorer households. These results demonstrate that a gear's capital-intensity is one determinant of a household's choice of technique.

Figure 9.2. Capital outlay and labour composition of different gears.

```
Capital outlay(Tk)/Tk1000/6 months
          |
   800  -+
          |
          |x brush-pile (incl.tolls) (8,678)
          |
          |                  x faron (125,617)
   600  -+
          |
          |
          |
          |
   400  -+
          |                       x gill net (148,380)
          |x brush-pile (8,339)
          |
          |
   200  -+                        x tana jal (160,211)
          |
          |                         x dori (166,128)
          |
          |                              hook (200,0)
          +----+--------+---------+----x----+---------+---
              50       100       150        250       300
          Labour(work-hours)/Tk1000/6 months
```

Of course, gear cost is not the only determinant of gear choice. The preceding description of fishing rights allocation explained that there is a spatial constraint upon gear use. The sub-lessee allocates spots to brush-piles, gill-nets or trap-embankments according to the season and their hydrology and topography. With lessees and sub-lessees externalising the cost of stock-depletion in open jalmohols it is usually availability of fishing space rather than fear of stock-dissipation that constrains the amount and composition of effort applied to a jalmohol. Fishermen can only choose a gear for which a suitable spot is available at that time.

A third determinant of choice of technique is the difference between the tolls charged for different gears. The gears that generate a higher surplus, brush-piles and pump-embankments, produce much higher tolls. The tolls paid for leasing year 1992-3 by households who only used gill-nets, push nets, tana nets, hooks and traps only amounted to 3.5% of net income between December 1992 and November 1993, defined as gross income less gear costs. The tolls paid by brush-pile groups in 1993-4, on the other hand, were equivalent to 51% of net income, defined as gross income less the cost of building and fishing the brush-piles. In other words, tolls effectively double the capital requirements of brush-piles but have very little effect upon the capital requirements of labour-intensive gears. This further directs poorer fishing households away from the brush-pile fishery.

Conclusion

This section has examined how households' access to the fishery is related to their economic and social position. Just as the community to which a household belongs determines its place on the "open-access" floodplain, it also determines a household's probability of being admitted to the relatively open-access dry-season fishery. Dry-season access is also positively related to a household's economic status within the community. This does not appear to be because lessees and sub-lessees are maximising rents and is probably related to their desire for the social support of their wealthier fellow-villagers. Fishermen's choice of fishing technique is again related to their economic status, with poorer fisherfolk relatively dependent upon capital-saving, labour-intensive gears.

Unlike the homogeneous marine fisheries of orthodox fisheries economics, Hail Haor's floodplain fishery exhibits heterogeneity - by season, location and gear type. The social heterogeneity of riparian villages keys into the ecological heterogeneity of the floodplain and admits different social groups to different ecological niches. The next stage in the analysis is to identify the socio-ecological niche occupied by poorer households and to assess how they perceive fisheries policy to be acting upon it.

Chapter 10

The position of poorer fishing households.

Introduction

It is a well-worn theme of development agricultural economics that the effect of government policy upon resource-poor farmers is often qualitatively different from its effect upon the agricultural sector in the aggregate. Two early steps in analyses of the relationship between policy and poor farmers are therefore to classify the poor and to locate their specific position within the sector as a whole. This section will classify and describe the poorer fisherfolk of Hail Haor and show that they occupy a distinct niche within the fishery. It will argue that they therefore experience fisheries policy differently from their richer neighbours and that they perceive the difference to be to their disadvantage.

The identification of poorer fisherfolk

The study identified poorer fisherfolk by means of one subjective criterion, wealth rankings given by their fellow-villagers, and one objective criterion, the household's estimated annual income. Before using these indicators to classify the fisherfolk it was necessary to test their significance. This was done by correlating households' subjective ratings with their annual estimated incomes.

The following regression equation was estimated for 60 sample households:

$$W_i = a + b_1e_{1i} + \ldots + b_5e_{5i} + b_6l_i + u_i$$

Where: W_i is household i's subjective wealth ranking, ranging from 10 (richest in that village's sample) to 1 (poorest in that village's sample)

e_{1i} to e_{5i} are household i's estimated annual gross incomes from fishing, agriculture, fish-trading, hired labour and craftwork (Tk).

l_i is the area of land owned by household i (acres).

The results of the regression are presented in Table 10.1. Estimated annual incomes and land-ownership explained 55% of the variation in subjective wealth rankings and the regression was significant at a 99.9% level of confidence. The r^2 value is particularly reassuring as the subjective wealth rankings could capture within-village but not between-village wealth differences. Predictably, there was a high correlation between the co-efficient upon income from agriculture and the co-efficient upon land-ownership. Removal of land-ownership from the regression only reduced the r^2 value by three percentage points to 0.52, showing high correlation between land and annual income.

Table 10.1. The determinants of subjective wealth rankings

Intercept	Estimate	t-value	significance
Income:	3.03	4.27	**
from fishing(Tk)	.00004	2.13	*
from agriculture(Tk)	.00025	4.88	**
from fish-trading(Tk)	-.00005	-.56	
from labour(Tk)	.00006	.64	
from craftwork(Tk)	.00005	.51	
Land-ownership (acres)	.263	1.96	*

** difference from zero is statistically significant at a 99% level of confidence.
* difference from zero is statistically significant at a 95% level of confidence.
$r^2 = .55$, n=60.

If wealth rankings are regressed upon total income alone, however, the correlation is much less pronounced, with r^2 falling by 40 percentage points to 0.12. This suggests that the source of income, as well as its value, determines the subjective impression of economic well-being. A simple regression of subjective wealth rankings upon income from agriculture gives an r^2 of 0.44. A simple regression of subjective wealth rankings upon income from fishing, on the other hand, gives an r^2 of only 0.03, with a t-value upon the estimator of a statistically-insignificant 1.40. Whilst subjective wealth rankings are certainly correlated with a household's financial income, therefore, they take more account of agricultural income than of income from other sources. It remains useful, therefore, to use total estimated income as an indicator of material poverty.

Poorer households' *niche* within the fishery.

The ecology of the Hail Haor fishery displays at least four types of asymmetry. There are distinctions between small fish and large fish species, between capital- and labour-intensive gears, between the floodplain and the depressions and between the monsoon- and dry-seasons. One path towards an assessment of poorer fisherfolk's experience of fisheries policy is to locate them within these four dimensions and to explore how policy affects, not the fishery as a whole, but the specific *niche* or *locus* that they occupy.

Table 10.2. Labour use of poorest and richest quartiles*
(work-hours per household per year)

	poor	rich
Fishing	2255	6403
Agriculture	456	1667
Fish-trading	0	229
Labour	198	152
Craftwork	681	31
Support	289	482
Total	3879	8974

* by annual estimated income

Poorer fishing households have a distinctive pattern of labour use. Table 10.2 compares the labour allocation of the poorest quartile of fishing households with that of the richest quartile. The total labour use of poorer households is just under half that of richer households. The result is the same if households are classified by subjective wealth rankings rather than estimated annual income. Households ranked in the poorest 30% worked an average of 5,188 hours per year while households ranked in the richest 30% worked an average of 7,428 hours per year. The median values for each group were 5,085 hours/household/year and 8,227 hours/household/year respectively. The difference between the means is statistically significant at a 95% level of confidence and the Kruskal-Wallis test shows the difference between the medians to be statistically different at a 95% level of confidence. The result is similar, but of course less pronounced, when allowance is made for the number of workers per household. The poorest quartile of households in terms of total annual income contributed 2682 hours/worker/year, compared with 3862 hours/worker/year for the richest quartile of households. These results suggest that a household's inability to put its labour to work is a major feature of poverty. They confirm the hypothesis that there is an "employment premium", that the market for labour does not clear and that there is non-price rationing of jobs by employers towards more advantaged households. This corroborates the socio-anthropological literature's observations that competition for employment opportunities creates vertical patronage alignments.

Poorer fishing households spend much less time fishing than richer households. The same result is obtained when households are classified by subjective wealth ranking. The households ranked in the poorest 30% fished on average 3,493 hours per year while the households ranked in the richest 30% fished on average 4,382 hours/household/year. The median values were 2,370 hours/household/year and 4,493 hours/household/year for the two groups respectively. These differences are not statistically significant, however, probably because of the importance of between-village variation as a determinant of fishing participation. Once again, this result remains true, but is less pronounced, when the number of household workers is taken into account. The poorest quartile of households spent on average only 55% as much time per worker fishing as the richest quartile (1591 hours/worker/year as against 2879 hours/worker/year). This confirms the hypothesis that the poorest households are not those of "full-time fishermen" but those that are excluded from the fishery.

Owning less land, 0.9 acres/household as compared with 2.7 acres/household, the poorest quartile of households only spent 27% as much time farming as the richest quartile of households. Craftwork, almost entirely the production of fish-traps and baskets, was an important fall-back activity for poorer households. They spent 22 times as long on this as the richer households, amounting to around a sixth of their annual labour use or over a quarter of the labour use of the poorest 50% of Hindu households. There are several reasons why poorer households are associated with trap- and basket-making:

a) Only Hindu fishermen, who are more likely than their Muslim counterparts to be excluded from the fishery, know how to make traps.

b) Trap-making households sell their output weekly, and can therefore operate on one week's working capital, only Tk200-300.

c) Trap-making requires no tolls and no fixed capital except a knife.

d) Hindu females make traps and poorer households are less able to afford the social status afforded by restricting women to domestic work.

e) The return to labour from trap-making is lower than that to fishing.

Poorer fishing households' pattern of earnings follow their pattern of labour use (Table 10.3). They are comparatively less dependent upon fishing for their livelihoods, with 55% of their incomes deriving from fishing as opposed to 78% for the richest quartile. This difference is taken up by poorer households' dependence upon craftwork for 18% of their incomes. Rich and poor households receive the same percentage of their income from agriculture but the absolute value is of course larger for richer households.

Table 10.3. Incomes of richer and poorer quartiles of households* by source.
(% of total)

	Poorer	Richer
Fishing	55	78
Agriculture	18	18
Fish-trading	0	3
Labour	9	2
Craftwork	18	0
Total ('000 Tk/household/year)	12.2	46.5

* by estimated annual income per household
Percentages may not sum to 100 because of rounding.

Because poorer households are more likely to be excluded from the fishery during the dry season they have a slightly different seasonal distribution of fishing labour. Households earning less than Tk20,000/year (n=22) worked 47% of their fishing hours and caught 54% of their fish by weight during the flood season between July and November as compared with 34% and 36% for those earning more than Tk40,000/year (n=10). There is a corresponding increase in the demand for poorer households' hired labour in agriculture and the brush-pile fishery during the dry season, with 82% of hired labour hours sold out in the five months between November and March.

As the previous section explained, poorer fishing households are led by the different capital requirements and toll requirements of different gears to adopt a distinctive pattern of gear use. Table 10.4 illustrates this point. They only catch 1% of their fish by weight in brush-piles, as compared with 8% for the richest households. They are significantly less dependent upon gill-nets and more dependent upon tana nets and push-nets. The poorer households' pattern of gear use is reflected in the composition of their catch by species.

Extrapolating from the weight of the catch of per household of the poorest households by gear and the composition of the catch observed at fish landing sites, it was possible to make an approximate estimate of the distribution of stocked species between different classes of fisherfolk. This was that fishing households earning less than Tk20,000 per annum caught 28kg of stocked species per household per year, of which less than 2kg per household per year came from the brush-pile fishery. Households earning over Tk40,000 per annum, on the other hand, took 125kg of stocked species per household per year of which 75kg came from brush-piles. This quantitative comparison is very approximate because the catch composition matrix (Appendix 4.3) was based upon a small number of observations and almost all were taken from a single market. The trend, however, is incontestable.

With 75% of the brush-pile catch by weight coming from stocked species the benefit of stocking to brush-pile owners would be substantial. For poorer households, of course, the effect is less spectacular. Assuming that artificial stocking doubled the catch of stocked species for all fishermen and that all fish were sold at the fully-grown price of Tk40/kg, poorer households could have gained a maximum of Tk560/household/year, an increase of 4.6% over their existing fishing incomes. If fish-growth or mortality were density-dependent or lessees and sub-lessees reduced the demand for self-employed fishing effort in order to conserve brush-pile stocks, this increase could easily be cancelled out.

Table 10.4. Catch composition by gear for poorer* and richer* households.
(% of catch by weight)

Gear	Poorer households	Richer households
Gill net	12	30
Push-net	20	6
Tana jal	23	1
Hook	17	11
Big hook	3	8
Trap	22	29
Brush-pile	1	8
Other	3	5
Total	100	100

Totals do not sum to 100 because of rounding.
* estimated income <Tk20,000 p.a..
** estimated income >Tk40,000 p.a..

Poorer households pay less tolls because their fishing is less profitable. The poorest 30% of households by subjective wealth ranking paid Tk387/household/year in tolls compared with Tk1430/household/year for the richest 30%. If the absolute importance of tolls was lower for poorer fishing households, so was their relative importance. The poorer households paid only 2.1% of their lower net fishing incomes in tolls whereas the richer households paid 5.8% of their higher net fishing incomes. This confirms that the policy goal of releasing fishermen from the "burden" of tolls would have very little effect upon poorer fisherfolk beyond perhaps reducing their security of tenure. If any sub-group stands to gain from such a policy it is the brush-pile- and pump-embankment-owning fishermen.

The foregoing discussion of the leasing system showed how lessees tended to allocate fishing opportunities within their own village so that a household's chances in the fishery depended partly upon its village of residence. Hail Haor's principal lessee resides in the twin villages of Buruna-Hazipur and the mean annual income of fishing households in these villages was Tk30,431, 20% higher than the mean household income of other villages. Muslim incomes are higher (1-tailed test) than Hindu incomes at a 90% level of confidence. Hail Haor's Hindu fishing households had less access to means of production than their Muslim counterparts. With 1.0 acres on average per household, they owned 38% less land than the Muslims but this difference is only statistically significant at a 70% level of confidence. At 1,577 hours per worker per year, Hindu fishermen spent only 68% as long fishing on average as their Muslim counterparts. This difference is statistically significant at a 95% level of confidence. It is somewhat surprising, therefore, that reported Muslim incomes are only 15% higher on average than reported Hindu incomes. This may be due to survey bias, with the explanation lying in the observed difference between the attitudes of Muslim and Hindu respondents to our interviews.

Poorer fisherfolk's views of fisheries policy

Fisherfolk's subjective perceptions of the operation of fisheries policy are of interest to policy-makers for three reasons. Firstly, they determine how much co-operation fisherfolk will offer the state in policy implementation. Second, being experts in local ecological and social systems, fisherfolk may be able to give a more technically accurate assessment of the operation of policy than outsiders. Thirdly, and perhaps most importantly, if fisheries policy has not left the target group with an increased feeling of well-being, it cannot be said to have succeeded.

Hail Haor's fishermen's perceptions of the operation of fisheries policy are grounded within their view of the role of the state in the fishery. Orthodox models of fisheries policy (e.g. Gulland 1983) describe the state as an enlightened manager, using its expert biological knowledge to maximise fisheries benefits. Hail Haor's fishermen, however, understand the state's role rather differently. They perceive the state's goal as being to increase its legal and illicit revenues from the fishery rather than to improve social welfare; in their view, the state tries to achieve this goal by allocating fisheries benefits (jalmohols, enforcement services and fish fry) to individuals in return for money and political support. Fishermen's understanding of their own personal relationship with the state varies according to their economic status but always remains within this view of the state as a venal patron. The very wealthiest in Hail Haor's fishing society, probably less than 10 in number, compete amongst themselves for fishery benefits, principally jalmohols, from the state. Those fishermen wealthy enough to invest in brush-piles or pump-embankments attempt to place themselves as clients of wealthy leaseholders. Lastly, for the vast majority of Hail Haor's fishermen who wish to obtain a toll-paying relationship with a sub-lessee, the state has a negative role. While their sub-lessee allocates fishing livelihoods to them, the state is capable of acting against ordinary fishermen in order to improve the fishery's productivity.

Lessees and brush-pile owners give qualified support to Hail Haor's artificial stocking programme. They say that they can recognise the stocked fish by their smaller size but that most of the brush-pile catch consists of naturally-recruited carps. This belief is supported by the almost-total absence of catla, mrigal or common carp, all of which were stocked in 1993, from the 1993-4 brush-pile catch. Most fishermen, on the other hand, argue that artificial stock-enhancement brings them no benefits. They say that they do not own the big (brush-pile) nets which would enable them to catch the stocked species and that they cannot make the poisha (contribution) necessary to obtain a suitable fishing spot. When asked their opinion of the stocking programme, fishermen of Buruna and Hazipur often told how a fisheries officer had leased the nursery pond from which the fish were to be released into Hail Haor to a private individual. In brief, they say that the benefits from stocking are restricted to those who can afford to invest in gear and access. This observation appears also to hold true for most of the water-bodies stocked by the 3rd Fisheries Project in W. Bangladesh (Leterme and Chisholm 1993).

Some fishermen, moreover, argue that they would be better-off without artificial stock enhancement. They explain that stocking induces lessees and sub-lessees to give more space over to brush-piles and pump-embankments which in turn restricts the effort of self-employed fishermen in the dry season. This opinion has not been confirmed or refuted by direct observation. Ordinary fishermen also argue that stocking makes lessees and sub-lessees put more pressure on the government to enhance the value of the brush-pile and pump catch with effort controls. This is certainly true; Hail Haor's fisheries officer himself said that "restocking has taught local influential people the importance of the Fisheries Act."

These effort controls are unevenly applied. They target labour-intensive gears, such as tana nets, gill-nets and push-nets but they ignore pump-fishing, which is illegal and, according to MRAG's (1994) analysis, harmful to total yields. Fishermen from the main lessee's village were relatively unaffected. Between July and September 1993, when the government was confiscating monofilament gill-nets, Buruna and Hazipur fishermen applied an average of 140,000 gill-net yard-hours per household per month, as compared to 5,000 yard-hours per household in other villages. 35% of households in Buruna and Hazipur used gill-nets during this period compared with 6% in other villages. Both differences are significantly different from zero at a 99% level of confidence. At the same time, however, Buruna and Hazipur fishermen were complaining that fishing groups from Shulpur had paid bribes to the fisheries officer in order to fish unobstructed with mosquito nets in No.1 Beel. It is probable that most fishermen view immunity from effort controls, like leases, as something to be purchased from government.

Most fishermen deeply resent effort controls, arguing that they should be allowed to fish because they are fishermen. One fisherman from Vimshi complained, "If the government people are going to take nets when they give fry, it is better without fry." They do not agree that effort controls produce long-term benefits by allowing fish to grow. Firstly, they are not convinced that the government is actually interested in stock protection because the fisheries officer sometimes allows fishermen to keep or buy back the gears in return for bribes, because of incidents like the Hazipur nursery pond and because enforcement is seen to be selective. Secondly, they say that they will not participate in the big-carp fishery that effort controls are supposed to enhance.

Most fishermen are completely unaware of the Government's reformulation of the leasing system through Fishermen's Associations, closed tenders and "fisheries development plans". Lessees and sub-lessees usually describe their operations as Fishermen's Associations and refer to themselves as "Chairmen". The fishermen, however, continue to speak of ijaradars (lessees) and zuma taka (tolls). They have no knowledge of recent changes to the tendering system. Even Hail Haor's principal lessee boasted that he would not have to implement his "Fisheries Development Plan" in return for his ten-year lease.

For the majority of Hail Haor's fishermen, earning Tk50-60 gross per 9-hour day with a capital of less than Tk5,000, the state's interventions in the fisheries sector are therefore at best negligible and at worst a cause if economic hardship during the monsoon season. For them, the operation of fisheries policy is not an accident. It is grounded in the venal relationship between government officers and influential members of local society.

Conclusions

Orthodox models of fisheries policy have traditionally aimed at maximising total fishery rents; heterogeneity within the fishery is not an issue because the sum of benefits, rather than their distribution, is the goal. However, if one is concerned with using fisheries policy to generate livelihoods for one sub-group of participants, in this case poorer people, it is important to understand how that sub-group obtains, or is excluded from, fishery benefits. It is necessary to explore the dimensions of heterogeneity within the fishery, to locate the poor people's position in each dimension and to analyse how fisheries policy affects their special niche.

This paper has identified one particular locus in the fishery with poor fisherfolk. They use labour-intensive gears, tend to operate in shallow water and during the monsoon season, generate few fisheries rents, pay few tolls and, perhaps most importantly, are the first to be excluded from the fishery altogether. Fisheries policy, which aims at promoting rents rather than promoting employment, tends not to benefit poor fisherfolk and can act against them by reducing the demand for their labour.

This kind of analytical framework has long been applied to questions of agricultural policy such as the identification of new technologies suitable for resource-poor farmers. Disaggregation is even more important in the case of Hail Haor because of the extra issue of subtractability; an increase in the take of one economic class can reduce the fish stocks or space available for others. It would therefore be particularly wrong in the case of a crowded, open-water fishery to identify the welfare of poor people with the productivity of the fishery as a whole.

Chapter 11

Bio-economic models of the distributional effects of fisheries policy in Hail Haor.

Introduction: the purpose of the models

The preceding chapters have described how poorer fisherfolk participate in the fishery on different terms from their richer neighbours. It was argued that they tend to use cheaper gears, to fish in shallower water and to concentrate their effort in the monsoon season. The jalmohol system and their confinement to less productive fishing techniques mean that most of their income is accounted for by the opportunity cost of their labour. Richer fisherfolk, on the other hand, participate in fisheries rents, which are largely generated by the more productive fishing techniques, such as brush-piles and de-watering by means of pumps.

The question then arises of how fisheries policy impacts upon poorer fisherfolk. It is not enough to argue, with the government, that all fisherfolk are poor and that what is good for physical productivity as a whole will also therefore be good for the poor. There is a wide amount of economic variation within the fishing community and fisherfolk of differing classes fish in different places, ways and times. Any policy-induced changes to the physical or economic environment will affect different social groups in different ways. There is therefore no *a priori* reason why the poor should benefit from fisheries policy and, given the nature of the policy-formation process in Bangladesh, it is probable that policies were not designed with their interests in mind.

Indeed, as the previous section upon the perceived effects of fisheries policy showed, poorer fisherfolk do not believe fisheries policy to be acting in their interests. They do not appreciate the yield benefits of artificial stocking, they resent effort controls, they think of Fishermen's Associations as fronts for the leasing system and, where the New Fisheries Management Policy has been enforced, they see no difference from what came before. In an ideal world, such perceptions of the effects of fisheries policy would be canvassed by the government and its donors as part of the policy and project cycles.

The aim of this chapter is to demonstrate analytically why poorer fishermen do not believe policy to be working in their interests. It draws upon two custom-built bio-economic simulation models. The first simulation shows how different fisheries policies would affect the incomes of the 60 households who gave data for the study's year-round Catch, Effort, Income and Cost survey. It asks the question, "Given the current relationship between a household's economic status and its pattern of fishing effort, how would fisheries policy affect different classes' incomes from this existing pattern of effort?" In other words, it looks at changes in value-per-unit-effort for the existing pattern of effort. The second simulation goes further, and looks at how the pattern of effort would be changed by fisheries policy. It asks the question, "Given that lessees and sub-lessees manage the pattern of fishing effort in order to produce high incomes for themselves, how would they alter it in response to fisheries policy and what would this mean for the incomes of fishing labour?" The two models are therefore complementary. The first looks at income changes within the framework of the existing pattern of effort and the second looks at the wider issue of the market for effort as a whole.

Fisheries economists sometimes use bio-economic simulations as management tools to test the effects of different interventions before their implementation. It should be emphasised that neither of the two models below should be used as a management tool because they are based upon a limited data set and an incomplete understanding of fish ecology. Their purpose is rather to re-confirm analytically the bio-economic processes that the fisherfolk themselves described verbally to the author.

Model 1: fisheries policy and differential changes in value-per-unit effort

Method

Fish prices by gear were estimated from data from the Catch, Effort, Income and Cost panel survey by regressing catch by gear, household and month upon gross fishing income by household and month. Catch/income observations that included a catch from brush-pile, lift net, taki jal, dry fishing, spear and cast net were eliminated from the regression because of the low number of observations for these gears. 247 observations were removed leaving 473 observations in the regression. The simulation used rounded versions of the regression estimates (Table 11.1). Price estimates were used for lift nets, taki jals, spears, cast nets, dry fishing and brush-piles, with the estimate for brush-piles coming from direct interviews.

Table 11.1. Prices used to simulate the differential effects of fisheries policy upon value per unit effort.

	Estimated price(Tk/kg)	s.e. of estimate	rounded price
Gill net	33.3	1.2	35
Push net	22.0	1.7	20
Tana net	13.2	1.8	13
Hook	35.1	1.7	35
Big hook	35.9	3.0	35
Dori	20.0	1.6	20
Faron	16.8	2.3	20
Bosni	20.8	4.9	20
Lift net			20
Taki jal			35
Spear			35
Cast net			35
Dry fishing			35
Brush-pile			40

The estimated prices were multiplied by catch by household, quarter and gear to obtain simulated fishing income by household, quarter and gear. Simulated fishing income by household quarter and gear was divided by total fishing income by household to obtain the share of each household's annual fishing income deriving from the use of each gear in each quarter.

The Marine Resource Assessment Group (MRAG 1994) estimated the proportional changes in the physical yield of each gear, by guild and quarter, that would result from various changes to the pattern of effort, such as closed seasons, effort quotas and gear bans. The Catch, Effort, Income and Cost panel survey data provided estimates of the share of each household's annual fishing income deriving from each gear and each quarter.

For the first simulation the policy-induced yield changes by gear and quarter were multiplied by the share of households' annual fishing income by gear and quarter to obtain policy-induced fishing income changes by household, gear and quarter. In other words, this simulation looked at how policy changes households' fishing incomes by changing their catch per unit effort.

As well as this yield effect, however, another important effect of fisheries policy is its effect upon the unit value of the catch by changing its species composition. A shift from small fish to carps, for example, could raise fishing incomes without any change in the volume of the catch. The composition of the catch under different policies, by gear and quarter, was therefore estimated from MRAG's (1994) biological simulations. Using estimated fish prices by guild (Table 11.2), fish prices by gear and quarter for each policy simulation were expressed as percentages of fish prices by gear and quarter under the baseline simulation. The results were used as estimates of policy-induced price changes by gear and quarter. The policy-induced yield changes by gear and quarter were multiplied by the policy-induced price changes by gear and quarter and households' estimated share of fishing income by gear and quarter. The results gave the combined yield and price effect of fisheries policy upon fishing households' incomes.

Table 11.2. Estimated fish prices by guild used to calculate catch-composition effects of fisheries policy upon incomes.

Guild	Tk/kg
Carps	50
Predators	35
Medium fish	30
Small fish	20
Shrimp	15

The estimated effects of the policies upon fishing households' fishing incomes were averaged by social group. The averages were unweighted in order that they should not be dominated by households with high catches. 14 households who received less than 35% of their annual income from fishing were eliminated because they were adding a lot of "white noise" to the results. The remaining 46 households were divided into terciles according to the wealth ranking given them by their fellow-villagers. Households that received all their fishing income from brush-piles in the third quarter represent an important social group. Because of their low numbers they did not appear in the study's random sample. They were therefore defined as a hypothetical social group for the purposes of this simulation.

Results

The results of this model should be read in the context of MRAG's (1994 p.94) multi-species, multi-gear yield-per-recruit simulations of the biological productivity of the Hail Haor fishery as a whole under the different management scenarios. These predict that no gear bans, closed seasons or effort reductions would increase the fishery's productivity. The only management scenario that raises the haor's physical productivity is actually an increase in fishing effort of 25% or 50%. The task of the economic model is therefore to show how different management interventions would redistribute a more or less fixed yield between different social classes.

Tables 11.3 and 11.4 show the proportional change in the gross fishing incomes of different classes of fisherfolk that would be produced by the effects of fisheries policy if they continued with the existing pattern of effort. The difference between the two tables of results is that Table 11.3 only represents the yield effect of policy whereas Table 11.4 also takes account of the price (catch composition) effect.

The first finding of the models is that gear bans have an unequal effect. Bans upon gill nets and seine nets, which are the gears confiscated by Hail Haor's fishery officer, produce high increases in the incomes of brush-pile owners at the expense of small falls in income for poorer fisherfolk. The model is capturing the fact that bans on cheap gears, which are used mostly by poorer fisherfolk, save more fish, mostly major carps, for brush-piles, which are owned by richer people. Bans on brush-piles, on the other hand, raise the incomes of poorer fisherfolk at the expense of brush-pile owners. The major carps and snakeheads that escape the brush-piles will be caught later, probably the following season, by cheaper gears. Although the aggregate percentage changes in the incomes of poorer fisherfolk are not high in either direction, these average figures conceal a lot of variation within each quarter and social group; it is certain that Hail Haor's gear bans can significantly disrupt the cashflow of poorer households.

The model clearly shows the regressive effect of closed seasons, as imposed by the Third Fisheries Project in western Bangladesh and attempted by Hail Haor's fisheries officer. Both simulations show closed seasons to redistribute income away from self-employed fisherfolk towards brush-pile owners. A 7-month closure during the growing season (June to December) increases brush-pile owners' fishing incomes by 141% at the expense of income reductions of between 14% and 39% for self-employed fishers, with the poorest losing most. The regressivity of closures is even more pronounced if the time-distribution of income is taken into account. Closures postpone the incomes of self-employed fishers, reducing their discounted present value, but the increased incomes of brush-pile owners still come in the third quarter, the brush-pile season. What these simulations demonstrate is that closures allow more fish to be saved from self-employed fishermen to be caught by brush-pile owners. Once again, therefore, rich villagers have an incentive to press for controls that harm poorer fisherfolk.

Finally, the model also simulates the effects of a 50% rise and a 50% fall in effort. Although these runs do not refer to any specific policies being implemented in Bangladesh, they do say something about the general thrust of these policies. In brief, effort reductions have a significant regressive distributional effect, because they save more fish for the end-of-season capital-intensive gears, and effort increases have a progressive distributional effect because they allow a greater share of the catch to be taken by self-employed fishers before the capital-intensive gears move in. Thus, although effort limitation, which is a central motif of Bangladesh's fisheries policy, is promoted in the name of productivity, its principal effect is distributional and regressive.

Table 11.3. Results of simulation of the distributional effects of fisheries policy in Hail Haor, taking account of yield effects only.

Baseline simulation	**Q1**	**Q2**	**Q3**	**Q4**	**Total**
High tercile	23	25	28	24	100
Middle tercile	30	24	23	23	100
Low tercile	32	26	18	24	100
Brush-pile owner	0	0	100	0	100
Gill net ban	**Q1**	**Q2**	**Q3**	**Q4**	**Total**
High tercile	23	20	38	21	101
Middle tercile	32	23	29	24	107
Low tercile	28	22	18	23	92
Brush-pile owner	0	0	184	0	184
Brush-pile ban	**Q1**	**Q2**	**Q3**	**Q4**	**Total**
High tercile	24	26	19	26	94
Middle tercile	31	24	19	25	99
Low tercile	32	25	17	24	97
Brush-pile owner	0	0	0	0	0
Seine net ban	**Q1**	**Q2**	**Q3**	**Q4**	**Total**
High tercile	23	26	32	25	107
Middle tercile	29	23	24	23	99
Low tercile	29	25	16	22	92
Brush-pile owner	0	0	128	0	128
50% fall in effort	**Q1**	**Q2**	**Q3**	**Q4**	**Total**
High tercile	20	19	29	22	89
Middle tercile	26	19	22	20	87
Low tercile	25	20	14	19	79
Brush-pile owner	0	0	150	0	150
50% rise in effort	**Q1**	**Q2**	**Q3**	**Q4**	**Total**
High tercile	24	28	27	22	102
Middle tercile	33	26	23	22	103
Low tercile	33	27	17	21	98
Brush-pile owner	0	0	78	0	78
June-Dec. closed season	**Q1**	**Q2**	**Q3**	**Q4**	**Total**
High tercile	0	0	58	28	86
Middle tercile	0	0	47	27	74
Low tercile	0	0	29	26	55
Brush-pile owner	0	0	239	0	239
June-Sep. closed season	**Q1**	**Q2**	**Q3**	**Q4**	**Total**
High tercile	0	38	40	20	98
Middle tercile	0	37	35	20	92
Low tercile	0	39	33	19	91
Brush-pile owner	0	0	145	0	145

(Fishing income by social group as % of baseline simulation.)

Note: Q1 is July to September, Q2 is October to December, Q3 is January to March and Q4 is April to June.

Table 11.4. Results of simulation of the distributional effects of fisheries policy in Hail Haor, taking account of yield effects and price effects due to changes in catch composition.

Gill ban		**Q1**	**Q2**	**Q3**	**Q4**	**Total**
	High tercile	23	20	39	21	103
	Middle tercile	33	23	29	24	109
	Low tercile	30	24	19	24	97
	Brush-pile owners	0	0	194	0	194

Brush-pile ban		**Q1**	**Q2**	**Q3**	**Q4**	**Total**
	High tercile	24	26	19	27	97
	Middle tercile	32	25	19	26	102
	Low tercile	34	27	19	27	107
	Brush-pile owners	0	0	0	0	0

Seine ban		**Q1**	**Q2**	**Q3**	**Q4**	**Total**
	High tercile	23	26	32	25	107
	Middle tercile	29	23	24	23	99
	Low tercile	31	27	18	24	99
	Brush-pile owners	0	0	130	0	130

50% fall		**Q1**	**Q2**	**Q3**	**Q4**	**Total**
	High tercile	20	19	30	22	91
	Middle tercile	26	19	23	21	89
	Low tercile	28	23	15	21	87
	Brush-pile owners	0	0	159	0	159

50% rise		**Q1**	**Q2**	**Q3**	**Q4**	**Total**
	High tercile	24	28	27	22	101
	Middle tercile	32	26	23	21	102
	Low tercile	33	28	19	22	103
	Brush-pile owners	0	0	75	0	75

Closed season June to December		**Q1**	**Q2**	**Q3**	**Q4**	**Total**
	High tercile	0	0	58	28	86
	Middle tercile	0	0	47	27	74
	Low tercile	0	0	33	28	61
	Brush-pile owners	0	0	241	0	241

Closed season June to September		**Q1**	**Q2**	**Q3**	**Q4**	**Total**
	High tercile	0	38	40	21	99
	Middle tercile	0	37	36	20	93
	Low tercile	0	43	36	21	100
	Brush-pile owners	0	0	146	0	146

Note: Q1 is July to September, Q2 is October to December, Q3 is January to March and Q4 is April to June.

Discussion

Taken in tandem with MRAG's biological simulations, the results of this model strongly suggest that the effort management policies of the Bangladesh government and its donors are primarily redistributional and regressive rather than productivity-enhancing. Effort limitation, which is a central theme of Bangladesh's fisheries management policy, tends to save fish from the poor for the rich. Gear bans and closed seasons, which are variations upon this theme, are therefore regressively redistributional to a greater or lesser degree.

However, there are two caveats. Firstly, it is based upon a yield-per-recruit biological simulation which does not take into account the possibility of recruitment failure. It may therefore underestimate the productivity benefits to be obtained from effort-limitation. Recruitment failure is not thought to be a problem for the smaller species generally caught by smaller gears but it is considered likely that stocks of major carps are being limited by a lack of breeding adults. If this were so, the policy prescription would be to limit the gears that catch adult major carps, namely the brush-piles. It is obvious why this option has not been considered.

The second caveat concerns the structure of the model itself. It assumes a fixed pattern of effort, allowing neither lessees nor fishermen to respond to changes in value-per-unit-effort by changing overall levels of effort or by re-allocating it between gears and seasons. Neither does it take account of the fact that any change in the profitability of a gear could be cancelled out by a change in the value of the relevant toll. These are the economic processes that the next model will address.

Model 2: A bio-economic simulation of effort management in a leasehold fishery.

Method

The object of this model is to predict how fisheries management policy will affect poorer fisherfolk by changing the level of employment in the fishery. It simulates the decision-making of a lessee or sub-lessee who is maximising his own profits, subject to external biological and economic constraints, by adjusting the level of effort applied to his jalmohol. Fisheries management policy affects fisherfolk's welfare indirectly; it changes the profit-maximising pattern of effort by establishing a new package of biological and economic constraints upon the lessee.

The pattern of effort that maximises the lessee's profits is identified by means of a grid-searching GW-BASIC programme (see Appendix 5.1 for listing). It uses a yield-per-recruit model with fish migration to predict the value of fish sales under different levels of employment. A Ricardian model of factor-share determination divides sales for each level of employment between wages, non-labour costs and rents. The rent-maximising level of employment is selected as the predicted outcome.

This model has two distinctive features. Firstly, many economic models of fisheries management assume that the technocratic manager has full control over the application of effort. Their task is therefore simply to identify the pattern of effort that maximises the target variable. This model, however, is a more realistic portrayal of policy implementation in Bangladesh, in that it only allows policy-makers to control effort indirectly, by changing the structure of incentives acting upon the lessee. Secondly, existing bio-economic models describe the application of effort under open access. This is probably the first bio-economic simulation of a leasehold fishery.

The fishery represented by the model

Numbers in brackets refer to lines in the GW-BASIC listing (Appendix 5.1).

The biological year starts in September with an exogenously determined influx (260) of fish of both large and small species from spawning and from river systems. The fish grow each month. Growth rates are as fast for larger species as for smaller but faster during the flood than in the dry season. Net biomass growth is fish growth minus natural mortality and is given for each month for both large and small species (190-200). Between one month and the next fish stocks are increased by net biomass growth and in-migration and decreased by fishing mortality and out-migration (2060-2070, 3050-3060, 4060-4070).

The leasing unit in question is one of a large number of similar, contiguous leasing units. Fish can move between leasing units and out-migration is a pre-determined fraction (250) of the month's fish stock. The lessee cannot affect in-migration by his own actions but the sum of all lessees' actions, by affecting fish stocks, does affect in-migration. A feasible outcome is identified when exogenous in-migration is the same as endogenous out-migration, indicating that all the lessees' decisions are consistent.

Two types of gear exist, "thinning gear" and "clearing gear". Thinning gear, which includes traps, hooks and gill-nets, can be used in varying quantities in every month except February. The catchability co-efficient of thinning gear is pre-stated for every month (210-220). It becomes more effective as the floods recede. Clearing gear, which represents dewatering and brush-pile fishing, is used in a fixed quantity in February only. Its catchability co-efficient is pre-stated (260). It is very effective at catching large species. For both types of gear the catch of a type of fish is the product of number of units of gear, the catchability co-efficient and the fish stock (2020-2030, 3010-3020, 4020-4030).

Two types of management régime operate around the year. The lessee hires fishermen to operate the clearing gear in February and manages fishing with thinning gear for the rest of the season. The flood returns at the end of April and with it open access and a new stock of fish. This is the end of the lessee's planning period.

Fish prices are higher for big species than for small species (230-240). Gear costs are constant (260). There is a constant wage (260).

In February, the lessee's income is the value of the catch less gear and wage costs (3040). Fishermen's incomes are the same as the lessee's wage costs (3030). In other months the lessee chooses the level of employment that gives him the highest total discounted income for the year (5000-5060). Fishermen's income is assumed to be the market wage (2040, 3030, 4040). The lessee takes the catch's value, less fishermen's income and gear costs (2050, 3040, 4050). In other words, this is a Ricardian model where the resource-owner takes in rents or tolls the difference between sales on the one hand and the going wage plus costs on the other.

The model calculates the lessee's total annual discounted income for all employment combinations for one pattern of in-migration (5000-5060). It notes the level of out-migration each month in this run (5060, 7010). It then calculates the lessee's total annual discounted income for all employment combinations for <u>another</u> pattern of in-migration, the pattern of in-migration this time being the same as the pattern of out-migration in the previous run. It repeats this process until two consecutive runs give the same result (7040-7050). This indicates a solution where out-migration, the product of our simulated lessee's decisions, is consistent with in-migration, the product of many other lessees acting in the same way. This outcome is analogous to that of perfect competition, where one producer is a price-taker but the price is formed by many producers acting in the same way. The programme converges upon a solution after only 5 to 10 iterations.

The pattern of employment that maximises the lessee's total annual discounted income for the final, consistent pattern of migration is the model's solution (8000-8030). It is identified to the nearest half-fisherman. It is the only outcome where the lessee cannot improve his income through individual action and the pattern of migration out of his lease unit is the same as the pattern of migration into it.

The model produced a baseline simulation. (Baseline exogenous variables are in Appendix 5.2). The effects of fisheries management policy were then simulated by altering various exogenous variables and observing how the outcome differed from the baseline solution.

Results

The simulation shows that the level of employment is significantly determined by the strength of the incentive upon the lessee to conserve fish stocks; the higher the profits from conservation, the lower the level of employment. Table 11.5 shows levels of employment for different discount rates. Higher discount rates lead to higher levels of employment because they make the lessee want to take profits sooner rather than waiting for fish stocks to grow. The model is thus picking up the arbitrage relationship described by Clark and Munro (1975) and Clark (1976), that profit-maximising fisheries managers will exploit the fishery up to the point where the rate of return upon conservation is equal to the opportunity cost of capital. Table 11.6 shows how the openness of the water-body, the ease with which fish move in and out of the jalmohol management unit, affects the level of employment. As the percentage of fish that escapes from the jalmohol per month varies from 0, a perfectly closed jalmohol, to 100, a perfectly open jalmohol, the lessee's selected level of employment rises from 8 to 22. With no escapement the lessee internalises the benefits from stock-conservation and reduces the use of "thinning gears" in order to improve the low-water catch. With complete escapement, however, the benefits from stock-conservation are completely externalised. Any fish that the model's lessee preserves will swim out to be caught by another lessee. He therefore increases the use of thinning gears in order to catch them as soon as possible.

Table 11.5. The relationship between the discount rate and employment

Discount rate (%/month)	Fishers employed
0	9.0
5	9.5
10	10.0
15	10.5
20	11.0

Table 11.6. The relationship between the jalmohol's openness and employment

Escapement (%/month)	Fishers employed
0	8.0
10	10.0
20	12.0
30	13.5
40	15.0
50	16.0
60	17.0
70	17.5
80	18.5
90	19.0
100	21.0

Artificial stocking with major carps was simulated by increasing the initial (early September) level of stocks of large species. As Table 11.7 indicates, stocking with large species has very little positive effect upon the earnings of self-employed fishermen, even with very high levels of stocking. Although lifting the initial stock of large species from 0kg to 1800kg would raise the net present value of the lessee's income by 226%, it would only raise labour income's net present value by 4.5%. One prediction of this model is therefore that stocking tends to enhance resource rents much more than labour income.

Table 11.7. The effect of artificial stocking with large species upon employment

Initial stock of large species (kg)	Fishers employed
0	10.0
300	10.0
600	10.0
900	10.0
1200	10.0
1500	10.5
1800	10.5

Artificial stock enhancement can moreover decrease labour incomes by strengthening the lessee's incentive to conserve stocks. This, of course, is most likely to happen when the lessee is most able to internalise the benefits of stock conservation because the discount rate is low or the jalmohol is closed to fish migration. Tables 11.8 and 11.9 show the effects of artificial stocking upon employment in each of these two situations. Stocking depresses employment, and therefore labour incomes, in both cases. The negative effect upon employment is strongest when both conditions apply simultaneously (Table 11.10).

Table 11.8. The effect of artificial stocking with large species upon employment with a zero discount rate.

Initial stock of large species (kg)	Fishers employed
0	9.5
300	9.5
600	9.0
900	9.0
1200	9.0
1500	9.0
1800	8.5

Table 11.9. The effect of artificial stocking with large species upon employment with a zero escapement rate (closed jalmohol).

Initial stock of large species (kg)	Fishers employed
0	8.5
300	8.5
600	8.0
900	8.0
1200	8.0
1500	8.0
1800	8.0

Table 11.10. The effect of artificial stocking with large species upon employment with a zero discount rate and a zero escapement rate (closed jalmohol).

Initial stock of large species (kg)	Fishers employed
0	8.0
300	7.5
600	7.5
900	7.0
1200	7.0
1500	6.5
1800	6.5

Fishing bans during the growing season also have an uneven effect. Table 11.11 shows how a delay in the start of the fishing season from September to December will affect the selected level of employment and the net present values of the incomes of fishing labour and the lessee. It predicts that a closed season would induce the lessee to engage more fishermen but, of course, for a shorter time. The net effect is a slender increase in labour's discounted incomes and a spectacular windfall for the lessee.

Table 11.11. The effects of closed seasons upon employment and discounted incomes.

Fishing starts:	Fishers employed	Labour income NPV (August Tk)	Lessee income NPV (August Tk)
September	10.0	64,019	153,603
October	13.5	69,237	184,432
November	18.0	72,327	211,718
December	23.0	69,801	237,359

However, a strong point that emerged from chapter 7 upon the management of effort was that there is a binding locational constraint upon fishing effort and employment; Hail Haor is chock-a-block with fishermen so the amount of gear and the number of fishermen working there are limited by the physical space available. In effect, this is an extreme case of the existence of crowding externalities as described in Chapter 3. Beyond a certain level of effort the marginal cost of effort for the jalmohol becomes infinite and it is physically impossible for effort to increase further . This binding locational constraint, the sudden appearance of prohibitive crowding externalities beyond a certain level of effort, prevents the class of lessees from applying as much effort as they would otherwise wish and therefore acts as a limit to rent-dissipation.Figure 11.1 illustrates this effect for a a perfectly open-access fishery. Without locational constrainrs, resource-users increase their effort until total cost (TC1) equals total revenue (TR) and rents are exhausted. With crowding externalities creating a limit upon effort, however, the TC curve becomes vertical (TC2). With effort thus constrained to e*, rents of TR* minus TC* are produced.

Figure 11.1. Locational contraints enhancing fishery rents

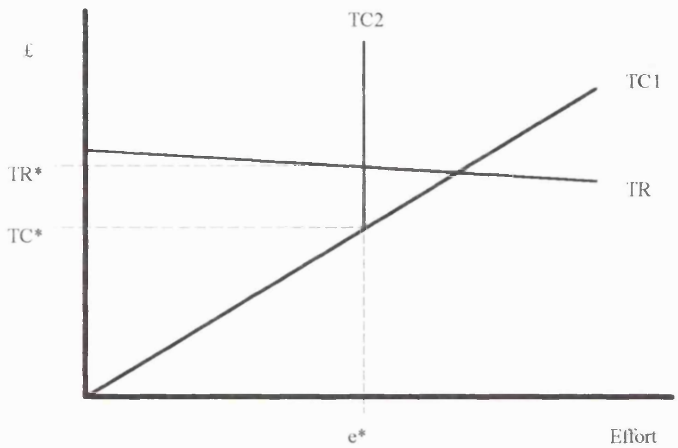


Table 11.12 shows how closed seasons would affect employment and incomes with a binding crowding constraint upon employment (effort). Comparing Tables 11.11 and 11.12, we see that the locational constraint scarcely affects the lessee's income because he recoups from stock conservation most of what he loses from effort restriction. For fishing labour, however, the combination of a closed season and a locational constraint is calamitous. Their period of employment is reduced without any corresponding increase in their level of employment.

Table 11.12. The effects of closed seasons upon employment and discounted incomes, with employment limited to 13.0 by lack of space.

Fishing starts:	Fishers employed	Labour income NPV (August Tk)	Lessee income NPV (August Tk)
September	10.0	64,019	153,603
October	13.0	67,010	185,175
November	13.0	54,118	211,138
December	13.0	42,397	224,296

We have seen that lessees in open water-bodies tend to engage large numbers of fishermen in order to catch fish before they migrate into neighbouring jalmohols. Whilst this is rational for the individual lessee, it depresses the incomes of the class of lessees as a whole because they are engaging more fishing effort than the Clark and Munro stock-cash arbitrage condition would recommend. As Table 11.13, indicates, therefore, lessees would profit from some kind of collective limit upon effort. In other words, lessees of open jalmohols like government effort controls because they ensure a more profitable outcome than lessees could obtain by limiting effort individually. The effects of government effort controls are regressive, however. They harm fishermen by reducing the demand for their labour. In brief, effort controls benefit the sub-lessees, lessees and government officials who receive fisheries rents, but at the expense of fishing labour.

Table 11.13. The regressive effect of government effort limitation.

Maximum employment	Fishers employed	Labour income NPV (August Tk)	Lessee income NPV (August Tk)
no limit	16.0	98,366	115,273
14.0	14.0	86,917	129,212
12.0	12.0	75,468	138,038
10.0	10.0	64,019	143,292

The benefits to lessees from government effort limitation become even larger if the stocks of large species have been enhanced artificially. Table 11.14 repeats the simulation of effort restriction with an initial stock of large species of 1200kg, twice that of the baseline run. The lessees' gain from effort limitation is now 30% instead of 24% and its absolute value has risen from Tk 28,000 to Tk 48,000.

Table 11.14. The yet more regressive effect of government effort limitation after doubling the initial stock of large species.

Maximum employment	Fishers employed	Labour income NPV (August Tk)	Lessee income NPV (August Tk)
no limit	17.5	106,953	159,498
14.0	14.0	86,917	192,451
12.0	12.0	75,468	201,618
10.0	10.0	64,019	207,136

Discussion

This constrained optimisation model has provided analytical confirmation of fishermen's complaints about current policy in Bangladesh. It has found that the effect of artificial stocking, closed seasons and effort controls is to increase the resource rents accruing to sub-lessees, lessees, government officials and the government. Fishermen's incomes are at best little changed and at worst significantly depressed by official management policy.

Artificial stocking enhances resource rents but does not significantly increase the demand for labour. Indeed, in a closed jalmohol it will decrease employment because lessees will place more emphasis upon stock conservation than before.

Closed seasons, as enforced by the Third Fisheries Project and attempted by Hail Haor's Fisheries Officer, raise resource rents spectacularly. Fishermen can just be compensated for the shortening of the season by a subsequent increase in employment. This, however, is unlikely because employment is limited by lack of space so closed seasons will most probably reduce fishermen's discounted income.

Effort limitation, the leitmotif of government management philosophy, raises resource rents and lowers labour income. Lessees in open water have an incentive to press the Fisheries Department for effort controls because they cannot achieve stock conservation by individual action. Effort controls become yet more profitable for lessees if the population of large species has been raised by artificial stocking. As was observed in Hail Haor, artificial stocking re-activates the regressive operation of the Fisheries Act. These results go some way towards explaining the political economy of fisheries management in Bangladesh.

It should be emphasised, however, that the tables above are not intended to be quantitatively representative of Hail Haor or any other water-body in Bangladesh. The aim of the model was to show analytically why fishermen were complaining about government policy. There are too many uncertainties about biological and economic variables for such simulation models to replace direct interviewing as a means of assessing management interventions.

Conclusions

This chapter has used two bio-economic models to analyse the effects of current fisheries management upon the welfare of poorer fisherfolk. The first model showed that the principal effect of effort management was upon the distribution of output rather than upon its overall level. It suggested that closed seasons during the growing season, gear bans and effort limits in general would tend to shift fish sales away from the labour-intensive gears used by poorer fishermen towards the capital-intensive gears used by richer people at low-water. Although the first-round effects of such interventions would probably be regressive, the model could not predict what would happen after lessees had altered effort levels and tolls in response to the new pattern of profitability. The second model looked at these questions and found that, after lessees' response had been taken into account, the effects of artificial stocking, closed seasons and effort limits would tend to be regressive. Closed seasons and effort limits would benefit rich people by raising the value of rents, whilst harming poor people by reducing the demand for their effort. A particularly interesting result was that lessees in open jalmohols had little incentive to limit effort themselves but did have an incentive to press for government-imposed effort limits.

Three important themes emerge from the models' results. Firstly, because the response of physical yields to effort-limitation is minimal, the main effects of effort management are upon the distribution of income rather than its total value. Second, a distinctive effect of effort controls is divert fish from the gears of one socio-economic class into the gears of another. Thirdly, there is a structural conflict of interests between rentiers, who benefit from less effort, and fishing labour, which benefits from more.

The author is not aware of any existing models that explicitly simulate the distributional effects of fisheries policy in this way. This chapter has shown conclusively, however, that it is very important for fisheries managers to be conscious of the distributional implications of their work. Without this awareness, one is likely to harm poorer fisherfolk in the name of productivity.

Chapter 12

The impact upon income distribution of an intensification of inland fisheries in developing countries: three theorems.

Background

It has become a commonplace that inland fisheries in developing countries are suffering from the degradation of fish habitats. The response of many governments and donor agencies has been to attempt to compensate for a reduction in the extent of inland fisheries by increasing the productivity of those that remain, using aquaculture and artificial stocking to restore their yields. This chapter investigates whether a shift from extensive to intensive fishing systems will tend to raise the incomes of poor fisherfolk in a world of fishing leases and scarce capital.

Three economic theorems are applied to this question. They model socio-economic phenomena that have been observed by this study and by other social scientists studying inland capture fisheries in Bangladesh (Blanchet and Talukder 1992; Rahman, Azad, Rathyit and Habib 1992a; Rahman, Azad, Rathyit and Habib 1992b, Wood 1990). They derive changes in labour's income from changes in a fishery's ecology. In economic language, they predict how rational agents with given factor endowments will respond to a shift in the production possibility frontier and what will be the consequences for factor incomes. Before presenting the models, therefore, the salient ecological and institutional features of the model's fishery must be presented. They will constitute the assumptions.

Labour, equipment and access to water (*de facto,* if not *de jure*) are required for the exploitation of a fishery, and the way in which these factors are brought together in Bangladesh's inland capture fisheries has been described in earlier chapters. Those with enough capital to purchase fishing-rights from the government and to provide equipment to fishermen become the effective masters of the resource. They sub-let these water-rights, either directly to fishermen or to Team-leaders, who recruit the labour that will fish the water-body. The lessee (*ijaratdar*) maintains control over the resource at his own expense by means of a team of water-bailiffs (*lathial, paharadar*). Because this is costly, controls are most tightly enforced when the fishery is at its most profitable, which is when the floodwaters have retreated, fish are concentrated and fish size is at its seasonal maximum. In this paper, organisation of the fishery will be modelled in terms of a profit-maximising Master, the lessee, employing unorganised labour to exploit the fishery. This is economically equivalent (Kremer 1992) to the lessee's charging user-fees.

The total extent of Bangladesh's inland fisheries is currently being reduced by the implementation of a Flood Action Plan (FAP), which is transforming former floodplains into enclosed polders. It is the aim of the Government of Bangladesh to compensate for the reduction in the area of fish habitats by artificially stocking the remaining water-bodies with hatchlings and fingerlings (Sklar 1992), mainly of quick-growing carps such as Katla, Rohu, Mrigal, Silver Carp, Common Carp and Grass Carp. Government policy in other countries, for example Indonesia and Thailand (Hardjamulia and Rabegnatar 1987; Paweputanon 1987) appears also to be based on the belief that restocking will compensate for a reduction in fish habitats. As a starting-point for the first theorem, therefore, this optimism will be taken at face value and it will be assumed that an x% reduction in the extent of a fish habitat is counter-balanced by an aquaculture-induced x% increase of the fish population density of the remaining waters, and that the shrinkage of the fish habitat does not materially affect that population's rate of growth and reproduction.

A defining ecological feature of Bangladesh's inland capture fisheries is their seasonality. The fish habitat is replenished by the monsoon rains (June-September) which permits a rapid growth of fish biomass. Between December and March the waters recede and fish concentrate in the remaining depressions, which may be natural (*beel*) or man-made (*kua*). With large fish concentrated in small areas at this time of year, fishing is more profitable than at the height of the flood, when fish are still small and dispersed over a wide area. The second theorem will show that this has important implications for the distributive impact of artificial stocking.

In Bangladesh, fishermen and entrepreneurs compete for sub-leases. The former have more difficult access to capital but the latter have to bear the costs and risk of management and supervision. These observations constitute the assumptions of the third theorem.

Theorem 1: a surplus production analysis of artificial stocking.

As explained above, it is assumed that a reduction in the extent of the fishery has been "cancelled out" by a corresponding increase in the productivity of the remaining waters. This ecological change may be described in terms of Schaefer's "Surplus Production" model of the fishery (Schaefer 1957). He derived the following relationship from empirical fisheries data:

$$f(P) = k_1 P(M - P) \qquad (1)$$

where P is fish biomass

$f(P)$ is the natural rate of growth of fish biomass

M is the non-zero biomass at which $f(P) = 0$.

k_1 is a constant

The rate of growth of fish biomass is an inverted-U function of the current stock of fish biomass. At very low biomass levels, biomass growth is restricted by low population. At very high biomass levels, biomass growth is restricted by a shortage of nutrients.

We may restate the policy-maker's optimism about the effectiveness of artificial stocking by assuming that it restores k_1 and M to the initial values that they held before the ecological change.

Schaefer's second equation described the response of a fishery to fishing effort:

$$L = k_2 EP \qquad (2)$$

where L is the weight of landings.

E is a measure of fishing effort.

k_2 is the "catchability co-efficient".

In other words, the probability of any one kilogramme of fish being caught and landed is a direct multiple (k_2) of the amount of fishing effort applied to the water. The catchability co-efficient may be conceptualised as follows:

$$k_2 = vr$$

where v is the fraction of the total fishery covered by one unit of effort.

r is the probability that any kilogramme of fish finding itself in that fraction of the fishery will be caught.

Seen thus, it appears reasonable to reflect the fall in the extent of the fishery by a rise in v, which is tantamount to a rise in k_2. Maintaining the parameters of equation (1) unchanged whilst raising k_2, one is effectively stating the aim of artificial stocking, that the fishery's productive capacity be maintained, but in a smaller body of water.

Unless the fishery is over-exploited to the extent that it is heading towards extinction, it will tend towards an equilibrium where landings, L, are equal to biomass growth, f(P). Substituting landings for biomass growth and

$\frac{L}{k_2E}$ for P (from equation 2)

into equation (1), landings are derived as a quadratic function of effort:

$$L = k_2EM - (k_2{}^2E^2/k_1) \qquad (3)$$

Schaefer simply specifies fishing costs as a linear function of effort:

$$C = gE$$

where g is the unit cost of effort.

This model, however, divides fishing costs into wage costs and equipment costs. If the labour and equipment markets are competitive and constant factor proportions are maintained, then:

$$C = HQE + WIE \qquad (4)$$

where Q is the ratio of equipment to effort.
H is the cost of using one unit of equipment.
I is the ratio of labour to effort.
W is the market wage rate.

If the fish market is competitive and the water-estate is small enough to be a price-taker, then the lessee's gross revenue is given by:

$$Y = pL \qquad (5)$$

where Y is the lessee's gross revenue.
p is the market price of fish.

The lessee's operating profits $(Y - C)$ are therefore described by the expression:

$$R = pk_2EM - (pk_2{}^2E^2/k_1) - HQE - WIE \qquad (6)$$

Differentiating with respect to E, the response of the lessee's profits to a unit increase in the application of effort is obtained:

$$\frac{dR}{dE} = pk_2M - (2pk_2^2E/k_1) - HQ - WI$$

$$\frac{d^2R}{dE^2} = -2pk_2^2/k_1$$

The negativity of the second derivative indicates that the lessee's profits are at a maximum when dR/dE is equal to zero. Defining E^* as the level of effort that maximises the lessee's profits,

$$E^* = \frac{k_1M}{2k_2} - \frac{k_1(HQ + WI)}{2Pk_2^2} \qquad (7)$$

Defining labour's income when the lessee is maximising his profits as (WIE^*),

$$WIE^* = \frac{WIk_1M}{2k_2} - \frac{WIk_1(HQ + WI)}{2Pk_2^2} \qquad (8)$$

The intensification of the fishery was described above as a rise in k_2. The impact of the intensification upon labour's income may therefore be expressed as:

$$\frac{d(WIE^*)}{dk_2} = \frac{-WIk_1M}{2k_2^2} + \frac{WIk_1(HQ + WI)}{Pk_2^3} \qquad (9)$$

It can be shown that this term is negative (i.e. the intensification lowers the wage bill) whenever:

$$HQ + WI < \frac{PK_2M}{2}$$

What does this condition mean? The left-hand side of the expression represents the constant average cost of effort. The right-hand side represents average revenue when the fish stock is at the level $(M/2)$ that produces the maximum sustainable yield (MSY). The inequation says, therefore, that labour will lose from intensification if average cost is less than average revenue at MSY. In other words, fishermen will lose from intensification if the fishery is profitable at MSY. One may assume from their susceptibility to over-fishing that most developing-country fisheries fall into this category[1].

The shift from an extensive to an intensive fishery is illustrated in Figure 12.1. The effort-yield relationships before and after the change are illustrated by two inverted parabolas. By subtracting total costs from the yield curves a pair of lessee profit curves are obtained. It is apparent that the curve representing profits after the shift peaks at a lower level of effort than the curve representing profits before the shift. This suggests that the lessee will apply a lower level of effort to the fishery, which would imply a lower level of labour income.

Unlike Theorem 1, which describes a change in a fishery's multi-year equilibrium, Theorems 2 and 3 look at how the pattern of fishing changes within the year itself.

Theorem 2: The time-distribution of managerial controls.

The theorem above assumes that the lessee exercises control over the water-estate at no cost to himself. In reality, however, the lessee must police the water. He must not only ensure that only fisherfolk contracted to him exploit the fishery. He must also ensure that they only operate in the specified areas with the specified gears. Where the lessee's rent is determined as a share of the catch, or the agreement specifies that all fish must be marketed by the lessee, as is frequently the case, the lessee must monitor the catch as well as the effort.

In Bangladesh, therefore, managerial control is costly for the lessee. Ullah (1985) reports that the cost of creating a team of water-bailiffs (lathials/paharadars) in the Jamuna river fishery constitutes such a significant sunk expense that it prevents competition between prospective leaseholders. Blanchet and Talukder report that the leaseholder of the Bogiani jalmohol in Shanir Haor in north-east Bangladesh employed a team of fifty paharadars for wages of around Tk900 per head per month. With the leaseholder responsible for their food, his policing bill could amount to around Tk67,500 (US$1,690) per month. This may be compared with an annual lease value of Tk475,300 for the same fishery.

It is evident, therefore, that the lessee will be least willing to incur these policing costs when the fishery offers low rents, that is when fish are small and dispersed during the flood season. He will be most willing to incur them when the fishery is at its most

---

1 If a fishery had average revenue less than average cost at MSY it would be immune to over-fishing, even under open-access, because it would not be profitable to take the effort level beyond that which produces MSY.

profitable, after the water's retreat. The inter-action of this process with the artificial introduction of fast-growing fries is likely to reduce the income of poor fisherfolk. This may be illustrated by a simplified model of the fishery.

The fishery starts the beginning of the season with an exogenously-determined biomass of fish. This biomass has a natural rate of increase across time. The fisherfolk around the water-body apply a constant level of effort to the fishery (assuming no feedback from biomass to effort), which generates a constant level of fishing mortality in the way described by Schaefer's equation (2) above. These assumptions generate an expression for fish biomass.

$$P_t = A(1+G)^t(1-X)^t \qquad (10)$$

Where P_t is fish biomass at time t.

A is the stock at the season's beginning $(t=0)$.

G is the rate of natural biomass growth (net of natural mortality).

X is the rate of fishing mortality.

The value of the catch at any time is given by

$$L_t = \pi X P_t = XA(1+G)^t(1-X)^t \qquad (11)$$

Where L_t is landings at time t.

π is the price of fish, assumed constant

In reality the fish stock would grow geometrically (equation 10), but, for the sake of algebraic simplicity, a linear approximation will be used to analyse the relationship between the introduction of a more rapidly-growing fish population and the income of fisherfolk across the season. Supposing that the catch is increasing at a constant rate over time, such that

$$L_t = M + tN$$

where N is the increase in the value of landings between t and $t-1$.

M is the initial level of the value of landings

By inspecting equation (11) one surmises that a rise in A or G would lead to an increase in the absolute rate of change ofthe value of landings for all time periods. Increases in t and

N describe the effects of artifical stocking upon the initial value of the catch and its rate of growth.

The lessee will assume control of the water-estate at t*, which is when the estate's profits start to cover the cost of enforcing his ownership.

$$M + t^*N - WIE^* = C$$

or

$$t^* = \frac{C + WIE^* - M}{N}$$

where:

C is the cost of enforcing his ownership.
(Equipment costs are omitted for ease of analysis.)

Fisherfolk will receive the catch until t* and wages thereafter, so their total income for the season will be:

$$\int_{t=0}^{t=t'} \{Ft\}\,dt = \int_{t=0}^{t=t^*} \{Lt\}\,dt + WIE^*(t' - t^*)$$

where:

t' denotes the time at the end of the season
F_t is fisherfolk's income at time t

The path of F_t across time is illustrated in Figure 12.2 by income line 1. As the graph indicates, fisherfolk's income may be divided into three components, the basic catch until t*, the catch increase until t*, and wages after t*.

$$\int_{t=0}^{t=t'} \{F_t\}\,dt = Mt^* + \frac{t^*(C+WIE^*-M)}{2} + WIE^*(t' - t^*)$$

or

$$\int_{t=0}^{t=t'} \{F_t\}\,dt = \frac{(M+C-WIE^*)(C+WIE^*-M)}{2N} + WIE^*t'$$

The first derivative of this expression with respect to N describes the impact of the introduction of faster-growing species into the water-estate.

$$\frac{d \int_{t=0}^{t=t'} \{Ft\}\,dt}{dN} = \frac{(M+C-WIE^*)(M-C-WIE^*)}{2N^2} \qquad (12)$$

This effect is represented in Figure 12.2 by the shift from income line 1, with an initial income growth rate of N, to income line 2, with the faster initial income growth rate of N'.As stocking tilts the income line upwards, fisherfolk receive higher incomes at the start but lose direct access to the water and become hired labourers at an earlier date (t*'). Their gain from the increased initial rate of growth is represented by the shaded triangle x. Their loss from moving earlier to hired employment is represented by the shaded quadrilateral y.

The denominator expression 12 will be positive so long as landings are growing across the season.
$(M-C-WIE^*)$ will be negative for all fisheries in which enforcement is unprofitable at the start of the season. This implies that, for the fisheries that interest us, artificial stocking will raise fisherfolk's incomes if and only if

$$WIE^* > M + C$$

In other words, wage earnings must be higher than the sum of the initial catch and the leaseholder's control costs. By increasing the value of the fishery, artificial stocking has brought forward the date upon which the water-lord decides to enforce control. This will lead to a reduction in fisherfolk's incomes unless the leaseholder's wage bill is substantially higher than the initial value of the catch.

In order to reach this conclusion two approximations were made; first, the level of effort applied to the fishery was fixed irrespective of the fishery's profitability; secondly, landings were assumed to increase arithmetically rather than geometrically. There is no *prima facie* reason, however, to believe the conclusion to be dependent upon these approximations. Inspecting Figure 12.2 it is clear that an upward shift in the income line, no matter what its shape, will bring forward the time when it crosses the WIE^*+C line.

Theorem 3: The time distribution of costs and benefits.

This theorem starts with two observations; that the government, in order to avoid default, collects fishing lease payments before the start of the fishing season and that, with an imperfect capital market, poorer people tend to have a higher marginal subjective rate of discount than richer people (in other words, they would be prepared to pay a higher interest rate for credit). These phenomena inter-act with a water-leasing system and an artificial stocking programme to reduce the incomes of self-employed fishermen. The theorem goes on to predict that restocking will induce a shift in the fishery from self-employment to hired fishing gangs.

Some inland, open-water fisheries in Bangladesh are open to exploitation by richer entrepreneurs using hired labour. The maximum price such an entrepreneur would offer for a water-estate lease would be:

$$V = \frac{(Y - wL - C)}{(1 + r_1)} - M$$

Where:

V is the lease price, including any bribes, offered by the entrepreneur
Y is the value of fish yields
w is the wage rate for hired labour
L is profit-maximising labour use
C is profit-maximising non-labour costs
M is the entrepreneur's margin for his time, risk-taking and control costs
r_1 is the rate at which the entrepreneur discounts costs and benefits from the fishing period back to the lease payment date

The analysis continues by considering a water-estate exploited by self-employed fishermen. They can only have obtained the lease by outbidding the entrepreneur. Thus, they must pay at least V in official transfers and bribes to gain access to the water. Having gained access, therefore, their net income, discounted to the date of lease payment, will be:

$$I = \frac{Y - C}{} - V$$

$(1 + r_2)$

or

$$I = \frac{Y - C}{(1 + r_2)} + \frac{(wL + C - Y)}{(1 + r_1)} + M \qquad (13)$$

where:

I is the discounted net income of self-employed fishermen

r_2 is the rate of discount of self-employed fishermen

By assumption:

$r_2 > r_1$ (the fisherfolk have a higher subjective rate of discount than the entrepreneur.)

The effect of restocking on the self-employed fishermen may be expressed as the rate of change of self-employed fishermen's net income with respect to the value of fish yields. By differentiating (13) the following expression is obtained:

$$\frac{dI}{dY} = \frac{1}{(1 + r_2)} - \frac{1}{(1 + r_1)} \qquad (14)$$

The right hand side of this equation is always negative because the rate of discount of self-employed fishermen is greater than the rate of discount of richer entrepreneurs. In other words, the income of self-employed fishermen will tend to be reduced by artificial stocking if they are competing with entrepreneurs for leases.

Stocking raises the lease price. (This was observed in two water-bodies stocked by the Third Fisheries Project in 1992. In one the artificial stocking led to a significant rise in the lease price. Another, for which access had been open, had its dormant leasing system revived.) Because the entrepreneur has a lower subjective rate of discount, restocking has a higher net present value to him than to the fisherfolk. The fisherfolk have to bid for the lease at the <u>entrepreneur's</u> valuation (much higher than before stocking) but they only benefit at <u>their own</u> valuation (a little higher than before stocking). They therefore lose more than they gain.

This theorem could in fact be applied to any situation where people of differing economic status are bidding for a factor of production in fixed supply. It could, for example, be used to describe the effect upon income distribution of the arrival of high-yielding varieties into a land-scarce economy.

There is, moreover, a point at which self-employed fishermen will no longer compete with entrepreneurs for access to water. If their opportunity cost of labour ("shadow wage rate", "reserve wage") is w^*, then they will be happy to compete for a lease so long as the present value of net fishing incomes is greater than w^*L. The point at which self-employed fishermen are indifferent between fishing and withdrawing is that which only permits them to earn the opportunity cost of labour, or:

reserve wage = income - lease price

$$\frac{w^*L}{(1+r_2)} = \frac{Y - C}{(1 + r_2)} + \frac{(wL + C - Y) + M}{(1 + r_1)}$$

or

$$\frac{w^*L}{(1+r_2)} - \frac{wL}{(1+r_1)} = (Y - C)\left(\frac{1}{(1+r_2)} - \frac{1}{(1+r_1)}\right) + M \qquad (15)$$

Bearing in mind that r_2 is greater than r_1, two conclusions becomes apparent from expression (15). Firstly, higher levels of Y, which are the goal of artificial stocking, only permit fishermen with lower opportunity costs of labour to remain in self-employment. Those with higher opportunity costs of labour will not outbid the entrepreneur and will be replaced by his hired hands. Secondly, the higher M is, the easier it is for fishermen to earn more than their reserve wage.

This theorem therefore suggests that artificial stocking will induce two changes in the pattern of fisheries exploitation. In some fisheries the incomes of self-employed fishermen will be eroded. In others, self-employed fishermen will be replaced by entrepreneurs using hired labour. This could conceivably create a small increase in labour income, but only if fishermen were earning less than the hired labour wage before the increase in fish yields.

Conclusions

This paper has described the socio-economic processes that one might expect to follow fish stocking in a leasehold fishery. The lines of causation were not identified by means of the economic theorems above. On the contrary, they were described to the author by fishermen themselves and it then only remained to translate their complaints into the language of neo-classical economics.

The first theorem above suggests that artificial stocking is unlikely to compensate poor fisherfolk for a decline in the area of fish habitats; the size of the habitat determines the demand for labour whereas the intensity of stocking determines profits. The second theorem goes on to argue that artificial stocking might aggravate the exclusion of poor fishermen from fishing grounds. If stocks are improved the leaseholder will assert control over the fishery earlier in the season. The third predicts that artificial stocking will reduce the incomes of self-employed fisherfolk, sometimes to the extent that they are replaced by hired labour. Re-stocking raises the lease value beyond what fisherfolk can afford.

Taken together, these theorems suggest that employment, labour income and labour's access to fish stocks may be reduced by artificial stocking. One concludes with the well-worn observation that project design should not only consider technical aspects of production but also the economics of the allocation of benefits.

Figure 12.1. Fishery intensification

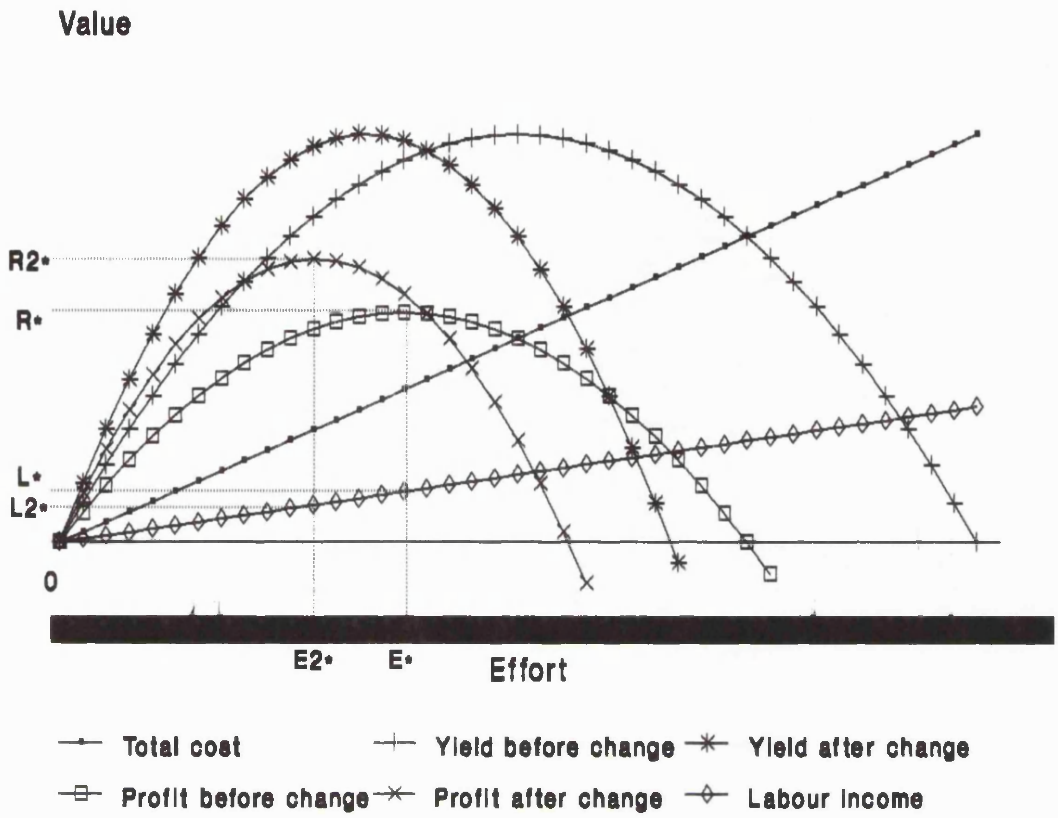
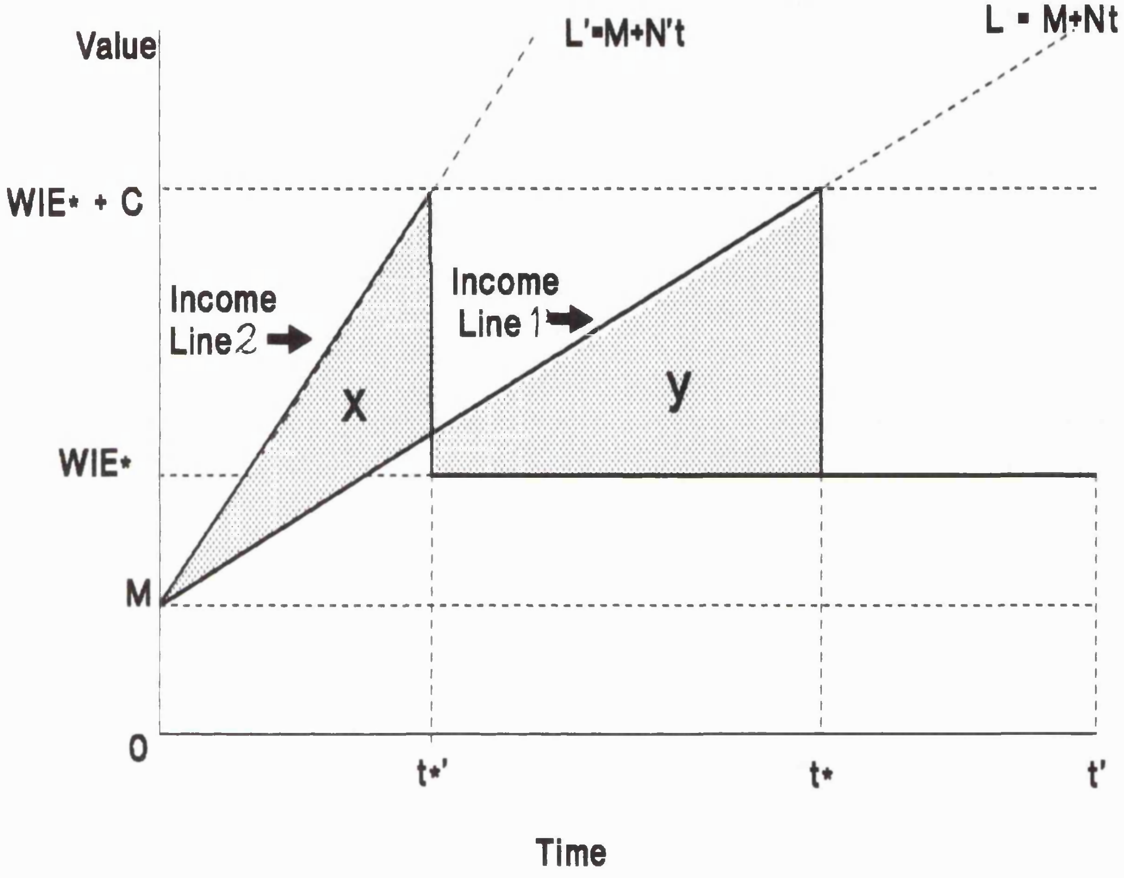


Figure 12.2. Fishing labour's income over time



Chapter 13

Pauperised by empowerment: renewable resource reform without capital-market competition.

---

0 Introduction

The control of renewable resources in developing countries by an élite is often cited as an obstacle to equitable development. A substantial literature (for example: Bailey 1982, Feeny et al. 1990, Panayotou 1982, Runge 1986, Dryzek 1987, Buck 1989, Ostrom 1990, Redclift 1992) argues that collective management by communities can provide a more equitable outcome. It argues, moreover, that collective resource management will prove as least as effective as private ownership in preventing Hardin's (1968) "Tragedy of the Commons", the depletion of the resource's physical productivity through uncontrolled access. The implied policy prescription is a transfer of control over resources from élites to local communities.

An illustrative example is provided by Bangladesh where "water-lords" control access to inland fisheries, frequently financing their operations with development-bank loans at a low nominal (McGregor 1989) or even negative real (Ahmed 1989) interest rate (Ahmed 1989). Bangladesh's New Fisheries Management Policy attempted from 1986 onwards to shift control over fishing rights from lessees to fishermen's collectives. Commentators (World Bank 1991, Rahman 1989, Siddiqui 1989, Naqi 1989) have approved the policy's design. They note, however, that implementation has been accompanied by social problems, to wit "leaseholder interference", "non-coherence of co-operatives", "domination of co-operatives by élites", "rivalry between fishermen", "restriction of credit availability by middlemen". They conclude nonetheless that unequal power relationships are an obstacle to equitable development and that the transfer of water-rights is a step in the right direction.

The model below explores the economic processes that follow the transfer of a natural resource from a rich owner to a poorer user group when the users remain dependent upon the ex-owner for capital. It predicts that the transfer of natural resource property rights in such circumstances will not help and is likely to harm the intended beneficiaries. It provides an analytical explanation of the persistence of vertical social alignments after the resource transfer. In brief, it qualifies the case for renewable resource reform.

1 Assumptions

1.1 Production function

There is a renewable natural resource, in this case a fishery. Output is produced by applying labour (l) to it, but the labour cannot work without equipment, such as fishing boats and nets, and working capital for wage advances and food. The value of equipment and capital at any one time constitutes the capital stock (k) applied to the natural resource.

This model uses the classic Schaeferian (Schaefer 1957) inverted-U renewable resource production function; as effort is applied to the resource, total production first rises because of increased exploitation and then falls because of stock depletion. The inverted-U is expressed in quadratic form, but the results hold so long as the marginal reponse of the renewable resource to inputs is always falling.

In this model it is difficult to substitute labour for capital or vice-versa. Remaining with the fisheries example, one could think of a varying number of fishing teams each operating with a fixed amount of labour, boats, nets and working capital. That is to say that the capital stock can stand as a measure of effort and the amount of labour used is also a constant multiple (I) of the value of the capital stock.

$$l = Ik \qquad (1)$$

The maximum value of the renewable resource's yield is A. The value of the capital required to produce A is M. The value of actual output is y. If the actual amount of capital applied is more or less than M, then y is always less than A. This relationship can be expressed as a quadratic function. Since labour use is a fixed multiple of the capital stock, the production function can be written in terms of capital alone.

$$y = A - B(M-k)^2$$

$$l = Ik$$

A, B, and M are all positive. B is a technically-determined constant. The production function can also be written as follows:

$$y = A - BM^2 - Bk^2 + 2BMk \qquad (2)$$

$$1 = Ik$$

If we differentiate with respect to k, we obtain:

$$\frac{dy}{dk} = 2B(M-k) \qquad (3)$$

$$1 = Ik$$

and

$$\frac{d^2y}{dk^2} = -2B$$

$$1 = Ik$$

(4)

In other words, the additional value (marginal value product) produced by each unit of capital is $-2B$ less than the additional value produced by the previous unit. This might be due to resource depletion or price effects or both.

1.2 Organisation of the resource

Three management régimes will be modelled as three different scenarios. In Scenario One the "Master" leases the water-body to fishermen. In Scenario Two any fisherman can use the water-body. In Scenario Three "community resource management" prevails. The fishermen control their own fishing effort so as to maximise profits. In all three scenarios, however, the Master is the fishermen's sole source of capital.

1.2.1 Scenario One

The model contains three groups of actors.

First, there is the Master, who has used his political influence to acquire not only proprietary rights to the renewable resource but also access to a source of cheap capital. McGregor (1989) describes how influential people in rural Bangladesh are able to obtain subsidised development bank credit. For analytical simplicity this paper models the

Master's cost of capital as zero. The results, however, only depend upon the Master having a lower opportunity cost of capital than the fishermen.

He works the renewable resource by hiring members of the second group, Labourers who have no capital of their own and can only work with capital provided by the Master. At the moment, however, the Master hires them at Labour's standard wage (w).

The variables for this scenario will be indicated by $'$. Thus,

k' is the stock of capital in use.
y' is the value of output.
R' is the Master's income from this renewable resource.
L' is Labour's income from this renewable resource.

1.2.2 Scenario Two

If the government reforms the management of the renewable resource, we may come to Scenario Two. The Master can no longer control entry to the renewable resource, but he still has a monopoly of capital. In this scenario, the Team-leaders determine how much labour is applied to the renewable resource, but they do so individually, not collectively. In other words, a classic "open access" situation exists.

The variables for this scenario will be indicated by $^{\circ}$. Thus,

k° is the stock of capital in use.
y° is the value of output.
R° is the Master's income from this renewable resource.
L° is Labour's income from this renewable resource.
T° is the Team-Leaders' non-Labour income.

1.2.3 Scenario Three

If the government removes the Master's power to control entry to the renewable resource, it may be transferred to a collective of Team-leaders, somehow selected from among what was formerly the Master's pool of hired labour, producing a situation of "community resource management". If there are different exploitation technologies the Team-leaders will commit themselves collectively to the most profitable option.

The variables for this scenario will be indicated by *. Thus,

k^* is the stock of capital in use.

y^* is the value of output.

R^* is the Master's income from this renewable resource.

L^* is Labour's income from this renewable resource.

T^* is the Team-Leaders' non-Labour income.

1.3 Government objectives

The government (or its donors) was dedicated to "development with equity" and the improvement of the welfare of "the poorest of the poor". In practice, it wished to improve the welfare of Labour, and especially those labourers without the capacity to become Team leaders.

It therefore decided to deprive the Master of the right to control access to the natural resource. The analysis below will show that the effect was not what the government intended.

2 Scenario One

The Master's revenue is determined by the production function, Equation (2) above. His capital costs are zero and his labour costs are given by:

$$L = Wl$$

or $L = WIk$ (5)

So his net income (R) is given by:

$$R = A - BM^2 - Bk^2 + 2BMk - WIk \qquad (6)$$

The marginal return to him of each additional unit of capital investment is given by:

$$\frac{dR}{dK} = 2BM - 2BK - WI$$

That R is at a maximum when $dR/dK = 0$ is confirmed by:

$$\frac{d^2R}{dK^2} = -2B < 0$$

To maximize his net income (profits), the Master therefore sets

$$k' = M - \frac{WI}{2B} \qquad (7)$$

In other words, he decides to obtain less than the maximum sustainable yield in order to reduce his labour costs.

We can obtain total output (y'), the Master's income (R') and Labour's income (L') by substituting into Equations (2), (5) and (6) above. In this Scenario, it will be remembered, potential Team-leaders receive the standard wage from the Master, so $T' = 0$.

$$y' = A - \frac{W^2 I^2}{4B}$$

$$R' = A - WIM + \frac{W^2 I^2}{4B}$$

$$L' = WIM - \frac{W^2 I^2}{2B} \qquad (8)$$

Total output (y') is shared between the Master (R') and Labour (L'). This is an allocatively efficient outcome in the sense that the Master has maximised fishery rents. It is an objective of distributive policy, however, that these rents should go to Labour. The government decides, therefore, to abolish the Master's control and the effects of this are considered in Scenarios Two and Three.

3 Scenario Two

The Master no longer controls access to the renewable resource and an "open access" situation exists. So long as average revenue is greater than average cost, Team-leaders have an incentive to work the resource with more labour and more capital. The Team-leaders do not only pay wages. They must also pay a rental to the Master for his capital. This rental amounts to *rk*, where *r* is the effective rate of interest charged by the Master. So, Team-leaders will add labour and capital until

$$y = rk + WIk$$

Substituting into the production function (2), we obtain:

$$rk = A - BM^2 - Bk^2 + 2BMk - WIk \qquad (9)$$

Now that the Master does not manage the resource, his only source of income is interest income. In other words,

$$R = rk$$

So we find that the Master's income function for the open access fishery (9) is exactly the same as that for the fishery under his own management (6). He therefore supplies the same quantity of capital:

$$k = k^O = k' = M - \frac{WI}{2B}$$

Because Team-leaders under open access add inputs until their rents are dissipated, Team-leaders' non-Labour income is zero, as before. The same value of capital is supplied as before, employing the same amount of labour at the same wage. It is therefore inevitable that the incomes of all three parties are the same as before.

$$y^O = A - \frac{W^2 I^2}{4B}$$

$$R^O = A - WIM + \frac{W^2 I^2}{4B}$$

$$L^O = WIM - \frac{W^2 I^2}{2B}$$

$$T^O = 0$$

The Master's share of output is unchanged, the only difference being that it is now represented by a rate of interest instead of a rate of return on capital.

$$r^O = \frac{R^O}{k^O} = \frac{R'}{k'} = \frac{A - WIM + \frac{W^2 I^2}{4B}}{M - \frac{WI}{2B}}$$

The sociological phenomena that accompany natural resource reform may be described in economic terms. Labour is now paying an effective interest rate of R^O/K^O. This is the "persistence of exploitation." The Master maximises his income by restricting the supply of capital, giving it to some teams and not others, effectively deciding who works. This is "domination of collectives by the élite." Individuals vie for access to the Master's limited supply of capital; this is "factionalism". The government may observe these phenomena and conclude that a promising reform was undermined by unfavourable social factors. In fact, natural resource reform alone was not sufficient to transfer resource rents to the fishermen because it only cut one strand of the multi-stranded relationship between the Master and Labour.

4 Scenario Three

The government has again removed the Master's power to limit access to the renewable resource, but that power is now vested in a collective of Team-leaders. They make profits (T) from the sale of fish (y) less labour costs (WIk) and the rental of capital (rk). By Substituting into (2), we obtain their profit function.

$$T = A - BM^2 - Bk^2 + 2BMk - WIk - kr \qquad (10)$$

We can differentiate this function with respect to k to obtain the incremental (marginal) profit to the Team-leaders from employing an incremental unit of capital.

$$\frac{dT}{dk} = 2BM - 2BK - r - WI$$

That T is at a maximum when $dT/dk = 0$ is confirmed by:

$$\frac{d^2T}{dk^2} = -2B < 0$$

Team-leaders will employ capital until the marginal profit from employing it is zero ($dT/dk = 0$). We thus obtain the profit-maximising level of capital use for any given interest rate or, in other words, the demand curve for capital.

$$k = M - \frac{(r + WI)}{2B} \qquad (11)$$

or $r = 2BM - 2BK - WI$

After the government reform, the Master's only income is from capital rental:

$$R = rk = 2BMk - 2Bk^2 - WIk \qquad (12)$$

The rental of an incremental unit of capital will bring him an incremental income of:

$$\frac{dR}{dk} = 2BM - 4Bk - WI$$

That R is at a maximum when $dR/dk = 0$ is confirmed by:

$$\frac{d^2R}{dk^2} = -4B < 0$$

In order to maximise his income, the Master will supply capital until $dR/dk = 0$, so he sets:

$$k^* = \frac{M}{2} - \frac{WI}{4B} \qquad (13)$$

Total output (y^*), Labour income (L^*), Team-leaders' non-wage income (T^*) and the Master's income (R^*) are obtained by substituting k^* (13) for k into equations (2), (5), (10) and (12).

$$y^* = A - \frac{BM^2}{4} - \frac{MWI}{4} - \frac{W^2 I^2}{16B}$$

$$L^* = \frac{MWI}{2} - \frac{W^2 I^2}{4B}$$

$$T^* = A - \frac{3BM^2}{4} - \frac{MWI}{4} + \frac{W^2 I^2}{16B}$$

$$R^* = \frac{BM^2}{2} - \frac{MWI}{2} + \frac{W^2 I^2}{8B}$$

Once again, a comparison with the results of Scenario One shows that the architects of the natural resource reform were disappointed. Although Team-leaders are now receiving resource-rents, Labour's income has been halved by a fall in employment, producing an unequivocal reduction in income for those not in a position to manage a team. (L is always reduced, but only by exactly 50% if the biological response function is quadratic.) The total effort applied to the resource has been halved. Since k was less than M before the reform, a reduction in k necessarily produces a reduction in total output.

In fact, it can moreover be shown that open access (Scenario Two) is superior to this community resource management, both in terms of allocative efficiency and equity. Since the result of open access was identical to that of management by the rent-maximising Master the open access result is also rent-maximising. The community resource management option, being different, is therefore necessarily allocatively inefficient. A comparison of L^* with L^O also shows that the employment prospects of Labour are worse under collective resource management than under open access.

Figure 13.1 provides a visual illustration of the three scenarios. As it shows, communal resource management restricts the Master's access to the marginal product of capital and thus provides him with a motive to restrict the supply of capital. It also illustrates the vanity of hoping that resource rents will simply be transferred with the resource. For resource rents to be at a maximum under communal management as they were under private ownership, the Master's income must be zero; in other words, he must provide free credit.

(Proof: The hoped-for outcome is one where $T = R'$. The only way to produce resource rents $(y-L)$ as high as R' is for output to be y', which in turn requires capital use to be k'. This requires labour use to be l' and therefore Labour income to be L'. Since $y = L+T+R$ and y and L are unchanged, the only way for T to rise from 0 to R' is for R to fall from R' to 0.)

Once again, it is possible to put an economic interpretation upon the sociological phenomena that accompany natural resource reform. Under collective resource management the Master continues to draw an income by restricting the supply of capital. This appears as "domination of collectives by the élite" and the competition among Team-leaders for capital manifests itself as "factionalism". Moreover, the excluded Labour and the Master have an incentive to ally themselves to destroy the collective and move to open access (Scenario Two). The excluded Labour could appear as a rival faction. Once again, the government might conclude that a promising reform was hindered by unfavourable social factors. The weakness of the reform was that it distorted Labour's dependence upon the Master without destroying it.

5 Conclusion

A set of strong predictions has been derived from the assumptions of a quadratic production function and a monopolistic money-lender with relatively cheap access to capital. The predictions, like the assumptions, will describe different situations to different degrees. Where empirical research shows the assumptions to be relevant, this model constitutes a qualification of the case for collective resource management.

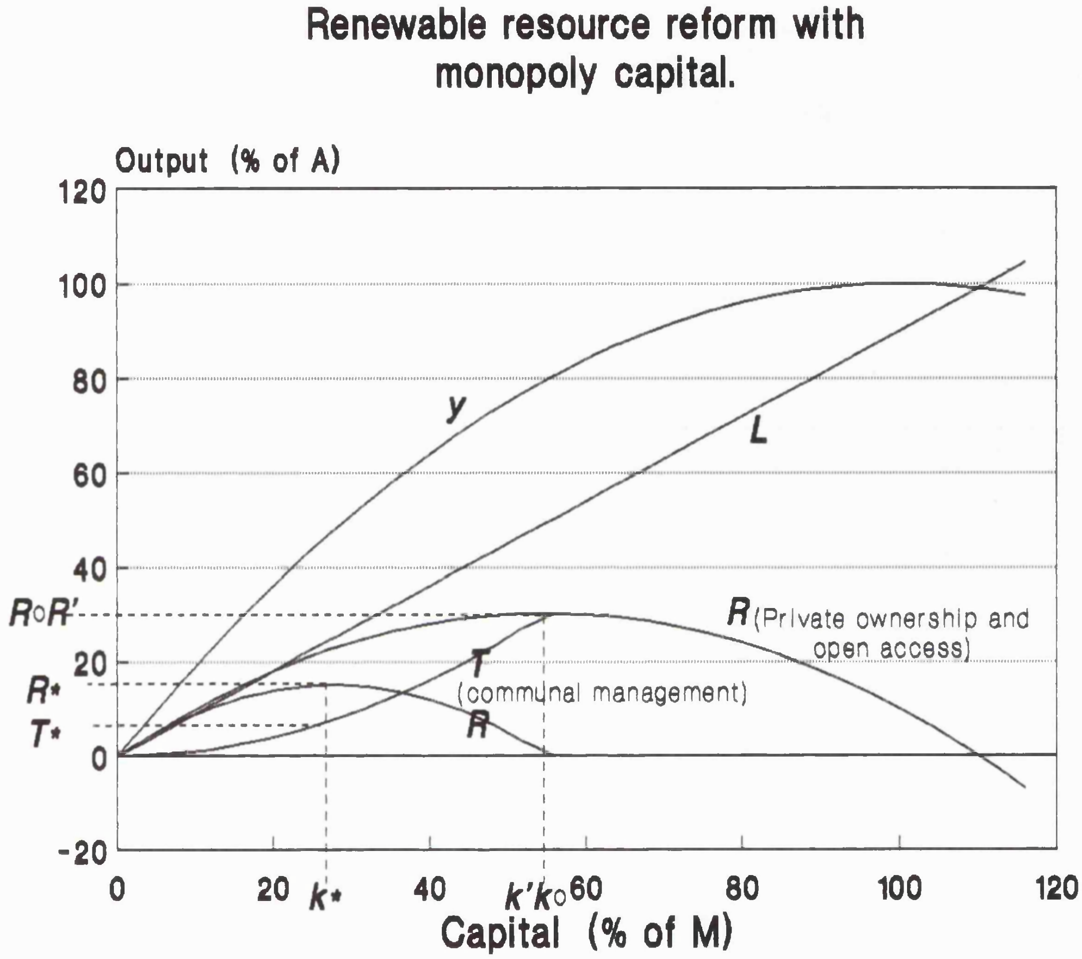
Collective resource management is currently in vogue. Its proponents argue that it is as allocatively efficient as private ownership whilst being distributively superior. The conversion of private property rights to collective resource management is therefore a popular policy prescription. This model has shown, however, that the presence of a monopoly of capital, a common occurrence in some countries, reverses the policy prescription. In this case, collective resource management is probably less allocatively efficient, more exclusive and therefore less favourable to those with only their labour to sell than private ownership.

The proponents of collective resource management argue that, as a replacement for private property, it is at least superior to open access. This model has shown, however, that open access with a monopoly of capital produces exactly the same outcome as private property.

These findings are of importance both for the analysis of past events and for the appraisal of future policies. Students of development and economic history often wish to deduce why some land reforms succeed and others fail. This model suggests that the competitiveness of the capital market is a determinant. Contemporary policy-makers should also be advised by this model that natural resource reform may be counter-productive unless undertaken within a liberalised capital market.

Lastly, the model illustrates that a policy process relying solely upon social observation and a commitment to equity will not necessarily attain its objectives. The methodologies grouped under the title "participatory development" are based upon the belief that policies are improved by consulting and empowering local people (see for example Redclift 1992). This model shows, however, that the removal of perceived "exploitation" may be counter-productive. Where there are multiple ties between patron and client, the cutting of one strand refashions the client's dependence without destroying it. There is no *a priori* reason to believe that the remoulded relationship will be superior to the old one. This paper suggests one way in which it could be inferior. It is therefore essential for policy-makers to supplement their desire for social equity with an understanding of the nature of economic subordination. Otherwise they may unwittingly bring about pauperisation by empowerment.

Figure 13.1. Three scenarios of tenurial reform



Chapter 14

Implications of the study for the management and assessment of inland capture fisheries in Bangladesh

Introduction

This thesis started, in chapters 1 and 2, by posing an number of questions about the impact of inland capture fisheries policy upon poorer people. Although government and donors were actively intervening in the sector in the name of poverty-alleviation, there was little understanding of how their interventions were affecting different groups of participants in the fishery. It was true that a number of studies of Bangladeshi inland capture fisheries were available but they did not address the question of how fishery economies worked and how policy affected them. In chapter 2, therefore, the thesis set itself the goal of describing how fisheries incomes were created and allocated and how policy interventions would affect their value and distribution. Chapter 3's review of fisheries management literature found that there was a lack of established theory upon the distribution of benefits, with existing models concentrating upon rent-maximisation rather than poverty-alleviation; new assessment methodologies would therefore be needed.

Chapters 5, 6 and 7 set about addressing the research problem with a qualitative description of how incomes were created and allocated in the Hail Haor fishery. Chapters 5 and 6 laid out the factors of production, water, fish, gear and people, and chapter 7 went on to explain the transactions whereby they are combined to make livelihoods of differing quality for each group of fishery participants. Then chapters 8, 9 and 10 quantified the economic outcome. They showed how incomes were divided between labour and rentiers and between richer and poorer fisherfolk and used micro-economic theory to explain the pattern of allocation. Chapters 11, 12 and 13 modelled how policy interventions such as artificial stock enhancement and effort controls would affect the distribution of income.

At this point, therefore, one is finally in a position to say how fisheries management affects poor people. The aim of this chapter is to bring together the findings of the study and, referring back to the initial questions posed in chapter 2, to their implications for the management of Bangladesh's inland capture fisheries. Firstly, to address the specific issue of how donors should intervene in this sector, the distributional impact of various policy interventions will be discussed. After that, the second part of the chapter will broaden the scope of enquiry to consider how such fisheries should be assessed in general. The chapter's main theme will be that current fisheries policy is distributionally regressive and that a new approach to fisheries assessment could open the way for more progressive policy interventions.

Qualification of the study's findings

Before analysing the effects of specific policy measures it is first necessary to ask how far the study's findings from Hail Haor are applicable to other water-bodies in Bangladesh. There are two possible obstacles to generalisation: Hail Haor could be a special case because of its physical ecology or because of its social systems. It if is, the study's general applicability should be qualified.

As a broad ecological generalisation, the haors of Greater Sylhet are different from floodplains elsewhere in Bangladesh in that they tend to retain water for longer after the end of the monsoon. This has implications for the pattern of effort. Whereas Hail Haor supports labour-intensive, moveable gears such as hooks, traps and gill-nets throughout the year, it is common for other floodplains to stop fishing altogether around January or February. This was confirmed quantitatively by a catch-effort study of Third Fisheries Project water-bodies (BCAS 1992). The Hail Haor results therefore probably describe a fishery with a relatively important "thinning gear" sector as defined in Chapter 11.

What then would a comparatively long floodplain season imply for the economics of income-distribution? Both the bio-economic models in Chapter 11 showed that, the shorter the floodplain season, the more incomes a redistributed away from poorer, self-employed fisherfolk with cheap gears towards fisheries rents and the owners of brush-piles and dewatering areas. This study of Hail Haor probably therefore describes an unrepresentatively labour-intensive and low-rent fishery.

Turning to the question of whether the social systems of the Hail Haor fishery are typical of Bangladesh's floodplain fisheries, the FAP 17 Project found a huge variety of contractual arrangements in inland capture fisheries across the country. Although the control of the economic surplus by local influential people was almost universal, it was expressed in different ways in different water-bodies (P. Townsley *pers. comm.*). Hired fishing labour was predominant in many floodplains, in contrast with the mostly toll-paying, self-employed labour of Hail Haor. One reason may have been that Hail Haor had longer moveable-gear fishing seasons and that the supervisory cost of employing dispersed fishermen on the floodplain would have been prohibitive.

What does the variation in contractual arrangements imply for the general applicability of the Hail Haor results? It has been shown elsewhere (Kremer 1992) that the economic outcome would be identical whether rents are appropriated via labour hire, toll-collection, a marketing monopsony or a capital equipment monopoly. The variety of contractual arrangements across the country could therefore be determined by differences in the technological efficiency of supervisory systems rather than substantive differences in the economics of surplus-allocation.

In brief, then a few points can be made about the application of this study's findings to other water-bodies. Firstly, because different fisheries have different ecologies, it should not be assumed that the level or distribution of output in other water-bodies will resemble this study's quantitative estimates for Hail Haor. Second, any observations made about the exclusion of poorer people from fisheries benefits are likely to be even clearer in other fisheries than in Hail Haor because of the shorter labour-intensive season. Thirdly, the economic principles of fisheries benefit allocation are likely to be similar across the country.

Critique of policy interventions

It is now possible to answer the questions about fisheries policy that were originally posed in chapter 2. They shall be considered in turn:

What are the effects of effort management upon incomes, employment and the distribution of income?

Chapter 10 described how self-employed fishermen perceived effort controls to be affecting their livelihoods. They disliked gear bans and closed seasons because they reduced their ability to maintain a flow of income from fishing. They did not perceive themselves to be benefiting from the yield gains that are supposed to follow from effort controls because they did not think they had access to the combinations of gear, season and location whereby the larger fish would be caught.

Chapter 11's bio-economic models confirmed the fishermen's perceptions of effort controls. MRAG's (1994) multi-guild, multi-gear, yield-per-recruit model of the Hail Haor fishery predicted that total yields would not exhibit a positive response to reductions in effort. A multi-fishery surplus production ("Schaefer curve") plot did not show any evidence that the high density of fishing effort in Hail Haor was depressing yields. The principal impact of effort controls, therefore, could be upon income-distribution rather than total productivity.

A bio-economic model based upon MRAG's simulation predicted that the principal immediate effect of effort controls, whether in the form of bans upon moveable gears, closed seasons or overall effort reductions, would be to shift incomes away from poorer fishermen and towards richer brush-pile owners. A bio-economic simulation of lessees' decision-making similarly predicted that closures during the growing season would at best not benefit fishing labour and would at worst, if there was a locational constraint upon fishing effort, harm labour severely.

Two economic processes explained these findings about the distributional impact of effort controls. Firstly, as chapter 8 modelled, there is a Ricardian trade-off between rents, which accrue to lessees, sub-lessees, venal officials and the government, and labour income, which accrues to fishermen. The former derives from the margin between sales and costs, which will be an inverse function of effort in a fishery like Hail Haor where total sales are unresponsive to effort. The latter depends upon employment, which is a direct function of effort. Second, as chapter 9 explained, a household's choice of technique is determined by its economic status. Growing-season effort controls preserve fish from techniques that are labour-intensive and therefore essential to poorer people for techniques that are capital-intensive and therefore dominated by richer people.

There is legitimate concern that over-fishing may be causing recruitment failure for larger species such as the major carps. There is therefore an economic case for creating reserve areas or restricting the use of gears that catch sexually immature major carps. This would imply bans on brush-pile fishing, which would be opposed by politically-powerful local élites.

To sum up, the finding of this study is that effort controls have little effect upon yields and enhance rents at the expense of income from employment. They are therefore distributionally regressive.

Licensing is intended to transfer fishing rents from the lessee to the fisherman. Does this occur? Is the lessee's current share high enough to justify the programme's administrative costs?

The theoretical discussion in chapter 13 predicts that a shift from leasing to licensing will not transfer resource rents from the lessee to fishing labour if the lessee retains control of the supply of capital. RRA findings from two New Fisheries Management Policy (NFMP) jalmohols (Appendix 6) show that the NFMP simply operated as the leasing system by another name. This was because the existence on paper of the NFMP failed to break the venal link between the lessee and government officials on the one hand and because the lessee retained factional support from fishermen in his own community on the other. (An explanation of the resilience of patronage relations in fishing factions was presented in chapters 7 and 9.) The evidence of this study therefore strongly suggests that a shift from leasing to licensing alone will not transfer fishing rents from lessees to fishermen.

Chapter 2 described the Target Group Approach used by NGOs to confer water-rights upon fishing labour. The justification for such interventions is that group action with NGO support can undermine the vertical patronage alignments that maintain the leasing system. The question then arises: "Is the share of tolls sufficient to justify the administrative costs of transferring water-rights?"

Chapter 8 presented this study's findings upon the potential value of rent redistribution. One important result was that, contrary to popular opinion, poorer fishermen paid a very low share of their gross income as tolls and most of this was attributable to lessees' intermediation costs. The effect of a cancellation of tolls upon poverty in the fishery would thus be insignificant. This policy probably receives political support because it would benefit the richer people who pay high tolls to use profitable gears such as brush-piles and pump-dewatering. The implication is that a shift from leasing to licensing would only raise the incomes of poorer fisherfolk if an NGO not only supported the Target Group's claim to water-rights but also assisted the Target Group to take over the capital-intensive gears previously owned by richer people.

To what extent does the leasing system encourage or prevent over-fishing?

The previous discussion of effort controls is of course relevant here. Their main effect was found to be the regressive redistribution of income rather than the prevention of biological overfishing. So far as the reduction of poverty is concerned, therefore, any policies, such as the extension of lease periods, which encourage lessees to restrict effort, are likely to be counter-productive.

Both sides in the debate over leasing use stock management arguments in support of their case. Opponents of leasing say that the lessee, unlike fishing labour, only has a short-term interest in the water-body and will therefore tend to over-exploit fish stocks. Supporters of leasing, on the other hand, argue that lessees can expect to hold a lease for many years, especially now that 8-10 year leases are available, and will therefore control over-fishing.

The finding of this study is that lessees' management of effort depends upon the hydrology of their jalmohol. If the jalmohol is closed then the benefits from effort management can be internalised. If the jalmohol is open and fish can swim in and out, on the other hand, lessees have no incentive to conserve fish biomass. The bio-economic model of lessee decision-making in chapter 11 showed that the openness of a jalmohol is a major determinant of the level of effort employed. The prediction is backed up by a comparison between effort management in Hail Haor, where the use of many gears is limited only by lack of space (chapter 7), and effort management in closed jalmohols, where lessees themselves shut down the fishery during the growing season (Appendix 6).

To sum up the study's findings on leasing and over-fishing, rent-maximising stock management should not be an objective in the design of property rights for these fisheries. Lessees use effort-limitation to shift income from labour to rents, not to increase yields, and their propensity to do so is, in any case, largely determined by their jalmohol's hydrology.

What are the effects of artificial stocking upon incomes, employment and the distribution of income?

One justification for the programme of artificial stock enhancement in Bangladesh was that it would raise the incomes of poor fisherfolk. Aid donors usually state that most of their projects should improve the livelihoods of poor people and that they would reject an otherwise viable project if it disrupted the livelihoods of poorer people. This study has found that artificial stock enhancement does not benefit poorer fisherfolk and may in certain circumstances cause them hardship.

Chapter 10 described how Hail Haor's poorer fishermen perceived the ADPII's stocking programme to be affecting them. They believed that they did not have access to the combination of location, season and gear that would enable them to catch the stocked fish. Some thought they were being harmed by the stocking programme because it led to an intensification of effort controls. Chapter 11's bio-economic model of lessees' decision-making predicted that almost all the benefits from artificial stocking would accrue to lessees, sub-lessees, officials and the government as rents. Any benefits to fishing labour through changes in the level of employment would be minimal, even for very high levels of stocking, and would be negative for closed jalmohols where the lessee was able to internalise the benefits of reducing effort. The model's simulation of closed seasons predicted that lessees with open jalmohols would be induced by artificial stocking to put pressure upon the government to restrict effort, which would reduce labour incomes by lowering the level of employment.

Two economic processes explain the regressive action of artificial stocking. Firstly, a Ricardian model of factor share determination predicts that a rise in the value of output will enhance rents rather than labour income if the derived demand for labour is inelastic with respect to the value of sales; the inelasticity could be caused by locational constraints upon employment or, in the case of a closed water body, a low internalised marginal value product of labour. Secondly, as chapter 9's account of choice of technique predicts, poorer fisherfolk will tend to be excluded from those combinations of location, gear and season where the stocked major carps will be caught.

The finding of this study is therefore that artificial stocking is a strategy for rent-enhancement rather than poverty-reduction. It may harm poorer fisherfolk's livelihoods if it creates stronger incentives for effort controls, which could be imposed directly by the lessee and sub-lessee or indirectly, on their suggestion, by the government and its donors.

If flood control embankments reduce the area of the floodplain, how will this affect fishing income and employment?

Chapter 7's study of effort-determination found that the level of effort, and therefore of employment, in the Hail Haor jalmohols was limited by lack of space. It described how competition for fishing space over supposedly open-access flooded private land had led to the establishment of territorial property rights. It is therefore highly probable that a reduction in the area of the floodplain would lead to a proportionate fall in labour use and therefore in the incomes of poorer fisherfolk. Chapter 8 estimated that Hail Haor supported 77 work-hours per hectare-month of flooding. With the average fishing household fishing for around 300 work-hours per month, one can estimate very approximately that the loss of four hectares of floodplain in a particular month would deprive one fishing household of its livelihood for that month.

What rôle could NGOs' Target Group Approach play in fishery development?

The rôle of NGO Target Groups in development in Bangladesh has been discussed in an extensive academic and professional literature. There is a consensus that they can give poorer people economic security and a greater share of the product of their labour by giving them direct access to productive assets. The question then arises of what role this approach could play in the inland capture fisheries sector.

As the preceding paragraphs upon licensing explained, self-employed fishermen in Hail Haor generally receive almost the entire value of their output after the costs of production have been taken into account. This is in marked contrast to agriculture, where the rent share is much more important, with sharecropping landowners appropriating around half of gross output as rents (Jansen 1987). Chapter 7 reported that fishermen usually own their own gear and sell their fish into a competitive market. The use of Target Groups to create new market relations within the existing productive system would therefore probably not improve fishing households' income. It would conceivably be possible for Target Group participants, with NGO support, to move into the more profitable late-season fishing activities from which they are currently excluded. This alone, however, would involve no net increase in the level of employment or the value of output because one set of operators was simply being replaced by another.

There are therefore a very restrictive set of conditions under which the NGO Target Group Approach could improve employment or productivity in the fishery in an equitable manner. Firstly, it must give Target Group participants effective ownership of the jalmohol. Without this, any increase in productivity will accrue to the leasing system through tolls. Second, it must allow Target Group participants to operate the more profitable, rent-producing sub-fisheries. Without this, any increase in productivity will accrue to the existing operators of capital-intensive gears. Third, it must raise the productivity of the fishery, probably by artificial stocking since that is the only intensification technology currently available. Without this, as chapter 8 demonstrated quantitatively, the value of rents available for transfer to fishing labour will be negligible. Finally, it must operate in a closed jalmohol. Without this, any of the new rents available because of intensification will be externalised through fish out-migration. Taken together, these four conditions are challenging to say the least. They have been met for some jalmohols in the IFAD/DANIDA/BRAC Ox-Bow Lakes Project in S.W. Bangladesh, which explains its partial success in creating equitable fishery development. The ecological and social difficulties of meeting these conditions in more open water-bodies which are exploited by many fishing factions mean that its success may not be replicated elsewhere.

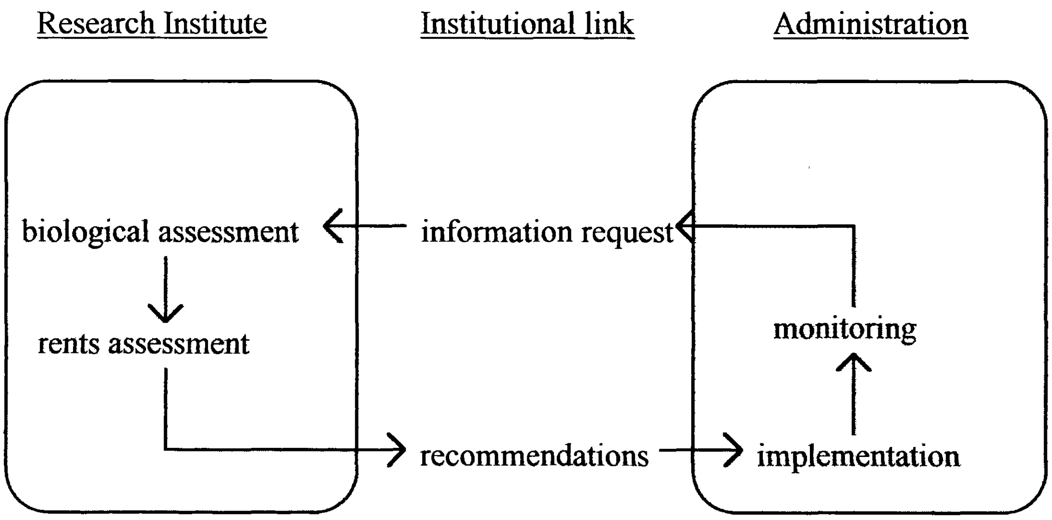
Methodologies for the poverty-oriented assessment of tropical inland capture fisheries

Chapter 3's review of the literature upon fisheries management found a consensus upon the procedures that the economic assessment of fisheries should follow. Gulland's FAO Fisheries Circular (Gulland 1983) summarises the orthodox approach to fishery assessment: the assessor's task is to use biological stock assessment techniques to advise the administrator of the pattern of effort that will maintain the fishery's productivity. The orthodox model of assessment can therefore be typified as "productivity-driven". It is also technocratic, in the sense that it assumes that an "administrator" has the intention and the ability to control the activities of fishers so as to secure the desired pattern of production. Fisheries management economics has remained firmly within the same productivity-driven, technocratic framework. Its contribution, as outlined in chapter 3, has been to emphasise economic rents as the most appropriate productivity target variable and to describe ever more complex relationships between effort management and rents.

Figure 14.1 stylises the orthodox approach to fisheries assessment. A biologist assesses the catch-effort relationship by means of surplus production or yield-per-recruit analysis.

This is transformed by an economist into a rent-effort relationship. The assessment team recommends a new pattern of effort, which the administrator enforces. Monitoring reveals new effort levels which necessitate ongoing assessment.

Figure 14.1. The orthodox model of fisheries assessment (simplified from Gulland 1983)



There are three important reasons why this model of fisheries assessment is not suitable for the management of inland capture fisheries in Bangladesh. Firstly, the use of rents as a target variable is inappropriate. Chapters 1 and 2 explained that income-distribution was a key issue in rural development in Bangladesh and that the stated intention of the Government of Bangladesh and its donors was to make fisheries management an instrument of poverty-reduction. As chapter 7 describes, rents accrue to richer members of society so a rent-maximising strategy would enrich the rich yet further. The incomes of fishing labour or of poorer households would therefore be a more suitable target variable. Second, the technocratic model of effort control is inappropriate. It should be accepted that fisheries officials do not have the resources to finance programmes of effort control and that most direct interventions will therefore be in response to political or financial incentives from local influential people. Third, the emphasis upon rigorous biological stock assessment is not cost-effective. As chapter 8 explained, total yields are likely to be fairly unresponsive to fishing effort in such multi-gear, multi-species, highly "r-selected" fisheries. The main impact of management measures is therefore likely to be upon income-distribution rather than yields. Yield-per-recruit or surplus production assessment typically requires accurate biological samples to be taken at least every month for a period of several years and data analysis requires skills that are currently scarce or unavailable in developing countries. An assessment which concentrates upon formal stock-assessment techniques is therefore likely to produce little policy guidance at a high cost.

Some alternative methodological approaches to the poverty-oriented assessment of tropical inland fisheries will be discussed below. The first, unattractively named "socio-ecological niche analysis", attempts to highlight the distributional impact of policy interventions by identifying relationships between economic status and resource use. The second, "factor-share analysis", applies Ricardian theory to the same question. The third, Participatory Resource Assessment, is already a key element in RRA and social anthropology toolkits. It will be argued that special care must be used in applying it to common-pool resources.

Socio-ecological niche analysis

Chapters 9 and 10 applied socio-ecological niche analysis to the Hail Haor fishery. The author has also applied it to the Lempuing River fishery in S. Sumatra, Indonesia and the Thale Noi fishery in the Songkla Lakes, Thailand. The theory underpinning this resource assessment methodology is that poorer people occupy a "socio-ecological niche", a particular locus, in the resource use system. This concept is analogous to that of an "ecological niche", the position in the ecosystem to which an organism is specifically adapted. Just as a guillemot, for example, is only physically and behaviourally capable of exploiting certain foods, poorer people are often only entitled by society and the market to exploit the common-pool resource in certain ways.

Poor people's socio-ecological niche will be determined by a combination of economic and social factors, including:

* the cost and riskiness of different techniques of resource-exploitation
* the cost of access to different parts of the resource-exploitation system
* the social links required for access
* cultural beliefs relating resource-exploitation to socio-economic status
* the skills or education required for different techniques of exploitation

The methodology for the socio-ecological niche assessment of renewable common-pool resources falls into three steps. The first is to disaggregate the resource-use system into its component activities. A renewable biological resource, for example, could be broken down by species exploited, season, location and technique of exploitation. The second step is to identify the socio-ecological niche occupied by poor people in these dimensions. An important possibility is that poorer people may be excluded altogether. The final step is to assess how resource management policies operate, not upon the resource system as a whole, but upon poor people's locus within that system.

Factor share analysis

This assessment methodology is based upon the conceptual division of sales into three components, non-labour costs, the opportunity cost of labour and economic rents. The value of output accruing to resource-poor participants will be the opportunity cost of labour multiplied by the level of employment plus whatever their entitlement to rents may be. Economic theory predicts that the allocation of rents will be determined by the property-rights regime. Under open-access, rents will be dissipated by an expansion of non-labour costs and the opportunity cost of effort. Under private property, rents will be appropriated by the owner. Chapter 7 described how Hail Haor exhibited a regime of insecure private property, where the owner allowed labour to receive a portion of rents in order to secure their political support for his property rights.

The factor share analysis methodology attempts to predict what factor shares will accrue to resource-poor participants in different policy environments. To do so, it needs to assess:

* how policy interventions will affect the level of employment, because one component of the resource-poor's income is the opportunity cost of labour multiplied by the level of employment
* how policy interventions will affect the value of resource rents accruing to resource-poor participants

This thesis has illustrated the application of factor shares analysis. Chapter 10 used quantitative data to apply it to the Hail Haor fishery and Chapter 11 built a factor-share-determination model into a bio-economic simulation of the impact of policy interventions upon lessee decision-making.

Participatory Resource Assessment

Chapter 10 of this thesis used Participatory Resource Assessment, the identification of the impact of policy interventions jointly with resource-users themselves by means of informal discussion and structured interviews. Participatory Resource Assessment has several potential advantages over orthodox assessment methodologies. It uses Indigenous Technical Knowledge (ITK), and is therefore sometimes able to obtain information more cheaply and more accurately than formal scientific methods. It involves resource-users and is therefore more likely to produce recommendations that they will support. Thirdly, when income-distribution in an issue, Participatory Resource Assessment is able clearly to identify the interests of different socio-economic groups. Its long-term goal is often a system of "Co-Management" (Berkes, George and Preston 1991), where the fisherfolk manage the fishery with legal and technical support from the state.

Although Participatory Resource Assessment is a promising methodology for the poverty-oriented assessment of tropical inland capture fisheries, the experience of this study (chapter 4) highlights some possible problems:

a) There can be a lack of congruence between what fishers and policy-makers are trying to obtain from the assessment. Fishers are aiming to increase their share of a biomass yield that they cannot improve through their own individual actions. Policy-makers, on the other hand, are aiming to increase the biomass yield itself. This is different from the case of RRA in agriculture where both farmers and policy-makers intend to improve yields.

b) There may be a lack of ITK on biomass production. Fishers, unlike farmers, have little incentive to acquire knowledge about biomass production because they are not in a position to affect it; they take it as given. Secondly, fishers, again unlike farmers, cannot see how biomass is produced because the production takes place out of sight under the water.

c) Since one fisher's harvest subtracts from that of others, there is an economic disincentive to share technical knowledge. Acheson (1981) found secretiveness to be a general characteristic of fishing societies.

These characteristics of common-pool resources imply that the practice of Participatory Resource Assessment may be rather different from that in the agricultural sector. The assessment is likely to produce zero-sum recommendations, where the participant suggests a change that will benefit some people while creating an equal and opposite loss for others. An example of this is the case of the Bangladesh NGOs who respond to fishermen's requests for credit to buy gear. With fishery benefits limited by fish stocks and fishing space, the purchase of gear by an NGO target group is likely to drive another group off the water without raising either yields or employment. Such zero-sum recommendations are likely to be discriminatory, where the participant suggests a change that will benefit him by harming another socio-economic group. Brush-pile owners' calls for closed seasons fall into this category, as do the caste fishermen's demands that "non-fishermen" should be excluded from some jalmohols.

In short, the finding of this study was that Participatory Resource Assessment was a quick, cheap and effective way of identifying the response of different socio-economic groups to the various policy interventions on offer. It was essential, however, not to take the respondents' recommendations at face value. The same conclusions emerged from the author's RRA studies of floodplain fisheries in Indonesia and Thailand.

Final conclusion

This chapter has summarised the findings of the 1992-4 study of the Hail Haor fishery in N.E. Bangladesh. A qualitative account of social, economic and institutional transactions in the fishery had been quantified with formal survey data and analysed by means of micro-economic models and simulation programmes. The final product was a reasoned analysis of the distributional impact of fisheries policy in Bangladesh. Policy interventions were found to be distributionally regressive. They worked to enhance the resource rents accruing to local influential people, government officials and the government. As a side-effect, they often harmed poorer fisherfolk. There was a conflict of interests between rentiers and labour because reductions in effort simultaneously raised rents and depressed labour income.

Orthodox approaches to fisheries assessment have not served poorer fisherfolk in tropical inland capture fisheries well because they have targeted rents, which accrue to richer people, rather than the income of poorer people. They have also ignored the political economy of policy-formation, which tends to be rent-led rather than labour-income-led. Alternative fisheries assessment methodologies have been proposed to redress this imbalance. "Socio-economic niche analysis", "factor share analysis" and Participatory Resource Appraisal are capable of delineating the distributional impact of policy interventions.

There are many reasons to be pessimistic about inland capture fisheries in Bangladesh. The competition for fishing space will become ever more acute as population increases. At current rates of growth, the fishing population of Hail Haor will have risen by over 100 households, the equivalent of a small fishing village, since the field research began. Higher competition for fishing space will strengthen the social and economic position of lessees and sub-lessees over fishing labour. The less powerful Hindu fishermen are likely to be displaced yet more from the floodplain and jalmohols as Muslim communities expand. The likely effects of flood control schemes upon fisheries are still unknown and there is a risk of increasing use of destructive fishing techniques such as dewatering, explosives and poison. The argument that "something must be done" about inland capture fisheries is bound to become ever more compelling with time. If fisheries policy continues to be driven by a mixture of the economic interests of lessees and the professional interests of biologists, the call will probably be for more of the same: more artificial stocking, more major carps, more closures. It will therefore become increasingly important for poorer fisherfolk that there should be a countervailing concern for the distributional impact of fisheries management.

Appendices

Appendix 1. Glossary of acronyms and Bengali terms

ADB	Asian Development Bank
adhika patro	fishing licence
ADPII	Second Aquaculture Development Project
aman	autumn rice crop
arotdar	wholesaler
aus	monsoon-season rice crop
baor	ox-bow lake
bel jal	lift net
ber jal	seine net
beel	water-filled depression
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
bel jal	lift net
beel	natural water-filled depression
BIDS	Bangladesh Institute of Development Studies
boshni	a fish trap
BRAC	Bangladesh Rural Advancement Committee
chora	stream
current jal	monofilament gill-net
dalal	tied credit-auction contract
DANIDA	Danish International Development Authority
DC	Deputy Commissioner
DOF	Department of Fisheries
dol (kata)	brush-pile
dori	a fish trap
ENIMOF	Experiments in New Approaches to Management of
Fisheries	
fai jal	gill net
FAD	fish aggregation device
FAP	Flood Action Plan
faron	a fish trap
FCD	flood control and drainage
felun jal	push net
FIVDB	Friends in Village Development in Bangladesh
FSR	farming systems research
ghor	house
gram	administrative / vernacular village
haor	floodplain in N.E. Bangladesh

IFAD	International Fund for Agricultural Development
ijaratdar	leaseholder
IMOF	Improved Management of Fisheries
JMS	Jatiya Motshojibi Somity
jotedar	zamindar's lessee
jolmohol	fishery leasing unit
kanja	manual dewatering
koin	a fish trap
lama para	waterside quarter
lunga	a fish trap
Maimal	Muslim fishing caste
mokha jal	tana jal or felun jal
MSS	Motshojibi Somobaya Somity (fishermen's association)
mut	60 yards
NFMP	New Fisheries Management Policy
NGO	non-governmental organisation
nikari	fish retailer
Nomosudra	Hindu fishing caste
ODA	Overseas Development Administration
paiker	fish porter / trader
panga	fishing by means of macrovegetation
RRA	rapid rural appraisal
shudhi	simple interest credit
taki jal	lifting seine net
tana jal	seine net
Thana	Sub-District (formerly Upazila)
TFO	Thana Fisheries Officer
TFP	Third Fisheries Project
Tk	taka (1993: US$1.00 = Tk25)
TNO	Thana Nirvahi (executive) Officer
Union	administrative area below Thana
USAID	United States Agency for International Development
zamindar	landlord paying tribute to British Indian Government
Zila	District

Appendix 2. Catch, effort, income and cost panel survey form.

```
+-----------------------------------------------------------------------+
|VISIT SHEET                                                            |
°        NAME              Father's name:            No.      Date      °
|A. What work was each hh member doing YESTERDAY?|B.Since LAST VISIT:   |
°Sex| Age| Activity x hours | Income(L/FT/C)     |LUMPY expenses:       |
|   |    |                 |                    |Item              Tk |
+---+----+-----------------+--------------------+YESTERDAY's daily     |
|Permits:(since LAST VISIT)                     |expenses:             |
°Tk  °jalmohol     °  gear  °monthstart°duration°                      |
+----+------------+-------+---------+--------+---------------+---+
| D. Fishing activities YESTERDAY:                                      |
|Sex Age  Gear x hours set    hh/      TOTAL catch    HH    HH income|
|              (place)        group    type x amount  share            |
+---+---+----------------+---------+---------------+-----+---------+
+---+---+----------------+---------+---------------+-----+---------+
|E. Home consumption y'day:|F. Notes.
|                   value  |
|C aught S mall     Tk     |
|B ought O ther            |
+--------------------------+
```

Appendix 3. Brush-pile survey form.

```
Name:______________   Village:___________   Date:___/__/__   ----
                                                              IDolsI

No. in group:____ How shared?____________________________

How many dols has your group built this year?_______
+--------------------------------------------------------+
IAreas (yds x yds)                                       I
I                                                        I
I                                                        I  A
I                                                        I
I                                                        I
I                                                        I
+--------------------------------------------------------+
+--------------------------------------------------------+
IJalmohol cost: Tk_______ Paid in the month of_________  I  B
+--------------------------------------------------------+
+-----------------------------+--------------------------+
IBuilding costs month of____  I                          I
I                             I                          I
ILabour:                          IBamboo:                    I  C
I                             I                          I
+-----------------------------+--------------------------+
I                             I                          I
I                             I                          I
IWood:                            IOther:                     I
I                             I                          I
+-----------------------------+--------------------------+
+--------------------------------------------------------+
I                                                        I
IFinance: Tk________ from arotdar for ___% of sales      I
I                                                        I  D
I         Tk________ interest loan at ___% per month     I
I                                                        I
+--------------------------------------------------------+
+---------------------------------------------------month+
IDol jal:  Month(s) purchased/hired_______________I      I
I                                                 -------   E
ICost of dol jal (Tk / Tk per month)______________I      I
+--------------------------------------------------------+
+--------------------------------------------------------+
IDol fishing until now:                         I        I
IArea  IDays ILab.     IRui katol,     Iother  Isales      I
Iydxyd I     Icost(Tk) Imrigal silver Ifish   ITk net ofI
I      I     I         Icarfu kg      Ikg     Idalal    I
I      I     I         I              I       I         I
I      I     I         I              I       I         I
I      I     I         I              I       I         I  F
I      I     I         I              I       I         I
I      I     I         I              I       I         I
I      I     I         I              I       I         I
I      I     I         I              I       I         I
I      I     I         I              I       I         I
I      I     I         I              I       I         I
+------+-----+---------+--------------+-------+---------+
```

Appendix 4.1. Households living beside Hail Haor (north of 24º21'N only).

Mauza	No. households
Buruna	517
Hazipur	272
Kalapur	480
Monargaon	80
Vimshi	332
Vimshidigak	24
Bhunabir	378
Bhunabir Digar	5
Baulashir	415
Shasan	173
S.Pachaun	243
Mirzapur	418
Shohostri	314
N.Pachaun	126
Total	3777

Appendix 4.2. Effort and catch per household for villages fishing north of the main embankment

	Fai		Felun		Bel		Ber		Taki	
	ThYdH	kg	NtH	kg	NtH	kg	NtH	kg	NtH	kg
Dec	110.3	26.3	14.0	3.8	.0	.0	1.8	2.1	.0	.0
Jan	138.0	15.6	28.5	6.9	.0	.0	1.6	7.7	.0	.0
Feb	48.0	8.0	21.0	3.9	.0	.0	.9	1.0	.0	.0
Mar	56.5	3.2	27.5	4.9	.0	.0	.3	.2	.0	.0
Apr	93.5	12.2	34.7	10.3	.0	.0	2.3	2.3	.0	.0
May	84.1	15.3	40.3	28.5	.0	.0	2.6	2.5	.0	.0
Jun	83.9	21.0	21.8	14.3	.0	.0	2.0	7.4	.0	.0
Jul	38.4	10.6	23.7	14.3	.0	.0	8.5	20.0	.0	.0
Aug	63.4	20.7	20.7	16.3	.0	.0	6.6	9.2	.0	.0
Sep	65.0	14.1	19.2	12.8	.0	.0	2.4	3.0	.0	.0
Oct	50.7	17.2	12.9	6.5	1.8	.9	6.1	11.9	.0	.0
Nov	96.4	15.3	3.3	1.6	1.2	.4	5.0	8.6	1.4	.9

	Hook		BHook		Kotch		Dori		Faron	
	ThHkH	kg	ThHkH	kg	KchH	kg	DiH	kg	FrnH	kg
Dec	10.2	3.0	21.0	5.6	5.1	1.1	2039	7.4	1728	4.1
Jan	16.5	3.2	.0	.0	13.2	2.0	3689	6.7	6300	9.5
Feb	54.6	6.5	.0	.0	4.8	.5	6242	7.1	7632	8.3
Mar	90.6	22.3	.0	.0	5.7	1.5	7612	10.9	9639	18.5
Apr	43.6	11.0	.0	.0	.0	.0	8084	21.6	9718	14.2
May	24.2	11.8	.0	.0	.0	.0	5069	18.5	2459	4.2
Jun	45.0	15.5	.0	.0	.0	.0	1037	2.0	720	.7
Jul	45.7	21.7	9.4	2.9	.0	.0	1349	2.0	1306	1.2
Aug	37.3	26.8	15.2	10.4	.0	.0	4694	7.1	1008	.3
Sep	33.9	17.9	12.6	4.4	.0	.0	3682	9.8	0	.0
Oct	42.8	19.2	11.5	9.5	.0	.0	4563	12.8	144	2.4
Nov	47.1	16.3	12.9	8.2	.0	.0	5698	14.0	484	1.5

	Bosni		Dol	Jhaki		Dry
	BosH	kg	kg	NtH	kg	kg
Dec	.0	.0	.0	.0	.0	2.1
Jan	.0	.0	17.0	2.9	.3	2.4
Feb	.0	.0	19.4	14.0	2.1	13.6
Mar	14.4	.3	4.1	13.5	4.2	8.9
Apr	223.2	.9	.0	1.2	.0	3.8
May	28.8	.2	.0	.0	.0	.0
Jun	28.8	.2	.0	.0	.0	.3
Jul	9.6	.6	.0	4.8	1.8	.6
Aug	28.8	.3	.0	.0	.0	2.2
Sep	36.0	.6	.0	.0	.0	.0
Oct	14.4	.2	.0	.0	.0	.5
Nov	36.0	.5	.0	.0	.0	.1

Note: effort units

ThYdH	thousand yard-hours
NtH	net-hours
ThHkH	thousand hook-hours
KchH	kotch-hours
DiH	dori-hours
FrnH	faron-hours
BosH	bosni-hours

Appendix 4.3. Catch composition by species.

(per cent: "-" indicates missing observation.)

Jun-Aug	Baim	Baliara	Bera	Boal	Boisa	Carp	Chanda
Bosni	-	-	-	-	-	-	-
Cast	-	-	-	-	-	-	-
Dol	-	-	-	-	-	-	-
Dori	.0	.0	2.5	.0	32.5	.0	9.3
Dry	-	-	-	-	-	-	-
Faron	-	-	-	-	-	-	-
Felun	.9	.0	3.2	.0	10.9	.0	5.7
Gill	1.2	.0	6.1	2.4	1.2	3.5	.6
Hook	.9	.0	.3	5.0	.0	.0	.4
BHook	.0	.0	.0	35.0	.0	.0	.0
Lift	-	-	-	-	-	-	-
Seine	1.6	.0	.6	.0	5.0	.0	30.5
Spear	-	-	-	-	-	-	-
Taki	-	-	-	-	-	-	-

	Chingree	Darkina	Gojar	Gonia	Kakiya	Kalbaush	Kalna
Bosni	-	-	-	-	-	-	-
Cast	-	-	-	-	-	-	-
Dol	-	-	-	-	-	-	-
Dori	24.5	3.8	.0	.0	.0	.0	.0
Dry	-	-	-	-	-	-	-
Faron	-	-	-	-	-	-	-
Felun	45.9	.0	6.6	.0	.0	.0	.0
Gill	.0	.0	.0	1.0	1.2	1.6	7.1
Hook	.0	.0	2.6	.0	4.1	.0	16.7
BHook	.0	.0	51.4	.0	.0	.0	.0
Lift	-	-	-	-	-	-	-
Seine	16.8	1.6	.0	.6	2.6	.0	.6
Spear	-	-	-	-	-	-	-
Taki	-	-	-	-	-	-	-

	Kawa	Katla	Koi	Koia	Magur	Mrigal	Mokha
Bosni	-	-	-	-	-	-	-
Cast	-	-	-	-	-	-	-
Dol	-	-	-	-	-	-	-
Dori	.0	.0	.0	.0	.0	.0	1.3
Dry	-	-	-	-	-	-	-
Faron	-	-	-	-	-	-	-
Felun	.0	.0	.0	.9	.0	.0	.4
Gill	.0	3.8	30.9	1.8	1.2	1.5	.0
Hook	.0	.0	5.0	.0	1.1	.0	.0
BHook	.0	.0	.0	.0	.0	.0	.0
Lift	-	-	-	-	-	-	-
Seine	.0	6.9	.8	.9	.0	.0	13.4
Spear	-	-	-	-	-	-	-
Taki	-	-	-	-	-	-	-

	Pabda	Puti	Rui	Shing	Shol	Silver	Taki	Tengra
Bosni	-	-	-	-	-	-	-	-
Cast	-	-	-	-	-	-	-	-
Dol	-	-	-	-	-	-	-	-
Dori	.0	26.3	.0	.0	.0	.0	.0	.0
Dry	-	-	-	-	-	-	-	-
Faron	-	-	-	-	-	-	-	-
Felun	.0	1.1	.0	.5	22.1	.0	1.6	.1
Gill	2.8	17.6	1.8	.6	.6	.0	11.1	.6
Hook	4.7	.9	.0	7.5	1.3	.0	40.3	9.1
BHook	.0	.0	.0	.0	12.1	.0	1.4	.0
Lift	-	-	-	-	-	-	-	-
Seine	.6	4.5	9.4	.3	.6	.0	1.5	1.3
Spear	-	-	-	-	-	-	-	-
Taki	-	-	-	-	-	-	-	-

Sep-Nov	Baim	Baliara	Bera	Boal	Boisa	Carp	Chanda
Bosni	-	-	-	-	-	-	-
Cast	-	-	-	-	-	-	-
Dol	-	-	-	-	-	-	-
Dori	.5	.0	.0	.0	25.5	.0	24.7
Dry	-	-	-	-	-	-	-
Faron	-	-	-	-	-	-	-
Felun	2.4	.0	.1	.0	7.5	.0	11.8
Gill	1.4	.0	21.7	2.0	.0	.0	.2
Hook	4.3	.1	5.8	2.5	.0	.0	.1
BHook	.0	.0	.0	65.0	.0	.0	.0
Lift	.0	.0	.0	.0	.0	.0	7.6
Seine	.4	.0	.0	.0	1.3	.0	16.0
Spear	-	-	-	-	-	-	-
Taki	-	-	-	-	-	-	-

	Chingree	Darkina	Gojar	Gonia	Kakiya	Kalbaush	Kalna
Bosni	-	-	-	-	-	-	-
Cast	-	-	-	-	-	-	-
Dol	-	-	-	-	-	-	-
Dori	30.3	3.0	.0	.0	.0	.0	.0
Dry	-	-	-	-	-	-	-
Faron	-	-	-	-	-	-	-
Felun	43.0	.0	12.6	.0	.0	1.0	.0
Gill	4.9	.0	.7	1.0	1.3	1.0	4.0
Hook	.0	.0	5.4	.2	3.8	.0	23.7
BHook	.0	.0	21.4	.0	.0	.0	.0
Lift	60.8	2.6	.2	.0	1.6	.0	1.0
Seine	7.8	9.6	.0	.0	.6	.0	.0
Spear	-	-	-	-	-	-	-
Taki	-	-	-	-	-	-	-

	Kawa	Katla	Koi	Koia	Magur	Mrigal	Mokha
Bosni	-	-	-	-	-	-	-
Cast	-	-	-	-	-	-	-
Dol	-	-	-	-	-	-	-
Dori	.0	.0	.0	.0	.0	.0	1.5
Dry	-	-	-	-	-	-	-
Faron	-	-	-	-	-	-	-
Felun	.0	.0	.0	7.5	.0	.0	.0
Gill	.0	2.9	30.9	2.1	1.8	.0	.0
Hook	.0	.0	1.2	5.8	2.9	.0	.0
BHook	.0	.0	.0	.0	.0	.0	.0
Lift	.0	.0	.0	.0	.0	.2	.2
Seine	.0	.0	.0	10.7	.0	.0	41.9
Spear	-	-	-	-	-	-	-
Taki	-	-	-	-	-	-	-

	Pabda	Puti	Rui	Shing	Shol	Silver	Taki	Tengra
Bosni	-	-	-	-	-	-	-	-
Cast	-	-	-	-	-	-	-	-
Dol	-	-	-	-	-	-	-	-
Dori	.0	14.8	.0	.0	.0	.0	.0	.0
Dry	-	-	-	-	-	-	-	-
Faron	-	-	-	-	-	-	-	-
Felun	.0	.6	.0	10.3	.8	.0	2.5	.0
Gill	.7	12.8	.5	2.1	.1	.0	7.0	1.0
Hook	.7	.6	.0	3.0	2.2	.0	35.8	2.1
BHook	.0	.0	.0	.2	13.5	.0	.0	.0
Lift	.2	24.0	.4	.0	.0	.0	1.0	.8
Seine	.0	10.6	.0	.0	.0	.0	1.1	.1
Spear	-	-	-	-	-	-	-	-
Taki	-	-	-	-	-	-	-	-

Dec-Feb	Baim	Baliara	Bera	Boal	Boisa	Carp	Chanda
Bosni	-	-	-	-	-	-	-
Cast	-	-	-	-	-	-	-
Dol	.0	.0	.0	5.0	.0	20.0	3.0
Dori	.7	.3	.8	.0	21.1	.0	.4
Dry	.0	.4	4.5	.0	.5	.5	.0
Faron	.0	.0	4.9	.0	1.3	.0	.3
Felun	.0	.0	5.0	.0	.0	.0	5.0
Gill	.5	.0	5.9	.0	.8	.0	1.5
Hook	.0	.0	.0	.0	.0	.0	.0
BHook	-	-	-	-	-	-	-
Lift	1.0	.0	.0	.0	.0	.0	.1
Seine	.0	.0	1.5	5.1	28.1	.0	.0
Spear	.4	.0	.0	.0	.0	.0	.0
Taki	-	-	-	-	-	-	-

	Chingree	Darkina	Gojar	Gonia	Kakiya	Kalbaush	Kalna
Bosni	-	-	-	-	-	-	-
Cast	-	-	-	-	-	-	-
Dol	20.0	2.0	.0	.0	.0	.0	.0
Dori	60.8	.2	.0	.0	.1	.0	.0
Dry	.5	.0	15.1	.0	.0	.0	10.8
Faron	1.8	.6	.0	.0	.1	.0	24.3
Felun	.0	.0	.0	.0	.0	.0	5.0
Gill	.9	.0	3.0	.6	.2	.0	11.7
Hook	.0	.0	.9	.0	.0	.0	7.2
BHook	-	-	-	-	-	-	-
Lift	50.7	.0	.0	.0	.0	.0	.0
Seine	4.0	.0	9.6	.0	.0	.0	2.0
Spear	.0	.0	40.1	.2	13.5	.0	5.2
Taki	-	-	-	-	-	-	-

	Kawa	Katla	Koi	Koia	Magur	Mrigal	Mokha
Bosni	-	-	-	-	-	-	-
Cast	-	-	-	-	-	-	-
Dol	.0	.0	.0	.0	.0	.0	.0
Dori	.0	.0	.0	3.5	.0	.0	.2
Dry	.0	.5	5.0	13.4	5.3	.0	.8
Faron	.0	.0	1.4	10.8	5.9	1.9	.0
Felun	.0	.0	5.0	.0	.0	.0	10.0
Gill	.0	1.0	10.4	1.4	2.6	.1	.4
Hook	.0	.0	.8	.0	11.5	.0	.0
BHook	-	-	-	-	-	-	-
Lift	5.0	.0	.0	.0	.0	.0	.0
Seine	.0	.0	1.5	.0	.0	.0	1.5
Spear	.0	3.4	.0	.0	1.0	.0	.0
Taki	-	-	-	-	-	-	-

	Pabda	Puti	Rui	Shing	Shol	Silver	Taki
Bosni	-	-	-	-	-	-	-
Cast	-	-	-	-	-	-	-
Dol	.0	8.0	40.0	.0	.0	.0	.0
Dori	.0	9.9	.0	.0	.0	.0	.5
Dry	.0	8.5	.5	12.5	8.6	.0	11.3
Faron	.0	9.8	14.8	8.8	2.3	.6	7.5
Felun	.0	45.0	.0	5.0	5.0	.0	15.0
Gill	.4	20.9	8.7	11.1	3.8	6.1	7.5
Hook	.0	.1	.0	22.6	5.8	.0	50.7
BHook	-	-	-	-	-	-	-
Lift	.0	24.7	.0	3.3	.0	.0	14.3
Seine	.0	1.5	37.3	.0	2.5	.0	5.5
Spear	.0	.0	14.2	1.0	2.4	14.5	4.2
Taki	-	-	-	-	-	-	-

Mar-May	Baim	Baliara	Bera	Boal	Boisa	Carp	Chanda
Bosni	8.0	.0	.0	.0	.0	.0	.0
Cast	.0	.0	.0	.0	.0	.0	.0
Dol	-	-	-	-	-	-	-
Dori	1.0	.6	.3	.0	27.9	.0	1.9
Dry	-	-	-	-	-	-	-
Faron	.0	3.0	4.5	.0	.0	.0	.0
Felun	.0	.0	.0	.0	8.4	.0	4.0
Gill	2.0	1.0	13.8	.0	.0	.0	3.4
Hook	4.3	.0	.0	.0	.0	.0	.0
BHook	-	-	-	-	-	-	-
Lift	-	-	-	-	-	-	-
Seine	-	-	-	-	-	-	-
Spear	4.5	.0	.0	.0	.0	.0	.0
Taki	.0	1.5	.0	.0	7.5	.0	.0

	Chingree	Darkina	Gojar	Gonia	Kakiya	Kalbaush	Kalna
Bosni	30.0	50.0	.0	.0	.0	.0	.0
Cast	.0	.0	20.0	.0	.0	.0	.0
Dol	-	-	-	-	-	-	-
Dori	51.3	2.2	.0	.0	.0	.0	.7
Dry	-	-	-	-	-	-	-
Faron	.0	.0	.0	.0	.0	.0	25.0
Felun	79.6	.0	.0	.0	.0	.0	.0
Gill	.0	.0	3.0	.0	.0	.0	5.8
Hook	.0	.0	.4	.0	.0	.0	23.6
BHook	-	-	-	-	-	-	-
Lift	-	-	-	-	-	-	-
Seine	-	-	-	-	-	-	-
Spear	.0	.0	24.0	.0	.0	.0	32.5
Taki	2.5	83.5	.0	.0	.0	.0	.0

	Kawa	Katla	Koi	Koia	Magur	Mrigal	Mokha
Bosni	.0	.0	.0	.0	.0	.0	.0
Cast	.0	.0	.0	.0	.0	.0	.0
Dol	-	-	-	-	-	-	-
Dori	.0	.0	.4	.2	.0	.0	.0
Dry	-	-	-	-	-	-	-
Faron	.0	.0	.0	1.3	2.5	.0	.0
Felun	.0	.0	.0	.0	.0	.0	.0
Gill	.0	.0	2.0	1.4	4.0	.0	.0
Hook	.0	.0	.7	.0	8.6	.0	.0
BHook	-	-	-	-	-	-	-
Lift	-	-	-	-	-	-	-
Seine	-	-	-	-	-	-	-
Spear	.0	.0	.0	.0	.0	.0	.0
Taki	.0	.0	.0	.0	.0	.0	.0

	Pabda	Puti	Rui	Shing	Shol	Silver	Taki	Tengra
Bosni	.0	8.0	.0	.0	.0	.0	.0	4.0
Cast	.0	.0	.0	.0	80.0	.0	.0	.0
Dol	-	-	-	-	-	-	-	-
Dori	.0	12.0	.0	.0	.0	.0	1.1	.3
Dry	-	-	-	-	-	-	-	-
Faron	.0	1.8	.0	14.0	1.0	.0	46.3	.8
Felun	.0	8.0	.0	.0	.0	.0	.0	.0
Gill	.0	42.0	1.0	4.6	.0	.0	14.0	2.0
Hook	.0	.0	.0	4.3	2.1	.0	55.3	.7
BHook	-	-	-	-	-	-	-	-
Lift	-	-	-	-	-	-	-	-
Seine	-	-	-	-	-	-	-	-
Spear	.0	.0	25.0	.0	14.0	.0	.0	.0
Taki	.0	5.0	.0	.0	.0	.0	.0	.0

Appendix 4.4. Income of fishing households (Tk/household/month).

	Fish Sales	(Costs)	Agr.	Fish trade	craft	hired labour
Dec	1903	1429	139	108	120	218
Jan	2405	1160	16	80	143	158
Feb	2463	642	26	31	167	274
Mar	2680	525	16	48	135	189
Apr	2344	462	16	60	126	210
May	2194	255	3011	56	100	78
Jun	1558	308	111	23	83	27
Jul	2001	313	0	0	105	42
Aug	2510	386	0	68	83	54
Sep	1738	429	1386	160	99	66
Oct	2241	553	0	158	59	56
Nov	1712	838	53	150	67	141
Total	25747	7298	4772	940	1284	1511

Appendix 4.5. Labour use of fishing households (Work-hours/household/month).

	Fish	supprt	Agr.	Fish trade	craft	labour total	labour fishing
Dec	306	51	88	18	47	29	25
Jan	303	15	133	13	43	30	14
Feb	270	9	106	7	65	36	25
Mar	374	19	62	12	40	28	14
Apr	364	20	115	8	39	44	7
May	286	33	99	7	14	29	7
Jun	225	7	61	7	6	28	0
Jul	299	53	48	0	7	40	0
Aug	323	58	19	26	9	26	0
Sep	261	24	86	24	12	35	5
Oct	311	47	31	19	10	28	2
Nov	271	45	35	20	29	30	18
Total	3592	380	880	159	320	382	115

Appendix 4.6. Estimated area of Hail Haor (north of of 24^{o}21'N only).

Month	area (ha)
December	5427
January	4342
February	3473
March	2779
April	2223
May	1800
June	10600
July	10600
August	10600
September	10600
October	8480
November	6784
Total (ha-months)	77708

Appendix 4.7. Purchases of fish-traps by fishing households (Tk/household/month).

Month	Tk
December	247
January	318
February	87
March	62
April	142
May	81
June	14
July	9
August	26
September	22
October	19
November	74

Appendix 4.8. Breakdown of catch value: total of 60 sample households ('000Tk/month)

	Fishing Revenue	Hired labour	Tolls	Traps & baskets	Other costs
Dec	114	12	5	15	54
Jan	144	5	5	19	41
Feb	148	4	14	5	15
Mar	161	3	5	4	19
Apr	141	3	3	9	13
May	132	2	0	5	8
Jun	93	2	0	1	15
Jul	120	2	0	1	16
Aug	151	1	1	2	19
Sep	104	1	1	1	22
Oct	134	2	8	1	21
Nov	103	2	12	4	31
sum p.a.	1,107	41	55	66	276
/hh p.a.	18.45	.68	.92	1.10	4.59
/2033hh	37,506	1,392	1,869	2,238	9,338

Appendix 4.9. Brush-pile cashflow and catch

				90% conf. int. for mean	
Variable	mean	s.d.	n	min	max
Leasing cost (Tk/ha)	11709	8329	11	7158	16261
Building cost (Tk/ha)	5572	2666	10	4027	7118
Fishing cost (Tk/ha)	6071	3857	10	3836	8307
Shudhi principal (Tk/ha)	2946	3213	10	1083	4809
Dalal principal (Tk/ha)	5264	4143	10	2683	7666
Revenue after dalal (Tk/ha)	31743	9752	10	26090	37396
kg/ha	575	182	11	476	674
% stocked species	63	14	10	55	72

Appendix 5.1. GW-BASIC listing of bio-economic simulation of effort management in a leasehold fishery.

```
10      REM: Dimension statements
20 DIM BIGSTOCK(10):DIM SMALLSTOCK(10):DIM RBIGSTOCK(10):DIM
RSMALLSTOCK(10)
30 DIM BIGGROW(9):DIM SMALLGROW(9)
40 DIM BIGPRICE(9):DIM SMALLPRICE(9)
50 DIM BIGCTY(9):DIM SMALLCTY(9)
60 DIM LESSEEY(9):DIM LABOURY(9):DIM RLESSEEY(9):DIM RLABOURY(9)
70 DIM BIGCATCH(9):DIM SMALLCATCH(9):DIM RBIGCATCH(9):DIM RSMALLCATCH(9)
80 DIM ESC(9):DIM A$(9)
90 DIM BIGINFLUX(9):DIM SMALLINFLUX(9)
100      REM: Data entry
110 CLS: PRINT "Hail Haor Bio-economic model 7"
120 PRINT:PRINT:PRINT
130 FOR X%=1 TO 9
140 READ A$(X%)
150 NEXT X%
160 DATA Sept.,Oct.,Nov.,Dec.,Jan.,Feb.,March.,April.,May
170 INPUT "What file contains data (biodata.?)";FILE$
180 OPEN "I",#1,FILE$
190 FOR X%=1 TO 9:INPUT #1,BIGGROW(X%):NEXT X%
200 FOR X%=1 TO 9:INPUT #1,SMALLGROW(X%):NEXT X%
210 FOR X%=1 TO 9:INPUT #1,BIGPRICE(X%):NEXT X%
220 FOR X%=1 TO 9:INPUT #1,SMALLPRICE(X%):NEXT X%
230 FOR X%=1 TO 9:INPUT #1,BIGCTY(X%):NEXT X%
240 FOR X%=1 TO 9:INPUT #1,SMALLCTY(X%):NEXT X%
250 FOR X%=1 TO 9:INPUT #1,ESC(X%):NEXT X%
260 INPUT
#1,BIGSTOCK(1),SMALLSTOCK(1),THINCOST,CLEARCOST,WAGE,BIGCLEAR,SMALLCLEAR
,THINLAB,CLEARLAB,R
270 CLOSE #1
280 FOR X%=1 TO
9:BIGINFLUX(X%)=BIGSTOCK(1)*ESC(1):SMALLINFLUX(X%)=SMALLSTOCK(1)*ESC(1):
NEXT X%
290 ITER%=1: LASTBIGSTOCK=34:LASTSMALLSTOCK=34
900     REM: Input employment levels
905 INPUT "How many closed months";CLOSURE%
910 INPUT "What is maximum employment until December";AA%
```

```
920 INPUT "What is maximum employment after January";BB%
923 INPUT "What is step";STP
927    REM: Influx iteration loop starts here
928 BESTARGET=0
930 FOR EMP1=0 TO AA% STEP STP
940 EMP2=EMP1:REM FOR EMP2=0 TO BB% STEP STP
2000   REM: September to January
2010 FOR X%=1 TO 5
2020 BIGCATCH(X%)=(EMP1/THINLAB)*BIGCTY(X%)*BIGSTOCK(X%)
2030 SMALLCATCH(X%)=(EMP1/THINLAB)*SMALLCTY(X%)*SMALLSTOCK(X%)
2040 LABOURY(X%)=WAGE*EMP1
2050
LESSEEY(X%)=(BIGCATCH(X%)*BIGPRICE(X%))+(SMALLCATCH(X%)*SMALLPRICE(X%))-
(THINCOST*EMP1/THINLAB)-LABOURY(X%)
2055 IF X%<=CLOSURE% THEN
BIGCATCH(X%)=0:SMALLCATCH(X%)=0:LABOURY(X%)=0:LESSEEY(X%)=0
2060 BIGSTOCK(X%+1)=(BIGSTOCK(X%)*(1+BIGGROW(X%)-ESC(X%)))-
BIGCATCH(X%)+BIGINFLUX(X%)
2070 SMALLSTOCK(X%+1)=(SMALLSTOCK(X%)*(1+SMALLGROW(X%)-ESC(X%)))-
SMALLCATCH(X%)+SMALLINFLUX(X%)
2080 NEXT X%
3000   REM: February
3010 BIGCATCH(6)=BIGCLEAR*BIGSTOCK(6)
3020 SMALLCATCH(6)=SMALLCLEAR*SMALLSTOCK(6)
3030 LABOURY(6)=WAGE*CLEARLAB
3040 LESSEEY(6)=(BIGPRICE(6)*BIGCATCH(6))+(SMALLPRICE(6)*SMALLCATCH(6))-
CLEARCOST-LABOURY(6)
3050 SMALLSTOCK(7)=(SMALLSTOCK(6)*(1+SMALLGROW(6)-ESC(6)))-
SMALLCATCH(6)+SMALLINFLUX(6)
3060 BIGSTOCK(7)=(BIGSTOCK(6)*(1+BIGGROW(6)-ESC(6)))-
BIGCATCH(6)+BIGINFLUX(6)
4000  REM: March to May
4010 FOR X%=7 TO 8
4020 BIGCATCH(X%)=(EMP2/THINLAB)*BIGCTY(X%)*BIGSTOCK(X%)
4030 SMALLCATCH(X%)=(EMP2/THINLAB)*SMALLCTY(X%)*SMALLSTOCK(X%)
4040 LABOURY(X%)=WAGE*EMP2
4050
LESSEEY(X%)=(BIGCATCH(X%)*BIGPRICE(X%))+(SMALLCATCH(X%)*SMALLPRICE(X%))-
(THINCOST*EMP2/THINLAB)-LABOURY(X%)
```

```
4060 BIGSTOCK(X%+1)=(BIGSTOCK(X%)*(1+BIGGROW(X%)-ESC(X%)))-
BIGCATCH(X%)+BIGINFLUX(X%)
4070 SMALLSTOCK(X%+1)=(SMALLSTOCK(X%)*(1+SMALLGROW(X%)-ESC(X%)))-
SMALLCATCH(X%)+SMALLINFLUX(X%)
4080 NEXT X%
5000   REM: Calculate markers
5010 TARGET=0
5020 FOR X%=1 TO 9:TARGET=TARGET+(LESSEEY(X%)/((1+R)^X%)):NEXT X%
5030 IF TARGET<BESTARGET THEN 6000
5040 BESTARGET=TARGET
5045 PRINT INT(BESTARGET)
5050 FOR X%=1 TO
9:RBIGSTOCK(X%)=BIGSTOCK(X%):RSMALLSTOCK(X%)=SMALLSTOCK(X%):RLESSEEY(X%)
=LESSEEY(X%):RLABOURY(X%)=LABOURY(X%):RBIGCATCH(X%)=BIGCATCH(X%):RSMALLC
ATCH(X%)=SMALLCATCH(X%):NEXT X%
5060
RBIGSTOCK(10)=BIGSTOCK(10):RSMALLSTOCK(10)=SMALLSTOCK(10):BESTEMP1=EMP1:
BESTEMP2=EMP2
6000   REM: End employment loop here
6010 PRINT ".";
6020 REM NEXT EMP2
6030 PRINT "*";
6040 NEXT EMP1
7000   REM: Model influxes here
7010 FOR X%=1 TO
9:BIGINFLUX(X%)=RBIGSTOCK(X%)*ESC(X%):SMALLINFLUX(X%)=RSMALLSTOCK(X%)*ES
C(X%):NEXT X%
7020 PRINT "    Iteration:";ITER%;"complete."
7030 ITER%=ITER%+1: IF ITER%>10 THEN 8000
7040 IF ABS(RBIGSTOCK(10)-LASTBIGSTOCK)>.01 THEN
LASTBIGSTOCK=RBIGSTOCK(10):GOTO 927
7050 IF ABS(RSMALLSTOCK(10)-LASTSMALLSTOCK)>1 THEN
LASTSMALLSTOCK=RSMALLSTOCK(10):GOTO 927
8000  REM: Print out results
8010 CLS
8020 PRINT "month","big","small","labour","lessee"
8030 FOR X%=1 TO 9:PRINT
A$(X%),INT(RBIGCATCH(X%)),INT(RSMALLCATCH(X%)),RLABOURY(X%),INT(RLESSEEY
(X%)):NEXT X%
```

Appendix 5.2. Exogenous variables used in the baseline run of the bio-economic simulation of effort management in a leasehold fishery.

Month	net growth		price		catchability		
	big	small	big	small	big	small	
	species		species		species		
1	.35	.35	60	20	.02	.02	.1
2	.35	.35	60	30	.02	.02	.1
3	.35	.35	60	30	.02	.02	.1
4	.25	.25	60	30	.02	.02	.1
5	.13	.13	60	30	.02	.02	.1
6	.13	.13	60	30	.03	.03	.1
7	.08	.08	60	30	.03	.03	.1
8	.08	.08	60	30	.03	.03	.1

Initial stock(kg): large species 600, small species 4200

Gear cost(Tk/m): thinning gear 450, clearing gear 7000

Wage(Tk/m)1200

Clearing gear catchability (kg/kg/m): large species .95, small species .1

Labour requirements/unit gear: thinning gear 1, clearing gear 10

Discount rate (%/m): 10

Appendix 6. Two New Fisheries Management Policy (NFMP) jalmohols

Beri Beel is a U-shaped, enclosed body of water 149 acres in area, around 25km north of Moulvi Bazar. It became a NFMP jolmohol in 1988. License fees were set to total Tk128,750 (US$3,200) in that year and have risen by 10% per year until the time of writing. Licenses are issued annually to 433 fishermen in 24 groups. The District (Zila) fisheries officer possesses a list of their names and village of residence. Each group has a named leader.

A series of visits to Beri Beel in late 1992 revealed the reality of the New Fisheries Management Policy. A syndicate of 24 local merchants and landowners controlled the fishermen's association. Their leader was a video-renter and fish-merchant. They were listed as the leaders of the 24 fishing-groups; the 409 "group members" were listed solely for cosmetic purposes. A dispute within the syndicate reduced its membership to 16. A second round of expulsions brought it to its final level of 12. In accordance with the rhetoric of the New Fisheries Management Policy, those remaining described those expelled as "non-fishermen".

Confident of its ownership of the natural resource, the syndicate invested in the fish stock. It did not catch fish during the growth period (July to November), it built brush-piles to encourage the growth and aggregation of larger species and it established a reserve fishery to ensure the following year's breeding stock. The syndicate hired two water-bailiffs at a total cost of Tk3,000 (US$75) to exclude self-employed fishermen. Their efforts were directed against 17 fishermen living in villages around Beri Beel who had resorted to working their long-lines and gill-nets clandestinely by night. The syndicate members explained that these villagers were "non-fishermen" and had therefore to be prevented from reducing the catch of the "genuine fishermen" of the "Fishermen's Association".

When the fishing season (December to February) arrived, the syndicate's control over the jolmohol ensured that profits were not dissipated through excessive effort. 12 hired labourers, two boats and a single seine net sufficed. The labourers were brought in from distant villages and lived in a temporary hut beside the water.

Buruburi Beel is another NFMP jolmohol in Moulvi Bazar district. Two villages lie on its southern shore, one Muslim and one Hindu. Under the old system, fishermen from both villages bought fishing rights from the lessee. Fishermen can not afford to pay NFMP license fees in advance of the fishing season. A landowner from the Muslim village therefore named himself Chairman of the "Fishermen's Association", registered his fellow-villagers as his membership and paid the license fees on their behalf. He collected tolls from Muslim fishermen throughout the fishing season and fished the deepest water in his own name by means of hired labour. He employs 5 water-bailiffs to prevent "non-fishermen" from fishing.

The Hindu fishermen, however, complain that the Fishermen's Association is restricted to Muslims and that they have been excluded from Buruburi Beel by the NFMP. They still have access to Jolwa Beel, a lease held by a syndicate of 6 fellow-Hindus, but they know that the Muslim landowner is lobbying for Jolwa Beel to be registered as a NFMP jolmohol. They fear that they would again be excluded from the resulting Fishermen's Association.

Both Beri Beel and Buruburi Beel are managed by members of the local community. In both cases, however, the local community exhibits a high level of economic inequality, and this inequality was carried over into the management of the natural resource. Over-fishing in Beri Beel was prevented by the exclusion of self-employed fishermen. In Buruburi Beel the same goal was achieved by the exclusion of a religious minority. Neither of these two management practices could be described as "equitable". Indeed, the Beri Beel syndicate's oligarchic control was a pre-condition for its far-sighted management of the fishery.

References

Acheson J.M. (1981) Anthropology of fishing. *American Review of Anthropology* **10**, 275-316.

Adasiak A. (1979) Alaska's experience with limited entry. *Journal of the Fisheries Research Board of Canada* **36**, 770-82.

Aguero M. (1986) Bangladesh fisheries: a challenge to resource managers. *Naga, the ICLARM Quarterly* **9:3**, 11-12.

Aguero M. (1989) *Inland water fisheries in Bangladesh: management options and national interventions*. In eds. Aguero M., Huq S., Rahman A.K.A. and Ahmed M.: *Inland fisheries management in Bangladesh*. Dhaka: Department of Fisheries. pp1-13.

Aguero M. and Ahmed M. (1990) *Economic rationalisation of fisheries exploitation through management: experiences from the open-water inland fisheries management in Bangladesh*. in ed. Hirano R. and Hanyu I. *Proceedings of the Second Asian Fisheries Forum.*

Aguero M., Huq S., Rahman A.K.A. and Ahmed M. (eds.) (1989) *Inland Fisheries Management in Bangladesh*. Dhaka: Department of Fisheries.

Ahmed M. (1991) *A model to determine benefits from the management of riverine fisheries in Bangladesh*. Manila: International Centre for Living Aquatic Resources Management.

Ahmed Z.U. (1989) Effective costs of rural loans in Bangladesh. *World Development* **17:3**, 357-363.

Alchian A.A. and Demsetz H. (1973) The property rights paradigm. *Journal of Economic History* **33**, 16-27.

Ali M.I. (1993) *Views on licensing system and New Fisheries Management Policy*. Presented at *Workshop on Improved Management of Open Water Fisheries*, Dhaka 22-23 August 1993.

Ali M.Y. (1989) *Environment, conservation and fishery resources in Bangladesh*. in ed. Aguero M., Huq S., Rahman A.K.A. and Ahmed M.: *Inland fisheries management in Bangladesh*. Dhaka: Department of Fisheries. pp36-52.

Ali M.Y. (1992) *Third Fisheries Project: report upon leaseholder study*. Dhaka: Bangladesh Centre for Advanced Studies.

Allen P.M. and McGlade J.M. (1987) Modelling complex human systems: a fisheries example. *European Journal of Operational Research* **30**, 147-67.

Anon. (undated) *Hail Haor and surroundings*. Map.

Aquatic Farms Ltd. (1992) *Impact of stocking on the fisheries of Hail Haor*. Dhaka: Ministry of Fisheries and Livestock.

Axelrod R. (1981) The emergence of co-operation among egoists. *American Political Science Review* **75**, 306-18.

Bailey C. (1982) Natural resource management: a basis for organisation of small-scale fishermen. *Rural Development Policy Review* **Winter 1982**, 19-22.

BBS (1990) *Small area atlas of Bangladesh: mauzas and mahallas of Sylhet District*. Dhaka: Bangladesh Bureau of Statistics.

BBS (1992) *1992 statistical yearbook of Bangladesh*. Dhaka: Bangladesh Bureau of Statistics.

BCAS (1992) *Third Fisheries Project: Floodplain Production Monitoring: Annual Report*. Dhaka: Bangladesh Institute for Advanced Studies.

BCAS (1993) Beel Dakatia: a development disaster! *Bangladesh Environmental Newsletter* **4:1**, 1,4-5.

Becker G.S. (1968) Crime and punishment: an economic approach. *Journal of Political Economy* **76**, 169-217.

Beddington J.R. and May R.M. (1977) Harvesting natural populations in a randomly fluctuating environment. *Science* **197**, 463-5.

Bell F.W. (1972) Technical externalities and common-property resources: an empirical study of the U.S. northern lobster fishery. *Journal of Political Economy* **80**, 148-158.

Berkes F. (1977) Fishery resource use in a subarctic Indian community. *Human Ecology* **5:4**, 289-307.

Berkes F. (1985a) Fishermen and the tragedy of the commons. *Environmental Conservation* **12**, 199-206.

Berkes F. (1985b) The common-property resource problem and the creation of limited property rights. *Human Ecology* **13:2**, 187-208.

Berkes F. (1986) Local-level management and the commons problem: a comparative study of Turkish coastal fisheries. *Marine Policy* **10**, 215-229.

Berkes F., Feeny D., McCay B.J. and Acheson J.M. (1989) The benefits of the commons. *Nature* **340**, 91-3.

Berkes F., George P. and Preston R.J. (1991) Co-management: the evolution of a theory and practice of the joint administration of living resources. *Alternatives* **18:2**, 12-17.

Beverton R.J. and Holt S.J. (1957) *On the dynamics of exploited fish populations. Fisheries Investigations of the Ministry of Agriculture, Fisheries and Food (Series 2) No. 19*. London: Her Majesty's Stationery Office.

Biggs S.D. (1989) *Resource-poor farmer participation in research: a synthesis of experiences from nine National Agricultural Systems*. OFCOR Comparative Study Paper No.3. The Hague: OFCOR.

Blanchet T. and Talukder J. (1992) *The people of Shanir Haor: Chapter III: Fishery*. Dhaka: Northeast Regional Project. Mimeo.

Bromley D.W. (1989) Property relations and economic development: the other land reform. *World Development* **17:6**, 867-877.

Bromley D.W. and Chapagain D.P. (1984) The village against the center: resource depletion in South Asia. *American Journal of Agricultural Economics* **66:5**, 868-873.

Buck S.J. (1989) Cultural theory and management of common property resources. *Human Ecology* **17:1**, 101-16.

Campbell H.F. and Lindner R.K. (1990) The production of fishing effort and the economic performance of licence limitation programs. *Land Economics* **66:1**, 56-66.

Casely D.J. and Lury D.A. (1981) *Data collection in developing countries*. Oxford: Clarendon Press.

Charles A.T. (1988) Fishery socio-economics: a survey. *Land Economics* **64:3**, 276-95.

Choudhury J.A. (1993) *BRAC involvement in redirecting benefits to genuine poor fishermen under improved management of openwater fisheries (IMOF)*. Presented at the Workshop on Improved Management of Openwater Fisheries (Phase II), July 1993, Dhaka.

Chowdhury A. (1993) *Socio-economic analysis of fisher community*. Dhaka: Department of Fisheries. Mimeo.

Clark C.W. (1973) Profit-maximisation and the extinction of animal species. *Journal of Political Economy* **81**, 950-61.

Clark C.W. (1976) *Mathematical bio-economics*. New York: John Wiley and Sons (pp1-67.)

Clark C.W. and Munro G.R. (1975) The economics of fishing and modern capital theory: a simplified approach. *Journal of Environmental Economics and Management* **2**, 92-106.

Conrad J.M. (1989) Bioeconomics and the bowhead whale. *Journal of Political Economy* **97:4**, 974-987.

Copes P. (1970) The backward-bending supply curve of the fishery. *Scottish Journal of Political Economy* **17**, 69-77.

Copes P. (1972) Factor rents, sole ownership and the optimum level of fisheries exploitation. *Manchester School of Economics and Social Studies* **40**, 145-62.

Coulter J.P. and Disney J.G. (1987) *The handling, processing and marketing of fish in Bangladesh. ODNRI Bulletin No.1.* Chatham: Overseas Development Natural Resources Institute.

Dey H.K. (1986) *Case study of depression fishing community in Bangladesh (Habiganj).* In ed. Huq A.: *Socio-economic study of typical fishing community in Bangladesh.* Chittagong: Department of Economics, Chittagong University.

DOF (1986) *Fisheries information bulletin 3:1: Water area statistics of Bangladesh.* Dhaka: Department of Fisheries

DOF (1988) *Fish catch statistics of Bangladesh.* Dhaka: Department of Fisheries.

Dryzek J.S. (1987) *Rational ecology: environment and political ecology.* Basil Blackwell: Oxford.

Ehsan K. (1993) *Social boundaries within a fishing community in Bangladesh.* Mimeo.

Emmerson D.K. (1976) Biting the helping hand: modernisation and violence in an Indonesian fishing community. *Land Tenure Newsletter* **51**, 1-15.

FAP17 (1993) *Review and bibliography of nutrition in Bangladesh.* Dhaka: Flood Action Plan 17 Fisheries Studies and Pilot Project.

FAP6 (1992) *Hail Haor Project.* Dhaka: North-east Regional Project (mimeo).

Feeny D., Berkes F., McCay B.J., Acheson J.M. (1990) The tragedy of the commons twenty-two years later. *Human Ecology* **18:1**, 1-19.

Field B.C. (1985) The optimal commons. *American Journal of Agricultural Economics* **57**, 364-7.

FIVDB (1993) *Kanlar Haor Project.* Presented at the Workshop on Improved Management of Openwater Fisheries (Phase II), July 1993, Dhaka.

Forman S. (1967) Cognition and the catch. *Ethology* **6**, 417-426.

Gibbs C.J.N. and Bromley D.W. (1989) *Institutional arrangements for management of rural resources: common property regimes*. In ed. Berkes F.: *Common property resources: ecology and community-based sustainable development*. London: Belhaven Press. pp256-72.

Gordon H.S. (1954) The economic theory of a common property resource: the fishery. *Journal of Political Economy* **62**, 124-42.

Grima A.P.L. and Berkes F. (1989) *Natural resources: access, rights to use and management*. in ed. Berkes F. *Common-property resources: ecology and community-based sustainable development*. London: Belhaven Press. pp33-54.

Gulland J.A. (1983) *Stock assessment: why? FAO Fisheries Circular no.759*. Rome: Food and Agriculture Organisation.

Haque K.A. (1993) *Biological assessment and management of fisheries*. Dhaka: Department of Fisheries (mimeo).

Hardin G. (1968) The tragedy of the commons. *Science* **162**, 1243-8.

Hardjamulia A. and Rabegnatar N.S. (1987) *Status of inland water fisheries of Indonesia*. In: Country status reports on inland fisheries presented at the 3rd session of the Indo-Pacific Fishery Commission Working Party of Experts on Inland Fisheries. FAO F

Hartmann B. and Boyce J. (1979) *Needless hunger: views from a Bangladeshi village*. San Francisco: Institute for Food and Development Policy.

Hartmann B. and Boyce J. (1983) *A quiet violence: view from a Bangladeshi village*. London: Zed Press.

Hartwick J.M. and Olewiler N.D. (1986) *The economics of natural resource use*. New York: Harper Collins. 530pp.

Herbon D. (1988) *The social and institutional structure of the micro-region*. in ed. Herbon D.: *Socio-economic strategies of survival in Bangladesh*. Aachen: Alano Verlag. pp9-35

Huq M. and Huq A. (1985) *Fishermen in natural depressions of Bangladesh: socio-economic conditions and standards of living*. in ed. Panayotou T. *Small-scale fisheries in Asia*. Canada: IDRC. pp84-93.

Jansen E.G. (1987) *Rural Bangladesh: competition for scarce resources*. Dhaka: University Press Limited.

Jensen K.M. (1987) *Non-agricultural occupations in a peasant society: weavers and fishermen in Noakhali, Bangladesh.* Copenhagen: Centre for Development Research.

Johnson R.N. and Libecap G.D. (1982) Contracting problems and guidelines: the case of the fishery. *American Economic Review* **72**, 1005-22.

Karpoff J.M. (1989) Characteristics of limited entry fisheries and the option component of entry licenses. *Land Economics* **65:4**, 396-93.

Kramsyo B. and Wood G.D. (1992) *Breaking the chains: collective action for social justice among the rural poor in Bangladesh.* Dhaka: University Press Limited.

Kremer A.R. (1992) *Pauperised by empowerment: renewable resource reform without capital-market competition.* Centre for Development Studies Occasional Paper 92/3. Bath: University of Bath.

Kurien J. (1980) Social factors and economic organisation of the traditional small-scale fishermen of India. *Social Action* **30:2,** 111-27.

Leterme J-L. and Chisholm N. (1993) *Study of project beneficiaries under the Third Fisheries Project.* Dhaka: Third Fisheries Project.

Like-Minded Group (1990) *Rural poverty in Bangladesh: a report to the Like-Minded Group.* Dhaka: University Press Limited.

Lipton D.W. and Strand I.E. (1992) Effect of stock size and regulations on fishing industry cost and structure: the surf clam industry. *American Journal of Agricultural Economics* **74:1**, 197-208.

Majumder M.K. and Durante L. (1993) River embankments that rob the poor. *Panoscope* **36**, 2-3.

Maloney C. (1986) *Behavior and poverty in Bangladesh.* Dhaka: University Press Limited.

May R.M., Beddington J.R., Clark C.W., Holt S.J., and Laws R.M. (1979) Management of multi-species fisheries. *Science* **205**, 267-77.

McCay B.J. (1978) Systems ecology, people ecology and the anthropology of fishing communities. *Human Ecology* **6:4**, 397-422.

McGranahan J. (1991) Fuelwood, subsistence foraging and the decline of common property. *World Development* **19**, 1275-87.

McGregor J.A. (1988) Credit and the rural poor: the changing policy environment in Bangladesh. *Public Administration and Development* **8**, 467-482.

McGregor J.A. (1989a) Towards a better of understanding of credit in rural development: the case of Bangladesh: the patron state. *Journal of International Development* **1:4**, 467-486.

McGregor J.A. (1989b) Boro Gafur and Choto Gafur: development interventions and indigenous institutions. *Journal of Social Studies* **43**, 40-51.

McGregor J.A. (1992) *Village credit and the reproduction of poverty in contemporary rural Bangladesh.* Presented at the Annual Conference of the Society for the Advancement of Socio-economics, Irvine, California.

Meary T.F. (1979) Limited entry in the Western Australian rock lobster and prawn fisheries: an economic evaluation. *Journal of the Fisheries Research Board of Canada* **36**, 789-98.

Ministry of Land (1988) Memorandum no. BHUM.Mo. 7-Ja.Bya.-1/87/13(64) Dhaka: Ministry of Land.

Ministry of Land (1991) Memorandum no. BHUM/7/5/91/424(12) of 12/09/91. Dhaka: Ministry of Land.

Moorehead R. (1989) *Changes taking place in common-property resource management in the inland Niger delta of Mali.* In ed. Berkes F. *Common property resources: ecology and community-based sustainable development.* London: Belhaven Press. pp256-272.

MRAG Ltd. (1992) *Biological assessment of the fisheries*: Internal Report to the Centre for Development Studies, University of Bath. London: Marine Resources Assessment Group.

MRAG Ltd. (1993) *Biological assessment of the fisheries. Final report, first draft.* London: Marine Resources Assessment Group (mimeo).

MRAG Ltd. (1994) *Biological assessment of the fisheries. Final report.* London: Marine Resources Assessment Group (mimeo).

Naqi S.A. (1989) *Licensing versus leasing system for fishing access.* in ed. Aguero M., Huq S., Rahman A.K.A., and Ahmed M. *Inland fisheries management in Bangladesh.* Department of Fisheries: Dhaka. pp 83-92.

Neher P.A. (1990) *Natural resource economics: conservation and exploitation.* Cambridge: Cambridge University Press. 360pp.

Netting R.M. (1976) What Alpine peasants have in common: observations on communal tenure in a Swiss vilage. *Human Ecology* **4:2**, 135-146.

Netting R.M. (1978) Of men and meadows: strategies of Alpine land use. *Anthropology Quarterly* **45**, 132-44.

Norgaard R.B. (1984) Traditional agricultural knowledge: past performance, future prospects and institutional implications. *American Journal of Agricultural Economics* **66:5**, 874-8.

Olson M. (1965) The logic of collective action. Cambridge: Harvard University Press.

Onal H., McCarl B.A., Griffin W.L., Matlock G. and Clark J. (1991) A bioeconomic analysis of the Texas shrimp fishery and its optimal management. *American Journal of Agricultural Economics* **3:4**, 1161-70.

Ostrom E. (1987) *Institutional arrangements for resolving the commons dilemma.* In eds. McCay B.J. and Acheson J.: *The question of the commons: the culture and ecology of communal resources.* Tucson: University of Arizona Press. pp250-65.

Ostrom E. (1990*) Governing the commons: The evolution of institutions for collective action.* Cambridge: CUP.

Panayotou T. (1982) *Management concepts for small-scale fisheries: economic and social aspects. FAO Fisheries Technical Paper no. 228.* Rome: Food and Agriculture Organisation.

Pauly D. (1980) *A selection of simple methods for the assessment of tropical fish stocks. FAO Fisheries Circular no. 729.* Rome: Food and Agriculture Organisation.

Pawaputanon O. (1987) *Inland fisheries in Thailand.* In: Country status reports on inland fisheries presented at the 3rd session of the Indo-Pacific Fishery Commission Working Party of Experts on Inland Fisheries. FAO Fisheries Report no. 370 (supplement).

Planning Commission (1991) *The fourth five-year plan. Revised draft-II.* Dhaka: Ministry of Planning.

Platteau J-P and Abraham A. (1987) An enquiry into quasi-credit contracts: the role of reciprocal credit and interlinked deals in small-scale fishing communities. *Journal of Development Studies* **23, 461-490.**

Pollnac R.B. (1988) *Evaluating the potential of fishermen's organisations in developing countries.* Kingston, Rhode Island: International Centre for Marine Resource Development.

Rahman A. (1985) *Peasants and classes.* London: Zed Books.

Rahman A. (1989) *Freshwater fishes of Bangladesh.* Dhaka: Zoological Society of Bangladesh.

Rahman A. (1992) The informal financial sector in Bangladesh: an appraisal of its role in development. *Development and Change* **23:1**, 147-168.

Rahman A. (1994) *Beel Dakatia: a man-made disaster*. Dhaka: Bangladesh Institute of Development Studies. Mimeo.

Rahman A. and Haque T. (1988) *Poverty and inequality in Bangladesh in the eighties: an analysis of some recent evidence. BIDS Research Report no. 91*. Dhaka: Bangladesh Institute for Development Studies.

Rahman A., Azad L., Rathyit R. and Habib A. (1992a) *Backstopping services to TFP: First Interim Report*. Dhaka: Bangladesh Institute for Development Studies. Mimeo. 35pp.

Rahman A., Azad L., Rathyit R. and Habib A. (1992b) *Backstopping services to TFP: Second Interim Report*. Dhaka: Bangladesh Institute for Development Studies. Mimeo. 28pp.

Rahman A.K.A. (1989) *The new management policy of open-water fisheries in Bangladesh under experimental monitoring and evaluation*. in ed. Aguero M., Huq S., Rahman A.K.A., and Ahmed M. *Inland fisheries management in Bangladesh*. Department of Fisheries: Dh

Rahman M.A. (1993) *Proshika's fisheries resources development programme*. Presented at the Workshop on Improved Management of Openwater Fisheries (Phase II), July 1993, Dhaka.

Rahman M.M. (1986) Small-scale fisheries in Bangladesh: some socio-economic problems and issues. *Bangladesh Journal of Agricultural Economics* **9:2**, 97-110.

Rahman S.H. (1989) *Fishing activity and distribution of benefits in Bangladesh*. in ed. Aguero M., Huq S., Rahman A.K.A. and Ahmed M.: *Inland fisheries management in Bangladesh*. Dhaka: Department of Fisheries. pp102-117.

Rahman S.H. and Roy D.K. (1990) *Consumption demand for fish in Bangladesh: an empirical analysis with cross-sectional data. BIDS Research Report no.121*. Dhaka: Bangladesh Institute for Development Studies.

Redclift M.R. (1992) A framework for improving environmental management: beyond the market mechanism. *World Development* **20:2**, 255-9.

Ruddle K. (1989) *Solving the common-property dilemma: village fisheries rights in Japanese coastal waters*. In ed. Berkes F. *Common property resources: ecology and community-based sustainable development*. London: Belhaven Press. pp168-84.

Runge C.F. (1986) Common property and collective action in economic development. *World Development* **14**, 623-635.

Sandler T. (1992) Collective action. London: Harvester Press.

Schaefer M.B. (1957) Some considerations of population dynamics and economics in relation to the management of the commercial marine fisheries. *Journal of the Fisheries Research Board of Canada* **14:5**, 669-681.

Scott A. (1979) Development of economic theory on fisheries regulation. *Journal of the Fisheries Research Board of Canada* **36**, 725-41.

Scott J.C. (1976) *The moral economy of the peasant: subsistence and rebellion in southeast Asia.* New Haven: Yale University Press.

Sen A.K. (1967) Isolation, assurance and the social rate of discount. *Quarterly Journal of Economics* **81**, 112-24.

Siddiqui K. (1989) *Licensing versus leasing system for government-owned fisheries (jalmohols) in Bangladesh.* in ed. Aguero M., Huq S., Rahman A.K.A. and Ahmed M.: *Inland fisheries management in Bangladesh.* Dhaka: Department of Fisheries. pp73-82.

Sklar L. (1992) *Technical review of the Bangladesh Flood Action Plan.* Tangail: Bhunapur Development Project. Mimeo. 39pp.

Smith I.R.(1979) *A research framework for traditional fisheries. ICLARM Studies and Reviews No. 2.* Manila: International Center for Living Aquatic Resources Management.

Smith V.L. (1969) On models of commercial fishing. *Journal of Political Economy* **77**, 181-98.

Toulmin C. (1991) Natural resource management at the local level: will this bring food security to the Sahel? *IDS Bulletin* **22:3**, 22-30.

Tsai C-F. (1991) *Manual of the household dependent monitoring program for estimating flood-plain fisheries parameters and fish production in Bangladesh.* Dhaka: Third Fisheries Project.

Tyler A.V. and Gallucci V.F. (1980) *Dynamics of fished stocks.* in ed. Lackey R.T. and Nielsen L.A.: *Fisheries Management.* Oxford: Basil Blackwell. pp.111-47.

Ullah M. (1985) *Fishing rights, production relations and profitability: a case study of Jamuna fishermen in Bangladesh.* in ed. Panayotou T.: *Small-scale fisheries in Asia.* Canada: IDRC.

Watson D.J. (1989) *The evolution of appropriate resource management systems.* in ed. Berkes F. *Common-property resources: ecology and community-based sustainable development.* London: Belhaven Press. pp55-69.

Weitzman M.L. (1974) Free access versus private ownership as alternative systems of managing common property. *Journal of Economic Theory* **8**, 225-34.

Welcomme R.L. (1985) *River fisheries. FAO Fisheries Technical Paper 262*. Rome: Food and Agriculture Organisation.

White P.L. (1984) *Crop diversification on tea estates in Bangladesh*. Srimangal: Bangladesh Tea Rehabilitation Project (mimeo).

Wilen J.E. (1979) Fishermen behaviour and the design of efficient fisheries regulation programs. *Journal of the Fisheries Research Board of Canada* **36**, 855-8.

Wood G.D. (1981) Rural class formation in Bangladesh 1940-1980. *Bulletin of Concerned Asian Scholars,* **13:4**

Wood G.D. (1990) *Review of appraisal for Third Fisheries Project (TFP) in W. Bangladesh with special reference to the distribution of benefits.* Bath: University of Bath. Report. 15pp.

World Bank (1991) *Bangladesh fisheries sector review*. Washington D.C.: World Bank.

World Bank (1993) *World Development Report 1993*. Oxford: Oxford University Press. pp329.