Sustainable Inland Fisheries Management in Bangladesh

Edited by

Hans A. J. Middendorp
Paul M. Thompson
Robert S. Pomeroy

ICLARM
International Center for Living Aquatic Resources Management

Danida

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Main photo: seine net fishing in Tangail District (source: FemCom). Left hand side from top to bottom: members of the beel management committee of Ashurar Beel (Dinajpur) meeting in front of their fish sanctuary (source: FemCom); fishers and NGO staff stocking carp fingerlings in Rajdhola Beel in Netrakona District (source: Paul Thompson); subsistence fishing by push net in a seasonal beel near Hamil Beel in Tangail District (source: Paul Thompson); a catch of small fishes from Ruhia Baisha Beel in Rangpur District (source: Paul Thompson); fishing by "current net" (nylon monofilament gill net, which is banned) with lift nets in the background, Singharagi Beel, Tangail District (source: FemCom); fishing by draining out a *kua* (floodplain ditch where fish concentrate in the dry season) in Digshi Beel, Pabna District (source: FemCom).

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FOREWORD

The inland fisheries of Bangladesh are critically important to its people for their food security and livelihood. Fish contribute about 60% of the animal protein intake of the people of Bangladesh. Inland capture fisheries contribute some 42% of total fish catch. Over 10 million people are reported to directly or indirectly gain their livelihood from the fisheries sector in Bangladesh, but in inland rural areas about 80% of households catch some fish each year, either for their own consumption or for sale.

The management of these fisheries has been a priority for the government, NGOs, international donors, such as Danida and IFAD, and ICLARM. The Bangladesh government has supported a range of experiments and pilot activities in inland fisheries management. These form an important body of experience of international relevance. ICLARM has conducted collaborative research in Bangladesh on inland fisheries management since 1988. In the last decade there have been significant developments internationally and in Bangladesh. Globally in this period the focus of fisheries management, at least in fisheries dominated by many small scale fishers, has moved to co-management models whereby decisionmaking is shared between government and resource users, and use rights and substantial management responsibilities are devolved to local communities.

In 1989 ICLARM was associated with a workshop on inland fisheries management in Bangladesh. At that time the new policy being piloted by the Government of Bangladesh was a licensing system for fishers. In 1997 ICLARM was again associated with a similar workshop, co-organized and funded with the Danida supported Oxbow Lakes Project II. Some issues have remained the same, but experience in Bangladesh has grown through a series of inland fisheries projects and these were represented in the workshop.

In the past 10 years in Bangladesh the emphasis in inland fisheries has moved in three ways. Firstly, towards technical solutions to meet fish demand by stock enhancement using carp fingerlings in lakes and floodplains. Secondly, towards alternative measures to restore and conserve natural fish populations which is linked with an increased understanding of the importance of small fishes as a source of free or low-cost food for the rural poor. Thirdly, towards community-based approaches to management of inland fisheries, often this has been linked with those communities undertaking fishery enhancements. The papers presented in the workshop held in Dhaka in 1997 comprise a set of detailed examples and assessments of experience of all three trends in Bangladesh fisheries, and of associated institutional issues.

It is clear from the workshop that these fisheries are very diverse and there are no simple answers to improving their management. However, the papers (for example, from the Oxbow Lakes Project II and from the Community Based Fisheries Management Project) do show the benefits of collaboration between government and NGOs, and show that fishing communities can, given this support, manage smaller fisheries very effectively. In more extensive floodplains and rivers, several papers indicate that technical measures to enhance fisheries are not enough, and the challenge is to resolve

administrative and institutional issues, so that government can work in partnership with much larger fishing communities.

Documentation of progress so far in this complex field is not just a reference point for future fisheries policies in Bangladesh. It also provides lessons that are directly relevant to other countries facing the challenge of developing fishery co-management institutions and reversing problems of over-stressed inland fisheries.

Dr. Meryl J. Williams
Director General
ICLARM

Within Bangladesh are more than four million hectares of inland fisheries. The production from this resource provides income and food for millions of people; in fact all of our people prefer eating our native freshwater fishes. Unfortunately, catches from these fisheries are under threat from loss of wetlands, human encroachment of the floodplains and lakes, and from overfishing because of increasing human population pressure.

This workshop was timely as it brought together experience from a wide range of experts, projects and organizations that have been working in the 1990s to counteract these trends. The recommendations of the workshop were prepared in a fully participatory manner and were one of many inputs into the formulation of the current national fisheries policy issued in 1998. The papers contained in these proceedings document much recent experience in the inland fisheries sector in Bangladesh and will form a valuable resource for fisheries planners, managers and workers in Bangladesh in developing strategies and implementing this policy during the 21st century.

Currently, based on the experience of the two projects that jointly organized the workshop, a community-based approach is being adopted in new projects of the Department of Fisheries. These projects will continue to emphasize the need for fisher participation in a wide range of management improvements, and the benefits of collaborating with other organizations, particularly NGOs, as we strive for more productive yet sustainable fisheries to meet the demands of a growing population.

Mr. Md. Abdul Matin
Director General
Department of Fisheries
Bangladesh

INTRODUCTION

Background

In the monsoon season, up to half of Bangladesh comprises inundated floodplains and wetlands which form a vast inland fishery. Consequently, catching and eating fish has become a central part of Bangali culture and diet. In addition to communities of specialized traditional fishers, most rural people have free access to seasonal floodplains for subsistence fishing in the monsoon.

Administrative arrangements for public inland fisheries in Bangladesh from 1950 to 1986 comprised only leasing of fishing rights. The Ministry of Lands (MOL) has, since 1950, managed state-owned inland openwater fisheries with the objective of raising revenues by dividing up the fisheries into *jalmobals* (fishing estates) and leasing fishing rights to these fisheries to the highest bidder for short-term (one to three years) periods. Despite measures in 1973 to restrict leasing to registered fisher cooperatives, this revenue-oriented strategy continued to result in overfishing and exploitation of the poor by leaseholders and their intermediaries.

A combination of recommendations from the Land Reforms Committee, pressure from Department of Fisheries (DOF) and lobbying from the National Fishers Association resulted in the introduction of the New Fisheries Management Policy (NFMP) on an experimental basis in some 270 waterbodies (out of a total of over 10 000) in 1986. The NFMP aimed to free fishers from exploitation by intermediaries, leaseholders and financiers, and to redirect the major benefits of fisheries to genuine fishers, while at the same time ensuring the conservation and propagation of fisheries resources. The strategy of NFMP was to gradually abolish the system of leasing rights in public waterbodies to middlemen and replace it with individual licenses for "genuine fishers". Management authority over NFMP-designated waterbodies was transferred from the MOL via the Ministry of Fisheries and Livestock (MOFL) to DOF for the duration of the experiment.

Under the NFMP framework, the DOF and a number of NGOs became involved in fisheries management. Some DOF projects used this framework for stocking-based fishery enhancements which increased production. There were also some gains in other capture fisheries where a more equitable distribution of fishing access was achieved. However, where there was no project or NGO support for the individual fishers, the ex-leaseholders often were able to retain control by advancing funds to pay license fees. No further waterbodies were handed over under NFMP.

Government policy changed again in 1995 when a MOL circular abolished revenue collection from openwaters (meaning rivers) and was interpreted as ending NFMP. This has resulted in open access fishing in rivers (where before either leaseholders or licensing had limited fishing effort to some extent), and reinforced the revenue–oriented competitive leasing strategy in other "closed" waterbodies. Exceptions are the few waterbodies currently being managed by DOF under various existing fisheries development projects, most of which follow licensing. Upon completion of the projects, these too will be leased out again, except where longer hand-over periods have been negotiated with MOL.

Despite these changing policies, the DOF, NGOs and development agencies continue to utilize leasing and licensing mechanisms and group management to develop co-management models for fisheries. While many fisheries have lacked any management arrangements since 1995, and many more are leased to individuals, there are still quite a number currently under a range of co-management arrangements between the government (DOF), NGOs and fishers and landless people. As a result of a range of projects and initiatives, there are now examples of government-led, NGO-led, fisher-led (with DOF and NGO support) and wider community-led or multi-stakeholder fishery management arrangements.

Institutional and policy changes and the projects associated with different management arrangements since the mid-1980s have been in response to growing evidence of and concern for loss of wetlands, overfishing and declines in some fish species, and these problems are discussed in several papers in these proceedings. In response to the problems of an increasing human population and declining inland fish stocks (particularly of carp), a number of interventions and projects have aimed to increase fish production from ponds and public fisheries. Aquaculture using hatchery-reared carp in ponds has expanded and intensified and now contributes an estimated 23% of total catch. However, the diverse wild fishes found in the many common pool fisheries in public waterbodies and seasonal floodplains support most fishing communities, they continue to give increasing cause for concern, and these common pool fisheries are the subject of this volume.

The main thrust of government interventions in these fisheries since the mid-1980s has been fish stock enhancements and culture based fisheries in common waterbodies, notably involving stocking of carp in permanent *baors* (oxbow lakes) with screened outlets to prevent escape of fish, and in open seasonal floodplain *beels* (lakes and wetlands). Secondly there have been policies and projects aimed at strengthening fisher rights (the moves to licensing of fishers and then fisher or community based management discussed above). Additionally there have been some more specific attempts to restore capture fisheries in certain areas by restoring links between rivers and floodplain wetlands. These initiatives in Bangladesh in the 1990s are of more than national importance, they add up to probably the largest body of experience of tropical inland fishery management through enhancements, community participation and development of common property regimes.

The objective of the workshop was to take stock of the lessons learnt for fishery enhancements and community participation from all these initiatives and projects; especially, but not exclusively, from the Community Based Fisheries Management (CBFM) project and the Oxbow Lakes Small Scale Fishermen Project, Second Phase (OLP II). The intention was to create consensus through interdisciplinary discussions on policy recommendations for inland fisheries management for consideration by the Government of Bangladesh, which at the time was preparing a national fisheries policy.

These proceedings document the experience of Bangladesh as presented in the workshop, much of this work is otherwise only available in unpublished reports. The papers represent a base point from which future interventions in Bangladesh are being planned to strengthen and expand community participation in management and enhancement of fisheries to ensure their sustainability. The lessons and experience documented add to the growing body of cases and practical experience in community management and common property fisheries worldwide, and detail experience of a number of fishing communities in enhancing inland fisheries.

The workshop

The National Workshop on Policy for Sustainable Inland Fisheries Management was the first national-level fisheries workshop held in Bangladesh to focus on fishery enhancement and community participation. The workshop was jointly organized by CBFM and OLP II. The CBFM program includes the project of the same name and several closely related projects, and altogether is a partner-

ship coordinated by ICLARM and funded by the Ford Foundation. The OLP II has worked to develop culture based lake fisheries managed by the fishers in south-west Bangladesh, and was funded by the International Fund for Agricultural Development and the Danish International Development Assistance (Danida). The workshop was hosted by the Bangladesh Department of Fisheries (DOF) and funded through respective project grants from the Ford Foundation and Danida.

The workshop aimed to bring together all stakeholders involved in inland fisheries for a national debate on inland fisheries policy issues. In total, 138 people participated in the presentations and working group sessions. The participants represented government, large national NGOs, smaller specialized NGOs, donors, national research institutes, and development projects (Appendix 1 gives a list of the participants). The active involvement of representatives from both government and NGOs was of particular note. Government-NGO collaboration and partnership is a key feature of the main projects represented in the workshop, and is a trend which seems set to form the basis for strengthening community management of inland fisheries on a wider scale.

Participants worked in groups to discuss successes and failures in sustainable inland fisheries management. Emphasis was on reaching common agreement on practical and realistic recommendations for implementation in the near-future. The working groups addressed five policy areas: research, development, fishery tenure and access, legal framework, and institutional strengthening. The recommendations of the workshop were circulated widely in Bangladesh shortly after the workshop, and are summarized in this volume. Subsequently, the National Sector Policy on Inland Fisheries in Bangladesh was finalized in 1998, it includes provision for fisher communities to hold the use rights to fisheries and states that inland waterbodies should be used primarily for sustainable fish production.

The papers

A total of 38 papers are included in the proceedings. They are divided into five sections: introduction, institutional issues, the CBFM approach and case studies, OLP II model and case studies, and issues in other fishery enhancements.

Types of community fisheries management

These papers cover issues of common property resources and fishery enhancement in the Bangladesh context. The CBFM project and OLP II approaches in the context of co-management and common property regimes are summarized, and key issues such as the need for security of tenure are raised.

Institutional issues

This section starts with legal issues including the lack of fisheries legislation in Bangladesh, the ad hoc nature of leasing administration, the need for a new regulatory regime, and the advantages and disadvantages of the fisheries cooperative societies. Other papers point out that cooperatives have often been dominated by powerful de facto lessees who capture an economic surplus. By weight of their power, the lessees have lower enforcement costs than do unorganized fishers, who often break up into factions in the face of increasing competition for fisheries in a confused policy situation. The rationale and background of the earlier system of licensing fishers under the NFMP is reviewed. Even when this is used as part of the means to secure fisher access, the fees collected are found to be very high compared, for example, with agricultural land tax. A parallel trend for participatory management in surface water management projects in Bangladesh has also encountered problems of rural elites capturing participatory bodies and has not involved fishing communities in decisions on flood control works.

CBFM approach

These case studies and papers reflect experience in the most part from just over one year of activity by different NGOs and DOF in initiating community management. The papers highlight some of the obstacles encountered in encouraging fisher communities to collaborate and work together both in beels and rivers, notably problems of changing to open access, of group formation, of establishing territorial use rights for fishers, and of transferring waterbodies from land administration to DOF. Community managed wetland habitat restoration is reported to have significantly enhanced the fishery in one location.

OLP II model and case studies

The model of fisheries management developed by OLP II reflects some six years of experience in developing co-management of oxbow lakes. The fisheries papers present operational tools based on associations between fish yield and Secchi depth and between yield and stocking density. Studies indicate that the catches of non-stocked indigenous fish are much higher than earlier estimates and may be comparable to yields of stocked carp. Systems of multiple stocking of lakes are shown to give higher incomes per day for the fishers and would make better use of the primary production of the lakes. The benefit-cost ratio is highest when fish are harvested at 1 kg or more. However, the fishers also chose to use brushpiles in the lakes which tend to yield large fish, as these fish may gain extra food from the brush piles.

Stocking carp is profitable for the participants, and case studies reveal project impacts including the involvement of women in fish farming in ponds fringing lakes, and economic and social gains. External agricultural changes and fishery management actions have affected the oxbow lake environment and some mitigation measures are outlined.

Issues in other fisheries enhancements

Papers review two large projects (the Second Aquaculture Development Project and the Third Fisheries Project) which stocked carp fingerlings and fry in large areas of open floodplain beels. In some of these beels, migration routes for natural recruitment of carp had been blocked by other infrastructure developments. The papers indicate that stocking was technically and economically worthwhile, but that benefits were unevenly distributed. Ultimately stocking was not sustainable due to limited participation by local people and problems in mobilizing local resources to cover stocking costs. Related studies found that non-selective gears used both for professional and subsistence fishing catch undersized stocked carp rather than gears which target carp. No clear trend in fish diversity associated with floodplain stocking was found.

Assessment of the first fish pass built in Bangladesh demonstrated that it could, at least partly, reverse the adverse impacts of embankments, and that fish diversity and catches were increased. A study of fish diversity and populations in relation to water depth in floodplain beels, including spatial modelling of fish distribution, shows that biomass was concentrated in shallow water in the monsoon - areas most at risk from drainage and enclosure from open floodplains. The last papers consider social and institutional problems in more intensive fishery enhancements: the difficulties of an NGO gaining access rights to semi-closed fisheries for its groups, the lower number of fishers benefited and lower yields where government controls lake management, and the social problems (particularly access right conflicts) affecting cage aquaculture managed by landless groups.

Recommendations

The key workshop recommendations relate to the need for participatory development of a policy to protect waterbodies as fisheries and enable management by organized communities which would have long-term security of tenure as an incentive for improved management, whether by stocking or through habitat protection and restoration. Linked with this theme, more detailed recommendations were made for research, development actions, fishery tenure, the legal framework and strengthening of concerned agencies. The key general recommendations are highlighted here:

1. The primary use of wetlands and inland waterbodies should be for fisheries exploitation, with the aim of poverty alleviation rather than revenue collection.

2. Sub-sector policies should be defined for each type of inland fishery. Legislation should favor community management and define the provisions of fishery tenure for community management for all types of inland waters:

a) Smaller waterbodies, where culture based management is feasible, should be handed over and managed by the organized fishers involved (community fisheries management).

b) For larger openwaters and flowing rivers, development of appropriate systems for community participation and co-management is still underway, but where fishing communities are organized, the same principles as for smaller waterbodies should apply.

3. Long-term security of tenure for fishers should be embedded in a legal framework, with specified transfer procedures under DOF supervision. Handover of any inland waterbody should be either directly from MOL to an organized fisher group/community or through a tripartite agreement between MOL, the fisher community and DOF.

4. The fisheries sector policy should clearly indicate strategies for the cooperation of MOFL/DOF with NGOs and the private sector.

5. Measures for habitat protection and restoration should aim at maintaining the remaining wetlands of Bangladesh and their biodiversity.

6. Timely availability of quality fingerlings should be ensured through the private sector, from genetically pure broodstock fish obtained from government broodstock farms.

7. Micro-credit for the inland fisheries sector should be provided at low interest rates without the requirement of collateral.

8. An openwater fisheries research and monitoring policy should be drawn up to direct research and data collection to support the needs of the overall national policy and the fishers.

The Editors

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ACRONYMS

BBS	Bangladesh Bureau of Statistics (a government agency)
BCAS	Bangladesh Center for Advanced Studies (a private Bangladeshi research organization/NGO)
BCR	Benefit-cost ratio
BIMS	Beneficiary impact monitoring study
BMC	Beel management committee
BPT	Baor pond team
BRAC	Bangladesh Rural Advancement Committee, the largest NGO in Bangladesh
BSKB	Barnai-Selimpur-Khola-Basukhali (a beel complex under the Third Fisheries Project, which is also an FCD project)
BWDB	Bangladesh Water Development Board
Caritas	A national NGO established by the Catholic Bishop's Conference of Bangladesh in 1967; "caritas" is a Latin word for love and charity
CBFM	Community Based Fisheries Management
CIDA	Canadian International Development Agency
CNRS	Center for Natural Resource Studies, a Bangladeshi NGO established in 1992 and specializing in natural resource management
CPR	Common property regime
CRED	Centre for Rural and Environment Development
DEEDS	Development, Extension, Education Services (a program of Caritas)
DFID	Department for International Development
DJMC	District jalmohal (waterbody) management committee
DMS	Development Management Scheme
DOF	Department of Fisheries
DTA	Danida Technical Assistance
FAD	Fish aggregating device, usually a brushpile or ditch/pond
FAO	Food and Agriculture Organization of the United Nations
FAP	Flood Action Plan (a series of flood mitigation and water management planning studies undertaken in 1990-1995)
FCD	Flood control and drainage
FCD/I	Flood control and drainage or flood control, drainage and irrigation (referring to projects)
FFG	Fish farming group
FPP	Fishpass Pilot Project of NERP

FRI	Bangladesh Fisheries Research Institute (also abbreviated as BFRI)
GIS	Geographical information system
GOB	Government of Bangladesh
ICLARM	International Center for Living Aquatic Resources Management
IDA	International Development Agency (part of the World Bank)
IDPAA	Institute of Development Policy Analysis and Advocacy (a branch of Proshika)
IFAD	International Fund for Agricultural Development
IMOF	Improved Management of Openwater Fisheries
JMS	Jatio Matshayajibi Samity (National Fishermen Association)
KHFA	Kawadighi Haor Fisheries Association
LFT	Lake fishing team
LMG	Lake management group
MEI	Morphoedaphic index
MOFL	Ministry of Fisheries and Livestock
MOL	Ministry of Land
MP	Market price
MRIP	Manu River Irrigation Project
NERP	Northeast Regional Project of FAP
NFEP	Northwest Fisheries Extension Project
NFMP	New Fisheries Management Policy (a system of licensing fishers introduced in 1987)
NGO	Nongovernmental organization
OLP II	Oxbow Lakes Small Scale Fishermen Project, Second Phase
PC	Production cost
PIC	Project Implementation Committee
Proshika	A national NGO, the full name is Proshika Manobik Unnayan Parishad. Proshika is an acronym of the bangla for training, education and action.
RDRS	Rangpur Dinajpur Rural Services
RLF	Revolving Loan Fund
RM	Resident monitor
SADP	Second Aquaculture Development Project
SRP	Systems Rehabilitation Project
SWA	Standard water area
TFP	Third Fisheries Project
TJMC	Thana jalmohal (waterbody) management committee
TNO	Thana nirbahi officer, the chief administrative officer in a thana
UNDP	United Nations Development Programme

GLOSSARY

aman	Main monsoon season crop of paddy
arath	Sale price and quantity of fish sold in the wholesale market
bana	Bamboo weir placed across a stream as a fish trap
baor	An oxbow lake
baul	Folk song
beel	Deepest part of a floodplain, often with a permanent area of water/wetland
ber jal	Seine net
bhashan jele	Itinerant fishers who fish in distant places that suit their needs
boro	Dry season (winter) crop of paddy
challan	Treasury form
chawk	Floodplain
chulha	A unit of people with a separate cooking arrangement
current jal	Nylon monofilament gill net with small mesh
daha	Deeper part of a beel
dall	Brushpile constructed to attract fish (a fish aggregating device)
dike	Embankment
ghat	Boat landing place
gher	Area of land enclosed with dikes for shrimp culture
haor	Deeply flooded saucer shaped depression in the northeast region of Bangladesh
hapa	Holding net usually used for fish fry
hartal	Political disturbance
icha	Shrimps and prawns
izaradars	Middlemen/leaseholders
jalkar	Fishery rent-receiver
jalmohal	Fishery leased out by government for revenue
jirati	Fishers who live close to the waterbody where they normally fish
kata	Brushpile constructed to attract fish (a fish aggregating device)
khal	Natural channel or canal
khas	Government land
khola	Temporary shelter used by seasonal migrant fishers
kochal	Seine net
komar	Brush park, a kind of fish aggregating device
kua	A ditch or pond dug in a floodplain area to concentrate fish as the water level falls (also known as *pagar*)

lathials	Stick wielders (monitors or water bailiffs)
mastaans	Local "musclemen"
matbors	Local village chiefs
matsyajibi	Fishers
mohajan	Moneylender
nitimala	Licensing (as under New Fisheries Management Policy)
pagar	A ditch or pond dug in a floodplain area to concentrate fish as the water level falls (also known as *kua*)
para	Neighborhood within the village
parishad	Council
pattani	Permanent settlement
sangathan	People's organization
savar jal	Very fine mesh nets used to catch fish fry
shomaj	Community
snakehead	Predatory fish of the family Channidae
thana	Sub-district
Tk	Taka, the Bangladeshi currency (in March 1997 at the time of the workshop, Tk 46= US$1)
zamindar	Family managing an estate and collecting revenue for colonial government during British period

SECTION I

Different Types of Community Fisheries Management in Bangladesh

Theoretical Basis for Community Based Fisheries Management in Bangladesh*

PAUL M. THOMPSON
International Center for Living Aquatic Resources Management, House 75, Road 7, Banani, Dhaka, Bangladesh

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Abstract

Common property resources are characterized by difficulty in excluding users and by users consuming the benefit at the expense of others. Management systems adopted so far for the inland openwaters of Bangladesh all have disadvantages, and policy is now in a state of change. Developing greater community participation in fisheries management is part of a move towards co-management arrangements, and is seen as a way of overcoming the problems encountered. Community involvement in all management functions is expected to result in more sustainable and equitable use of fishery resources, and in more efficient decisionmaking and compliance with management decisions. Based on international experience, a number of conditions under which community based management is more likely to succeed are identified.

Introduction

Since the early 1980s a growing emphasis in global literature and practice related to openwater fisheries management has been on "community based fisheries management" and "co-management". The common starting point is the special problems facing sustainable management of common property resources, alternatively known as common pool resources (Ostrom 1986). Common pool resources, such as openwater fisheries, are normally characterized by:

- difficulty in excluding users; they are "... sufficiently large as to make it costly (but not impossible) to exclude potential beneficiaries from obtaining benefits from [their] use" (Ostrom 1990), for example extensive floodplain-beel systems with a shared fish stock; and
- users consuming the benefit and so reducing the catch per effort of others—subtractability (Berkes and Farvar 1989; Pomeroy and Williams 1994).

Thus Oakerson (1992) argued that common property resources in practice are characterized by some degree of subtractability (which could result in unsustainable levels of exploitation but might be limited by rules); by an exclusion problem, even though they may not be open access; and by some degree of indivisibility so that even if the resource can be parceled up it is part of a wider system. In common property fisheries, fish are available in a common pool but once caught are private property not available for others to catch. This has been depicted as the "tragedy of the commons" (Hardin 1968): that open access results in unsustainable levels of exploitation of resources which are renewable but can be exhausted, such as fisheries. However, this concept of the commons as open-access resources is now recognized to be misleading, because in many cases they are property common to communities with their own rules prescribing their use. It has resulted in inappropriate policies and projects focused on establishing state ownership, which did away with local institutions for sustainable management, and in which state regulators have not proved any more effective in achieving such management.

The tragedy of the commons has been redefined by social scientists as a problem of open-access regimes, with common property regimes distinctly defined as a system of community rights over a resource which can overcome the problems of open access (Feeny 1994). The new perception of the commons (Bromley and Cernea 1989; Berkes

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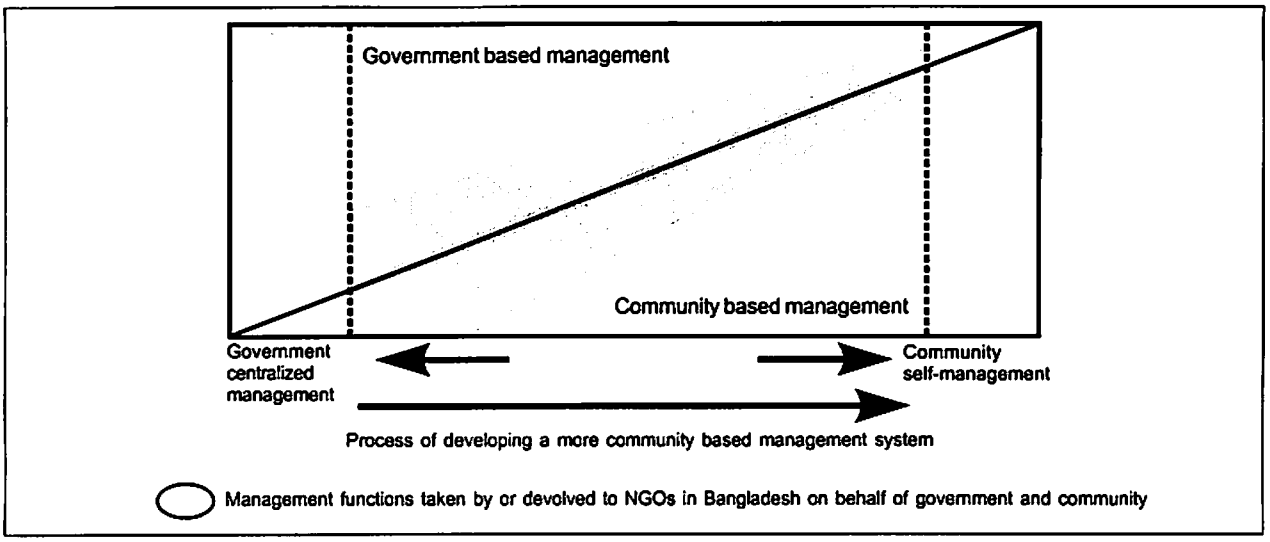

Fig. 1. Levels of community participation in co-management (after Berkes 1994; Pomeroy and Williams 1994).

1994) regards free access to be an unusual system of property rights over natural resources such as fisheries, which should not be confused with common property resources wherein a property-rights regime exists such that users jointly own the resource and are subject to rules and practices set by that community of users. A complex recent history of fisheries policies and initiatives in Bangladesh has resulted in the existence of a range of property right systems for fisheries, including state or government ownership of all fisheries; open access in rivers (since late 1995); traditional common property in floodplains and some beels; private (individual or company) use rights under leasing arrangements; and community access through both leases and licensing.

Much recent literature has focused on documenting and analyzing examples of traditional or indigenous resource management systems. These tend to be community based, and offer advantages over the alternatives of privatizing resources or introducing state control. Analysis of examples of community management systems has been matched in a number of countries by design of interventions to develop similar management systems based on community participation in fisheries management.

This paper summarizes some of the lessons relevant to Bangladesh which have been drawn in literature related to common property resources, community based fisheries management (CBFM), and co-management. This forms the rationale for the Community Based Fisheries Management Project in Bangladesh (Capistrano et al. 1994), which is summarized in several other papers in this volume.

Community based fisheries management and co-management

In a strict definition of CBFM, decisions about fisheries management in a particular area are made at the local level by the community using the fishery, with no clear role for government. This can be contrasted with co-management, which Sen and Nielsen (1996) define as "an arrangement where responsibility for resource management is shared between the government and user groups". However, the distinction is in practice not so clear since there is a continuum of possible co-management arrangements, with increasing levels of community responsibility for resource management. In Bangladesh and other countries, a focus on CBFM means developing greater community participation in management, in other words moving to the right in Fig. 1, with a corresponding reduction in government control over fisheries. However, it is rare for there to be no co-management, since strengthening and enabling community management needs supportive legal authority and rights: government (both national and local) must provide enabling laws, policies and procedures. For example, government may make general decisions and rules regarding fishery management at the national level, but place responsibility for more detailed local management decisions with the fishing community.

Table 1. Levels of co-management.

Level	Description
Instructive	Centralized management, where government informs users of its decisions
Consultative	Government takes decisions after consulting users
Cooperative	Government and community are equal partners in taking decisions
Advisory	Users advise government of their decisions and government endorses these decisions
Informative	More or less CBFM—users inform government of the decisions they have taken

The gradation of co-management arrangements, as shown in Fig. 1, is classified by Sen and Nielsen (1996) into five levels (Table 1).

Thus fisheries management interventions in Bangladesh, such as the introduction of the New Fisheries Management Policy (NFMP) in 1986 and projects to stock floodplains, suggest at a high level an instructive arrangement (government instructs fishers of its decisions without consultation). However, at a lower level many fisheries are leased out, and here leaseholders have been left with full authority to take detailed management decisions, of which they may merely inform the Department of Fisheries, and in which the Ministry of Land has no interest provided revenue is received when due. This form of co-management is between government and individual leaseholders, who then interact (and exploit) fishing communities. Only in cases where fisher cooperative societies have been able to gain and keep possession of fisheries on leasehold is there scope for users to take management decisions and for some form of co-management involving community participation. In this context the switch to the NFMP can be seen as a change in administrative responsibility in the interests of sustainability and equity, but licensing on its own offered no participation by fisher communities. Only where it linked with attempts, such as those by NGOs, to organize fishers could it offer a connection to developing co-management between fishers and government.

The reason for developing and strengthening the level of community participation in fisheries management in Bangladesh, as reported in these proceedings, is the evidence for benefits for fisheries management found in other countries and in various reviews of community management, common property and co-management.

Fisheries management benefits

Fisheries management

Table 2 summarizes seven management functions in which communities have a role in co-management of fisheries (adapted to the Bangladesh context from Pinkerton 1989). The logic of this sequence is that informed and effective management is impossible without information; that available technologies, the fish population and individual fisher decisions determine the second step; and that key management decisions relate to the size of catch and distribution of access to that catch, and to maintaining the fishery as a whole and the habitats on which it is based. These management decisions result in rules and regulations which must be enforced and monitored. Having a management system makes it possible to then plan enhancements to the fishery, which links with longer term planning.

Each of these management functions may apply at various levels forming a hierarchy or vertical range from local to national or international fishery management (Berkes et al. 1991). The more open the fishery in terms of fish stocks which

Table 2. Fisheries management functions.

No.	Function	Explanation
1	Data gathering and analysis	Reliable information is the basis for sound management decisions (items 2-4)
2	Harvesting logistic decisions	Deciding when, where and how to catch or not catch fish
3	Harvesting allocation decisions	Deciding how much to catch and by whom
4	Protection of fish habitat	Limiting uses which would displace fish
5	Enforcement of regulations	Decisions under items 2-4 lead to rules and regulations which then have to be followed
6	Fishery enhancement	May be stocking of fish, or measures to restore fish numbers through natural recruitment; habitat restoration or creation for this purpose is closely linked with item 4
7	Long term planning and policy decisions	A framework and local plans for implementing 1-6

Table 3. Performance criteria in fisheries management.

Efficiency	*Optimal* rate of use of fishery *Benefits exceed costs*, i.e., benefits of co-management institutions exceed full costs of arrangements (including "transaction costs")
Equity	*Representation* of the range of interests (stakeholders) *Process clarity*—a transparent management process *Homogeneous expectations* among the participants regarding management *Distributional equity*—benefits are in proportion to the costs incurred, or community members regard the distribution of benefits to be fair
Sustainability	*Stewardship* of the resource—maintaining its productivity and ecological characteristics *Resilience* of the management system to cope with changes and shocks (environmental, economic or administrative) through flexibility

form a large system—through migration for example—the greater the need to integrate local community based management into a wider or higher level co-management arrangement, since it is not feasible for local communities with devolved management rights to coordinate over a large system without governmental support and wider policies and regulations. These management functions could be carried out by a single leaseholder who is granted by government the rights to manage a fishery, or by government directly as under a licensing system; so in what ways is CBFM expected to be better?

Benefits of CBFM

The increased worldwide attention paid to CBFM—to document cases, generalize findings, and promote initiatives to develop community based resource management systems—has come about through experience of poor performance of alternative management systems, and through study of examples of traditional systems of community management of natural resources which have not only survived but appear to perform better than the alternatives. Application of this understanding in creating new community based resource management systems also is generating information on how to establish CBFM systems. Three broad criteria (Table 3) have been applied to define better performance in fisheries management, and to judge the performance of co-management or CBFM arrangements: efficiency, equity and sustainability (Hanna 1996).

Based on Pinkerton (1989), six benefits from greater community participation in fisheries management can be identified:

1. Fishers cooperate in planning to increase or conserve fish stocks, which is defined as improved management (sustainability).
2. Fishers share the costs and benefits of improved management (economic equity).
3. There is better conflict resolution among fishers (intra-group social equity).
4. The position of fishers when dealing with other stakeholders (water users, fish traders, etc.) is enhanced by their being organized (inter-group social equity).
5. Fishers and government are willing to share data and their understanding of the fishery (maximizing use of indigenous knowledge is one theme in CBFM where there is a tradition of resource use).
6. When fishers have more control over fisheries which they effectively own as a community (i.e., where there is security of tenure) there is greater trust between fishers and government, which brings two types of benefit:
   a) Fishers have an incentive to take a longer term management perspective (sustainability).
   b) Enforcement of rules is more effective as these rules have a high level of acceptance and so compliance and self enforcement are high; hence the "transaction costs" of institutions for fishery management are reduced (efficiency benefit).

In Bangladesh all of these potential benefits are of value to fishers and in the national interest, but community management may threaten those who benefit most from existing access and institutional arrangements in fisheries. The context of past fisheries management and fishery trends in Bangladesh is that fish provide some 60%

of animal protein in the Bangladeshi diet, and demand is mostly met from inland capture fisheries (which have declined but still contribute more than 50% of all fish consumed). Total production has remained high, but in recent years growth has come from culture fisheries and larger, commercially more valuable species have suffered major declines in openwaters. Fishers have had little direct involvement in planning improved management in the past. In fact they were largely excluded from management decisions by government policy, which divided up the river–floodplain–lake systems and leased out these sub-divided fisheries (*jalmohals*) to middlemen, who generally managed to retain control when attempts were made to give preferential access (subject to revenue collection) to fishers.

What is needed for CBFM?

There are strong arguments in favor of CBFM as an approach to addressing the problems of increasing pressure on fish resources in Bangladesh; dominance of short term revenue collection aims in fishery management; and inequity in the distribution of returns from fishing (with much of the benefits going to the rich). Hence the conditions which will enable CBFM to be effective in Bangladesh should be recognized. Based on reviews of various studies and experiences in other countries by Pomeroy and Williams (1994), Ostrom (1992) and Pinkerton (1989), a number of general principles have been identified which make community based management more likely to be successful. The following are considered to be the most important in a Bangladesh context:

- The fishery should not be too large and should have clearly defined boundaries, both physical and ecological (for example it should not comprise mainly migratory species).
- The user community should not be too large and should be clearly defined, with criteria for participation locally accepted (for example people who live close to the waterbody).
- The user community should be cohesive and homogeneous in terms of social and economic criteria, and preferably comprise existing (traditional) organizations involved in the fishery. Where new community organizations are established to manage fisheries, the various existing fishing interests need to be represented.
- The benefits of participation in CBFM should be seen to outweigh the costs.
- There should be certain and clear rights of access for the users (community), who have the legal right to organize.
- Government should formally decentralize authority and delegate it to the community, so that those affected by management decisions participate in decisionmaking.
- There should be good coordination between government and community, and within the community; forums for discussion and conflict resolution between all stakeholders should be provided.
- Local government agencies and community organizations should have a long term commitment and authority to implement fishery management plans.
- The community should be dependent on fishery resources and have a shared perception of real threats to those resources through unsustainable exploitation.
- There should be a focus for fishery management actions: to enhance the fishery, including habitat protection.
- Management rules should be enforceable (for example a few simple rules and regulations) and widely recognized.
- Traditional knowledge of fisheries should be incorporated into management, and a link established between conservation of fish and of related culture and values (traditional rotational fishing systems and sanctuaries have tended to break down under short term leasing and increasing fishing pressure).
- There should be research support to community managers from outside organizations, which can guide management actions and demonstrate their impacts.
- There should be a core group or energy center around which CBFM develops, through the guidance of an experienced facilitator. NGOs have a particular role in facilitating CBFM.

Lessons from CBFM in Bangladesh

Based on limited experience in the CBFM project, and experience in the other fishery management projects in Bangladesh reported in this volume, a few early lessons can be drawn:

- CBFM has developed faster where the fishery and community are well defined and limited and have past experience in fishery management; where the community falls completely within the scope of assistance from a partner NGO; and where there is a demonstrable benefit from an intervention managed by that community (which may be stock enhancement or conservation and habitat restoration). These factors appear to be more important than a focus on a particular intervention—such as stocking, which did not result in CBFM—or on sustainable benefits where the other factors were not met.
- The key stakeholders in fisheries are poor people who fish for their livelihood, and they have a leading role to play in responsible fishery management. NGOs working with organizations of poor fishers have already helped to raise fisher incomes and empower poor fishers, who have shown their capability to manage fisheries for themselves, including culture-based common fisheries.
- Subsistence fishers and richer stakeholders in fisheries should not be excluded from fishery co-management, particularly in more open common fisheries. NGOs and government need to recognize this and cooperate to facilitate formation of wider community based fishery management organizations or forums. Ultimately government should then devolve clearly defined local fisheries management responsibilities to these community bodies.

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Overview of the Community Based Fisheries Management Project*

MD. MOKAMMEL HOSSAIN, MD. SHAMSUL KABIR
Community Based Fisheries Management Project, Department of Fisheries, Matshya Bhaban, Dhaka, Bangladesh

PAUL M. THOMPSON, MD. NURUL ISLAM and MD. MANJUR KADIR
International Center for Living Aquatic Resources Management, House 75, Road 7, Block H, Banani, Dhaka 1213, Bangladesh

HOSSAIN, M.M., M.S. KABIR, P.M. THOMPSON, M.N. ISLAM and M.M. KADIR. 1999. Overview of the Community Based Fisheries Management Project, p. 9–18. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Community based fisheries management was introduced in 1996 in 15 inland open waterbodies in Bangladesh. The aim is to develop shared responsibility between the government and local resource users to manage these fisheries. To do this the Department of Fisheries is working with five national NGOs. Baseline information on eight waterbodies and their communities is presented. Both fishers organized by the NGOs and the wider community of subsistence fishers have identified fishery management needs, and already some enhancements through stocking have been tried. The main problems encountered have related to handover of waterbodies from the Ministry of Land. Greater flexibility and clearer long term responsibilities are recommended.

Introduction

Fisheries management policy in Bangladesh has been in a state of change for the past decade. There is general agreement that openwater fisheries have been in decline (Ali 1991). Government has responded with projects designed to expand fish culture systems, but these technologies do not lend themselves to adoption in openwaters and exclude many people who fish in openwater areas. Experience has shown that it is hardly possible to effectively manage openwater fisheries without active community involvement (Capistrano et al. 1994; Islam, this vol.). However, a clear and effective policy has yet to be developed to meet the objectives of sustainable use and a more equitable share of returns to fishers.

Since 1987, the Department of Fisheries (DOF), the Ford Foundation and the International Center for Living Aquatic Resources Management (ICLARM) had been involved in experiments in management of openwater fisheries in Bangladesh based on greater grassroots involvement in management and working with NGOs. Previous experiments were linked with the New Fisheries Management Policy (NFMP) and involved handing over of waterbodies to DOF, which licensed fishers. Valuable lessons were learnt from these earlier projects (Capistrano 1996; Ahmed et al. 1997). They showed that it is necessary to involve all stakeholders in fisheries management, which implies a community-based approach rather than attempts to exclude or eliminate middlemen. There is also a need for alternative income opportunities to be developed for those dependent on fishing, to provide incomes during slack seasons and to relieve pressure on fishing. It was further recognized that it is necessary to devise new management approaches that take account of the inherently common property nature of these resources, and that are both equitable and ecologically sustainable.

The Community Based Fisheries Management (CBFM) Project has been designed in response to these lessons and identified needs. The rationale of the project is that government agencies and NGOs can work with the communities to develop appropriate programs, whether in fishery management

*ICLARM Contribution No. 1531

or in developing alternative activities and income sources. This experimental approach forms a learning process which the project is documenting. Experience from the project is expected to help direct formulation of future openwater fishery management policies in Bangladesh and in general.

The project aims to develop openwater fishery management systems which are both more equitable and ecologically sustainable. Important questions for research and fisheries policy that it addresses are therefore:

- Can community based management result in sustainable use systems?
- Are the benefits in such systems more equitably distributed?
- What are the most appropriate models of community based management?

Because of the complex and varied nature of openwater fisheries and the communities which exploit them, the project is testing different systems of co-management, and processes of developing such systems with the help of NGOs. The rationale of the project composition is that government agencies and NGOs complement each other in meeting these needs, and are partners in the project.

Following previous experiments, further work was needed to develop co-management systems for a wider range of waterbodies of different types. Flexibility in implementation is an essential aspect of the project so that the partner NGOs can work with the communities to develop appropriate programs, whether in fishery management or in developing alternative activities and enhanced incomes.

CBFM Project activities

The CBFM Project is funded by the Ford Foundation and is implemented by a partnership of DOF, ICLARM and several NGOs including Proshika, Caritas and BRAC. Project activities fall under two broad headings: action in the form of community organizational development and fisheries management; and research, monitoring and assessment.

DOF is responsible for negotiating through the Ministry of Fisheries and Livestock for the transfer of the waterbodies from the Ministry of Land. DOF ensures the active involvement of its staff (district and thana fishery officers) in the development of co-management in the project waterbodies. It has prime responsibility for conducting surveys to monitor and assess the development of and impacts of community based management.

The partner NGOs have prime responsibility for helping fishing communities to strengthen their organizations and develop alternative income sources. They form groups of fishers, provide training and credit towards developing alternative income sources to supplement fishing income (and so, it is hoped, increase incomes and reduce pressure on fisheries), provide assistance to poor fisherfolk (for example to improve their gear), and operate general community programs such as education and health awareness. The groups formed by NGOs form the organized fishing community, which is the basis for coordinated actions to plan for and then carry out improvements in fishery management.

ICLARM provides technical assistance to the other partners, particularly for research activities and surveys, and facilitates NGO–government collaboration. The combination of all three partners at each location is expected to work with the community to help fisherfolk to agree on management strategies and to self-enforce any rules they establish. Fig. 1 shows the overall model being adopted in the project, but it must be emphasized that the partner NGOs have much flexibility in how they work with fishing communities; thus an NGO may act as a facilitator or as an intermediary between the fishers and government.

Progress

The CBFM Project effectively started functioning in the working areas of two NGOs—Caritas (five waterbodies) and Proshika (eight waterbodies)—at the start of 1996 (seven of these waterbodies had come within the ambit of the NFMP and the NGOs had undertaken limited work earlier with the communities concerned). Coverage has gradually expanded. In October 1996 three smaller NGOs were included in the project, each working in one waterbody, but one has subsequently been dropped due to local conflicts and reported malpractice, leaving two

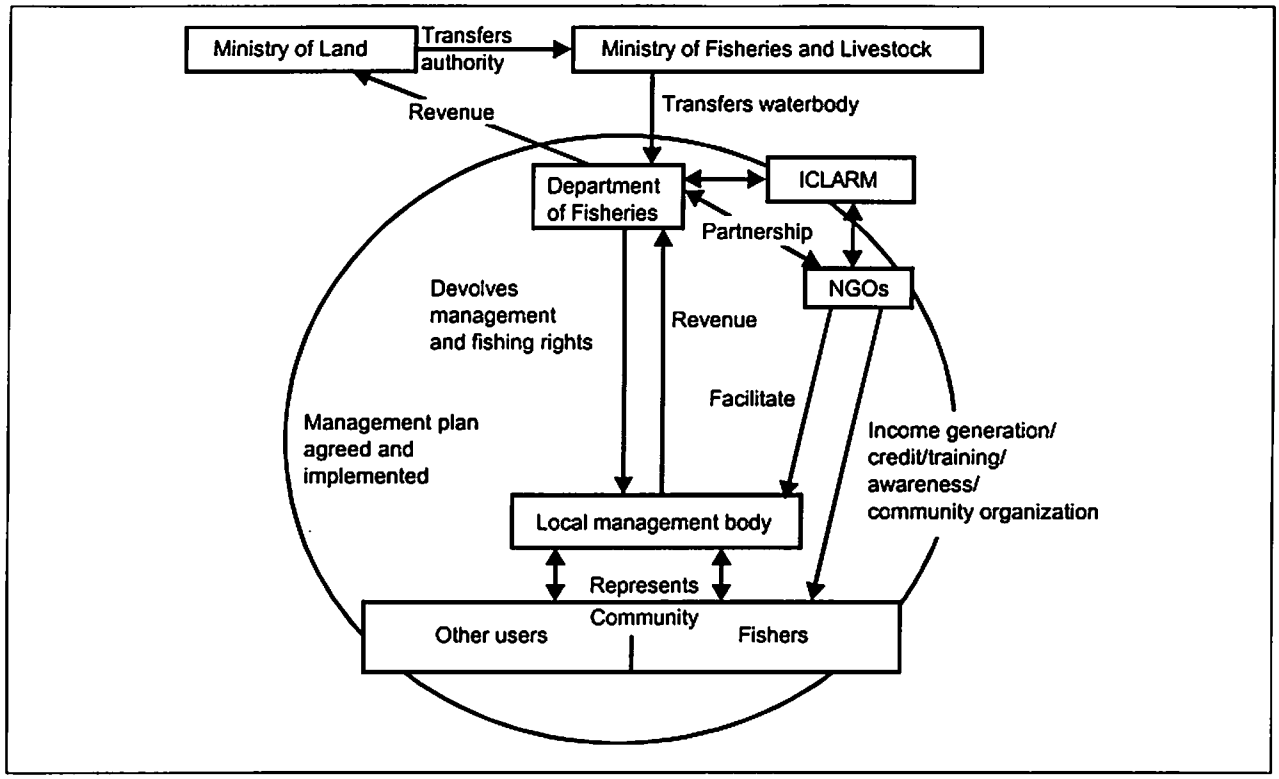

Fig. 1. Schematic model organization of CBFM.

Note: Supporting surveys by DOF and ICLARM cover the community, the fishery, the process of developing CBFM and impacts of the project.

active smaller NGO partners: Banchte Shekha and the Centre for Rural and Environment Development (CRED). In June 1997 another NGO, BRAC, formally joined the project after five of its intended waterbodies were handed over by the Ministry of Land, bringing the project coverage up to 20 waterbodies and five NGOs. In each case the NGO has a memorandum of understanding with DOF. Groups of fishers have been formed in each area by the NGO partner concerned (Table 1), and through a series of coordination meetings, the project is developing in each location a partnership between the fishers, NGO and government. Waterbody locations covered in 1996 are shown in Fig. 2.

Most of the local community members are stakeholders to some extent in these fisheries, since most households fish at least occasionally (Table 1). The partner NGOs have concentrated on organizing households which fish for an income, and on average have covered about 20% of households with some involvement in fishing from the project waterbodies. The progress of the project is covered in more detail in papers by the main partner NGOs active from early 1996 (Alam et al.; Huq et al.; Shelly et al., this vol.).

Fishing communities and their preferences

Survey design

To establish the situation at the initial stage of the project, basic socioeconomic data were collected including occupation, education, land ownership and food security; fishing assets and activity, fish consumption and fishing restrictions; and opinions on fishery management, fishery trends, and fishery management needs.

Table 1. Coverage of CBFM Project sites by partner NGOs in 1996.

Waterbody type		Beels	Rivers	Total
Sites:	Total	5	10	15
	Proshika	0	8	8
	Caritas	4	1	5
	Other NGOs*	1	1	2
Total households		4 885	13 164	18 049
NGO households		747	2 260	3 007
Households that ever fish (%)		85	87	87
Fishing households in NGO groups (%)		18	20	19

**Banchte Shekha and CRED. Five waterbodies added with BRAC not included. One waterbody with BAZI was subsequently dropped.*

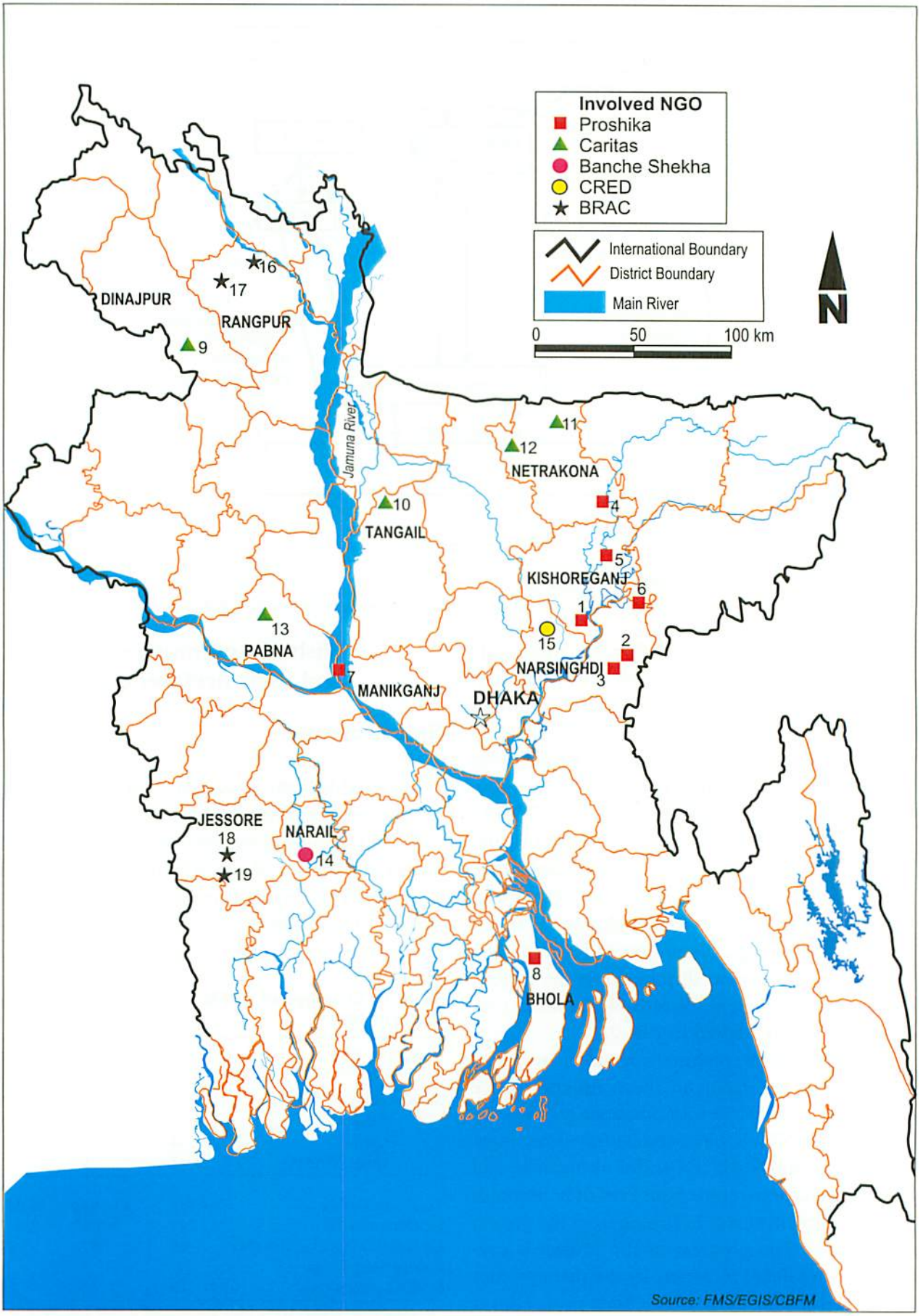

Fig. 2. Location of CBFM Project waterbodies.

Table 2. Summary of CBFM waterbody status in early 1997.

No.	Waterbody	Type	NGO	Status in early 1997
1	Kali Nodi	River	Proshika	Previously under NFMP, now free access
2	Titas Nodi (Block ka)	River	Proshika	Previously under NFMP, now free access
3	Titas Nodi (Gokanghat-Goshaipur)	River	Proshika	Previously under NFMP, now free access
4	Boyrala Nodi	River	Proshika	Previously under NFMP, now free access
5	Moisherkandi-Bornpur River	River	Proshika	Previously under NFMP, now free access
6	Dhaleswari Nodi	River	Proshika	Free access but fishers being excluded by rich
7	Jari Jamuna and Bancha Mora Nodi	River	Proshika	Previously under NFMP, now free access
8	Tetulia Nodi	River	Proshika	Free access
9	Ashurar Beel	Beel	Caritas	Local sanctuary agreed by beel management committee
10	Hamil Beel	Beel	Caritas	Successfully managed and stocked by community
11	Ubdakhali Nodi	River	Caritas	Previously under NFMP, now free access
12	Rajdhola Beel	Beel	Caritas	Held by private leaseholder (handed over later in1997)
13	Digshi Beel	Beel	Caritas	Handed over; stock protection planned
14	Goakhola-Hatiara Beel	Beel	Banchte Shekha	Private land, NGO plans habitat restoration
15	Arial Khan River	River	CRED	Pen culture tried
16	Dum Nodi Beel	Beel	BRAC	Stocked by cooperative, NGO support from mid-1997
17	Ruhia Baisa Beel	Beel	BRAC	Part open, part excavated for culture, NGO support from mid-1997
18	Krishnochandraper Baor	Baor	BRAC	Stocked by cooperative, NGO support from mid-1997
19	Shimulia Baor	Baor	BRAC	Stocked by cooperative, NGO support from mid-1997

The process of developing co-management is also being documented.

Surveys were undertaken in 1996 for a sample of households living in villages around each waterbody. Because of its distinct environment, fishery and community, each waterbody is a separate test of developing community management, so separate random samples were taken of NGO participant and non-NGO participant fishing households from the villages using each waterbody. The project is concerned with not only empowering and improving the lives of people who fish for a living (and are organized in NGO groups) but also maintaining subsistence fisheries that are vital to poor people.

Table 2 provides an overview of 19 sites, numbered as in Fig. 2. Of these, comparative data are presented for eight sites comprising four beels (lakes) where Caritas is working (Ashurar, Digshi, Rajdhola and Hamil Beels, in northwest and north central Bangladesh), and four sections of river where Proshika is working (Titas Ka, Dhaleswari, Jari Jamuna and Moisherkandi, in the northeast and north central regions). Combining waterbodies gives an overview of opinions and of the fishing community in two types of waterbody. However, there are substantial variations between regions, types of fishery, communities, and NGO activities. In particular the level of community participation in fishery management differs between sites which have been grouped together.

Beel and river fishing communities

Most NGO participant households are engaged in fishing for a livelihood, although in the beels this is mainly a part-time income (Table 3). Traditional "full-time" fishers are largely Hindu in Bangladesh and form a clearly defined community where cooperation through fishing in teams is widespread, but increasing numbers of Muslims have taken up the profession, particularly around beels. Most non-NGO households around the beels fish only for household consumption, whereas in the rivers, 60% of non-NGO households also earn an income from fishing. Thus the level of dependence on fishing among households living near rivers but not organized into NGO groups is relatively high.

The participant households in NGO groups on average are poorer than other households in the same communities; this is consistent with the project objectives of targeting poorer fishers to redress inequities by enhancing their access to

Table 3. Characteristics of heads of household in baseline sample.

Waterbody type:		Beel		River	
Household type:		NGO	Non-NGO	NGO	Non-NGO
Number of households		230	240	217	240
Religion (%)	Muslim	72	83	41	82
	Hindu	28	18	59	18
Education (%)	None	50	38	44	49
	Read/<class 5	39	36	43	37
	Class 5+	11	26	13	14
Fishing (%)	Full time	40	3	66	28
	Part time	52	7	25	31
	Subsistence	6	67	7	28
	Do not fish	2	13	2	13
Main occupation (%)	Fishing	59	3	74	33
	Cultivation	18	45	11	27
	Labor	15	26	7	24
	Handicraft/trade	5	7	4	8
	Business/service	1	11	2	2
	Other	2	8	2	6

credit, information and control over fishery decisions. However, the differences are more apparent around the beels than by the rivers (Table 4). For example the area of land owned and the proportion of houses incorporating tin construction are notably higher for non-NGO households around the beels, while there is less differentiation in economic terms in the riverine communities.

Fishing involvement

Development of CBFM is at an early stage in the project waterbodies, and the survey indicates the situation before community management plans were formed, in terms of orientation to cooperation and of fishery management. Many of the NGO participant households, who almost all fish for a livelihood (Table 5), fish in teams with larger gear (often gear is not owned by all the team members; gear owners receive extra shares of the catch). Most fishers already face restrictions on fishing, although these are of different types and vary greatly between sites. In general those who fish for an income had to pay to fish (either to government directly or to leaseholders), but very few non-NGO participant households reported paying to fish, including a smaller percentage of those who fish for income. Instead they are limited in *when* they can fish (the monsoon) under what is effectively a free access arrangement for subsistence fishing. There is wide recognition of problems facing these fisheries, and most respondents reported that fish numbers are declining, although this may relate to declining catches relative to fishing effort. The common reasons given were destructive gear (most common), too many people fishing (especially in rivers), and reduced water area (especially in beels); in addition fish disease (Epizootic Ulcerative Syndrome) was reported to be a problem in some beels.

Table 4. Household non-fishing assets.

Waterbody type:	Beel		River	
Household type:	NGO	Non-NGO	NGO	Non-NGO
Number of households	230	240	217	240
Area of own land (ha)	0.19	0.52	0.17	0.31
Houses, area of (m^2)	24.6	30.5	18.4	18.6
House				
Wall (%)				
straw/jute/bamboo	64	55	90	83
tin/concrete	1	16	9	17
earth	35	29	1	0
Roof (%)				
straw/jute/bamboo	62	37	22	24
tin	38	63	78	76

Respondents were asked if they agreed or disagreed with a number of statements about fisheries. Just under half of fishers believe they know how to manage the fisheries they exploit better than current management practice (Table 5); though 71% of fishers organized by NGOs around the beels believe they can manage better than at present, as they have already received training, and in three cases have observed stocking with major carp. However, most fishers report that at present they have no say in how their fishery is managed; this is particularly the case among non-NGO participant households around the beels (at the time of the survey, fishers had been organized to take up management through stocking with fingerlings in only one beel—Hamil). Other households did not all agree that their voices were heard, some did not know or could not answer the question. Hence fisher participation in management of these waterbodies was less than the fishers feel capable of at the outset of the project.

Fishing activity and fish consumption were recorded for the previous day. The monsoon to

Table 5. Summary of fishing issues in eight waterbodies.

Waterbody type:	Beel		River	
Household type:	NGO	Non-NGO	NGO	Non-NGO
Number of households	230	240	217	240
Percentage of households that:				
Fish for income	93	25	93	63
Fish in a team	53	5	65	30
Paid to fish in previous year	83	13	75	36
Report fishing restrictions	87	87	76	60
Report declining fish	90	84	96	95
Report knowing how to manage fishery better than at present	71	45	47	42
Report no say in fishery at present	58	81	49	58

post-monsoon period is one of extensive fishing activity. Differences in fish consumption were greater between type of waterbody than between NGO participant and non-NGO participant households. For the sample 24-hour period, more households were involved in fishing in the rivers, and ate more fish from their own catch, whereas in the beels many non-NGO participant households which ate fish bought those fish (Table 6). Per capita fish consumption was higher than the national year-round average of about 23 g/person/day, and was higher in the riverine areas than in the beels.

Preferred interventions

Respondents were asked what measures were needed for better management of their fishery. The factors limiting actions were also requested, the one most often quoted being lack of government and NGO initiative. While stocking fish was widely suggested (Fig. 3), this is based in several of the sites on the observation or expectation of free stocking by government; it may not imply that communities will be willing to invest in stocking. Importantly, in the rivers, fishers did not feel they had secure access rights under a free access system, and wanted to have restrictions on gears which they consider harmful—including brushpiles (*katas*) which are widespread and are a means for local landowners to obtain *de facto* rights over parts of the fishery. In the beels, measures to restore habitat were favored, along with measures to retain water and fish. These opinions are being fed back into community decisions on fishery management at these sites. Interest and capability in fisheries management are being raised among local organizations and communities through NGO activities and regular monitoring and feedback systems which aim to bring potential co-managers together to make informed management decisions.

Examples of fishery enhancements

In Hamil Beel, the most successful project site so far, the fishing community with existing fishing rights over a small enclosed beel fishery (16 ha)

Table 6. Household fishing activity and fish consumption in 24 hours*.

Waterbody type:	Beel		River	
Household type:	NGO	Non-NGO	NGO	Non-NGO
Number of households	229	240	217	240
Percentage that fished	49	28	84	76
Percentage that ate fish	56	50	82	81
Percentage that ate fish they caught	37	13	53	52
Percentage of eaten fish from own catch	61	34	65	63
Fish consumption (g/person/day)**	39	36	52	55

* *Monsoon and post-monsoon 1996 (August-November)*

** *Includes own catch plus bought fish*

Data missing for one NGO-participant beel household

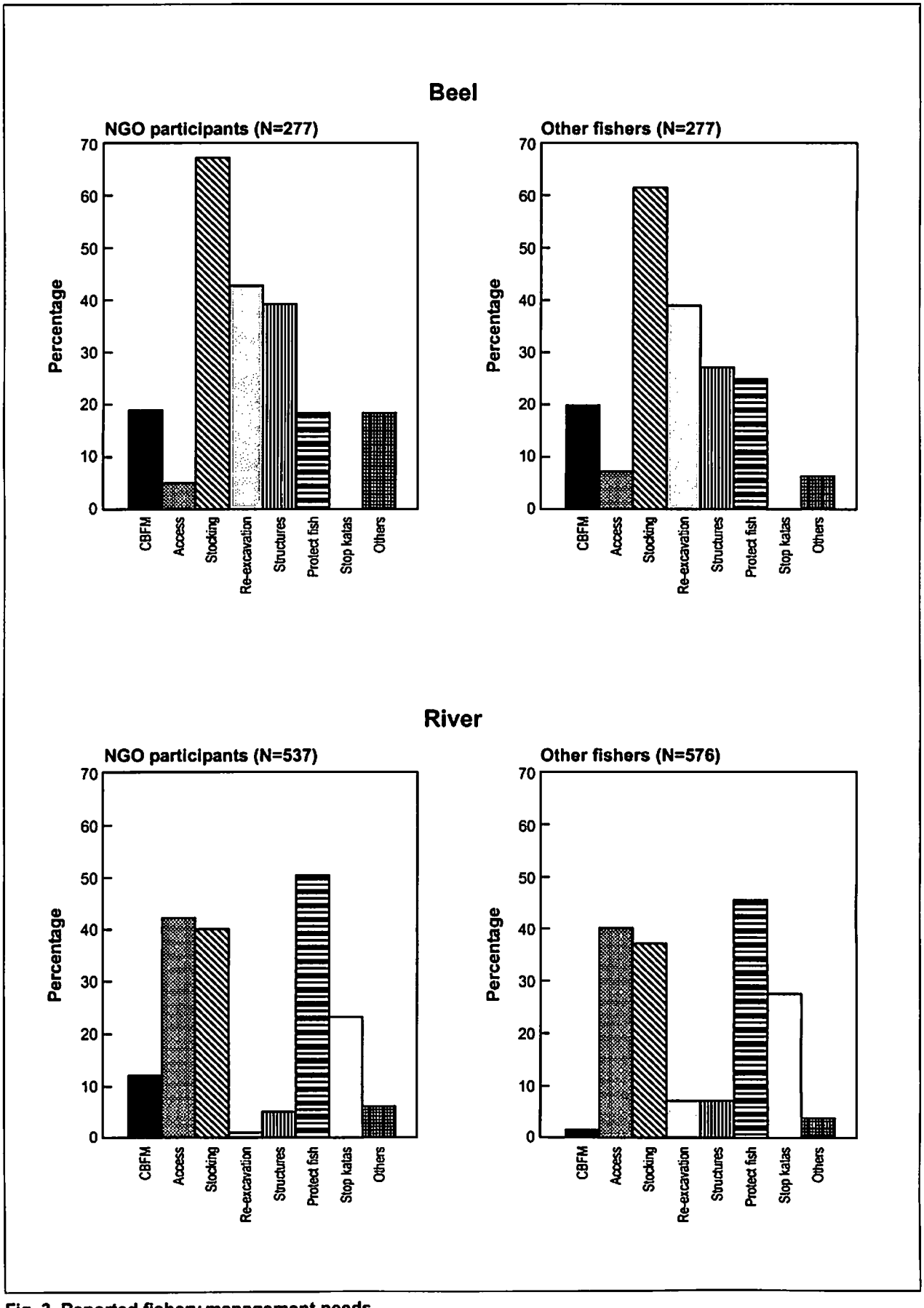

Fig. 3. Reported fishery management needs.

Note: Katas are not a problem in beels, since outsiders cannot build them there.

has managed carp stocking with support from Caritas. The fishers formed a beel management committee representing all the fisher groups with rights over Hamil Beel, and it arranged stocking of seven species of carp (about 62 000 fingerlings) during May–September 1996. Just over 29 000 carp weighing 20 t were then harvested between September 1996 and February 1997 (Alam et al., this vol.). This was much higher production than in previous years of stocking; moreover the increased total income was distributed equally (Tk 5 400 per person in the 1996–1997 harvest season).

In Arial Khan River, CRED formed six fisher groups comprising 78 fishers. They have tested culture based enhancement in the river by stocking 30 000 carp fingerlings in a 3-ha pen constructed of bamboo fences during the dry season (when there is a much reduced flow in the river). This trial proved partially successful and gave a positive financial return, but due to late stocking some fish were transferred to rented ponds to grow to marketable size when the pen was threatened by rising water levels. Similarly Proshika has an experiment with cage culture in one river—Kali Nodi—which is intended to pilot a means of enhancing fishers' incomes and control of the resource.

In line with fisher preferences, in 1997 there are plans in some waterbodies to enhance fisheries through measures not based on stocking. In Ashurar Beel, fishers have agreed to protect fish in the deepest part of the beel in a sanctuary to be declared by the community, and in Goakhola–Hatiara Beel, there is a plan for the groups (of women subsistence fishers) organized by the NGO to protect some ditches in the floodplain and to re-excavate a channel linking with the river nearby. In some of the rivers under the project, there were earlier sanctuaries declared by government, but the fishing communities did not respect these restrictions very well. It is hoped that the communities will coordinate to take similar measures themselves; they are being motivated to protect fish but they presently lack rights to achieve this in rivers.

Conclusions and recommendations

The fisheries where the CBFM Project is working are mostly of modest size, but in some cases are ill-defined. Moreover, communities vary in size and, in several sites, the fishing community covers 20 or more villages. Accordingly, while traditional fishers are a cohesive community, there is a much wider diverse community of stakeholders, including many poor people who depend on fishing for the animal protein in their diet. Dependence on these fisheries is high, and there is a widespread recognition that the resource is in decline. Most fishers favor measures to enhance fish stocks directly, and to conserve stocks through limitations on fishing, but work to help them organize to cooperate in achieving this is at an early stage. The CBFM Project is developing local frameworks for community decisionmaking on fisheries and for coordination with both government and other stakeholders. This is being facilitated by partner NGOs and by DOF staff, but there are a number of serious impediments.

Constraints and problems

The project partners have faced the following key problems in undertaking the project:

- Only nine out of 28 waterbodies proposed for the project have so far been handed over to DOF. Specifically, government has taken no decision over the status of flowing rivers and whether communities can take management responsibility for them within the framework of a DOF project. The Ministry of Land appears to take decisions on a project-by-project basis with no clearly considered policy.
- When handing over waterbodies, the Ministry of Land imposed a condition of a 25% increase in revenue over the previous year, and then a 10% per annum increase in the lease revenue. This is unfair when the fishery is handed over for poor fishers to manage, especially where enhancement is not feasible.
- The boundaries of waterbodies and relevant communities are uncertain or are not demarcated. Revenue based *jalmohal* areas are not ecological or social units.
- The Ministry of Land has a short term perspective in handing over waterbodies (only 3 years), which will not encourage sustainable management or community interest.

- Lack of proper coordination between government and NGOs has resulted in failure of fishers to establish their rights in some sites.
- Ecological degradation due to construction of embankments and sluice gates, canal digging, roads and other construction work without considering potential impacts on fisheries has had negative impacts on the fisheries and limits development potential.
- Fishers are still exploited by middlemen and have low incomes.

Recommendations

The following initial recommendations are made:

1. Policies at present are in a state of change. Community based management of fisheries is a way to develop a better management system which shows promise, but will take different forms in different types of fisheries. A flexible approach is needed for pilot projects before recommending any general framework.
2. The Government of Bangladesh should be consistent and fair in its fisheries revenue requirements and not penalize poor fishers.
3. Flexibility to include associated floodplains and the fishing community in management plans is needed. Areas covered should be based on the waterbody–fishery system and people's opinions, not on past administrative and revenue collection boundaries.
4. Once communities are organized for co-management, rights should be handed over by long term lease to DOF, on condition that it devolve local management responsibility to the community.
5. Clear agreement on responsibilities and on timely actions is needed between government and NGOs, but this should be aimed at greater involvement of communities.
6. NGOs can raise fishers' awareness of sustainable fishing and help organize sanctuaries and local fishing rules.
7. Development agencies should consult locally with organized fishers before taking up projects such as embankments and roads which could affect fisheries. DOF and NGOs should help ensure fishers' participation in this process, and ensure that measures to mitigate the effects of such projects, or even to enhance fisheries, are built into such projects.

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Fisheries Co-management and Sustainable Common Property Regimes Based on Long-term Security of Tenure in Oxbow Lakes in Bangladesh

NIAZ AHMED APU, MD. ABDUS SATTAR, DEV NATHAN, JOHN D. BALARIN and HANS A.J. MIDDENDORP

Oxbow Lakes Small Scale Fishermen Project, Second Phase, Department of Fisheries, BRAC and Danida Technical Assistance, Matshya Bhaban, Arabpur, Jessore, Bangladesh

APU, N.A., M.A. SATTAR, D. NATHAN, J.D. BALARIN and **H.A.J. MIDDENDORP.** 1999. Fisheries co-management and sustainable common property regimes based on long-term security of tenure in oxbow lakes in Bangladesh, p. 19–30. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

In Bangladesh, long-term security of tenure is a precondition for establishment of a common property regime (CPR) in oxbow lakes by the fishers themselves. The sustainability of such a CPR in an oxbow lake fishery depends on fostering cooperation between fishers by providing incentives, maintaining equity, and ensuring democratic rotation of leadership and monitoring of all operations by the fishers themselves.

Introduction

The Oxbow Lakes Small Scale Fishermen Project, Second Phase (OLP II) is a social fisheries project in 23 natural oxbow lakes in southwest Bangladesh along the border with India (Fig. 1). The objective of OLP II is to transfer the culture based fisheries management of oxbow lakes to the fishers themselves by creating appropriate institutions and a mechanism for guaranteeing security of tenure. OLP II has evolved over time a sustainable institutional arrangement for co-management of oxbow lakes by the Government of Bangladesh and organized groups of fishers supported by a national NGO (Middendorp et al. 1996).

Oxbow lakes are common resources, both the fish and the water forming part of the common resource. The management of common resources by the stakeholders (i. e., fishers) is referred to as a "common property regime" (CPR). A CPR involves shared management, shared labor and rights to withdraw benefits by a clearly defined set of users—it is not "open access" but group management (Pomeroy 1994). Unmanaged common resources tend to be over-used by the people living near them (Ostrom 1990).

CPRs should be distinguished from general public or government ownership. CPRs are forms of management grounded in a set of accepted rights and rules by a group of resource users for the sustainable and interdependent use of a collective asset. A CPR endows the group with regulatory authority, which is a way of allowing a community of users to make collective choices, without the willing consent of each member (McKean 1992).

National governments of many countries in Asia and the Pacific have often underestimated the role and capacities of local communities in the management of fisheries; at the same time local communities cannot successfully implement fisheries management by themselves alone (Ruddle 1994). More dynamic partnerships between fishers and governments are now evolving, using the capacities and interest of the local community, complemented by the ability of the national government to provide enabling legislation and to act as facilitator. Such a type of management partnership, whereby the national government and the community share authority, is referred to as co-management (Pomeroy 1994). The amount of authority vested in the national government and in the community depends on the country and on site-specific conditions (Pinkerton 1989; Berkes et al. 1991).

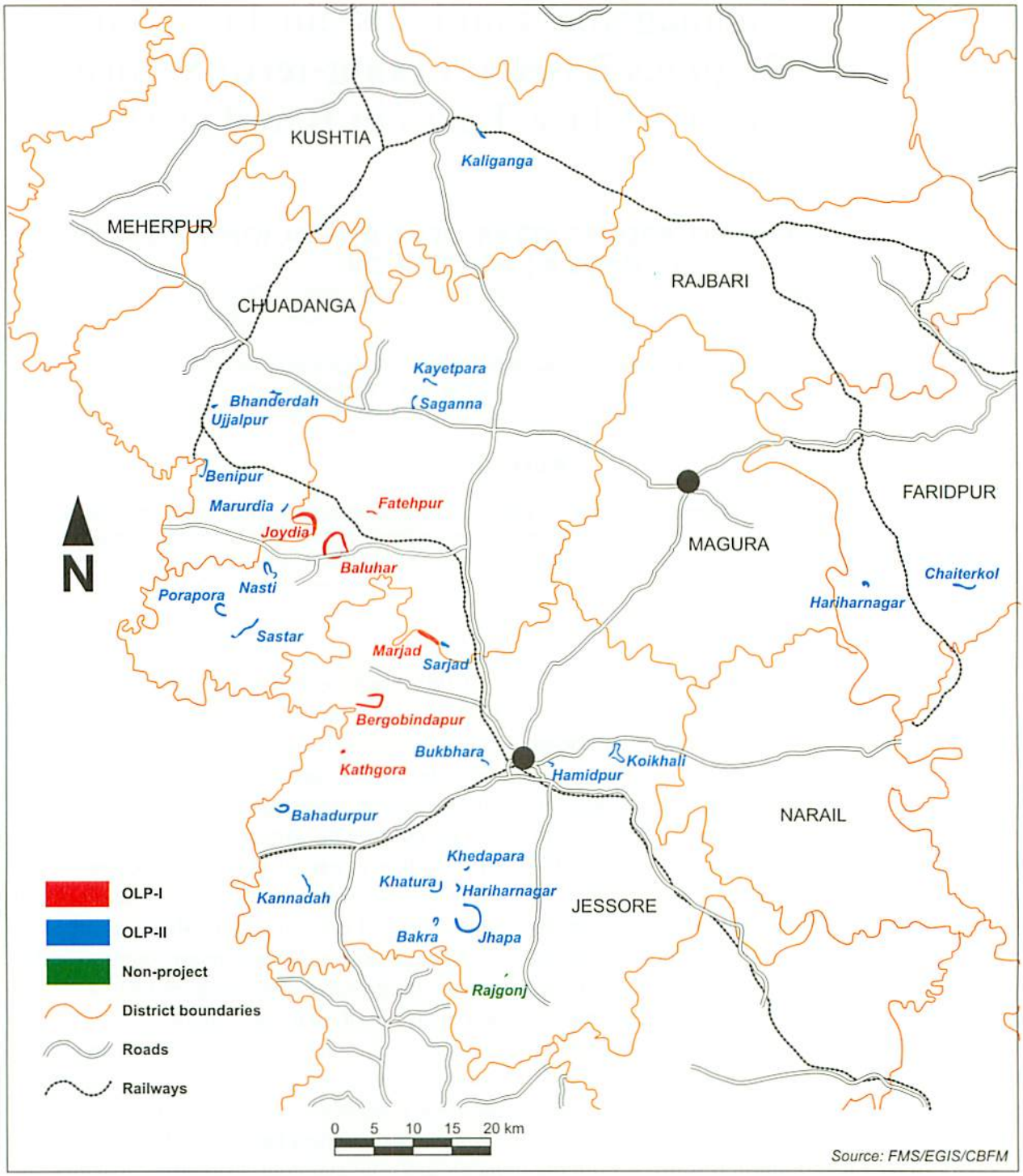


Fig. 1. Baors under the Oxbow Lakes Projects in Bangladesh.

In Bangladesh, the transfer of fisheries management of the oxbow lakes directly to the local fishers' community is essential to establish a functional CPR. Such regimes are considered more appropriate for social development than the traditional privatization of the oxbow lakes under direct government management or private leasehold. OLP II as a "social fisheries project" emphasized poverty alleviation through a clear poverty focus in target group selection and by making credit available in a sustainable institutional framework.

This paper argues that the establishment of a CPR in an oxbow lake fishery in Bangladesh depends on the co-management arrangements, whereby long term security of tenure is considered

a precondition. The sustainability of such a CPR in an oxbow lake fishery depends on fostering cooperation between fishers by providing incentives; maintaining equity in benefits and cost sharing; ensuring democratic rotation of leadership; and monitoring of all operations by the fishers themselves.

History of fisheries exploitation of oxbow lakes

During the British colonial period, all oxbow lakes were part of the *zamindari* estates in the State of Bengal. These were large estates managed by landed families, primarily for collecting taxes on behalf of the colonial government. After the abolition of zamindari in 1950 by the East Bengal State Acquisition and Tenancy Act, oxbow lakes and other big waterbodies were retained by the state under the Ministry of Land (MOL) and subsequently leased to private individuals through auction. Many oxbow lakes were obtained on lease by the Hindu ex-employees of the *zamindars* (feudal landlords) or sometimes by Muslims close to the local administration. Professional fishers were employed to catch fish and were paid a maximum of 25% of the catch.

From 1968, the Department of Fisheries (DOF) became involved in increasing fish production in oxbow lakes through the Development Management Scheme (DMS). Eleven lakes totaling 1 500 ha were part of this scheme. DOF appointed one officer for each of the lakes to coordinate clearing of water hyacinth, and fingerling stocking by involving the local (traditional) fishers; the latter harvested the stocked carps and received 40% of the catch (15% higher than previously received from private leaseholders). Only fishers listed by DOF were allowed to catch stocked carps, but access to catching indigenous fish was still free to all. At the time, little was known about oxbow lake stocking (size and species composition) and only a limited supply of fingerlings, collected from the wild, was available.

The independence of Bangladesh in 1971 created many expectations, reflected in the formation of cooperatives of "genuine poor fishers". Legally, cooperatives may be formed by any professional group including both rich and poor members of that profession. In order to obtain formal registration from the Department of Cooperatives, which was made a condition for participating in the auctions for lease of waterbodies, persons of standing in the community were invited to become members of the cooperatives as well. These influential people also often provided capital and in turn received a large share of the catch. Soon this unequal relationship led to abuses, reducing ordinary fishers once again to the equivalent of sharecroppers and leaving control over lake management and marketing in the hands of the patron. Up to the present day, most fishers' cooperatives have been under the influence of persons from rural elites fostering their private interests.

The first Oxbow Lakes Project (OLP I), financed by the World Bank, started with six lakes totaling 1 059 ha in 1980 and has continued as a completed project after 1987. As in the DMS, a list of traditional Hindu fishers is approved by DOF (at a rate of about seven fishers for every 10 ha). The DOF baor managers follow the model of traditional exploitation by wealthy leaseholders, regarding the fisher community, which receives a 40% share of the catch, primarily as a harvesting task force (IFAD 1988). Like a private leaseholder, the DOF baor manager is responsible for fingerling stocking, removal of water hyacinth, screen maintenance and guarding of the lake (Sattar et al. 1997).

OLP I made a major contribution in technology transfer of stocking and harvesting practices appropriate for oxbow lakes. As a direct spin-off from the establishment of the Kotchandpur Central Hatchery for stocking OLP I lakes, about 100 private carp hatcheries now operate in and around Jessore. However, management of the oxbow lakes fishery through a government officer leaves little room for the participation of fishers; and this type of management depends on continuous government support.

Under all fisheries management systems of oxbow lakes in Bangladesh prior to OLP II, fishers simply fished without stocking fingerlings or were treated as wage laborers for a stocked capture fishery. The objective of OLP II was to transfer

the complete fisheries management, including fingerling stocking, weed removal, guarding, fish harvesting and marketing, to the fishers themselves with a view to long-term sustainability. The approved fishers' group bears all expenditures (including lease costs), but catches and markets all the fish itself.

With credit made available to the fishers through the NGO, BRAC, most lake fishing teams (LFTs) no longer rely on a fixed supplier, and purchase fingerlings by tender. Without credit the LFTs would have remained dependent on suppliers' credits for stocking—a major channel for siphoning off fishers' earnings.

Security of tenure as pre-condition for a common property regime

The most important factor in establishing a CPR in culture based fisheries in oxbow lakes is guaranteeing long-term security of tenure to the fishers, allowing them to benefit from their investments in stocking, weed removal and screen maintenance. There are two aspects of security of tenure: (a) security of the long-term fishing rights awarded to the fishers' group through lease arrangements with the Government of Bangladesh, thus safeguarding exclusive access to the oxbow lake fishery; and (b) security of the long-term membership of each individual fisher through annual licensing, thereby safeguarding individual fishers from removal from the membership list by government or NGO officers other than for "gross misconduct"(Table 1).

Table 1. Institutional arrangements for a common property regime (CPR) under OLP II.

Step in establishing a CPR	Institution responsible
1. Handover of 23 oxbow lakes from from MOL to MOFL/DOF under New Fisheries Management Policy	MOL
2. Collection of annual lease fee for oxbow lake; subsequent renewal of individual licenses	DOF
3. Approval of LFT and FFG members	TJMC/DJMC
4. Right to use the oxbow lakes and payment of annual lease fee	LMG
5. By-laws and fishing rules	LFT and FFG

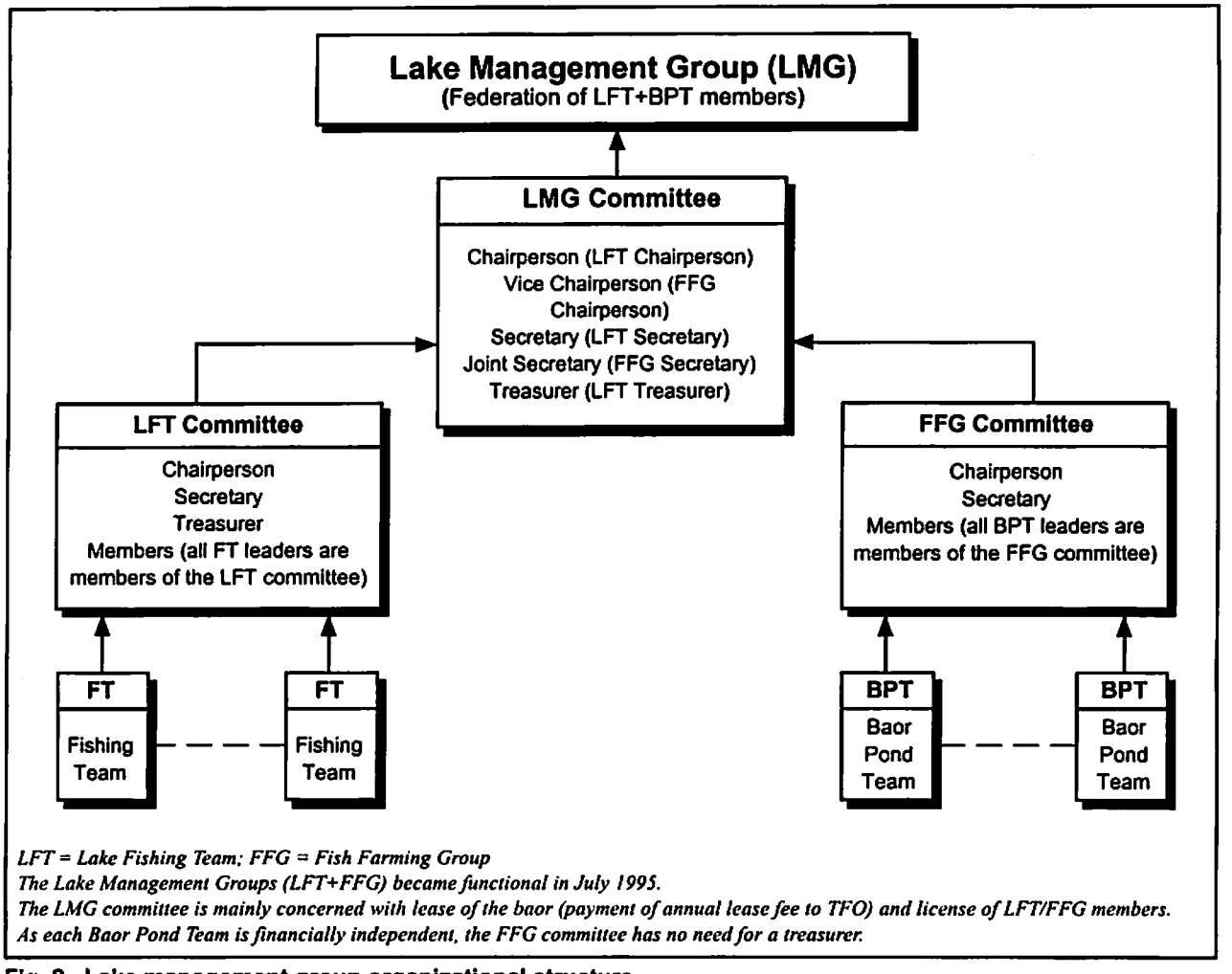
A short lease is not conducive to investment in the stocking of fingerlings nor to the maintenance of screens at lake inlets and outlets for retaining stocked fish. Moreover, any fixed term lease, even for a period sufficient to allow the investment to mature, always involves a danger that adequate maintenance of facilities will not be carried out near the end of the term; as a result, the resource will become over-exploited. In the loan agreement for OLP II signed in 1989 by the International Fund for Agricultural Development (IFAD) and the government, an indefinite tenure (lease) of the project lakes was agreed upon. Translating this into administrative decisions involved transfer of the lakes from MOL to DOF against an approved fishers' list for each of the lakes, similar to the procedure for other waterbodies under the New Fisheries Management Policy (NFMP) introduced in 1986.

DOF is currently the leaseholder of the lakes under OLP II; the fisheries user right is in the hands of the respective lake management groups (LMGs), which consist of the LFT (comprising a number of fishing teams) plus the fish farming group (FFG) comprising a number of pond groups managing the FFG ponds constructed on public (*khas*) land at the edges of the oxbow lake (Fig. 2). The LMG pays the annual lease fee to MOL through the thana (sub-district) fisheries officer (TFO) of DOF and, in return, the TFO issues annual fishing licenses to each approved fisher.

The list of LFT fishers and FFG members is prepared jointly by DOF and BRAC for approval by the thana and district *jalmohal* (waterbody) management committees (TJMC and DJMC). A clear poverty focus is maintained by enforcing the OLP II target group criteria adopted from BRAC: (a) land ownership less then 0.2 ha; and (b) annual income less than Tk 10 000 (US$225). After the list is approved by TJMC/DJMC, the listed fishers elect their LFT executive committee leaders and adopt a set of by-laws as operational rules (Fig. 3).

The specific arrangements for security of tenure under OLP II include the following steps:

1. A letter of exchange between MOL and the Ministry of Fisheries and Livestock (MOFL) confirming handover of the lakes to DOF for



LFT = Lake Fishing Team; FFG = Fish Farming Group
The Lake Management Groups (LFT+FFG) became functional in July 1995.
The LMG committee is mainly concerned with lease of the baor (payment of annual lease fee to TFO) and license of LFT/FFG members.
As each Baor Pond Team is financially independent, the FFG committee has no need for a treasurer.

Fig. 2. Lake management group organizational structure.

exploitation by the LMG for a period of 50 years, on 10-year renewable lease, based on satisfactory performance of fisheries management and prompt payment of the annual lease fee by the LMG. (The LMG consists of both LFT and FFG, but our presentation focuses on fisheries management by the LFT).

2. Formal handover by separate lease agreements of each of the 23 oxbow lakes at present under OLP II from MOL to the respective district fisheries officers (DFOs) of DOF.
3. Preparation and annual updating of the list of fishers is done jointly by DOF and BRAC. The list is formally approved by the TJMC/DJMC as stipulated in the NFMP.
4. Payment of lease fee by the LMG through a Treasury form (*challan*) in favor of the TFO. Individual licenses to each LMG member for fishing and fish culture are issued by the TFO upon payment of the lease fee. The LFT and FFG share proportionally in paying the fee.
5. A user right agreement between DOF and LFT fishers and FFG fish farmers separately, for maintaining the physical fisheries infrastructure (for example, screens, fish landing complex, water control structure, fingerling ponds, FFG ponds).

Decisionmaking arrangements in LFTs of OLP II

In general, decisionmaking arrangements in LFTs are defined by authority relationships that specify who decides what in relation to whom, and are usually not confined to any single organization or institution. The decisionmaking arrangements developed for LFT fishers in OLP II can be categorized into three sub-sets: (a) operational rules regulating use of the lake by LFT fishers; (b) rules establishing conditions of collective choice within the LFT and those immediately involved: DOF, BRAC and Danida

Aims and objectives

The aims and objectives of the LMG shall be as follows:

a) To make the fishers conscious and aware of their own rights and to protect the same, creating in them such a spirit of solidarity as would enable them to become self-reliant to look after and solve their own problems jointly.
b) To coordinate the activities of licensed fishers of the respective lake.
c) Organize group awareness and rules for the systematic management of the lake and increased fish production.
d) Discuss and decide the annual budget and monetary requirement and credit needs for fishers, and maintain a book of all expenditures, income, accounts and savings.
e) LMG will discuss and prepare in advance a stocking and harvesting plan by season, species, number and size, and maintain a record of the same.
f) Prepare and execute detailed plans and programs for the furtherance of the objectives of the LMG, to meet regularly to discuss progress and problems and maintain a record of the same.
g) To organize regular monthly meetings, training, seminars and workshops to mobilize the fishers for achieving the goals of general awareness for self-reliance.
h) To establish a joint LMG group savings account specifically for maintaining funds for group expenses such as payment of lease fee, fingerling purchase and emergency use.
i) Through unity, promote and establish self-respect and self-reliance in the community to make it free from exploitation.

Accounts

- An LMG account shall be jointly operated by the signatures of the Chairperson, Secretary and Treasurer of the LMG Committee. The account will be opened against the post of the LMG Committee.
- Each member will keep a passbook where individual savings and the amount of credit received and repaid will be reflected.
- Each year the current committee will handover responsibility including accounts to the newly elected committee within 7 days of the election.
- The Treasurer shall specifically maintain all account books, recording all receipts of money received or sales and all collective expenditures such as lease fee, fingerling stocking, security, etc. The Treasurer shall also process accounts, and make monthly progress reports during the LMG meeting.

Eligibility for fisher membership

a) The entry criteria to become an LMG fisher shall be defined as a person who is a fisher and rural poor who personally owns less than 0.5 acre (0.2 ha) of land or earns less than Tk 10 000 yearly.
b) Must have a licence from DOF under the project.
c) The MOFL approved the following criteria as preconditions for eligibility to selection as fishers of the project (Letter No. 3/Matshya [Beel:Baor] 7/29/620 dated 25/08/94):
   i) catches fish for at least 80% of the time with own hands;
   ii) shares on an equitable basis the cost and benefits of fishing;
   iii) agrees that one can be a committee member by election and only for one-year consecutive term.

Meetings

- Each fishing team under the chairmanship of the FT leader shall arrange to hold weekly meetings, and to meet jointly to discuss various issues.
- The LMG shall have a monthly fixed date when all fishers get together to discuss issues, and in that meeting the LMG Committee will inform and get approval for next month's activity. They shall also discuss credit status, harvesting schedule, quotas, auction prices, cost sharing, income and expenditure of the previous month, etc.
- Members of the LMG Committee will also meet weekly to work out the activities.
- The LMG Committee will coordinate the LMG monthly meeting, and the Secretary will maintain a resolution record of all decisions made jointly.
- A quorum for each such meeting shall be with the presence of one third of the LMG members and any decision shall be taken on the basis of simple majority.

Fig. 3. Example of lake management group by-laws.

Technical Assistance (DTA); and (c) external factors, referring to decision structures outside the immediate group (see Table 2).

Enforcement of security of tenure by fishers

Enforcement of fishing rights after handover of oxbow lakes

The legal rights for exploiting the oxbow lakes fishery, obtained from MOL through DOF, then have to be enforced. In Bangladesh, as in most other Third World countries, this is not always easy. Decisions taken at higher levels are often sabotaged by influential local people in collusion with corrupt officials. Even after formal handover of fisheries management of the lake to the LMG (LFT + FFG), usually the former leaseholder and other influential local people try to hold on for as long as possible. For example in OLP II, it took five years to get 23 lakes handed over to DOF, while Jhapa Lake, although officially handed over, still is in fact under the control of the previous leaseholder.

Table 2. Categories of decisionmaking arrangements in fisheries co-management of oxbow lakes under OLP II.

Decisionmaking arrangements	Rights and rules of lake fishing team (LFT) fishers in OLP II
Operational rules	Stocking decisions: species ratio, fingerling density, fingerling size, price, time of stocking Harvesting decisions: harvesting size of each species, fishing quota, harvesting time Marketing decisions: auction at the lakeside fish landing center, sale to fish wholesaler in town, sale to neighborhood residents at discount prices Guarding decisions: duty of members by rotation, sanctions in case of absence, hiring of guards, payment of protection money
Collective choices	Membership criteria for LFT: (1) less than 0.2 ha of land; (2) annual income less than Tk 10000; and (3) participation in fishing and related activities "with own hands" Fishing rules of the LFT: (1) participation in fishing for at least 80% of the fishing time; and (2) equity in sharing income and costs, on the basis of labor LFT by-laws: (1) fixed monthly meeting dates; (2) expenses to be approved monthly at these meetings; (3) sanctions for poaching and other offenses; and (iv) democratic election of LFT office bearers with no successive terms permitted
External factors	Legal or social arrangements influencing LFTs: (1) New Fisheries Management Policy (1986) allowing for direct management by fishers' groups; (2) bilateral agreement signed between government and donor for long term security of tenure for fishers under OLP II; and (3) total rejection by LFT members of the LFTs becoming registered fisheries cooperatives.

Securing user rights on the ground is further complicated by the fact that most land records date back to the British period, which ended in 1947, and have not been updated since; as a result there are many conflicts. Moreover, the lake area actually under water varies considerably between the monsoon and dry season, and paddy is grown on the temporarily dried-up parts which legally belong to the lake area under the lease (they consitute khas or public land forming part of the jalmohal or waterbody). Since fish culture has raised the value of oxbow lakes, the cultivators of these lake fringe areas have either insisted on their right to catch fish that swim into their flooded fields, or in some cases, sought compensation from LFTs for supposed damage by grass carp to their rice crop.

The paradox of increasing the resource value of a lake through better fisheries management, thereby raising the income of participating fishers but at the same time increasing outside pressure to share the new riches, has led Toufique (1994) to question whether poor fishers in Bangladesh would be at all able to secure their rights over waterbodies rich in fish, and to suggest that successful long-term transfer of fisheries management to fishers themselves is possible only in the least productive waters.

Enforcement of exclusive fishing rights in relation to other people living around the lake

Controlling poaching is another aspect of enforcing property rights. Initially there was some justifiable scepticism in the minds of the rural poor as to whether OLP II would really be able to establish the property rights of licensed fishers. When it became clear that most LMGs, with the support of OLP II, succeeded in transferring property rights and enforcing a CPR to the benefit of LFT and FFG members, pressure increased from other poor people, mostly young landless Muslims, to join the LFTs. Because LFTs initially had few members, fisheries benefits per fisher were relatively high and, given the underemployment and poverty in the area, such pressure was to be expected. When people from villages around a lake felt their village was under-represented in the LFT, that pressure sometimes took the form of mass poaching. Subsequently (in 1995) the LFTs agreed to double their membership to nearly 2.5 fishers per hectare of water, including people from all settlements around each lake, and the poaching issue disappeared.

The experience of controlling poaching shows that the cooperation of the society at large, organized in the various communities (*shomaj*) and

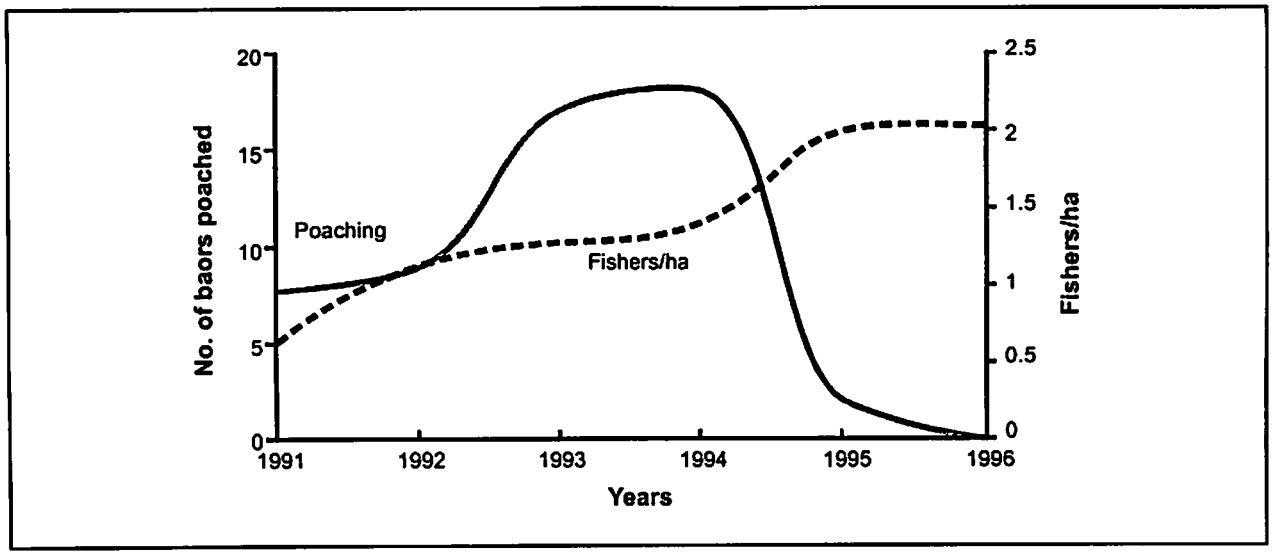


Fig. 4. Poaching and increase in fishers in oxbow lakes under functional common property resource.

neighborhoods (*paras*) around an oxbow lake, is indispensable in securing fisheries rights. Including LFT members from all groups living around a lake ensured their tacit cooperation. This "social fencing" reduces losses in fish culture operations, and the increase in membership is compensated by higher yields harvested and marketed through the LFT (Fig. 4).

Before OLP II, poor people were usually tacitly permitted by the leaseholder to catch small wild fish for their livelihood. However in most oxbow lakes under OLP II, the LFT members initially firmly established their exclusive "right" to catch non-stocked indigenous fish on the grounds that it would be difficult to determine whether anybody else fishing for non-stocked fish were also poaching stocked carp. Recently, in a few lakes, LFT fishers have again allowed non-members to catch non-stocked fish. This is a kind of social adjustment as well as an indicator of having effectively secured the fishing rights. At present LFT fishers feel confident that nobody will catch and eat a large carp without their finding out about it one way or another.

CPR in oxbow lakes

Day-to-day implementation of a CPR in OLP II

Participation in the LFT is open to both traditional Hindu fishers and Muslim landless farmers interested in fishing as a livelihood, provided that they live within 1 km of the lake. The list of LFT fishers is prepared jointly by DOF and BRAC for approval by the DJMC. A clear poverty focus, excluding richer persons from becoming LFT members, is maintained by enforcing the OLP II target group criteria adopted from BRAC (see above).

LFT members are required to participate "with their own hands" in fishing for at least 80% of the time (see Table 2). Sending a household member to the fishing team as a replacement is strictly prohibited, which makes LFT membership effectively non-transferable. Other main labor duties to be shared are guarding against unauthorized fishing, screen repair and annual removal of water hyacinth, lotus and other macrophytes, which would otherwise clog the lake completely. In some oxbow lakes, the LFTs have hired guards; in others the members themselves take turns at guarding.

BRAC, through funding from Danida and IFAD, has provided easy access to credit to LFT fishers at an interest rate of 15% per annum ("declining balance") and a system of weekly repayments, through an arrangement that requires all LFT members to become members of the BRAC village organizations (VOs). The BRAC VOs include both LFT fishers and other individuals, and not all LFT fishers are members of the same VO. BRAC loans to LFT fishers are treated as individual loans as stipulated by Bangladeshi law, although they are actually group loans. All expenditures from the loan money are made collectively through the LFT account maintained with BRAC, for which neither the individual LFT

members nor the other VO members (those who are not LFT members) feel responsible.

Sustainability of a CPR in the LFTs of OLP II depends on four policy decisions: (a) fostering cooperation between LFT members, whether they be traditional Hindu fishers or unskilled Muslim landless laborers, coming from various villages around the lake; (b) maintaining equity in labor inputs and benefits in order to maintain cooperation in the long run; (c) institutionalizing rotation in leadership through annual democratic elections for office bearers of the LFT; and (d) supporting the development of self-monitoring systems whereby the LFT members monitor all activities and deal with any irregularities themselves.

Incentives to cooperate

Cooperation between the fishers is necessary for enforcing and securing their exclusive access to the lakes for fisheries management. Given the usually low levels of village cooperation in Bangladesh, it was particularly important in implementing a CPR to fashion incentives fostering cooperation between members of newly formed LMGs, so that individuals would forgo short-term benefits for common long-term benefits.

One basic incentive to cooperate is access to the lake, a substantial resource. Other incentives are the prospect of infrastructure work by OLP II, and credit for stocking fingerlings (unlike the former wealthy leaseholders, poor LFT members could hope to organize fingerling stocking only as a group).

Equity in income and cost sharing

Equity can be achieved in many ways, not necessarily only by equally dividing all costs and income between all members. In the first two years of OLP II (1991 and 1992), equity was thought of as equity of access to fishing. However, the experienced Hindu fishers monopolized the knowledge of fishing techniques, while the landless Muslims entering into regular fishing knew little of group fishing techniques, either with seine nets (*kochals*) or with brush shelters (*komars*) and so had much lower catches per unit of effort. In the beginning, the skilled traditional fishers and some influential persons operated as separate fishing groups, catching and selling most of the fish.

However, in most lakes, skilled fishers were few and, after a time, they had to accept a more equal sharing of income. At present the sharing of income usually depends on actual participation in fishing: 50% of the total day's income of all fishing teams is deducted for costs to be paid out of the central fund, and the rest is equally distributed among all those who participated in that day's fishing. Another measure was to divide the skilled fishers among the fishing teams, thereby minimizing differences in catch per unit of effort between teams. Days and places for fishing are also rotated between fishing groups.

Rotation of LFT leadership through elections

Leadership of each LFT and of the constituting fishing teams rotates because office bearers may not serve successive terms. Initially the election by-laws permitted individuals to stand for election only once, but this requirement was later modified.

It is traditional in Bangladesh for local leaders to hold onto power as long as possible, so rotation was initially much resented. It helped, however, to create a large group of people within each LFT experienced in handling LFT affairs with the outside world (Fig. 5). It was further found that very few office bearers got themselves re-

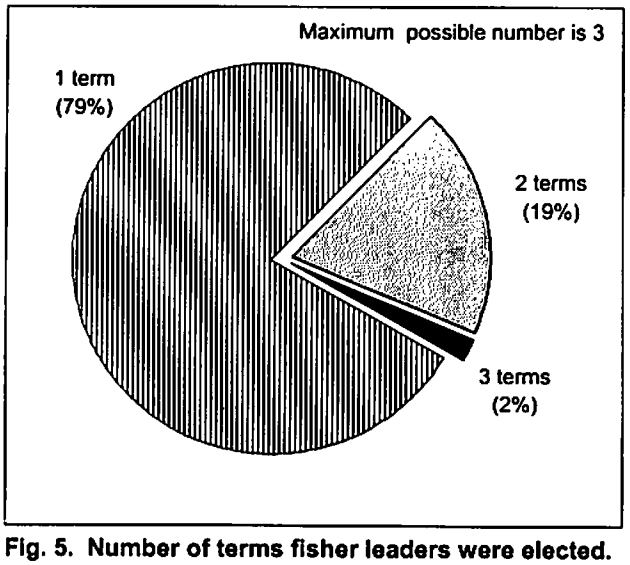


Fig. 5. Number of terms fisher leaders were elected.

elected after having been out of office for a year. Few fishers dare to openly defy influential LFT members, but the by-laws provided an excuse for change as retribution for self-enrichment at the expense of the ordinary members.

Monitoring by group members

LFT group members need to keep a close watch on the office bearers of their LFT committees, who are responsible for stocking, harvesting, handling the LFT's accounts and distributing funds to the members. Monitoring by LFT members of the fingerling stocking procedure has proved to be crucial. In the beginning, fingerlings were often released without notice and with no fishers present, and occasionally even at night. However, incidents of this type decreased after strong protests by some LFT members.

A number of monitoring systems have been developed by the LFTs to circumvent the initial monopolization of fish sales by office bearers and a few other important fishers. One method is to auction the catch at the landing site, allowing everyone to see. Another is to rotate the groups taking the fish to market, allowing the LFT members in turns to share in any additional benefits from wholesale commissions.

However, most of the expenses recorded as "miscellaneous expenses" are not receipted and are therefore difficult to monitor by ordinary LFT members. For instance, while the general accounts in the Marufdia LFT are well maintained and checked by the ordinary members, funds spent on legal proceedings are handled by just a few persons. Miscellaneous expenses accounted for about 13% of total operating costs of LFTs in 1995–1996, down from 26% in 1994–1995 (Oxbow Lakes Project II 1996a, 1996b).

Checking of LFT records is also done by the TFO and the BRAC area manager before the annual LFT elections in order to clear the outgoing LFT committee. This external monitoring has not been very effective, however, because the only sanction is the threat of removing someone from the list of licensed fishers, which has proved difficult in most cases. It is further recommended to include the fishers in the annual review of the list of fishers by the TFO and the BRAC area manager, through endorsement of their own list by majority vote in a general meeting, before submission for approval to the TJMC and DJMC.

Sustainability of the fishers' groups after completion of OLP II

The sustainability of institutional arrangements of LFTs is closely related to the question of security of tenure. A short lease does not allow the users to make investments which would produce a return only after a long time. The loan agreement between the Government of Bangladesh and IFAD stipulates that "continuity of license must be assured and the duration of the tenure shall be indefinite, in line with the NFMP". It should be noted that the commitments made by the government remain valid at least for the duration of the loan agreement between it and IFAD (50 years), even though the project itself will soon be completed.

The weakest element in these arrangements is at the end of each of the 10-year lease periods. It is stipulated in the letter of exchange between MOL and MOFL that "at the end of the ninth year of the current lease, the DFO shall submit a request for extension of the lease to the Deputy Commissioner (DC). The DJMC, after checking and evaluating the fisheries activities of the DOF and the LMG in the respective lakes, may recommend to the DC an extension of the lease to the DFO for another 10 years". However, the listed fishers of the LMG are not represented in the DJMC whereas many outsiders are members, so the fishers will depend on the goodwill of the DFO and the DC for continuing their fishing livelihood.

The legal vulnerability of the LMGs is another point of concern. The fishers organized in an LFT under the LMG are legally considered informal groups only, incapable of enforcing a legal obligation upon anyone other than on persons agreeing to be bound. The BRAC VOs of which the fishers are members are also legally incapable. Although the LMGs have by-laws, these are not registered with any government department. Moreover, the fishing licenses are issued to individual fishers and not to LMGs, so an LMG is helpless to enforce the right of its members as a group. Finally and most importantly, individual fishers do not

have the financial power or education to protect their rights in court (Imam, this vol.).

The position of the fishers' groups needs to be strengthened. It has been observed that in case of conflict between LFT fishers and outsiders, neither BRAC nor DOF gave much support to the LFT fishers. It is clear that LFT fishers will have to defend their interests by themselves alone, a situation that has already led to some incidents involving loss of life. It is recommended that legislation for security of tenure for fishers be enacted, to enable direct leasing of oxbow lakes and other semi-closed waterbodies to poor fishers' groups; this should be followed by a supportive government order declaring a time frame for implementation.

To further strengthen the existing institutional arrangements of LFTs and BRAC VOs, it is recommended that BRAC streamline its membership requirements so that all fishers can become members of the same BRAC "LFT–VO" and so that the VO committee leaders are the same as those of the LFT. Dual membership of fishers in both the LFT and the LFT–VO would provide a safeguard against possible bureaucratic treatment from either DOF or BRAC staff. It is recommended that BRAC create a separate wing within its Rural Development Programme to cater to needs of LFT fishers as a group business operation rather than individual assistance credit. Aside from this, the weekly repayments of Tk 5 per LFT–VO member is a farce in the context of the large business operations of oxbow lakes fisheries that pay millions of Taka each year for fingerling stocking; it should be streamlined.

Under the present circumstances, however, after completion of OLP II, the interests of the LFT groups will be served best if DOF continues to hold the leases of each of the lakes, as stipulated in the loan agreement between the government and IFAD, issuing annual individual licenses to the fishers upon payment of the annual lease fee. During the project period, most oxbow lakes have become almost completely free of water hyacinth and lotus, and fish yields have gone up considerably each year through better stocking and harvesting practices. As a result, former leaseholders and other influential persons are again interested in privately leasing the lakes for their personal benefit. In all or nearly all of the lakes presently under OLP II, registration of a non-functioning fishers' cooperative is being maintained, presumably to retake the leases when the opportunity arises. The Department of Cooperatives is unable to cancel these "fake" cooperatives, and a second fisheries cooperative may not be registered on the same waterbody. Therefore a change back to a system of short leases of the oxbow lakes through auction is likely to cause the lakes to pass out of the hands of the LFT fishing groups, which the government, IFAD, BRAC and Danida all wish to benefit.

Conclusions and recommendations

The most important factor in establishing a CPR in culture based fisheries in oxbow lakes in southwest Bangladesh is guaranteeing long-term *security of tenure* to the fishers so that they can benefit from their investments in stocking, weed removal and screen maintenance. There are two types of security of tenure: (a) security derived from the long-term fishing rights awarded to the listed fishers' group through lease arrangements with the government; and (b) security derived from long- term LFT membership of the individual fisher through automatically renewable annual licensing. Legislation for security of tenure for fishers needs to be enacted to make possible direct leasing of oxbow lakes and other semi-closed waterbodies to poor fishers' groups. This needs to be followed by a supportive government order declaring a time frame for implementation.

Further, sustainability of a functional CPR in an oxbow lake fishery depends on:

- cooperation between LFT group members
- equity in income and cost sharing
- democratic rotation of leadership
- monitoring by group members

Cooperation incentives are necessary to encourage fishers to forgo individual short-term benefits for common long-term ones. Equity can be achieved in many ways, not necessarily by equally dividing all costs and income by all the members. Democratic rotation of leadership enhances self-monitoring. Monitoring by general members and

regular checking on LFT office bearers supports proper stocking and marketing practices, thereby maximizing the fishers' income share. In the annual review of the fishers' list by DOF and the NGO involved (which is subsequently approved by the TJMC and DJMC), the LFT fishers should participate through endorsement of their own list by majority vote in a general meeting.

Acknowledgements

The OLP II (1991–1997) was executed jointly by the Bangladesh DOF , BRAC and DTA. The project was funded through a loan to the Government of Bangladesh from IFAD and through a grant from the Danish International Development Assistance.

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Fisheries Enhancement and Participatory Aquatic Resource Management: Two Types of Management in the Oxbow Lakes Projects in Bangladesh

HANS A.J. MIDDENDORP and JOHN D. BALARIN
Oxbow Lakes Small Scale Fishermen Project, Second Phase, Department of Fisheries, BRAC and Danida Technical Assistance, Matshya Bhaban, Arabpur, Jessore, Bangladesh

MIDDENDORP, H.A.J. and **J.D. BALARIN.** 1999. Fisheries enhancement and participatory aquatic resource management: two types of management in the Oxbow Lakes Projects in Bangladesh, p. 31–34. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Culture based fisheries in oxbow lakes should be considered as lake aquaculture. Two types of co-management arrangements for lake aquaculture are presently practiced in Bangladesh: direct management by the Department of Fisheries (DOF), with the fishers as laborers; and self-management by fishers' groups organized with DOF support. The six oxbow lakes under direct management reported on average 37% lower carp yields and 28% lower selling prices for the harvested carps than the 20 oxbow lakes managed by fishers' groups themselves. Annual carp income under DOF direct management was US$101/ha compared with US$208/ha under DOF support. The DOF-supported lakes accommodated more than 12 fishers' household members per hectare compared with only four in the directly managed lakes.

Culture based fisheries means lake aquaculture

Long-term sustainable inland fisheries management requires enhancement of the aquatic resource and participatory management by the stakeholders themselves. This type of fisheries management, which aims at improving fish stocks and thereby implies some kind of ownership over those stocks, should, according to a recently revised definition by the Food and Agriculture Organization (FAO), be considered as aquaculture. This new definition can be summarized as follows: (a) aquaculture is the farming of aquatic organisms; (b) farming implies intervention in the rearing process to enhance production; and (c) farming implies individual or corporate ownership of the fish stocks.

Aquatic farming can be ranked by intensity of management, similarly to the common classification for livestock systems: starting from fishing ("hunting")—which is not aquaculture because stocks are usually not owned, nor are there any rearing interventions—towards a range of more and more intensively managed and controlled types of aquaculture. In culture-based fisheries ("ranching"), not all steps in the rearing process are controlled and the fish are usually fully dependent on natural feed, while the ownership of the stocked fish is sometimes disputed. In pond culture, ownership of the fish is evident and the rearing process from stocking to harvesting is more or less fully controlled although, especially in tropical ponds, there is still a large dependence on natural feed. Pens, cages, tanks and raceways ("feedlot management") are intensive, fully controlled rearing systems completely dependent on external feed (Table 1).

In oxbow lakes, which are state-owned aquatic resources, fingerlings are stocked by either the Bangladesh Department of Fisheries

Table 1. Analogy between livestock husbandry systems and aquatic farming.

Management	Livestock husbandry systems	Aquatic farming
Extensive	Hunting	Fishing
	Ranching	Culture based fisheries
Intensive	Pasture	Pond culture systems
	Feedlot	Pen culture, cage culture, tanks and raceways

(DOF) or the fishers' groups, aquatic vegetation is regularly removed, and screens are maintained to prevent fish from escaping. These are culture based fisheries, based on stock enhancements, which, according to FAO, now should be considered as an extensive type of aquaculture or "lake aquaculture".

Participation in aquatic resource management

Strategies for inland fisheries management, in order to be technically, socially and environmentally sustainable, must consider both fisheries enhancements and community participation. The premise here is that fisheries enhancement may be technically possible but has no long term sustainability without participation of the stakeholders from the communities concerned. Fisheries enhancement implies a wide range of activities, such as fingerling stocking, fish sanctuaries and habitat restoration, arrangements for security of tenure and appropriate legislation concerning catches, gears, sanctuaries, etc. Participation is defined here as a process to involve all stakeholders in the sharing of responsibilities, in decisionmaking and in the equitable distribution of benefits (Fig. 1).

Levels of participation in the management of an aquatic resource vary, ranging from direct government management (where the government representative merely instructs the fishers) to creating an enabling environment for self-management by organized fishers. In terms of co-management arrangements in fisheries management, fishers' participation increases with decreasing government involvement (Fig. 2).

Oxbow Lakes Projects I and II

The Oxbow Lakes Small Scale Fishermen Projects, First and Second Phase (OLP I and II) in Bangladesh provide an unique opportunity for comparing the effect of different levels of government participation in co-management on key indicators such as carp yield (kg/ha) and carp value (Tk/ha). Both projects follow the same fisheries enhancement approach in the same physical environment, but with different levels of government involvement. Both are located in the same region in southwest Bangladesh along the border with India (West Bengal). Both projects aim to enhance fisheries production from natural oxbow lakes through culture based fisheries management using the same techniques, i.e., by screening the inlets and outlets, regularly removing vegetation covering the lakes, and stocking of six or seven carp species.

In co-management terms, OLP I is characterized as direct fisheries management by DOF, whereby a government officer directly manages the fisheries. Fishers from an approved list are employed on a catch-share basis and are responsible only for maintaining their fishing gear. DOF does not pay lease fees for the OLP I lakes (Sattar and Huda Khan, this vol.). OLP II, however, is

Strategies for sustainable inland fisheries management

Fisheries enhancement	Community participation
Environment protection	Stock ownership
Appropriate legislation	Equity in resource use
Culture based fisheries	Protection of investments
Habitat restoration	Limited access
Fish sanctuaries	Co-management

Fig. 1. Fisheries enhancement and community participation in relation to sustainable inland fisheries management.

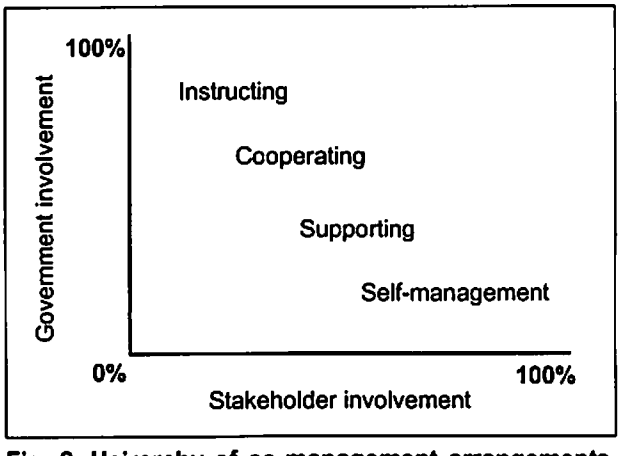

Fig. 2. Heirarchy of co-management arrangements, showing decreasing government involvement in inland fisheries management (adapted from Pomeroy and Williams 1994).

better described as DOF-supported fisheries management in which management responsibilities have been completely transferred to the lake fishing teams (LFTs). DOF has created under OLP II an enabling environment with emphasis on security of tenure through guaranteed long term rights to the lake for the fishers, approval of the fingerling stocking plan, and approval of the fishers for membership of the LFT in consultation with BRAC, a national NGO. The fishers manage their own affairs, share in 100% of the benefits and cover all costs, such as stocking, gear, marketing, etc. In addition they pay the annual lease fee via DOF to the Ministry of Land. Easy access to credit is provided to the organized fishers by BRAC (Middendorp et al. 1996; Apu et al., this vol.).

Three indicators were chosen for comparison between DOF direct management and DOF support: annual yield of stocked carps as recorded in the Lake Record Books; average carp sale price; and average carp sales value per hectare of lake area. The values reported here are three-year averages of the annual averages from July 1993 to June 1996. The values for OLP I were reported by Sattar and Huda Khan (this vol.); those for OLP II were calculated from the annual statistical reports (Oxbow Lakes Project II 1994, 1995, 1996).

Income from carp fishing in OLP I was calculated as 40% of the total sales value of the carps (Sattar and Huda Khan, this vol.). In OLP II it was calculated as carp sales minus operating costs (Rahman et al., this vol.).

Results and discussion

There are six oxbow lakes under DOF direct management (OLP I) with a total lake area of 1059 ha and a total of 742 fishers (0.70 fisher/ha) (Sattar and Huda Khan, this vol.). The combined water area of the 20 lakes under culture based fisheries management with DOF support (OLP II) is 1053 ha; in total 2197 fishers are involved in these lakes—on average 2.3 fishers/ha (coefficient of variation, CV = 38%) (Rahman et al., this vol.).

Table 2. Management indicators of culture based fisheries with different levels of fishers' participation (Oxbow Lakes Projects I and II): three-year averages of 1993–1994, 1994–1995 and 1995–1996.

Management indicator	DOF direct management (OLP I)	DOF-supported management (OLP II)
Annual reported carp yield (kg/ha)	361	493
Average carp sale price (Tk/kg)	29.4	37.7
Carp sales per unit of area (Tk/ha)	10 627	18 600

Average annual carp yield in July 1993–June 1996 was reported to be 361 kg/ha in the six oxbow lakes under DOF direct management, compared with 493 kg/ha in the 20 lakes under fishers' management with DOF support. The recorded average carp selling price was Tk 29.4/kg in OLP II[1], compared with Tk 37.7/kg under OLP II. Thus, fishers under DOF support recorded on average 37% higher carp yields and received on average a 28% higher price. As a result, the total value of carps sold per unit of area was 75% higher under DOF support than under DOF direct management (US$433/ha compared with US$253/ha) (Table 2).

Under OLP II, operational costs including the lease fee averaged 55% of total carp sales (Rahman et al., this vol.); the fishers received the remaining 45%. This compares with the fishers' fixed catch share of 40% under OLP I, with 60% going to general revenue and operating costs (Sattar and Khan, this vol.).

Under OLP I, the three-year average annual income from carp fishing was US$101/ha and the average net annual income per fisher US$134, compared with US$208/ha and US$83 per fisher, respectively, under OLP II.

Fishers under OLP I thus enjoyed about 61% higher annual incomes than those under OLP II, even though carp income per hectare was much higher in OLP II. However it must be emphasized that under OLP II three times as many fishers are involved in fishing per hectare of waterbody than under OLP I. Assuming that each fisher supports a household of six persons including himself, there

[1] US$1 = Tk 42 in 1996.

would be about four people supported per hectare of water under OLP I, compared with more than 12 people under OLP II. In a densely populated country like Bangladesh, emphasis should clearly be on poverty alleviation by maximizing the number of people benefiting from the limited natural resources such as oxbow lakes. It is concluded that co-management arrangements whereby DOF supports an enabling environment but with little influence on day-to-day fisheries management contribute more to poverty alleviation than direct management of the fisheries by government officers.

Acknowledgements

OLP I (1978–1986) was executed by the DOF and financed by the World Bank, and is currently managed as a "completed project" directly by DOF through the Project Implementation Unit of OLP II.

OLP II (1991–1997) was executed jointly by DOF, BRAC and Danida Technical Assistance, and funded through a loan to the Government of Bangladesh from the International Fund for Agricultural Development, and through a grant from the Danish International Development Assistance.

It is acknowledged here that the success of DOF-supported management under OLP II is based on the technical achievements of DOF direct management in OLP I in the early 1980s.

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SECTION 2

Institutional Issues in Community Fisheries Management

Analysis of the Legal Regime for Inland Fisheries in Bangladesh

MOHIUDDIN FAROOQUE
Bangladesh Environmental Lawyers Association, House 9, Road 8, Dhanmondi R/A, Dhaka 1205, Bangladesh

FAROOQUE, M. 1999. Analysis of the legal regime for inland fisheries in Bangladesh, p. 37–43. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

There is lack of fisheries legislation in Bangladesh despite the importance of fisheries to the country. Management is predominantly revenue oriented through leasing, which remained outside judicial control for many years. The *ad hoc* nature of administration of fishery leases, which lacks accountability, has been recognized in the courts, and civil cases have clarified some management issues. Although many criminal cases are filed relating to the Protection and Conservation of Fish Act 1950, its enforcement is not effective. A new integrated regulatory regime based on the principle of sustainable management is needed. Recommendations are made to make fisheries management more ecologically sustainable through enforcement of appropriate laws and compliance by fishers with those laws.

Introduction

The status and progress of laws on inland fisheries in Bangladesh do not reflect the importance of fish in the national diet, in employment and in economic values. This resource of great importance has been governed virtually by *ad hoc* policies. The absence of a long-term regulatory framework has been largely responsible for the failure to introduce sustainable fisheries management. The judicial process and case law therefore played a crucial role in expounding the limits of the legal framework and of management practice. The famous case of the last century was Srinath vs. Dinabandhu Sen (42 Cal. 489 PC), where the Privy Council recognized the expanding right of a *jalkar* (fishery rent-receiver) to exercise rights in newly formed channels or areas inundated based on the principle that "the fish follows the river and the fisher follows the fish". In Bangladesh the laws on inland fisheries are few. (Table 1).

The Protection and Conservation of Fish Act of 1950 defined "fishery" as "any waterbody, natural or artificial, open or closed, flowing or stagnant (such as river, haor, baor, beel, floodplain, canal, etc.), where activities for growing fish, or for conservation, development, demonstration, breeding, exploitation or disposal of fish or of living organisms related to such activities are undertaken, but does not include an artificial aquarium of fish used as a decorative article, pond or tank". The word "fish" includes "all cartilaginous, bony fishes, prawn, shrimp, amphibians, tortoises, turtles, crustacean animal, molluscous, echinoderms and frogs at all stages in their life history". The fisheries within reserved forest, declared so under the Forest Act of 1927, are part of the said forest and are managed by the Forest Department; in this case, "fish" are perhaps regarded more as "forest produce". The remaining fisheries are mostly under the control of the Ministry of Land (MOL). "Fishery" is here taken to mean the business of catching fish and the associated right to fish. Besides, any waterbody recorded as a fishery in the Record of Right, which contains ownership and classification of every land-based property in Bangladesh, was legally treated as such even though it might not fall within the definition.

Inland fisheries management in Bangladesh

The prevailing leasing system is dominantly revenue oriented through periodic leases. This leasing to the highest bidder through open auction is subject to the laws regulating fish conservation, and to a ban on sub-leasing. Priority is given to registered fisheries cooperatives. Enforcement of laws and leasing conditions are the responsibilities of the leasing agencies. Usually closed fisheries are

Table 1. Legislation relating to fisheries in Bangladesh.

Law	Comments
State Acquisition and Tenancy Act, 1950	Abolished *zamindari* system and declared "fisheries" (*jalmohals*) non-retainable under private ownership.
Protection and Conservation of Fish Act, 1950	Repealed the earlier Fisheries Act of 1897. The rules under the 1950 Act were formulated in 1985.
Other laws with an impact or bearing on fisheries	
Embankment and Drainage Act, 1952	
Water and Power Development Boards Order, 1972	
Ground Water Management Ordinance, 1985	
Forest Act, 1927	
Agricultural Pesticides Ordinance, 1971	
Bangladesh Inland Water Transport Authority Ordinance, 1958	
Inland Shipping Ordinance, 1976	

leased for three years and openwater fisheries for one year.

To change the revenue-oriented approach to one of conservation, and to establish rights of genuine fishers, the New Fisheries Management Policy (NFMP) was introduced on an experimental basis in 1986 in some 300 *jalmohals*. It was based on the concept that "he who has the gear owns the waterbody". However, the NFMP created a new fishing elite rather than ensuring social equity. It proved not to be conservation friendly because lease price is pre-fixed and accordingly the value of individual licenses is determined without reference to the status of the resource. It failed to favor actual fishing communities that had insufficient funds to pay licenses.

Due to the non-availability of loans from Krishi Bank, many licensees borrowed money from traditional rural moneylenders at interest rates of 7–15% per month or from wholesale fish buyers (*aratdars*). Previously lessees regulated fishing in the leased fishery, but under the NFMP, fishing was unrestricted. People fished with prohibited gears and also without valid license. This has created and perpetuated an intermediary class of *matsyajibi* (fishers, here meaning fisher leaders and fish traders, but this term is also used to include all fishers – both traditional Hindu fishers and Muslim fishers).

There were conflicts between licensed fishers having different types of gear in the same jalmohal. Moreover, different rates of license fee were set for the same type of gear in the same fishery when it was included in different administrative boundaries. The NFMP was criticized for being hastily formulated and imposed on the people without proper consideration of local factors. According to field officials concerned, fishers hardly felt involved in it.

According to a circular of 12 September 1991, fisheries under 20 acres are leased by the thana nirbahi officer (thana administration). Those above 20 acres are normally leased for three years, and openwater fisheries for one year, by the Additional Deputy Commissioner. MOL forms a committee in each district, headed by the Deputy Commissioner, to lease out fisheries by way of closed tender through bidding. The amount bid for a fishery should be at least 25% higher than the previous year's rent. Under some exceptional circumstances, MOL may lease out fisheries through negotiation. However, in practice it may decide, exercising its discretion, to lease out a fishery without following normal procedures.

The process of leasing by MOL remained outside effective judicial control for a long time. In fact the ministry entertains applications from aggrieved persons and exercises quasi-judicial authority, sometimes allowing representation through lawyers. Disputes arising out of leases granted by local administration through tender sale may be referred to the Divisional Commissioner. Any appeal against the decision of this official goes to the Member, Board of Land Registration, whose decision should be final. However, writs are sometimes filed against the decision of the Member.

A circular of 4 September 1995 provides for a procedure for managing open fisheries pursuant to a public announcement by the former Prime Minister abolishing leasing of openwater fisheries and effectively dissolving the NFMP. It apparently

attempts to protect the interest of poor fishers in openwater fisheries and confers rights without any return. Surprisingly, it shows no concern for sustainability of the fish resource: everyone has access to these fisheries, with no financial or other responsibility. Thus it has deliberately created an open-access situation without restriction as if everyone's property is nobody's liability. The circular has been interpreted by MOL as meaning that flowing waters which are navigable throughout the year are exempt from leasing; they have become free access resources with no property rights nor restrictions on fishing.

Judicial process and remedies

Civil jurisdiction

The civil courts take cognizance on matters affecting leases under section 9 of the Civil Procedure Code (CPC), 1908. Its jurisdiction, as per section 15, would depend on territorial location of the fishery, valuation of the suit (annual lease money) and the place of occurrence of the cause of action. Generally in these cases, application under Order 39, Rules 1 and 2 of the CPC follows praying for an ad interim injunction. These suits are usually declaratory in nature. An injunction, even for a short period, provides an opportunity for the order holder to extract the maximum short-term profit from the fishery. Many cases end at the trial court level. In many cases, injunction is prayed for under section 55 of the Specific Relief Act, 1877, to keep the resource under possession of the order holder.

Appeal against or revision of the judgement of a trial court lies in the High Court Division (HCD). On appeal the HCD entertains merits on questions of both law and fact. The forum of appeal is more easily available than that of revision. Revision happens only if the court is satisfied that the judgement of the lower court contains an error frustrating justice. However, in the absence of any *ad interim* order the judicial remedies do not yield substantial benefit to the party.

In the case of Haji Nurul Islam vs. Serajul Islam and others (4 Bangladesh Law Decisions [BLD] 1984 Appellate Division [AD], 36), the AD considered the legal status of circulars and settlement rules. It held that the settlement policy for fisheries published in the form of a circular contained *ad hoc* principles, and the settlement rules did not have any statutory force nor were they published in the official gazette for general information to the public. Fazle Munim, Chief Justice, said: "At best, this offered a guideline for the purpose of the officers of the department without prescribing any section against the violation of the principles contained therein, so far as the members of the public are concerned". This judgement created an anomaly, and arbitrary actions on the part of the government, whose circulars could not be challenged earlier, as held in the judgement, now have a sort of semi-legal status.

Overall, the following leasing disputes have been resolved by case law:

- Declaration of title to protect leasehold right (Upazila Nirbahi Officer Bajitpur vs. Maijchar Matshajibi Samabaya Samity, 12 BLD 1992 HCD, 556).
- Decision against cancellation of lease and granting of lease for the same period (Bangladesh vs. Haji Mojaffar Uddin, 8 BLD 1988 HCD, 40).
- Conflicts of ownership with other government bodies claiming ownership of a fishery.
- Legality of authority to grant lease (Haji Nurul Islam vs. Serajul Islam and others, 4 BLD 1984 AD, 36).
- Boundary of fishery (Sheikh Abdul Jabbar vs. Abdul Hannan Sheikh and others, 13 BLD 1993 AD, 195; Civil Revision No. 2979 of 1988).
- Declaration of extension of lease on compensatory grounds (ibid.).

Criminal jurisdiction

There are criminal proceedings for offenses relating to fisheries in lower trial courts, as well as proceedings against acts committed in relation to fishery or fishing rights that fall under general criminal law. A typical example of the latter is conflict between fishery and agriculture. Most villages have low and marshy lands that retain water and are often inundated during the monsoon. Often these lands are used for both crop cultivation and fish culture. Sometimes fishers wishing to culture and catch fish lease these lands from their owners. They release fish fry in the water

while the landlord cultivates crops. To boost profits, some lessees release herbivorous fish which destroy crops; as a result, a dispute occurs between the fishers and the landowner. This becomes acute when the fishers want to preserve the herbivorous species until the monsoon ends, creating a tense situation and sometimes violence. As a result, writs are filed by farmers. Examples are Matiur Rahman vs. Abdullah Hil Masud, bearing No. 927 of 1996; and Haroon Mahmud vs. Abdullah Hil Masud, bearing No. 928 of 1996 in the Court of Magistrate first class, Tangail, under sections 427, 147 and 148 of the Penal Code, 1860. Many such disputes are resolved outside the courts through local mediation; usually the farmers get compensation from the fishers.

There are also cases relating to the catching and selling of undersize fish, and to the use of current nets, fixed engine[1], *moshery* and *ber* nets, etc. These cases are filed by the thana fishery officer (TFO) or the sub-inspector of police against persons who catch unauthorized undersize fish and sell or use unauthorized gears. They are normally filed before the Magistrate Courts and dealt with by the magistrates under the Protection and Conservation of Fish Act, 1950.

Many cases are filed by TFOs. For example, in 1996 the TFO of Dohar Thana filed 12 cases in the Court of Chief Metropolitan Magistrate, Dhaka; the TFOs of Palash and Monohardi Thanas filed 42 and 9 cases, respectively, in the Court of Magistrate of Narshingdi; and the TFOs of Shaturia and Manikganj Sadar Thanas filed 12 and 33 cases, respectively, in the Court of Magistrate at Mankiganj.

Findings from cases and enforcement problems reviewed

Enforcement of the Protection and Conservation of Fish Act, 1950

Most offenders do not give their real name and address when they are apprehended and, as a result, the cases are dismissed or the magistrate inflicts a very nominal fine such as Tk 50-200 (US$1.14–4.55); or, considering the offender's poverty, the magistrate may waive the fine and order the offender to remain in the courtroom as punishment.

As prosecutor, the TFO has to find a witness if the case is contested, but people do not come forward to testify, so the TFO loses the case. Magistrates treat these cases as petty offenses and hence delay dealing with them. The lenient sanctions do not serve to deter offenders. At the same time, TFOs are supposed to arrange mobile courts for these offenses, which is very difficult because magistrates are stationed at thana headquarters and the police force lacks provisions for such courts. Consequently on-the-spot fines cannot be imposed, so there is no effective deterrent for those who do not care to abide by the law.

There are on average two officers, one field assistant and one messenger posted as fisheries staff in each thana, but many posts are vacant. It is not possible for a TFO to visit the whole area due to insufficient manpower and logistics (especially lack of a boat). In most cases, offenses are committed at night, when the TFOs do not feel secure visiting fisheries. Furthermore, TFOs cannot make frequent visits to areas where offenses are common due to lack of funds and other necessary institutional support.

The power of TFOs to arrest without warrant is meaningless and in practice useless, in the sense that they feel insecure trying to arrest offenders on the spot as the offenders are well organized. Moreover, local elites do not consider the acts in question to be offenses. Sometimes TFOs are compelled to release an offender after arrest, when threatened by an unruly mob. The social pressures on the thana nirbahi officer and the TFO are enormous, so they avoid imposing penalties for fisheries offenders as provided in law.

There is a legal provision that forfeited fish may be sold by auction, yet it is rarely invoked by TFOs. The forfeited fish often go rotten. There is no provision to save seized juvenile or broodfish by releasing them back in the water.

Writ jurisdiction

Initially, it was difficult to invoke writ jurisdiction under Article 102 of the Constitution since the management of fisheries is effected

[1] Any type of large fixed fishing gear, for example, systems of fences and fish traps or nets.

through policies, not laws. Another obstacle was that a lease was a contractual relation between the government and the lessee, so it was difficult to apply Article 102. During this phase in the evolution of writ jurisdiction (since 1972), the rules and principles provided in the Government Estate Manual were regarded as unenforceable and non-statutory in nature and hence could not create any justiciable right (Talekhal Progressive Fishermen Cooperative Society Ltd vs. Bangladesh and others; 1 BLD 1981 AD, 103).

The writ jurisdiction was widened to accommodate fishery cases by the AD in the case of Sharping MSS Ltd vs. Bangladesh and others (11 BLD 1991, 189). These cases are in the nature of *certiorari* (under which remedies are sought to declare certain government actions as unlawful or of no legal effect). Long pendency delays result in further leasing of a fishery on which an interim order has been issued. In the Sharping case the HCD concluded that:

> "It is now well settled that a writ would be maintainable even though the rights of the petitioner arose out of a contract if the executive authority acted *mala fide* or acted arbitrary in cancelling a lease though purporting to act under terms of the contract but in fact acting beyond the terms of the contract, arbitrarily on grounds having no nexus with the contract or the law of the land" (39 Dhaka Law Report 1987, 84).

However, on the question of maintainability the AD, on appeal, considered two basic points:

> "(i) if it is a pure and simple contract which is entered into by the Government in its trading capacity for any breach of such contract, writ will not be available as remedial measures, (ii) on the other hand, if the contract is entered into by the Government in the capacity as sovereign then the writ jurisdiction can be invoked for breach of such contract" (7 BLD 1987 AD, 106).

On special lease agreement, BH Chowdhury, Justice, remarked, "it is a new kind of wealth which the Government distributes by way of settlement amongst the class of people who deserves it. In doing so the Government has to enter into agreement but such lease agreement can by no stretch of imagination be termed as an ordinary contract entered into by two individuals as a trading venture" (7 BLD 1987 AD, 116). This opinion was a clear departure from the observation of the HCD, in terms of the status of the lease for judicial enforcement.

On the status of circulars issued from time to time, Shahabuddin Ahmed, Justice, observed:

> " 'Fishery' is a non-retainable *khas* land under section 20 of the State Acquisition and Tenancy Act and vested absolutely in the Government. Under section 76 of this Act it lies at the disposal of the Government who may either manage it *khas* or make settlement thereof in accordance with rules to be made by them. In the absence of any such rules, the Government must follow certain fixed standards, principles, guidelines applicable to all persons seeking settlement and shall not act arbitrary or in discriminatory manner" (7 BLD 1987 AD, 120).

The term "manage it *khas*" in the verdict of the AD of the Supreme Court implies that such fisheries will be managed by the government in accordance with provisions enumerated in the manual for management of government fisheries. However, in many subsequent cases, the HCD deviated from the case law created by the AD as to the maintainability and enforceability of circulars. Nevertheless, the AD strengthened the Sharping opinion in Sheikh Abdul Jabbar vs. Abdul Hannan Sheikh (13 BLD 1993, 195) by holding that the court has the jurisdiction to determine if policy on leasing was violated, although it could not direct the government to grant a lease to any specific person.

The courts in Bangladesh have brought some control over government practices by assuming jurisdiction. Settlement guidelines or policies have been declared enforceable. The judicial analysis of the situation is largely about evolving uniformity in the spirit of natural justice. However, the fishery as a stakeholder in itself, and its conservation aspects as a component of an aquatic ecosystem, have not yet received judicial appreciation.

Disputes resolved outside of court

Generally fishers and people relating to the fishery sector are an illiterate and poor downtrodden section of society. They are not aware of the laws and rules of the country nor of their legal rights, duties, obligations and responsibilities. They also try to avoid court procedures. For this reason, many disputes arising in the fishery sector are resolved outside the courts by mediation, arbitration and negotiation. The procedures of the Arbitration Act, 1940 are not followed in these indigenous systems of dispute resolution; following complaints from an aggrieved party, local elites, leaders, elected representatives and wise men mitigate or dissolve such disputes.

Major findings

The following conclusions are drawn from this review of laws and legal proceedings:

- There is a dearth of law on fisheries. Existing laws do not cover many significant aspects of the subject.
- Control, possession and ownership of fisheries are conflicting and institutionally overlapping, creating regulatory gaps and inefficiency in implementation.
- Policy-based management created arbitrary leasing with minimal accountability in law, arbitrary and anomalous leasing practices, and uncertainty about the legal status of government circulars and about contractual obligations under a lease agreement.
- The Protection and Conservation of Fish Act has failed to achieve its objectives due to procedural complications prescribed in the administration of criminal justice, primarily by the Criminal Procedure Code, 1898. Moreover, jurisdictional issues limit proper application of the law, and the courts take a lenient view when imposing sanctions.
- The upazila system was effective for quick enforcement of law as magistrates were available in every upazila (upazilas were renamed thanas in 1991, with a change in the administrative and judicial process at this level of government). Magistrates should therefore be placed in every thana so that TFOs can file cases immediately and arrange for mobile courts; or magisterial power should be given to the TFOs so that they can impose fines on offenders on the spot.
- Unfortunately some TFOs have never heard of some laws relating to fisheries. It is true that funding constraints, lack of staff, inefficiency, procedural mismanagement and many other problems cripple the country's fishery sector. However, TFOs and relevant government officials must have sufficient knowledge about fishery laws, and the fishery sector must be regulated and conserved according to law.
- The recent declaration opening the openwater jalmohals for all is not beneficial for the actual fishers, as powerful new fishers dominate and exploit the former. A licensing system is more beneficial for fishers than the leasing system, as licenses would be issued by the government, and intermediaries would have less chance to exploit and dominate the fishers. Management power should be given to the Ministry of Fisheries and Livestock from the Ministry of Land Administration and Land Reform, which is managing fisheries purely as a source of revenue and ignoring the rights of traditional fishing communities, the benefits of their experience, and the sustainability of the resource.
- Court decisions partly clarified the management issues requiring intervention.
- Leasing is not covered by laws, so it is regulated by policy guidelines. Hence, to a large extent, the case law on the topic still governs the scope and nature of judicial remedies.
- Access to judicial process and remedies available in civil, criminal and writ jurisdictions vary, *inter alia*, according to the capability of the party. Ad interim orders and injunctions issued in these jurisdictions often create hindrance to revenue earning as well as to sustainable management. However, in the absence of any ad interim order, the judicial remedies do not yield substantial benefit to the party.
- Lack of proper adjustments and enforcement of other sectoral laws is having a severe impact on fisheries, and also retarding sustainable institutional growth in this sector. Management has to

be brought under a definite and long-term institutional framework.

- Biodiversity conservation laws on aquatic ecosystems and resources have yet to be introduced.

The following recommendations are made:

1. An integrated regulatory regime should be developed for the protection and conservation of aquatic resources and ecology.
2. Laws should be enacted to govern the fishery in a sustainable manner. This process has to be used to orient and mandate judges towards conservation when administering justice and interpreting laws and circulars.
3. The existing leasing practice should be changed, to enhance the role of elected local government.
4. The role of the Department of Fisheries over public fisheries throughout Bangladesh should be expanded and strengthened up to field level, if necessary, with magisterial power and prescribed working plans.
5. Sufficient staff, and adequate funds and enforcement powers, should be given to TFOs so that they can visit the places where offenses are committed.
6. A task force comprising a fishery officer, magistrate and law enforcement officer is essential to monitor the violation of laws related to fish, particularly in the most productive fisheries.
7. An appropriate legal framework should be evolved for community based management of fisheries.

Legal Status of Fishers' Groups for Security of Tenure in Semi-closed Waterbodies in Bangladesh

AKTHAR IMAM
Barrister at Law, Advocate Supreme Court of Bangladesh, House 515, Road 10, Dhanmondi R/A, Dhaka, Bangladesh

HANS A.J. MIDDENDORP
Oxbow Lakes Small Scale Fishermen Project, Second Phase, Department of Fisheries, BRAC and Danida Technical Assistance, Matshya Bhaban, Arabpur, Jessore, Bangladesh

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Abstract

Long-term security of tenure of fishers' groups for exploiting inland semi-closed waterbodies in Bangladesh can be established only if the fishers' groups may enter directly into contracts with the Ministry of Land and the Department of Fisheries; for this they must acquire legal status. The Fisheries Co-operative Society under the Co-operative Societies Ordinance (1984) and the Co-operative Societies Rules (1987) appears to be the most appropriate legal entity for fishers' groups. Fishers, however, are reluctant to register as a fisheries co-operative society because of alledged widespread malfunctioning of such cooperatives.

Introduction

Security of tenure, i.e., long-term exclusive rights for fishing and fish farming, is a precondition for the development of the oxbow lake fisheries in Bangladesh as well as a protection of the rights and interests of fishers. Security of tenure is an incentive to fishers to increase fisheries yield and, as a result, augment their incomes. Under the present arrangements, 23 lakes (*baors*) under the Oxbow Lakes Small Scale Fishermen Project, Second Phase (OLP II) have been handed over by the Ministry of Land (MOL) to the Department of Fisheries (DOF) which issues annual licenses to fishers after approval of the fishers' list by the thana and district *jalmohal* committees, in line with the New Fisheries Management Policy introduced in 1986. The fishers' groups initially established in each oxbow lake were called lake management groups (LMGs); these were expanded in 1994 to include both fishers (lake fishing teams—LFTs) and fish farmers on baor fish ponds (fish farming groups—FFGs). The LMG pays the annual lease fee for the right to exploit the baor for fisheries (Apu et al., this vol.).

The loan agreement between the International Fund for Agricultural Development (IFAD) and the Government of Bangladesh (GOB) for OLP II, signed in 1989 and valid for a period of 50 years, stipulates the sustainability of the fisheries operations as follows: "continuity of licence award must be assured and the duration of tenure shall be indefinite." Further, as per a letter of exchange dated 6 February 1996 between MOL and the Ministry of Fisheries and Livestock (MOFL), the period of lease of the baors by MOL to DOF "...shall be extended for ten years at a time after completion of the current ten-year period, for a total period of fifty years, to conform with the Loan Agreement between GOB and IFAD."

Moreover, the memorandum of understanding on OLP II, dated 1 January 1995 and signed by MOFL, the Royal Danish Embassy—Danida, the United Nations Office for Project Support, DOF, the Local Government Engineering Department and BRAC, reiterates the security of

tenure with an automatic renewal of the baor handover period to DOF, which shall issue annual licenses to the LMG members (both LFTs and FFGs), who alone will be allowed to participate in fisheries activities within the baor area.

The legal institutionalization of the fishers' groups has been identified as a basic necessity for ensuring long term sustainable participation in community based fisheries, particularly in semi-closed waterbodies localized within a distinct geographical boundary, such as oxbow lakes. At present neither the LMGs nor the LFTs or FFGs have a formal institutional structure, and so are not legal entities but simply informal associations, which by definition are legally incapable of creating or enforcing a legal obligation upon anyone other than persons voluntarily and individually agreeing to be bound.

At present the fishers do not lease the lake themselves although they "reimburse" the lease fee to DOF. In other words the fishers always remain dependent on the goodwill of the DOF officers, while at the same time DOF is generally not in a position to challenge MOL on their behalf in the event of any dispute over the water area. To ensure their long term sustainability, the LFTs and FFGs therefore need to be recognized as legal entities having enforceable rights and interests, so that they may have full legal capacity to take on any legal obligations, to enforce the obligations of the individual members, and to deal with third parties—for example in legal proceedings—rather than for each LFT member to be individually liable.

However the most important reason for recognizing fishers' groups as legal entities is that it would enable them to enter directly into legal agreements with the government or with NGOs. It has been specifically recommended by the authors that the issue of security of tenure be addressed by a tripartite agreement between MOL, DOF and each LFT; this would permit the fishers to defend their interests in court in case of any changes to their fishing rights imposed on them by local government officials or any other party—for example encroachment on part of the lake. Under the present arrangements (handover of the baors to DOF rather than to the fishers directly) the risk, however small, that the fishers might be deprived of or even ousted from the baor without the option of any legal recourse, will always remain.

Appropriate legal entity for fishers' groups

Overview of legal options

There are four main options in Bangladesh for the establishment or incorporation of such groups as the LFTs and FFGs without entering into the unnecessary administration and costs that would be associated with a complicated legal structure. The entities in question are (a) co-operative society; (b) joint stock company; (c) charitable association/society; and (d) voluntary social welfare agency.

However, charitable associations registered under the Societies Registration Act (1860) and associations registered under the Voluntary Social Welfare Agencies (Registration and Control) Ordinance (1961) do not have the right to sue or be sued, nor the right to enter into contracts in their own names. Furthermore fishers' groups are not charitable organizations but fish for profit, and neither the act nor the ordinance provides for registration of such groups. It follows that even if registration under these laws is possible, it would not serve the interests of the LFTs and FFGs in respect of security of tenure.

The two remaining options are thus to register either as a joint stock company or as a co-operative society, both of which provide corporate status and identity to such an association of persons. Joint stock companies are required to be formed under the Companies Act (1994) and the rules framed thereunder; co-operative societies fall under the Co-operative Societies Ordinance (1984) and the Co-operative Societies Rules (1987). Joint stock companies and co-operative societies are both corporate bodies having perpetual succession and common seal with power to hold property, to enter into contracts, to institute and defend legal proceedings and to do all things necessary for the purpose for which they have been constituted. Neither joint stock companies nor co-operative societies are limited to any geographic or administrative boundaries.

Joint stock companies

Joint stock companies may be formed for any lawful purpose. The shareholders have the final

authority in joint stock companies. Upon the death of a shareholder, shares devolve in accordance with the laws of inheritance. Shareholders may have either limited or unlimited liability, although usually joint stock companies are registered with the liability of the shareholders limited to the unpaid amount on share. Joint stock companies, either private or public, must have a minimum of two members; there is no upper limit, but any company with more than 50 members must be a public joint stock company. It follows that any LFT with more than 50 members would have to be a public joint stock company.

Registration under the Companies Act is effected by the Registrar of Joint Stock Companies upon submission of a duly subscribed memorandum and articles of association and letters of consent from persons named as directors. The registration fee for a non-profit company is about Tk 300; for other companies it depends on the authorized capital. Each member of a joint stock company must hold at least one share in that company if the liability of the members is limited by shares. There are no restrictions on membership.

The affairs of a joint stock company are managed by a board of directors, with a minimum of three directors in the case of a public joint stock company. The board functions in accordance with provisions of the articles of association of the company, and there is usually a managing director who has delegated authority to run the company's day-to-day affairs. Members are elected directors in accordance with the provisions of the articles of association, but every year at least one-third of the directors of a public company must retire, though they may stand again for election. Neither the government nor the registrar, however, can reconstitute the board of directors.

The government's power to interfere in the affairs of a joint stock company are limited to appointing inspectors if it considers that the company was formed for any fraudulent purpose; or if the activities of the company are being conducted in a manner to defraud its creditors, shareholders or any other person, or in a manner oppressive to its members; or if any person involved in the formation or management of the company has been found guilty of fraud or misconduct in relation to the company or any of its members; or if the members of the company have not received information regarding the affairs of the company that they could logically expect to receive. On the basis of the inspectors' report, the government may institute proceedings for the recovery of damages or property.

Auditing requirements as prescribed under the Companies Act are very strict in respect of a public joint stock company. Auditors must be chartered accountants, and there are extensive reporting requirements such as balance sheets, annual reports, annual accounts and an auditor's report. Public companies are subject to taxation of up to 50% of their profits. Joint stock companies can be exempted from taxation only by legislation.

Co-operative societies

A co-operative society has as its objective the promotion of the common interest of its members. In such a society the general body of members has the final authority. The Co-operative Societies Ordinance (1984) empowers the government, by notification in the official Gazette, to exempt any co-operative society or class of co-operative societies from the application of any of the provisions of the ordinance or any rules thereunder, and also to direct that any such provisions shall apply to such extent as may be specified in the notification. The Co-operative Societies Rules (1987) are framed under the rule-making power to carry out the purpose of the ordinance. The notifications are executive orders and may be issued by the concerned ministry or department of the government.

Co-operative societies are registered by the Registrar of Co-operative Societies upon submission of an application in the prescribed form together with two copies of the by-laws of the society. They can be registered with a minimum of 10 members and there is no upper limit. Co-operative societies are usually registered with the liability of the members/shareholders limited to the unpaid amount on share. The registration fee for a co-operative society is Tk 100. Each member must buy a share which, for non-trading co-operatives, usually has a nominal price of Tk 10. Upon death of a shareholder, his/her share may

be transferred to a nominee. There is a district co-operative officer in every district, and thana nirbahi officers have been authorized to register co-operative societies formed within the boundaries of their sub-districts.

Co-operative societies exist which have multiple objectives and members from different occupations. However, fisheries co-operative societies having fishing as their single objective are specifically mentioned under the Co-operative Societies Ordinance. Further, no person shall be eligible for membership unless such person belongs to the same class or occupation as that of the other members. The deputy registrar has clarified that this criterion is to be strictly maintained in the case of persons belonging to the same profession, e.g., rickshaw pullers or teachers. If this condition is properly enforced in the case of fisheries co-operative societies as well, only "genuine" fishers would be eligible to become members; persons from the same social background but not dependent on fishing for their livelihood would be excluded. However, the fishers in OLP II reported that at present almost all fisheries co-operative societies are controlled by members of an elite who do not themselves fish.

It is further stipulated in the Co-operative Societies Ordinance that no person who is a member of any co-operative society shall be admitted to membership of any other "such" co-operative society except for a co-operative land mortgage bank. The Department of Co-operatives has obtained a clarification from the Ministry of Law, to the effect that "such" shall be interpreted as being of the same nature or having the same major objective. This would mean that if a co-operative society has already been registered with the objective of fishing in oxbow lakes, the LFTs or FFGs would not be allowed to form a separate co-operative society but rather would be required to join the existing one.

Given that in most—probably all—baors a registered fisheries co-operative society already exists, albeit non-functioning or "sleeping", the registration of the LFTs or FFGs as new co-operative societies may be complicated. For the purpose of avoiding dual membership, a new fisheries co-operative society would have to be treated by the Registrar of Co-operatives as being a co-operative society of different nature or with a different objective. It may be necessary to obtain a written undertaking from the registrar that the LFTs and FFGs currently active in fisheries management of the baors would be exempted from this provision.

The management of a co-operative society shall be vested in a managing committee constituted in accordance with the ordinance and with the rules and by-laws. Under the Co-operative Societies (Amendment) Ordinance (1991), the term of the management committee is three years, and upon expiry of its term the committee stands dissolved. At present the LFT and FFG committees are elected annually according to their by-laws, and this would also require exemption from the registrar.

The Co-operative Society Rules (1987) provide for the election of the managing committee according to areas into which the area of the operation of the co-operative society shall be divided (Rules 15 and 36) and each area shall elect at least one member to the committee. This would ensure the representation of each village around a baor on the managing committee. Rule 39 provides that, except where the initial members of the committee, including the chairman and the vice chairman, are named in the by-laws or in the application for registration of a co-operative society, the initial members of the managing committee including the chairman and vice-chairman shall be appointed by the registrar.

The ordinance specifies a number of cases when the registrar may interfere in the management of a co-operative society. If the managing committee is not reconstituted before expiry of its term, its functions shall be performed by such person or committee as the registrar may deem fit to appoint. Further, on application by the co-operative society, the registrar is empowered to depute a government servant to manage the affairs of the co-operative society or dissolve and reconstitute the managing committee by holding a special general meeting (Sections 21, 22). The registrar can dissolve the co-operative society by written order when upon audit or inspection (Sections 76, 82 and 83) or on enquiry (Section 84) the registrar is satisfied that the co-operative society suffers from insolvency or the committee is mismanaging the affairs and where 50% of the

capital of the co-operative society represents government shareholding, loans or guarantees.

Abuse of these provisions to the detriment of the fishers' groups can be prevented only by obtaining exemption from their operation or by limiting the extent of their application under Section 5(b). Historically, dissolution has involved mostly co-operative societies with a strong political involvement or high financial value, usually on the grounds of mismanagement as an excuse to enable vested interest groups to take over. For co-operative societies with little political or financial importance and not dependent on the government, the threat is usually small. However, the baor fisheries are at least locally considered to be big business enterprises, with an estimated average fish sales value of Tk 25 000/ha in 1995–1996 (Middendorp et al., this vol.), so some apprehension in this respect seems justified.

Reporting requirements are simple and clearly prescribed in Rules 61, 62 and 67 of the Co-operative Society Rules (1987). The ordinance empowers the government to remit any tax or fee payable under any law for the time being in force in respect of which the government is competent to remit the same.

Whereas a joint stock company cannot bind outsiders or third parties to any obligation toward the company unilaterally, the Co-operative Societies Ordinance (Sections 47, 48) specifically provides for levying water charges or embankment protection charges in relation to water sources and embankments managed and maintained by the co-operative society. These provisions offer scope to fisheries co-operative societies to better defend their water rights against unlimited extraction of surface water or even groundwater by shallow tube wells within or close to the baor area, for irrigation by paddy farmers, or even to charge compensation.

Conclusion

The Companies Act gives the government very little power to make or adapt the rules to provide for any specific needs such as a fisheries joint stock company may have, and it has no power to grant exemptions from the provisions under that act. On the other hand, the Co-operative Societies Ordinance empowers the government to exempt any co-operative society from the application of any of the provisions of the ordinance or any rules thereunder. This is a major distinction between the two legal regimes and it thus appears that the flexible co-operative societies ordinance is more appropriate for fishers' groups.

Moreover there are only a few hundred public companies in Bangladesh, while there are several thousand co-operative societies. Companies are sophisticated organizations for an association of persons to pursue the principal aim of making a profit. Joint stock companies are not familiar in rural Bangladesh, and the complexities of running a public limited company are likely to be alien to the LFT and FFG groups of OLP II. The Co-operative Society Ordinance has an inbuilt flexibility and ease of application, as it was intended for poor people of little or no education.

The functioning of fisheries co-operative societies, however, has generally been criticized because, in most cases, vested interest groups appear to have taken over their management for financial or political purposes (pers. comm., discussion meeting, this workshop). Cases were cited where fisheries co-operative societies have been taken over by wealthy businessmen, paying the fishers on a daily basis (a share of the catch) in return for providing capital for the leasing of waterbodies. Another example quoted by workshop participants is the replacement of elected management of fisheries co-operative societies by persuading the registrar to dissolve the managing committee and substitute an *ad hoc* committee, thus allowing local elite persons to "take over" the society. Again, as stated above, the co-operative societies most at risk are the financially and politically important ones, where the slightest perceived mismanagement provides an excuse for outside interference. The scope for interference can be greatly reduced, however, by having the LFTs and FFGs treated as a special class of co-operatives and by exempting them from such provisions of the ordinance and the rules as could result in unnecessary interference from the Registrar of Co-operatives.

It is therefore concluded that while both joint stock company and co-operative society are cor-

porate legal entities suitable for the institutionalization of fishers' groups exploiting oxbow lakes, co-operative societies appear to be more familiar to the fishers, and the legal regime under which they function provides much more flexibility, as well as particularity of application to such occupational groups, than is the case with joint stock companies. The Co-operative Societies Ordinance does provide corporate identity to groups of beneficiaries, and the regulatory regime under the ordinance, if judiciously and properly applied, would provide a valuable monitoring method for achieving the desired objective. However, in view of the strong concerns repeatedly expressed about the viability of genuine co-operatives in the light of past experience, it must be made clear that the suggested new societies are not intended to be similar to the traditional fisheries co-operative societies.

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On the Problem of a Justifiable Lease Fee in Government Semi-closed Waterbodies under Fisheries Management by Fishers' Groups in Bangladesh

MD. MOKLESHUR RAHMAN, HANS A.J. MIDDENDORP and NIAZ AHMED APU
Oxbow Lakes Small Scale Fishermen Project, Second Phase, Department of Fisheries, BRAC and Danida Technical Assistance, Matshya Bhaban, Arabpur, Jessore, Bangladesh

RAHMAN, M.M., H.A.J. MIDDENDORP and N.A. APU. 1999. On the problem of a justifiable lease fee in government semi-closed waterbodies under fisheries management by fishers' groups in Bangladesh, p. 51-55. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Lease fees of 20 oxbow lakes in Bangladesh under culture based fisheries management were generally less than 10% of the total carp sale value. However they varied widely between lakes, from US$1.4 to US$100.1/ha. It is proposed to set the lease fee for oxbow lakes managed by recognized fishers' groups at a flat rate based on the water area of each lake. Preferably this should be at the same rate as the agricultural land tax (US$5.9/ha), or otherwise at the average lease fee in 1995-1996 (US$20.1/ha).

Introduction

Twenty-three oxbow lakes in southwest Bangladesh have been handed over by the Ministry of Land (MOL) to the Department of Fisheries (DOF) under the Oxbow Lakes Small Scale Fishermen Project, Second Phase (OLP II), in line with the New Fisheries Management Policy (NFMP) adopted in 1986. These 23 lakes have been handed over for a period of 50 years, as specified in a 1989 loan agreement between the Government of Bangladesh and the International Fund for Agricultural Development (IFAD) and confirmed by a letter of exchange between MOL and the Ministry of Fisheries and Livestock (MOFL), signed in February 1996. User rights for fisheries exploitation of each lake have been transferred to the lake management groups (LMGs), on condition of payment of annual lease fees to the thana fisheries officer. Most LMGs consist of a lake fishing team (LFT) for the fisheries management and a fish farming group (FFG) for the ponds constructed on public land in the fringes of the lakes (Apu et al., this vol.).

Twenty of the 23 lakes under OLP II are under intensive culture based fisheries management by the LFTs (Middendorp et al. 1996). Chaiterkol and Hariharnagar Lakes in Faridpur District are openwater fisheries and Jhapa Lake is *de facto* managed by a private leaseholder. The lease fee of each lake at the time of handover from MOL to DOF was fixed at the highest lease fee paid through auction in the three years before handover, and increased annually at a fixed rate of 10%. Not surprisingly, the lease fees per hectare of waterbody vary a lot between lakes and differences become wider every year.

The objective of the study was to arrive at recommendations for a more justifiable lease fee system, by comparing the financial results and actual lease fees in the 20 oxbow lakes under culture based fisheries management with possible alternative lease fees based on the agricultural land tax and the income tax. A detailed analysis of the financial performance of 10 well-established fishers' groups, all in their fifth year of operation, is presented by Middendorp et al. (this vol.).

Materials and methods

The standard water area (SWA) is the calculated water area of the lakes on 1 January 1995

(Oxbow Lakes Project II 1995), which is used for comparing the financial parameters on an area basis. The handover area (H/O) is the lake area recorded in the handover documents from MOL to DOF. The number of fishers in each LFT is the number of active fishers, including licensed fishers as well as fishers still awaiting their license but regularly participating in fishing.

Daily fish yields and financial data are routinely recorded in the Lake Record Books with the help of Danida Technical Assistance staff and BRAC staff (Oxbow Lakes Project II 1996). Income from carp fisheries is defined as carp sales minus operating costs, and is expressed as carp income per ha (SWA). Operating costs include fingerling costs, equipment costs, lease fee, guarding costs, marketing costs and miscellaneous costs (Middendorp et al., this vol.).

The actual lease fees of 20 lakes under OLP II for fiscal year 1995–1996 are compared with two hypothetical alternatives based on the agricultural land tax and the income tax. Considering a culture based fishery as a kind of farming, as it involves ownership of the fish as well as management control (Middendorp et al., this vol.), the lease fee may be compared to the agricultural land tax. Alternatively, when a culture based fishery is considered as a private enterprise in a semi-closed waterbody with all the benefits accruing to a fisheries cooperative (Imam and Middendorp, this vol.) or to a private leaseholder employing the fishers, the lease fee may be compared to income tax.

Results and discussion

Profit-making and loss-making lakes

The combined SWA of the 20 lakes under culture based fisheries management is 1053 ha, compared with the recorded 1131 ha officially handed over. There were 2197 fishers involved in all 20 lakes, or on average 2.3 fishers/ha (coefficient of variation CV = 38%). Total carp sales reached US$396 257 in 1995–1996, averaging US$485/ha, and carp income averaged US$217/ha. Operating costs, which include the lease fee, averaged US$268/ha. Fingerling purchase costs averaged US$155/ha or 57% of total operating costs (Table 1).

Eighteen lakes made a profit from carp fishing of on average US$252/ha in 1995–1996 (CV = 109%). However, net income from carp was virtually nil in Kannadah. Kannadah enjoys very good runs of chapila (*Gadusia chapra*), which enter the lake to breed (Haque et al., this vol.). While wild fish contributed less than 4% to the combined sales value of carps and wild fish of the 20 lakes under culture based fisheries management in OLP II, in Kannadah sales of wild fish amounted to US$279/ha, representing 45% of the sales value of carps and wild fish combined in that lake in 1995–1996 (Oxbow Lakes Project II 1996).

Sastar and Kayetpara also had low carp incomes. Sastar is a very long, swampy lake with very low carp yields (Hasan et al., this vol.) while Kayetpara has long suffered from local bandit groups.

Two lakes incurred losses. In Ujjalpur-Bakra carp sales, although not good, were acceptable, but the operating costs exceeded carp income by far due to very high miscellaneous expenses, indicating mismanagement. In Khatura the LFT had broken down into factions and "unreported fishing" was paramount, as is apparent from the very low carp sale value (Table 1).

Lease fees compared with agricultural land tax and income tax

The total lease fee for the 20 lakes was US$16 159 in 1995–1996. Lease fees varied widely between lakes, from US$1.4/ha in Sastar to US$100/ha in Ujjalpur, or on average US$20.1/ha (CV = 103%). The historical lease fees obtained at auction were extraordinarily inflated in some cases when the lake was taken for prestige reasons with no relation to its potential fish yields.

The lease fees generally were well below 10% of the carp sale value, except for Ujjalpur Lake, which is taxed with an excessive lease fee of US$100/ha (31% of carp sales value), compared with the second-highest lease fee of "only" US$40.8/ha for Marufdia Lake (Table 1). Although this apparent anomaly has been repeatedly brought to the notice of the authorities concerned for the last three years, no decision

has been forthcoming. The lease fee of Jhapa Lake, however, was reduced by the authorities from US$20.1/ha to only US$4.5/ha in 1988, although Jhapa was never brought under LMG management and still is in fact exploited by a private leaseholder, who has the advantage of the reduced fee.

Agricultural land tax is a fixed tax on landholdings of more than 1.6 ha (4 acres). The land tax rose from US$1.8/ha in 1976 to US$5.9/ha in 1995–1996, corresponding to an average annual increase of about 1% only. It is concluded that the present taxation of the fishers through payment of lease fee for state owned common water resources is on average three times higher than the taxation of farmers, while the income of farmers generally exceeds that of fishers (Nathan et al., this vol.). If the lease fees were based on the agricultural land tax, the total for all 20 lakes would be US$6 193 (Table 2).

Income tax is a progressive tax, starting from 0% for the first annual income tranche of Tk 60 000 and rising to 25% of income exceeding Tk 300 000. Assuming that the total carp income would accrue to an individual leaseholder or a fisheries cooperative, a hypothetical income tax liability can be calculated. The fishers' groups, trying to maximize their catches, do not pay their members a daily wage but rather a share of the fish sale proceeds after deducting costs, so arguably the total carp income would be taxable.

For comparison, the approximated income tax

Table 1. Lease fee in relation to lake area, as per handover document (H/O) and standard water area (SWA), and in comparison to annual carp sale value and total operating costs (including lease fee) in 1995–1996.

	H/O (ha)	SWA (ha)	Lease total (Tk)	Lease/ H/O (Tk/ha)	Lease/ SWA (Tk/ha)	Carp sale (Tk/ha)	Operating costs (Tk/ha)	Lease/ carp sale (%)
Profit-making lakes								
Sariad	10	9	5 477	548	609	25 400	17 250	2.4
Hamidpur	10	13	7 200	720	554	11 819	8 533	4.7
Hariharnagar (J.)	18	30	8 375	465	279	21 049	10 376	1.3
Marufdia	26	25	42 882	1 649	1 715	22 761	15 981	7.5
Kaliganga	27	15	17 225	638	1 148	48 365	21 098	2.4
Ujjalpur	35	34	142 978	4 085	4 205	13 707	12 462	30.7
Bhanderdah	37	48	30 446	823	634	13 152	5 661	4.8
Kannadah	40	23	24 962	624	1 085	16 516	16 358	6.6
Koikhali	47	11	7 634	162	694	55 408	8 710	1.3
Benipur	47	45	31 673	674	704	21 076	9 715	3.3
Saganna	50	35	34 606	692	989	24 541	13 253	4.0
Khedapara	57	45	24 760	434	550	13 385	10 862	4.1
Nasti	66	54	42 712	647	791	37 445	17 648	2.1
Porapara	91	88	65 227	717	741	23 386	10 114	3.2
Sastar	98	134	7 973	81	60	5 381	5 035	1.1
Kayetpara	108	116	52 343	485	451	5 570	5 048	8.1
Bahadarpur	121	104	41 521	343	399	21 041	5 395	1.9
Bukbhara	135	135	38 330	251	284	12 639	8 274	2.2
Loss-making lakes								
Ujjalpur–Bakra	25	20	7 372	295	369	10 112	18 391	3.6
Khatura	65	69	44 977	692	652	4 264	4 665	15.3
All lakes								
Total (n = 20)	1 131	1 053	678 673					
Average	57	53	33 934	751	846	20 351	11 241	5.5
St. dev.	39	41	31 014	849	871	13 501	5 089	6.8
Excluding loss-making lakes								
Total (n = 18)	1 041	964	626 324					
Average	58	54	34 796	780	883	21 813	11 210	5.1
St. dev.	41	43	32 024	890	912	13 419	4 837	6.7

Note: US$1 = Tk 42 in 1996.

for an oxbow lakes fishery is calculated both with and without considering labor costs. Labor costs were estimated at US$94 per fisher per year (Tk 50/day), based on the number of 79 fishing days observed at Bahadarpur in 1995–1996 (Nathan et al., this vol.). This estimated labor cost actually corresponds closely with the recorded carp income of US$217/ha and the average number of 2.3 fishers/ha in this study, i.e., US$94.3 per fisher.

Fourteen of the 20 lakes had carp earnings high enough to pass the income tax threshold of US$1429 (Tk 60000), leading to a hypothetical total tax for all 20 lakes of US$33868. Average income tax over all 20 lakes would be US$38.5/ha, almost double the average lease fee. When labor costs were deducted from the carp income, only four lakes would face income taxes, totaling US$8714 or on average US$11.1/ha calculated over all 20 lakes (Table 2).

Recommendations

Considering that the average number of fishers is 2.3 fishers per hectare of lake area while the land tax is levied only on holdings exceeding 4 acres (1.6 ha), it can be argued that the lease fee, on the basis of agricultural land tax assessment, should be nil, or similarly, that the carp income per fisher would not exceed the threshold of US$1429 and therefore no income tax would be payable. Certainly, from a nationwide view of exploiting common water resources for

Table 2. Tax alternatives based on carp income and agricultural land tax (Tk).

	Carp income		Tax without deducting labor costs		Tax after deducting labor costs		Agricultural land tax	
	Total	Per ha	Total	Per ha	Total	Per ha	Total	Per ha
Profit-making lakes								
Sariad	73 348	8 150	1 335	148	0	0	2 223	247
Hamidpur	42 717	3 286	0	0	0	0	3 211	247
Hariharnagar (J.)	320 194	10 673	46 549	1 552	0	0	7 410	247
Marufdia	169 505	6 780	11 500	460	0	0	6 175	247
Kaliganga	409 010	27 267	68 753	4 584	0	0	3 705	247
Ujjalpur	42 320	1 245	0	0	0	0	8 398	247
Bhanderdah	359 591	7 491	56 398	1 175	0	0	11 856	247
Konnadah	3 633	158	0	0	0	0	5 681	247
Koikhali	513 674	46 698	94 919	8 629	55 419	5 038	2 717	247
Benipur	511 256	11 361	94 314	2 096	0	0	11 115	247
Saganna	395 072	11 288	65 268	1 865	0	0	8 645	247
Khedapara	113 552	2 523	4 000	89	0	0	11 115	247
Nasti	1 069 02	19 797	233 756	4 329	136 981	2 537	13 338	247
Porapara	1 167 988	13 273	258 497	2 937	60 997	693	21 736	247
Sastar	46 338	346	0	0	0	0	33 098	247
Kayetpara	60 571	522	57	0	0	0	28 652	247
Bahadarpur	1 627 099	15 645	373 275	3 589	112 575	1 082	25 688	247
Bukbhara	589 350	4 366	113 838	843	0	0	33 345	247
Loss-making lakes								
Ujjalpur–Bakra	−165 590	−8 280	0	0	0	0	4 940	247
Khatura	−27 673	−401	0	0	0	0	17 043	247
All lakes								
Total (n = 20)	7 320 980		1 422 457		365 972		260 091	
Average	366 049	9 109	71 123	1 615	18 299	468	13 005	247
St. dev.	458 087	11 972	103 866	2 250	40 738	1 238	10 171	0
Excluding loss-making lakes								
Total (n = 18)	7 514 243		1 422 457		365 972		238 108	
Average	417 458	10 604	79 025	1 794	20 332	519	13 228	247
St. dev.	453 860	11 607	106 753	2 306	42 556	1 297	10 526	0

Values are in 1996 taka. Area used is SWA.

community development leading to poverty alleviation—rather than for maximization of government revenue—recognized fishers' groups should be exempted from paying lease fees.

Payment of the annual lease fee by LMGs, however, is generally accepted as confirmation of security of tenure; it is likely that abolishing lease fee payments would change the oxbow lakes into a "free-for-all" open-access type of fishery, where nobody would be willing to share in the costs of fingerling stocking, and yields would fall because of over-fishing. Something similar happened when lease fees for river fisheries were abolished in late 1995 and over-fishing became rampant.

For all practical purposes, therefore, it is recommended that the lease fee for oxbow lake fisheries be based on actual water area. It is further recommended that it be set at the same level as the agricultural land tax, following the same adjustments, i.e., at US$5.9/ha (Tk 247/ha), and at the same rate of annual increment of 1% only. The advantage of a flat tax on water area is that lake areas can be measured relatively easy, while income assessments would require proper records to be kept and independently verified, which in Bangladesh opens a Pandora's box of problems.

A "second best" option would be to establish a flat rate close to the present average lease fee of US$20.1/ha (Tk 846/ha) for the 20 culture based fishery lakes under OLP II. This would attenuate the unjust differences between lakes, while maintaining the combined total government revenue for the 20 lakes. The annual increase in the flat lease fee should be indexed to a generally acknowledged indicator of inflation or, for instance, the prime lending rate of the Bangladesh Bank. Note that in 1995 the government dropped the 10% annual increase in lease fee (i.e., doubling of the lease fee in 7 years) for some 300 waterbodies under NFMP excluding, however, the 23 oxbow lakes under OLP II and waterbodies under other similar projects.

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Property Rights and Power Structure in Inland Fisheries in Bangladesh

KAZI ALI TOUFIQUE
Bangladesh Institute of Development Studies, E17 Agargaon, Sher-e-Bangla Nagar, Dhaka 1207, Bangladesh

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"Force, not fairness, determines the distribution of wealth in a society. ... in considering possible income redistribution programs, account must be taken not only of the political problems ... but the potential use of force as individuals readjust their wealth positions."

Umbeck (1981, p. 57)

Abstract

One of the main methods used by Bangladesh to try to increase the welfare of fishers in inland openwater fisheries is the transfer of property rights over publicly held waterbodies (*jalmohals*) directly to the fishers, but instead intermediaries or lessees have managed to retain those rights. Differential enforcement costs of establishing and maintaining property rights over waterbodies are identified as the key factor behind the transfer of rights from the fishers to the lessees. Lessees have greater social power and consequently can realize more economic surplus. Lessees tend to have lower transaction costs as they make use of their social networks to enforce their control of fisheries. Consequently they can establish rights over the more productive waterbodies; for example 48% of total catch represented economic rent in lessee-held waterbodies, but economic rent was only 25% of total catch in fisher-held waterbodies.

Introduction

One of the main methods used by Bangladesh to try to increase the welfare of fishers in its inland fisheries sector is to transfer property rights over publicly held waterbodies (*jalmohals* or *jalkars*) directly to the fishers. But it has been observed that a class of individuals from outside the community of fishers is in effect retaining property rights over these waterbodies. This class of individuals is referred to as the lessees (*ijaradars*). The objective of this paper is to explain why the fishers have failed to secure property rights over the waterbodies in question.

This is not a trivial problem. When a lessee establishes *de facto* rights over a waterbody, the waterbody is privatized in the sense that the lessee enjoys exclusive rights over it. Note that it is *de facto* rights that matter in the present context. A lessee may have both *de jure* and *de facto* rights, or may have only *de facto* rights while the fishers retain *de jure* rights. This process of privatization of publicly held waterbodies makes community based common property resource management programs impractical, if not impossible, to implement. It is difficult to contemplate community based fisheries resource management where there is a dominating individual from outside the fishing community who holds exclusive property rights over the resource. The first step towards developing any community based fisheries resource management program is therefore to establish and maintain property rights of fishers over the resource system. This means reallocation of property rights over waterbodies from the lessees to the fishers. As the introductory quotation from Umbeck warns, there will be political problems with such reallocation and the lessees may use force to readjust their wealth positions. Thus an analysis of the failure of fishers to hold property rights over waterbodies in the inland fisheries sector of Bangladesh will shed light on how to take the first step towards community based sustainable fisheries resource management.

Background

Common property management is a very complex way of managing a resource. It is particularly difficult with a fugitive resource such as fisheries

because fish in general are migratory in nature (Schlager et al. 1994; Toufique 1998). A resource may be commonly owned in one country but privately owned in others. It is the choice made by a society whether some resources are to be privately owned, or owned in common, or not owned by anybody at all except the state. Thus common property relates to institutions or rules or relationships between persons and the resource. These institutions are developed by society over a long period through a process of generation and reallocation of rights. In the process of defining and reallocating property rights, there are winners and losers, and there is political maneuvering and application of force or violence by those adversely affected by the change. In short, institutional changes have been slow and painful (North 1990).

We have little historical information on how fisheries resources have been managed in Bangladesh. Existing evidence (Buchanan-Hamilton 1877; Pokrant et al. 1997) suggests that in the colonial period, private property rights gradually replaced traditionally held rights of fishers. Unfortunately, the exact nature of these traditionally held rights is not clear. During most of the colonial period, waterbodies were included as part of the estates of the *zamindar* (landlord or landholder) in Bengal. The zamindar leased these waterbodies to individuals who are still called ijaradars. Some of these ijaradars were actually fishers. Even now some individual fishers hold leasing rights over a few waterbodies in the Sirajganj study area and have been termed "fishermen lessees" (Toufique 1996a, 1997). Such a class of fisher lessees has also been observed by Kremer (1994) in Hail Haor in Moulvi Bazar District (northeast Bangladesh). The lessees collected tolls from those fishing in the waterbodies under their control. With the abolition of the zamindari system, responsibility for managing the waterbodies was vested in the Revenue Department (Board of Revenue) of the then East Pakistan Government under the East Bengal State Acquisition and Tenancy Act of 1950.

Since the independence of Bangladesh, two major strategies have been adopted to transfer property rights over these publicly held waterbodies to the "genuine" fishers: leasing and licensing systems. The way these systems actually function is very complex; however, in essence the leasing system attempts to transfer property rights to registered fishers' cooperatives, whereas the licensing system attempts to transfer property rights to individual fishers in the form of non-transferable, renewable licenses. However, in response to the leasing system, fake cooperatives started to evolve. The cooperatives were fake in the sense that they were mostly formed or controlled by the ijaradars. This fueled an era of *de jure* leasing of waterbodies by the cooperatives but *de facto* leasing by the ijaradars through manipulation of the leasing process. Similarly, the licensing system resulted in growing numbers of fake fishers and the lessees continued to remain very active in these waterbodies (Flood Action Plan 17 1994b). It has been observed in Sirajganj that the license fees for the fishers were paid by the lessees, a fact that was known to the licensing and leasing authorities.

In 1995 the government abolished the licensing system except in some specific project waterbodies. The leasing system has also been abolished in the "open waterbodies", defined through practice as flowing rivers. The effects of this policy change are not yet known (Toufique 1996b). Some newspaper reports indicate that fishers have still not been able to establish their rights over the waterbodies. In fact, the State Minister for Fisheries and Livestock admitted at the inaugural session of a seminar on development and management of open waterbodies on 10 September 1996, that the abolition of the leasing system of open waterbodies has now led to a situation of "might makes right" in parts of the country (Daily Star, 11 September 1996). A Bangla weekly (Dainik Bangla, 22 November 1995: p. 7) reports a case of failure in implementing this policy in the district of Sunamganj. Similar situations have been reported in Kishoreganj (Bhorer Kagaz, 20 December 1996) and in Chapai Nawabganj (Bhorer Kagaz, 2 February 1997). These reports are fragmentary, but the author's discussions with those working in fisheries support the picture they paint, as well as the views expressed by the minister. Thus it seems that government has failed to get rid of the lessees even though it not only introduced leasing to fishers' cooperatives and licensing systems, but also abolished these systems. The question is *why?* A judicious answer will, it is hoped,

help to avoid some pitfalls in implementing community based sustainable fisheries management in Bangladesh.

Main argument and evidence

Establishment and maintenance of property rights over waterbodies involves incurring costs. Differential enforcement costs of establishing and maintaining property rights over waterbodies are the key element behind the failure of the fishers to secure such rights. This differential arises from the asymmetry in social power between fishers and lessees: more rent (economic surplus) is realized by the latter, creating potential benefits from transfer of rights between the two parties. Evidence for this is provided from a 6-month field study in Sirajganj (northwest Bangladesh) in 1992. Previously Ullah (1985) and Jensen (1987) referred to the role of power in establishing property rights over waterbodies, but neither of them extended their arguments or developed formal models to explain the causal links.

It is often argued that it is not power but lack of finance that explains why fishers cannot obtain leasing rights over waterbodies. This capital market imperfection view is found in Kremer (1992) and Flood Action Plan 17 (1994b), but two arguments demonstrate its weakness.

First, the failure of the licensing system has shown that it is not access to the credit market that explains why fishers do not bid for leasing rights. License fees were set to recover the lease value and so were lower than the tolls paid by fishers to the lessees (who made a profit by collecting tolls from fishers in excess of the lease value paid to government). However, the requirement to pay license fees in one cash installment may have been prohibitive, since lessees may have been collecting revenue over a longer period, sometimes through credit relations with fishers.

Second, the abolition of the leasing and licensing systems in open waterbodies did not help the fishers to establish their rights despite the fact that it made access to the waterbodies *de jure* free: freeing the fishers of the need for credit to pay for leasing or licensing did not help them establish rights over the fisheries. It has been found in Sirajganj that the fishers borrow heavily from informal sources. While most loans are at 10% monthly interest, this is the same rate as for informal loans in general in rural areas, and it shows that fishers do have access to credit. No evidence of credit tied to lessees or fish traders was encountered in the Sirajganj study area, but such practices may be more prevalent in closed fisheries and deserve further study. Thus, though the financial constraint argument is important, it does not satisfactorily explain situations where no fees, or at least no very high expenses, are required for establishing property rights.

Another explanation often put forward for the fishers' failure to lease in the waterbodies is the "priced out" argument (Flood Action Plan 17 1994b). According to this argument, the fishers cannot afford to buy property rights over waterbodies because their base value increases by 25% every year. But again this argument cannot explain why fishers are having problems establishing property rights over open waterbodies which are now *de jure* open access. In theory, auction values are supposed to rise 25% a year, but no evidence is provided to show that they have actually been growing at that rate. Auction values were collected for 44 open waterbodies leased out every year in Sirajganj during 1986–1992; these values grew at an annual rate of about 10% (Toufique 1996a). Similarly in certain fishery development projects, lease value is increased by 10% a year. Thus the actual constraint from increasing lease costs is lower than claimed in Flood Action Plan 17 (1994b). The "pricing out" argument may be valid for waterbodies where total lease cost is high (lease values per hectare vary greatly between waterbodies), but it does not explain why fishers do not retain control of waterbodies with low lease values.

We have to look elsewhere to understand why the fishers have failed to establish property rights over waterbodies. For this we need a clear understanding of the concept of *rent* (economic surplus).

Rent

What is the benefit of having property rights over a waterbody? Such rights convey to the holder the right to rent. Rent is a complex concept. The term is frequently used to describe payment of tolls

by the fishers to the lessees. While tolls are definitely a financial form through which rent is transferred from fisher to lessee, they are not the only form of rent transmission, nor do they channel all the rent to the lessees. In the fishing context, rent is defined, in economic terms, as the surplus over *all* the (opportunity) costs incurred in the process of capturing fish. These costs can be broken down into two components: the material costs and the costs of establishing and maintaining property rights. Material costs include mainly the cost of fishing effort; this involves the real costs of the capital invested, the costs of raw materials, labor and so on.

The crucial component of costs for the present analysis is the cost of establishing and maintaining property rights. These costs are not generally incurred in a resource of the open access type, but they are necessarily incurred if any individual wishes to establish property rights over a resource such as a waterbody. They include the costs of guarding a waterbody (for example, employing *lathials*—literally stick wielders—or monitors or water bailiffs); the real resources (for example travel and paperwork) used to lease the waterbody; the cost of maintaining the boundary of the waterbody; and the cost of settling disputes that arise either in the protection of property rights or in the capture of fish from the waterbody. These costs of establishing and maintaining property rights can be termed "transaction costs". Thus we can define rent as the excess of the value of fish catch over all related costs. Note that catch value is the product of the price of fish and the quantity of fish caught. For the purpose of this analysis, gross rent can be defined as the excess of the value of catch over all material costs:

Gross rent = value of catch – material costs

Hence net rent is defined as gross rent in excess of transaction costs:

Net rent = gross rent – transaction costs

Net rent is the actual value added to society from establishing property rights over a waterbody.

This paper argues that the lessees are able to generate more net rent than the fishers because they have relatively lower transaction costs (the costs of establishing and maintaining property rights). The major source of this transaction cost differential is the social power asymmetry between the two. Some recent projects in other parts of Bangladesh, such as the Oxbow Lakes Project and the Community Based Fisheries Management Project discussed elsewhere in this volume, have attempted to address this asymmetry by empowering well defined groups of fishers.

Social power and transaction costs: the link

The crucial role of enforcement activities is to ensure the realization of maximum possible rent. The least-cost way of realizing or retaining net rent depends on two crucial abilities of those who hold rights over open waterbodies: their ability to prevent capture attempts, and their ability to collect tolls from the fishers[1]. This paper will show that these abilities are mainly determined by the social power of the agents involved.

Like any other valuable resource, a waterbody is exposed to capture attempts, and this poses a serious threat to property rights, since capture attempts, if not prevented, will result in the realization of lower rent. Capture attempts may involve forceful taking of fish from the fishers, or unauthorized collection of tolls by another party, or forceful entry into the waterbody (for example, poaching). The risk of partial or total encroachment on the waterbody by neighboring lessees is also quite high (Ullah 1985). To minimize such capture attempts, the property rights issue has to be informally settled, recognized and respected by the existing and potential fishers and other agents. When required, force can be used to establish these rights (Umbeck 1981). The fact that maintaining informal property rights can involve the use of force explains the relevance of power.

The degree to which capture attempts can be contained and the right amount of toll collected depends on the ability of the agents to impose severe sanctions. This sanctioning ability ultimately

[1] Except that in some closed fisheries (but not those investigated in this study) lessees stock fish on the strength of their rights over the waterbody, using fishers as a labor force and cultivating fish as a business rather than collecting tolls.

depends also on social power. In Sirajganj, most of the lessees are the past or present members or chairpersons of local institutions of the state, which implies that they come from relatively more powerful sections of the rural population. A powerful lessee can make credible threats (seizing of fishing gears, taking away fishing rights, etc.) for any breach of contract. Such threats are frequently implemented; to quote from Flood Action Plan 17 (1994b, p. 65):

> "...the use of political or bureaucratic power or even ... brute force is apparently viewed as a legitimate means of obtaining or retaining one's hold on a lease ... lessees often have politically advantageous positions because they represent the local power structure and have links to higher levels of government."

Even if threats are not actually implemented, the potential for their implementation, or a history of their implementation in the past, can often result in the desired behavior from relevant parties.

Apart from having strong links with higher levels of the government, the lessees develop a strong network of acquaintances living across the banks of the waterbodies who are also very powerful. These acquaintances are often what is known as *matbors* (local village chiefs), who like the lessees may be members of local institutions. Such a social network comprising the most powerful and influential individuals helps to reduce the enforcement cost, particularly when a waterbody is very large. One of the most important components of transaction costs is the cost of hiring guards; according to figures provided by the Flood Action Plan 17 (1994b) guard costs on average amounted to about 16% of total costs for nine waterbodies studied, and varied between a minimum of 1% and a maximum of 37%.

Like lessees, fishers have to pay for enforcement activities as well as for financing leasing expenses when they intend to establish property rights over waterbodies. Hence funds have to be raised. Decisions on the rate of toll to be charged have to be taken jointly by the fishers. Then comes the real problem of collecting the toll. Accounts also have to be maintained and endorsed by the fishers, and all these tasks have to leave enough time for the actual fishing. The problem of toll collection (governance) for the fishers in Sirajganj is reflected in malfunctioning cooperatives, internal feuding resulting in violent clashes among disputing fishers, and heavy borrowing from informal sources to fund leasing costs (Toufique 1997).

On the other hand, fishers are an extremely heterogeneous class, dissimilar in many ways. It is therefore difficult for them to initiate any collective action for establishing and maintaining property rights over waterbodies. Five sources of heterogeneity among fishers can be identified:

1. Fishers are divided on the basis of religion. Fishing is no longer an almost exclusive domain of the Hindus; many fishers are now Muslims.
2. Fishers are divided according to ownership of fishing assets. Some own no fishing asset at all; and of those who do, some own gears (such as push-nets) which give a low catch per unit of effort, while others own more efficient gears.
3. There is always an outsider–insider problem. Even among traditional fishers there are two dimensions to this problem. There is a distinction between *bhashan jele* and *jinati* or *jaman jele*. The former are itinerant fishers who fish in distant places that suit their needs. The latter do not travel far for fishing, but live very close to the waterbody where they normally fish. This latter group is also divided in terms of allegiance to the lessees: those fishers who collaborate with the lessee to maintain the lessee's property rights usually fare better—they often pay a lower toll or get an opportunity to fish in a lucrative spot for a longer period.
4. Fishers are differentiated in terms of fishing skills, which implies differential capability to earn rent (Johnson and Libecap 1982).
5. Fishers have different levels of involvement in fishing: there are part-time fishers, full-time fishers, subsistence fishers and commercial fishers.

All these differences, and the fact that fishers usually are poor and less educated and belong to the lowest strata in rural society (Chowdhury 1987), mean that for fishers, the costs of collective action to establish and maintain property rights over

waterbodies are very high compared with those of the lessees. Their ability to prevent capture attempts and to collect tolls is limited, so they are less capable of generating rent.

Quality of waterbody, rent and transaction costs: the link

This link is not as obvious as it seems in the first place. The higher the quality of a waterbody, the higher the value of the catch (assuming a constant price). But when the quality of a waterbody is high, transaction costs will also be high. Thus total rent will depend on the balance of these opposing factors. We will assume, however, that the higher the quality of a waterbody, the higher the amount of net rent.

A rich waterbody is more prone to capture attempts. It requires higher enforcement activities because the length of a season for a given gear is usually long and there are more fishing gears operating. The higher the quality of a waterbody, the higher is the net rent differential between lessees and fishers. In such a situation the lessee is able to compensate the fishers for giving up fishing rights by maintaining their remuneration at a level that they would have earned if they held those rights (see Fig. 1).

In the figure, hypothetical total net revenue curves for the lessees and the fishers—respectively, NR(L) and NR(F)—are shown as a function of the quality of a waterbody (the NR functions could be curved or straight lines). Due to the asymmetry in social power between the two groups, NR(L) > NR(F). Note that NR(F) is the amount of net rent received by the fishers collectively when they hold rights over a waterbody; since it is less than NR(L), the lessees can always ensure that the fishers receive at least NR(F) and so are also not worse off. This explains why fishers either do not favor establishing property rights over waterbodies, or else pass these rights to the lessees. It is important to recognize also that the deal struck by the lessees and the fishers can be anywhere between NR(L) and NR(F). The closer it is to NR(L), the better off are the fishers; such a situation indicates strong leadership on the part of the fishers. The closer it is to NR(F), the worse off are the fishers; this indicates poor leadership on their part.

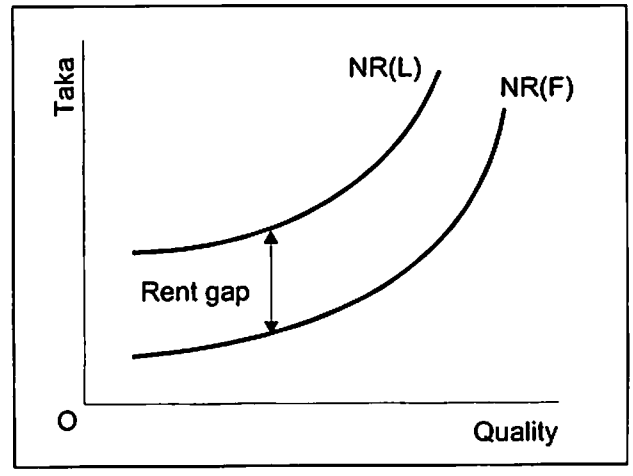

Fig. 1. Differential net rent.

The trading of property rights between lessees and fishers does not have to be explicit. Payments on the side may be disguised and need not be pecuniary in nature. They may involve giving preferential access to a lucrative fishing spot, or imposing less severe penalties for defaulting on toll payments for the fishers who take the leading role in the exchange process. Sometimes a coalition of rich fishers or the top members of a fishers' cooperative have been found to be reaping all the benefits of this exchange (Toufique 1996b, 1997). Some influential members of fishers' cooperatives have also been found to be employed as monitors by the lessees; in this case the instrument of compensation is job creation. For example, in Sonai waterbody, four full-time monitors are hired for a monthly wage of Tk 700 each. These monitors are also the influential members of the cooperative.

The author has estimated net rent as a percentage of total catch for 60 fishing teams fishing in 13 waterbodies in the district of Sirajganj (Toufique 1996b). Of these waterbodies the fishers had property rights over six (the number of fishing teams surveyed was 29). In the seven lessee-held waterbodies 48% of total catch represented economic rent; the corresponding figure for the waterbodies held by the fishers was 25%. This supports the argument above that net rent is higher in waterbodies where the lessees have established property rights.

Policy recommendations flow immediately from Fig. 1. The long-term goal should be to make NR(F) equal to or greater than NR(L); this would imply the demise of the lessees, since they would no longer be able to generate more rent than the

fishers. The short-term goal should be to raise the NR(F) curve; this requires empowerment of the fishers. Such empowerment could also result if more of them owned the fishing assets they use. Ownership of fishing assets gives fishers an added incentive to establish their rights over waterbodies.

Conclusion

Community based sustainable fisheries resource management presupposes that fishers hold property rights over fisheries resources. In the case of inland fisheries in Bangladesh, the evidence is that most fisheries resources are still under the control of those who are not fishers—the ijaradars. This paper has attempted to explain why the fishers have failed to establish property rights over waterbodies. The social power of the ijaradars is the main reason for failure of the state to transfer property rights over waterbodies to the fishers. This power is also the reason why existing lessees have lower costs of establishing and maintaining property rights over these waterbodies.

General policy on inland openwater fisheries should aim at reducing the difference in transaction costs, especially enforcement costs, between fishers and lessees. The first steps to achieving this can be made even within the existing power structure. The following policies are recommended for the shorter term:

- enforcement by the state of existing rules and laws with respect to property rights over publicly held waterbodies, and implementation of necessary and appropriate changes when and wherever required, such as increasing the penalties for using destructive fishing methods;
- empowerment of the fishers, which can be done by local representatives if they are strongly committed to the fishers' cause, or by NGOs; it could include helping the fishers develop leadership capability or getting leases on better terms by negotiating on their behalf for lease rights; and
- provision of credit to help the fishers to acquire fishing assets; this will increase the net rent retained by fishers.

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Influence of Power Structure in Fishery Management: A Case Study of Ubdakhali River*

MD. NURUL ISLAM and PAUL M. THOMPSON
International Center for Living Aquatic Resources Management, House 75, Road 7, Banani, Dhaka, Bangladesh

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Abstract

Changes in access to a river fishery in northcentral Bangladesh are related to changes in policy and the responses of different stakeholders and powerful members of society. Local factors affecting the fishery included increasing fishing pressure, large increases in government revenue collected from the fishery, loss of part of the fishery to another district, a government fish sanctuary, siltation, and water abstraction for irrigation. For more than 20 years, a traditional system existed under which a moneylender funded access to the fishery for members of the fishers' association, controlled marketing, and limited fishing through a rotational system. This arrangement ceased in 1995 when the fishery was made open access. NGO involvement under the Community Based Fisheries Management Project had a limited impact, as the fishers had no defined rights over the fishery. The NGO (Caritas) and government cooperated with the fishers to resist outsiders' attempts to take over the resource, but alliances among stakeholders are fragile and temporary.

Introduction

Successive governments in Bangladesh since the mid-1970s have taken measures which were claimed to reduce exploitation of fishers and make openwater fishing more sustainable. This paper describes for one river how fisheries stakeholders and those with local power and influence—the local "power structures"—have responded to changes in policies. Without this understanding, attempts to introduce greater community participation in fisheries management, or to introduce any change in management, may be ill-planned and are likely to be subverted to their own purposes by those with most power in the local communities.

Ubdakhali River flows past Kalmakanda Thana in Netrokona District in north-central Bangladesh (see Hossain et al., this vol., Fig. 2 for location). It is located 10 km south of the Garo Hills and the Indian border and 52 km north of Netrokona District headquarters. This river section was due to come under the Community Based Fisheries Management (CBFM) Project in 1996. In its western (upstream) reach (Fig. 1), part of the river dries up for two months (February–March) each year, while the downstream reach of the river, in Dharmapasha Thana of Sunamganj District, flows throughout the year. During the dry season, water depth in the downstream reach is 4.5–6 m, while in the upstream reach it is 3–4.5 m. In the monsoon, the area is submerged by flash floods from the Garo Hills.

There are 11 villages adjacent to both banks of the river. Eight of these are inhabited by traditional fishers. There are around 1 500 households in the 11 villages, with an average household size of 5.8. Of these households, 249 are *jaladas* or traditional fishers by birth. The ratio of Hindus to Muslims in these 11 villages is 55:45. Several gears are used in the river, and Table 1 shows the ownership pattern. Although cast nets are most numerous, the maximum catches are from large *ber jal* (seine nets), and from harvesting *katas* (brush piles which act as fish aggregating devices). The peak fishing period is November to January, the lean months are March, April and July; catches are average in the other months.

Fishing access

Table 2 summarizes key events and implications for the balance of power among fishers and between fishers and others since 1972. After the

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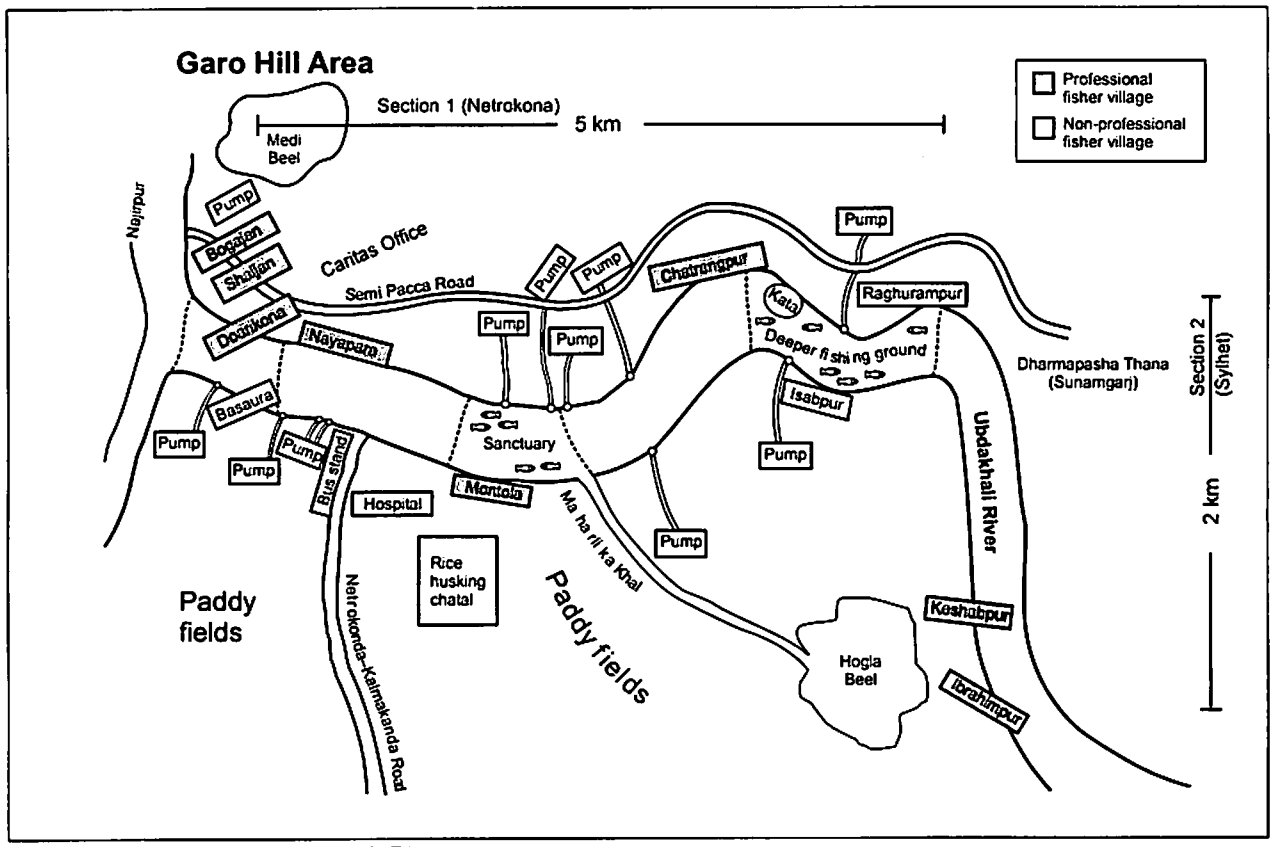

Fig. 1. Sketch map of Ubdakhali River.

independence of Bangladesh in 1972, fisheries (*jalmohals*) were leased to the highest bidder, but with a preference for cooperative societies composed of fishers, by the district administration on behalf of the Ministry of Land (Ahmed et al. 1997). Accordingly, in 1972 the "Keshabpur Matshayajibi Samity" (Keshabpur Fishers' Co-operative) comprising 113 fishers in 11 groups from eight villages, took the lease of Ubdakhali River for three years. It continued to be leased for 3-year periods up to 1986. Ubdakhali River was one of 300 jalmohals transferred to a licensing system when the New Fisheries Management Policy (NFMP) was introduced in 1987. A committee was formed, comprising the thana nirbahi officer (TNO, the chief administrative officer in the thana), the thana fisheries officer (TFO), and two fisher representatives, to arrange

Table 1. Fishing gear operated in Ubdakhali River, by village.

Village	Gear (nets)						
	Cast net	Gill net	*Berjal*	*Katijal*	*Chatajal*	*Dojala*	*Vatijal*
Shaljan and Bogajan	35	–	2	6	–	–	20
Doarikona	15	–	2	11	5	–	–
Nayapara	25	–	2	25	8	5	–
Basaura	30	25	–	–	–	–	–
Montola	20	–	2	30	10	3	–
Gojakulia	5	–	1	7	–	–	–
Chatrangpur	35	60	–	–	–	–	–
Isabpur	25	15	–	–	–	–	–
Raghurampur	40	45	–	–	–	–	–
Keshabpur	25	–	2	3	–	–	–
Ibrahimpur	30	–	2	5	–	–	6
Total	285	145	13	87	23	8	26

Table 2. Fishery management and power structure in Ubdakhali River since Independence of Bangladesh.

Year	Power and access to fishing		
	Policy/intervention	Response of power structure	Fishery management
1972–86	Lease in name of Keshabpur	*Mohajans* (moneylenders) pay lease money and fishers are guaranteed a market. Fishers give 50% share to mohajans.	During this period mohajans introduce system of rotating fishing between fishing teams to protect fish stock (only three *ber jal* operated at one time) in peak period.
1987	New Fisheries Management Policy introduced (licensing). Fish sanctuary established by Department of Fisheries.	Mohajans pay license money and guaranteed fishers a market. Fishers give 50% share to mohajans.	Informal access to sanctuary arranged with district officials by Montola.
1987–89	Nayapara leads licensing.		Rotating access in peak period continued.
1990–91	Nayapara and Keshabpur lead licensing.		
1990	67 acres of river transferred to Sunamganj District after legal proceedings.	Section 2 taken on lease by a moneylender-leaseholder from Sunamganj.	Rotating access in peak period continued.
1992–95	Keshabpur and Montola lead licensing.		
1995	Prime Minister's declaration of open access. Forthcoming Community Based Fisheries Management (CBFM) Project announced.	License money collected but then reportedly distributed back to only fishers of Nayapara and Keshabpur by thana fisheries officer (TFO).	Rotating access in peak period continued.
1996	Caritas starts organizing fishers for CBFM but avoiding those fishers implicated in litigation.	Thana nirbahi officer (TNO) brings case against TFO regarding license money. Local MP declares fishery to be leased out to Freedom Fighters (non-fishers).	Local farmers invest in *katas* in best area. Conflict over katas with Caritas fishers. Rotational fishing ends.
1997	TNO declares that waterbody is a flowing river; ligitation prevents leasing to Freedom Fighters.		Part of river dries up for first time in 10 years.

collection of license fees from the fishers. One representative from each fisher village was selected for collecting license fees directly from the fishers.

Government revenue collected from the river increased substantially in real terms in the 3-year leases given in 1978 and 1981 and, after a large drop when licensing was introduced, gradually rose again (Fig. 2). Increases in real revenue after adjusting for inflation bore no relation to fish production, which was not reported to have increased in this period, and were a severe burden on the fishers, as revenue has to be paid in advance. Poverty and lack of alternatives meant that fishers were compelled to take out loans at high rates of interest, tied to sale of their catches, from local moneylenders (*mohajans*) to pay the lease and then license fees. During both the leasing and the licensing periods, one local mohajan controlled the fishery. He actually paid the fees, invested in a major kata and, with some fisher leaders, enforced rules to limit overfishing. Organized fishing was practiced by 13 fishing teams each possessing a seine net; only three nets were

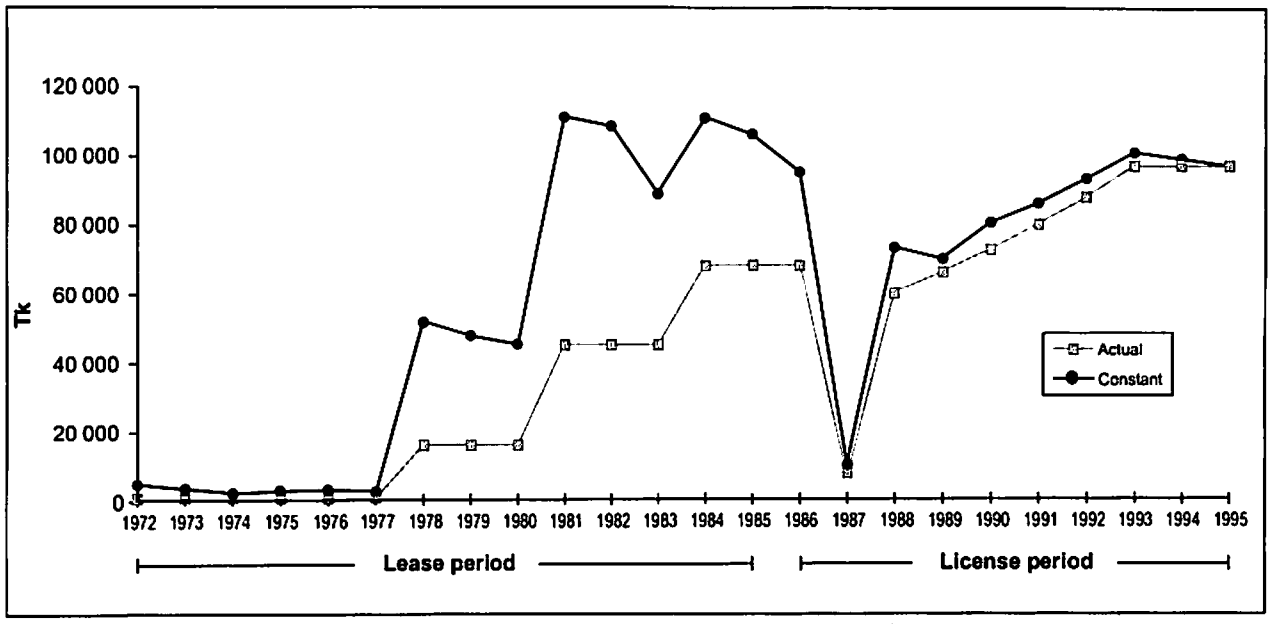

Fig. 2. Lease and license revenue of Ubdakhali River at actual and constant (1995) prices.

permitted by the mohajan to operate at any one time, following a rotational system. This conservation system was allied with exploitation by the mohajan and his powerful extended family, who claimed 50% of the fishers' catches. This management system has now fallen apart due to increasing pressure on a smaller resource base.

Although katas are not legal in flowing rivers, they contribute a very important part of total catch. Only three to four katas were built in the deeper fishing grounds in the eastern part of the river. More than Tk 200 000 (US$4 500) was earned from the largest of the katas in 1995–1996, and around Tk 75 000 from each of the smaller katas. The cost of building the katas was shared by the fishers, using credit from the mohajan.

Part of the river was selected for a fish sanctuary in 1987 by the Department of Fisheries (DOF); there was no participation from the fishing community in planning for or protecting this sanctuary. A guard and boatmen were posted there to protect the fish, but although fishing was officially banned there, fishers and thana officials report that a group of fishers arranged informal access to the sanctuary with the district authorities.

The total area of the 9-km long river section named Ubdakhali is around 87 ha (215 acres); in 1990 it was subdivided into two sections. Through legal proceedings, a local mohajan and lessee of jalmohals from Sunamganj District caused the eastern portion of around 27 ha (Section 2—see Fig. 1) to be brought under the jurisdiction of Sunamganj District. Subsequently he took the lease to this section. The remaining portion of Ubdakhali (Section 1) has an area of about 60 ha (148 acres) including Hogla Beel (a small beel adjacent to the river), and the Netrakona District fishers now have a smaller area to fish in.

Fisher–fisher and fisher–non-fisher relationships

The most productive fishing ground in the river is adjacent to the non-fisher villages of Chatrangpur and Raghurampur. The inhabitants of these villages are mainly Muslim and are relatively affluent. The present Union Parishad (UP) chairman and two mohajans—his cousins—are from Chatrangpur village. This family has good connections with the local administration. Its moneylenders provide loans to the fishers, at a very high rate of interest, to pay license fees, buy nets and boats and build katas, with repayment tied to the sale of their catches.

Keshabpur, Montola and Nayapara (see Fig. 1) are the most important of the eight fisher villages because fisher representatives have always been selected from them. Nayapara is adjacent to the thana headquarters, facilitating links between fisher representatives and the local administration. Most of the fishers of Nayapara migrated

there from Sylhet because the scope for fishing in Sylhet became limited. Montola village is where the fish sanctuary was located; its fishers have good connections with the mohajans. The fishers of Keshabpur are also powerful because their groups have been established for a long time and have connections with the Central Matshayajibi Samity (fishers society) in Dhaka. Hence, power appears to have been balanced between the three fishing villages during the leasing and licensing periods.

However, this situation was not without conflicts. The selection of fisher representatives was reportedly not fair, causing personality clashes between fishers and the fisher villages they represented. While the mohajans paid the costs of materials for the katas, fisher representatives reportedly exploited the fishers by inflating their expense bills to their own advantage. During the peak harvesting season, subsistence fishers used "current" nets (nylon monofilament gill nets) around the katas; and the fishers complained that the powerful and influential Muslims of Chatrangpur and Raghurampur villages took big fish by force.

The situation since 1995

Since late 1995, the waterbody has been open access (see Table 2), following a change in government policy to make access to open (flowing) waterbodies free (Ali, this vol.). The fisher representatives collected license fees totaling around Tk 80 000 before they knew that NFMP had ended, and it is alleged that this money was pocketed by the TFO and the fisher representatives from Nayapara and Keshabpur villages. A case against them was filed by the TNO with the anti-corruption office.

Under the CBFM Project, Caritas (an NGO) started working with the fisher community in early 1996. Six fisher groups have been organized from five villages comprising 113 households. Caritas formed these groups with the help of the previous fisher representative from Montola village. The groups entirely excluded Keshabpur and Ibrahimpur fishers. However, although the available river area has decreased (see above), fishers from Ibrahimpur and Keshabpur area are still engaged in fishing in Section 1 of the river. The fisher representatives who collected the last license fees and some of their supporters were excluded from the fisher groups because they were subject to legal proceedings; they have been trying to strengthen their role and obtain access to the fishery, with the help of DOF staff.

In 1996 the organized fishers purchased bamboo and other materials, using more than Tk 15 000 of their own money for a kata. But when they put their bamboo in the river, other non-fishers from adjacent villages also put leaves in the same kata. The fisher leader of Montola had close contact with those non-fishers who invested in the kata and arranged to harvest this and other katas for a 50% share of the catch, excluding the other organized fishers who had invested in the kata. All the fishers, even those from his faction, were unhappy with this.

Further stresses on this limited fish resource have appeared. In the dry season, pumping of water for irrigation and siltation have reduced overwintering areas for fish and, in the winter of 1996–1997, part of the river dried up for the first time. Also, because of population growth and lack of other opportunities, gradually more Muslims have started to fish, often using current nets (which are illegal).

Thus the fishers are now more factionalized and under pressure from outsiders than in the 1970s. Fig. 3 illustrates the changing power structure. Noting the power vacuum, and the delayed transfer of the river to DOF for the CBFM Project, the local Freedom Fighters Association (a welfare and business association for veterans of the Bangladesh war of liberation) tried to get access to the fishery through the local member of parliament by claiming it was a closed waterbody which they should get on lease (government policy since 1996 is to favor Freedom Fighters in access to resources). Following a meeting between the TFO, fisher representatives and Caritas workers, the TFO and TNO encouraged the fishers (with Caritas assistance) to file a case against the Additional Deputy Commissioner (Revenue), who is responsible for leasing out jalmohals, on the basis that Ubdakhali River is a flowing river and so cannot be leased out. This move appears to have succeeded, and the fishers have maintained access for

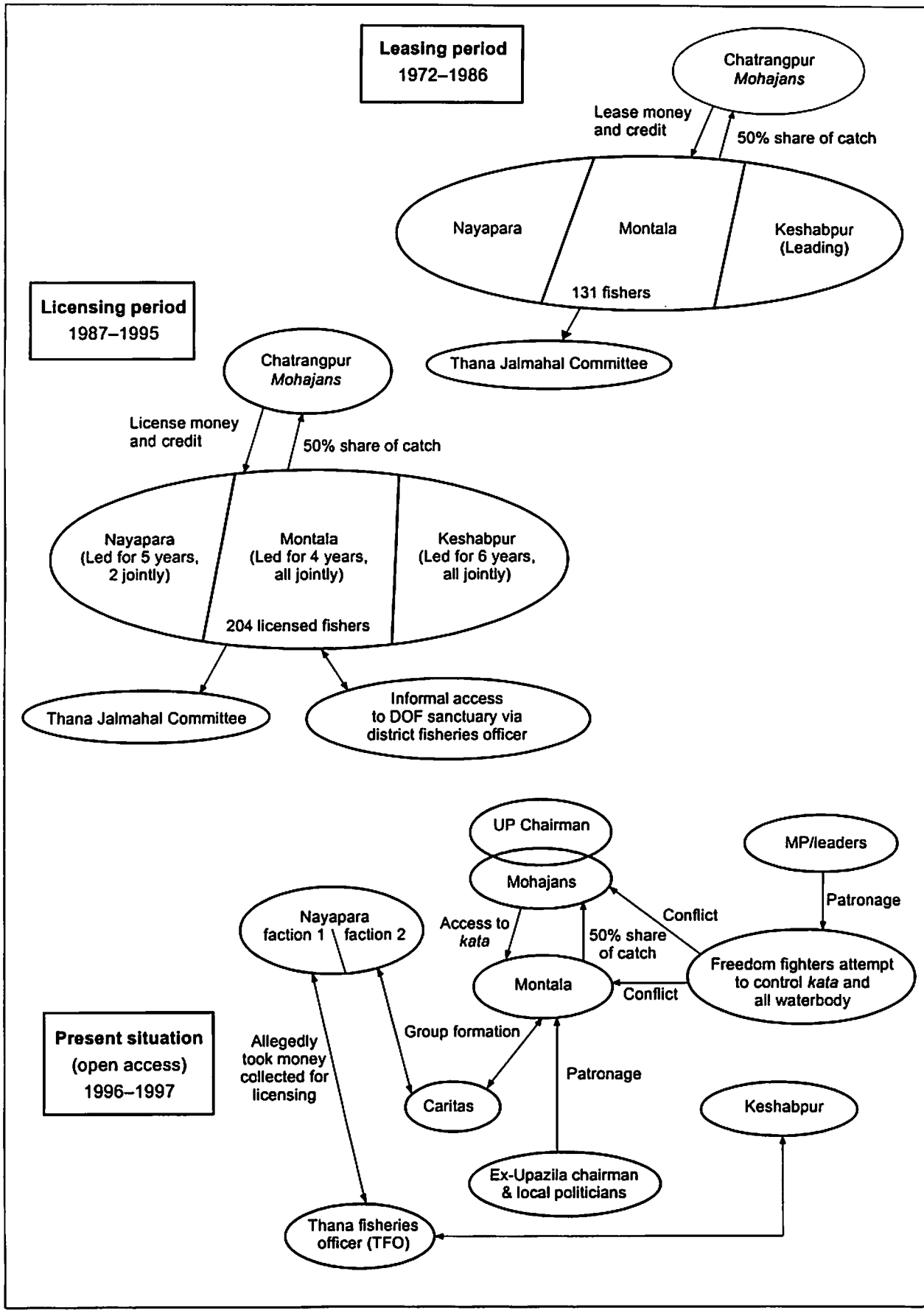

Fig. 3. Interaction between fisher community and local power bases in Ubdakhali River.

Note: During the 1980s thanas *(sub-districts) were renamed* Upazilas *and the administration was headed by an elected chairperson.*

the moment. However, the river has yet to be formally handed over for the CBFM Project and the legal proceedings are still not finished. Meanwhile the fisher leader from Nayapara, having good relations with the TFO and having dealt with upper-level officials, took the opportunity to lead the fishers of Nayapara and Keshabpur. He collected subscriptions from 80 fishers (both Caritas and non-Caritas) totaling some Tk 15 000 to meet expenses (travel, legal fees, etc.). The Caritas-organized fishers subscribed with their group savings. It is alleged that he spent less than the amount subscribed and kept the rest for himself.

Problems and recommendations

This case study shows that many interests are involved in the struggle to gain access to returns from limited fish resources. The power structure of the 1970s and 1980s centered around the mohajans and a balance of power between fishing villages. This balance of power broke down at the same time as fishing pressure increased and successful attempts were made to divide up the resource and take part of it into private control. In the face of these pressures, the fishers became more divided, and exploitation by their leaders became more apparent.

In identifying the poorest fishers for group formation and subsequent community fishery management, Caritas ignored two villages. Nor was the opportunity taken to incorporate other key stakeholders, particularly the thana administration and local leaders and mohajans, into fishery planning. In the past, the mohajans paid for fishers' license fees and other costs, and also facilitated marketing (which is difficult as the river is remote from major markets), but exploited the fishers by taking half the catch and by charging high interest rates on cash loans for fishing equipment.

So far, co-management arrangements have been limited by the change in policy which made the river a free access resource. The thana administration has helped prevent the Freedom Fighters from taking over the fishery, but the TFO and the law-enforcement agencies have tended to support the mohajans and other intermediary exploiters. The opportunity to build on past fishery management, which conserved fish stocks, has not been taken up.

Although CBFM Project activities have started, the status of this section of river is at present uncertain as DOF was not able to retain rights over it for the CBFM Project after the end of the NFMP. Consequently, the local fishing communities and DOF lack clear rights over the fishery. This paper shows that an understanding of the context and history of fishery management in relation to local power structures is needed when planning to increase community participation in fishery management. Based on the events described, the following recommendations can be made for developing community management:

- The DOF, local government and NGOs should have good coordination and a genuine commitment to help fisher communities manage fisheries wisely.
- NGOs should critically address the needs and priorities of poor fishers (such as alternative credit sources). They must seek local agreements with other stakeholders, so that exploitation is reduced but the benefits of existing relations among fishers and with non-fishers are not lost, and so that management agreements with other water users are reached.
- Conservation measures for sustainable fishing should be familiar to the fishing community, and be based on their knowledge of the fishery, and on existing institutions and rules, or on restoring rules followed in the past.

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Society and Community Based Management Under the New Fisheries Management Policy

MD. ISLAM ALI
Jatio Matshayajibi Samity (National Fishermen Association), 3/2 Purana Paltan, Dhaka 1000, Bangladesh

ALI, M.I. 1999. Society and community based management under the New Fisheries Management Policy, p. 73–76. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

The Jatio Matshayajibi Samity (National Fishermen Association) lobbied for a change in Bangladesh fisheries policy away from leasing for revenue, which favored middlemen. In 1986 the government introduced the New Fisheries Management Policy and 257 fisheries were actually handed over to the Department of Fisheries for licensing to fishers. This change in policy benefited fishers where government agencies cooperated with them. But in 1995 the government abolished leasing in rivers, and as a result fishers have lost their rights in these waters and are exploited by influential people. Political will and cooperation among branches of the government are needed if openwaters are to be managed by fishers themselves. A return to the licensing system is recommended, linked with a change from revenue oriented to conservation and social oriented fisheries management. Coordination with other government agencies is needed to prevent loss of openwater fisheries.

Introduction

Bangladesh's inland water resources are among the world's richest, creating a favorable environment for fish and other aquatic animals. In the past, Bangali people were characterized by the slogan *mache-bhate bangali* (fish and rice make Bangali) due to the dominance of these two foodstuffs. Now fish resources, particularly inland capture fisheries, appear to be in decline and some 10 million traditional fishers face poverty and loss of fishing rights. Moreover the existence of inland waterbodies is under threat due to manmade and natural causes. Such a state of affairs is a national issue. In a country where development could have been stimulated by exporting fish, demand is not being met from domestic production. The Jatio Matshayajibi Samity (JMS) or National Fishermen Association believes that this failure to achieve Bangladesh's fisheries potential is due mainly to lack of an appropriate fisheries management policy. The government has always been interested in earning revenue from fisheries rather than biologically sound management.

Two policies were adopted by past governments of Bangladesh: from 1973 a leasing system through negotiation with the fisher cooperative societies, and from 1986 the New Fisheries Management Policy (NFMP). These two policies were supposed to result in management by fishing communities, but the actual outcome was not as expected.

Background to policies

Traditional fishers form a distinct social class, looked down upon by other members of rural society. Consequently they have lagged behind in terms of economic and educational development. Traditional fishers are often employed as fishing laborers by middlemen/leaseholders (*izaradari*) and moneylenders (*mohajans*) and other powerful members of society. As a result they have been pushed into poverty. To improve the socioeconomic situation of fishers, the JMS started negotiations with the then Awami League government which as a result introduced in 1973 a system of negotiated leasing of fisheries to the fishers' cooperative societies—a form of community based management of fisheries. After the overthrow of this government, the revenue-oriented system was restored, whereby fisheries were leased out by auction to the highest bidder. This policy patronized the middleman's interest and deprived the fishers of their rights. Considering how destructive this policy was for fisheries management, the JMS lobbied to introduce a system which would favor the development of

fish resources as well as socioeconomic development of the fishers, by ensuring their right to use and manage fisheries for production. More than 50 000 fishers held a rally in Dhaka in support of their demand in 1986, and the government then introduced, in consultation with the JMS, the NFMP based on the slogan of the JMS, *jaal jar jala taar* ("whoever has the net has the water").

New Fisheries Management Policy

The basis of "jaal jar jala taar" was to recognize the collective right of traditional fishers over the inland capture fisheries (except the privately owned ponds) to ensure sustainable development of fish resources as well as for the socioeconomic development of fishers. The fundamental principles of "jaal jar jala taar" were:

- to establish the collective right of traditional fishers over government-owned fisheries;
- to increase fish production;
- to ensure socioeconomic development of fishers by releasing them from exploitation by middlemen;
- to hand over all government-owned fisheries under this policy (NFMP) in stages over a 10-year period, and
- to ensure a reasonable revenue from fisheries for the government.

This policy was framed taking into account past failures in fisheries management, and the socioeconomic development strategies of Bangladesh. The aim was to work in a cohesive and coordinated way for the betterment of fishers and for increased production.

We believe that the NFMP resulted in community based management through a regime of common property rights, and in increased production and sustainable fishing as well as economic development of poor fishing communities. Under the NFMP, 257 out of a proposed 300 fisheries were handed over by the Ministry of Land to the Ministry of Fisheries and Livestock to be administered by the Department of Fisheries. This policy gave the fishers direct rights over fisheries. The JMS found that the NFMP achieved positive results where the relevant agencies of government extended their coordination, and where a spirit of collective action developed among the fishers because of the policy. But where this cooperation was absent, the result was not satisfactory. As an example, Table 1 provides a comparison of the fishery in Terogaria Beel (42 ha) in Meherpur District in southwest Bangladesh before and after

Table 1. Comparison of fishing in Terogaria Beel before and after NFMP.

Issue	Position before NFMP in 1986	Position after inclusion in NFMP in 1996
Fishers engaged in fishery	40–50	82
Annual government revenue*	Tk 7 000–8 000	Tk 10 000
Fish production	Nature-dependent	From fingerlings (culture based)
Fish species	Koi, singh, lati, puti, etc. (mainly native catfish and small fish)	Native catfish plus stocked carp (rui, catla, mrigal, silver carp, karfu).
Quantity of fish produced annually	10–12 t	25–30 t
Average annual per capita fisher income*	Tk 10 000–15 000	Tk 25 000–30 000
Socioeconomic condition of fishers	Subsistence survival under the exploitation of debt to izaradar	After maintaining minimum standard of living, fishers able to save. All have built a house of corrugated iron sheeting and purchased a small plot of land. Every family now sends its children to school. Fishers donated funds for development of the local primary school.
Fishing right	Fishers caught fish on payment of toll to izaradar	Fishers have the right to their own fish. But local leaders/powerful individuals are always trying to oust the fishers and to take the beel under their management.

**Actual prices; in 1986 US$1 = approximately Tk 33; in 1996 US$1 = approximately Tk 43*
Source: President of the Jalmahal Management Committee

NFMP-based management by the local branch of the JMS. Under the NFMP, the number of active fishers was about 80% higher than under the leasing system; as a result of stocking, the annual fish catch and fisher incomes more than doubled, and social conditions improved according to the fishers.

Impact of openwater declaration

In 1995 the then prime minister declared the abolition of the leasing system for open rivers in the name of the rights and welfare of professional fishers, but this has not had any positive impact. Rights cannot be established simply by a gazett notification or verbal declaration unless a letter specifying the right, or written evidence in support of the right, is handed over to the fishers concerned to support their physical possession of the fishery. In practical terms, immediately after this declaration, the professional fishers lost their rights to openwater fishing as well as to the fisheries under the NFMP. "Musclemen" and influential people are increasing their share of benefits from these fisheries and exploiting the professional fishers by permitting them to keep only a nominal part of their catch. Moreover, in the absence of any management actions, production of fish is declining day by day due to over-exploitation and indiscriminate fishing.

Future measures

Of all government policies, the NFMP was, in the opinion of the JMS, the best. Unfortunately, the government's gazette notification declaring the abolition of leasing and the management of openwater fisheries means that traditional fishers have been deprived of their specific rights. In such a precarious situation, there is an urgent and immediate need to adopt a policy which guarantees the sustainability of fish resources and gives the right to use and manage fisheries to the fishers themselves. Efforts for socioeconomic development of fishers through alternative income generation projects are also needed.

There has been legislation for conservation of fish in Bangladesh since 1950, but the Department of Fisheries has not been successful in implementing it. If the law is strictly enforced, fishers will be rigorously punished for violation of conservation laws and for use of prohibited fishing gears, although they violate the laws in order to survive. Alternative regulatory measures are needed, including a ban on the production of prohibited fishing gears and their import. Training and motivation in support of compliance with the conservation laws are also needed. The JMS could work to make possible fishery management by fishers, but lacks the resources, training and leadership to do this; it needs support from government and funding agencies to be effective.

Conclusion

Given the lack of accountability in government and society, a policy of checks and balances on the relevant agencies is needed. The ultimate goal of fisheries policy should be to hand over the right of management of the fisheries exclusively to the fishers through their organizations (the JMS), but this is not feasible in the short term. Sustainable development of fish resources and socioeconomic development of fishers therefore require a policy of coordination and the establishment of fishers' property rights. The NFMP provided for this, but did not achieve its aims because assistance and coordination from government agencies and financial institutions were lacking. Political will, coordination and cooperation between concerned ministries and government agencies and administrators, and support to traditional fishers through their central organization (the JMS) or from development organizations are needed if management of openwater fisheries, based on the fishers themselves, is to be improved.

Recommendations

The JMS believes that to improve fishery management and protect fishers' interests:

- The first requirement is the collective right of traditional fishers over fisheries.
- All waterbodies should be brought under the "jaal jar jala taar" policy, i.e., under the NFMP.
- The revenue oriented system should be stopped

forthwith in the greater interest of resource sustainability.

- Fish conservation laws should be implemented not only through rigorous punishment for breaches but also by developing self-compliance by way of motivation, training, and creating awareness among fishers to respect these laws; and by creating alternative income-generating projects for organized fishers in the fish conservation season.
- Physical works are needed to prevent natural siltation and encroachment for agriculture and other uses. This should be done through coordination committees formed by the Department of Fisheries, the Ministry of Land, funding agencies and fisher associations. Otherwise it is feared that openwater capture fisheries will disappear.
- To eliminate poverty among fishers and ensure their general development, integrated socio-economic projects should be undertaken in fishing villages through the JMS and NGOs.
- Pollution, including excess application of insecticides, should be controlled.
- Commitment, accountability and timely execution by government agencies are needed in implementing fisheries policies.

Introducing Participatory Management in Flood Control, Drainage and Irrigation Systems

JENNIFER E. DUYNE
Bangladesh Water Development Board Systems Rehabilitation Project, Dhaka, Bangladesh,
and Euroconsult, Arnhem, The Netherlands

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Abstract

During the 1990s the principle of people's participation in water management projects was accepted by the Government of Bangladesh, and a set of formal guidelines has been adopted. The Systems Rehabilitation Project has been involved in implementing participation, and several lessons have been learned which are relevant to participatory approaches in fishery management. These include the implications for policymaking of diversity in local issues, the conceptual confusion between participation and group formation, the tendency of rural elites to capture participatory organizations, and the conflict between the basic principles of participation and decisionmaking hierarchies of agencies assumed to enhance participatory processes. Despite the guidelines, participatory planning in the water sector has so far not sufficiently involved fishing communities, considering the potential impacts of projects and water management decisions on their livelihoods.

Introduction

For more than a decade, participatory approaches have been advocated in academic and development circles as a means to increase equity and to improve the performance of public irrigation systems (Uphoff 1986; Parlin and Lusk 1991; Ostrom 1992). Related theories and concepts, all emphasizing the importance of creating local level organizations, have had a strong influence on the approaches followed in the water sector in Bangladesh. The project discussed in this paper, the Systems Rehabilitation Project (SRP), has been an important vehicle for the introduction and institutionalization of participatory management of Bangladesh's flood control, drainage and/or irrigation (FCD/I) systems.

The paper presents a number of critical issues influencing the viability of participatory approaches in Bangladesh. Though these issues derive from an analysis of experiences related to the attempt to enhance participation in the context of FCD/I systems of the Bangladesh Water Development Board (BWDB), it is argued that these are of direct relevance to other sectors, including fisheries. Issues such as the implications for policymaking of diversity in local issues and concerns, the conceptual confusion between participation and group formation, the tendency of rural elites to capture participatory organizations, and the conflict between the basic principles of participation and decisionmaking hierarchies of agencies assumed to enhance participatory processes, tend to apply to other sectors and agencies as well.

Another issue raised by this paper is that, considering the dramatic impact of FCD/I systems on openwater fisheries (see for example Ali 1990; Flood Action Plan 17 1994), it is essential that organizations concerned with fisheries and with related stakeholders closely follow the policymaking process related to the management of this infrastructure. The recognition of fisherfolk, and of all those poor people whose protein intake depends on access to common water resources, as primary stakeholders in surface water management systems in Bangladesh will depend to a large extent on whether there is sufficient advocacy for their recognition in policymaking circles.

The Systems Rehabilitation Project

SRP started in 1990 and was completed at the end of 1997. The overall objective of the project was to rehabilitate and improve the management of 38 BWDB FCD/I systems. The project was

funded by the World Bank, the European Union, the World Food Programme and the Government of the Netherlands.

The beginning of SRP coincided with the period when the importance of people's participation in development processes was just about to gain acceptance among government agencies in Bangladesh. In the context of the BWDB, recognizing the importance of people's participation was closely related to increasing awareness that the public sector does not have the means to ensure adequate operation and maintenance (O&M) of its infrastructure. Accordingly, it has been assumed that the sustainability of public water management infrastructure can be ensured only by sharing O&M responsibilities with its beneficiaries. This explains why participatory management became a central component of a project which was originally designed primarily to rehabilitate and improve dilapidated FCD/I systems.

SRP's contribution to the enhancement of people's participation in water development projects has been threefold:

- *Pilot projects.* An approach towards participatory management of FCD/I systems was developed and tested in six pilot projects. After a 3-year pilot phase, a related concept and related strategies were gradually introduced by BWDB staff in all 38 FCD/I schemes covered by SRP. The experience gained in these 38 water management schemes has been instrumental in reviewing the viability and replicability of concepts and strategies for participatory water management and in the formulation of empirically tested policy recommendations (SRP/BWDB 1997a)
- *Policy formulation.* SRP emphasized from the beginning that, unless efforts towards introducing participatory water management were backed by an official policy, the project's endeavors would be neither sustainable nor replicable. Accordingly, SRP actively supported a working group of high level government officials in the formulation of the "Guidelines for People's Participation in Water Development Projects" (Ministry of Water Resources 1994), a policy document that was formally approved by the Ministry of Water Resources in July 1995. These guidelines are an important milestone because people's entitlement to participate in water resource projects was officially recognized for the first time, and because the lengthy process that led to their formulation in itself helped to raise awareness and change attitudes among the officials involved (Hanchett 1997). Although the guidelines have a number of limitations, the lively debate about people's participation in water management (Wood 1995; Huq 1996), and the search for alternative approaches (Duyne 1997), would not have been possible without them. The ongoing revision of the guidelines will, it is hoped, incorporate both the conceptual criticisms of them (Wood 1995), and the critical findings of an in-depth study about their impact on the ground (SRP/BWDB 1997a).
- *Institutional support.* Through intensive institutional support to the BWDB and specific recommendations on necessary organizational reforms, SRP aimed at creating awareness and capacity within the BWDB to adopt participatory management approaches.

One of the main achievements of SRP in enhancing people's participation has been raising awareness and acceptance within the BWDB of the basic principles of such participation, and stimulate interest in people's role in water management. Increasing numbers of BWDB officials sincerely support the basic principles of people's participation. Closely related to this is a growing awareness that the BWDB's responsibilities and concerns should go beyond the construction of water management infrastructure, and that it should be equally responsible for delivering a service to its clients.

SRP has made important contributions to knowledge of flood control and drainage (FCD) systems (SRP/BWDB 1997a). Although more than 70% of the approximately 500 water management systems constructed by the BWDB are classified as FCD systems, there was very little awareness of the specific nature of water management in FCD systems. The function, objectives and stakeholders of FCD systems were assumed to be the same as those of irrigation systems. Until the 1990s only farmers were recognized as beneficiaries of FCD systems, and other affected groups in society were largely ignored in project planning and

management. SRP advocated for recognizing not only farmers but also fisherfolk and other categories of rural households as legitimate stakeholders in water management infrastructure. This has considerable implications for the introduction of participatory management approaches (SRP/BWDB 1995).

Critical issues in participatory water management

Experience from SRP is summarized below, along with comments on its relevance to the enhancement of community participation in openwater fisheries.

Diversity

An important lesson learnt by SRP through its direct involvement in enhancing participatory water management in a relatively large number of systems all over the country, is that even within Bangladesh there are significant variations in water-related issues and concerns. Recognizing diversity is possible only by following an inductive approach. SRP tried to avoid imposing preconceived ideas on participatory management and to adapt its approach to the local conditions. Intensive consultation, which is the first step to enhance participatory management, was used to assess local conditions. During these information and consultation campaigns, SRP staff targeted groups of stakeholders to inform them about the project and its intended activities and to learn from them what their water-related concerns were and whether and how they wanted to participate in the management of the FCD/I system. These campaigns proved that FCD schemes generally have an important role in the livelihood of all categories of stakeholders, and provided further empirical evidence that the exclusive focus on agriculture in the past often led to inadequate planning, design and management of FCD systems (SRP/BWDB 1997b). Merrey (1996) points out that even irrigation projects are increasingly used for purposes other than irrigation and strongly argues that this reality calls for major institutional changes among those agencies in charge of their management.

The Guidelines for People's Participation in Water Development Projects were prepared without recognizing the significant diversity of water management issues and stakeholders across the country. Although a flexible approach was suggested, nobody implementing the Guidelines had the authority to make modifications. Consequently (for example), even in water management systems where fisherfolk are a key stakeholder category, BWDB failed to recognize them as legitimate "beneficiaries" of their projects and did not entitle them to become members of water users' organizations. Thus there is still a gap between the principle of participation by all stakeholders in FCD system management, and recognition of the rights of fisherfolk and their empowerment within this process.

Replicability

While SRP has been quite effective in involving direct system users in the management of the FCD/I systems in its six pilot projects, the replication of its approach in the remaining 32 sub-projects had only limited success. This shows that policy declarations are not sufficient to ensure participation, as they need to be consistent with the formal mandate and the institutional capacity of the implementing agencies. Ensuring participation beyond the artificial project conditions into general government practice is a major challenge which requires not only political commitment, but very often also radical institutional reform.

The conceptual confusion between participation and group formation

All too often group formation has become a synonym of participation. Rather than clarifying in which particular domains, tasks and decision-making processes people are entitled to participate, the guidelines present a detailed organizational framework for "water users' organisations". The guidelines, however, lack a clear delineation of tasks, rights and responsibilities for these organizations, and there is no clear mandate which provides them with the authority to enforce any action or decisions made. In many BWDB projects,

the formation of groups became an end in itself, rather than a means towards participation. It is not really clear what the organizations are for: whether they exist to provide a channel for consultation with the BWDB, to become directly responsible for managing resources and infrastructure, to provide a means for conflict resolution, or some combination of all of these functions. In the absence of a clear understanding, field staff in charge of enhancing participation either developed their own interpretations; became more preoccupied with procedures at the expense of functions; or (perhaps more commonly) got so discouraged and disoriented by the unrealistic task given to them that they failed to go beyond the formation of "paper organizations". It is likely that similar confusion will result in diverted effort or partial participation in fishery management, since it would appear that much effort has been on formation of groups by NGOs without there necessarily being a clear role for these groups (see for example Huq et al., this vol.).

Conflicts between basic principles of participation and the BWDB's decisionmaking hierarchies

The guidelines were formally adopted without establishing whether any changes were needed to the internal procedures and decisionmaking hierarchies of the BWDB. There is a basic contradiction between the declared commitment to participatory management and the centralized nature of the Board. Barenstein (1994: 80–81) describes the BWDB as an "unbalanced organization, genetically geared to centralised decisionmaking for the construction of infrastructure. Divisions, subdivisions and 'circles' are imposed on the human geography of Bangladesh from an inherent—but carefully nurtured—top-down vision of 'delivering the goods' whether the subjects like it or not." Without a major effort to decentralize the BWDB and to make the agency more accountable towards local government institutions, it may be difficult to achieve accountability towards the infrastructure users. If BWDB field staff do not have any decisionmaking power, as is currently the case, the process of organizing and consulting system users about their O&M concerns and preferences is likely to remain just an exercise. Similarly, recent initiatives in fisheries management by communities have not addressed changes in government responsibilities and arrangements regarding these fisheries, as demonstrated by *ad hoc* transfers of responsibility (Hossain et al., this vol.; Apu et al., this vol.).

The risk of capture of participatory organizations by rural elites

Theories and concepts of participatory development tend to neglect the hierarchical nature and the unequal distribution of power and resources characterizing societies in which they are to be implemented. Ignoring the conflict between the basic principles of participatory approaches and the social structure of a society may result in the capture by vested interest groups of organizations intended to enhance equity and democratic participation.

In many SRP sub-projects, the rural elite have been able to assume key positions in water users' organizations. In some cases, where different socioeconomic categories of people have common interests in water management, this helped strengthen the capacity to negotiate with BWDB officials. However, there are often conflicts among the groups of stakeholders on how to operate water management infrastructure. The present constitutional arrangements of users' organizations do not ensure that they are not hijacked by vested interest groups; on the contrary, by not recognizing any category of users other than farmers as project stakeholders, the operation of FCD/I systems is bound to be biased in favor of this category of people. A rigorous socioeconomic analysis and an assessment of indigenous water management practices in each specific context where participatory organizations are to be developed, and a thorough understanding of the implications of these conditions for the intended approach, are essential to overcome this risk.

When is participation viable and effective?

In recent years, participation has almost become an "article of faith" professed as a solution to all

sorts of development problems. While in the 1960s the word "participation" had an almost subversive connotation, it is today accepted as a concept and promoted as an objective even by the most totalitarian regimes. However, such institutionalized participatory approaches have been termed "manipulated or teleguided forms of participation" (Rahnema 1992).

Already the Fourth Five Year Plan of the Government of Bangladesh (1990–1995) emphasized that "inadequate attention to the institutional framework required for O&M of schemes on a self-sustaining basis with effective local participation" is one of the main constraints in developing water resources. However, poor O&M is only one of the problems affecting the performance of water management infrastructure, and the introduction of participatory management approaches to existing systems is not necessarily the solution. As convincingly argued by Gisselquist (1991), many FCD/I systems are ineffective not because of poor O&M but because they are conceptually weak, wrongly designed and inadequately constructed. Gisselquist classified "failed" BWDB projects in four distinct categories: projects with a poor concept, projects with poor design, projects with poor construction, and projects with poor O&M. Only projects which do not belong to any of the first three categories may become more effective through the introduction of participatory management approaches. Participatory planning of rehabilitation and improvement works may contribute to overcome initial failures, and to enhance a sense of ownership essential for the mobilization of local resources for O&M (Thompson and Sultana 1996).

SRP was able to ensure participation in a number of key decisions in some of its pilot areas. The sustainability and replicability of SRP's achievements in the domain of participation depend to a large extent on whether the above-mentioned issues are seriously taken into account in the formation of future policies.

Conclusions and recommendations

This paper has presented a critical review of current policies and approaches to enhance participation in the context of Bangladesh's public water management infrastructure. Many of its conclusions are believed to be just as applicable to the management of other natural resources, and in particular to community management of fisheries in Bangladesh. Its conclusions and recommendations are as follows:

- Bangladesh is not a homogeneous country. The socioeconomic characteristics of farmers and fisherfolk, their relationship to other stakeholders in common property resources, and the informal normative system regulating access to common resources show significant variations across the country. This diversity needs to be fully recognized in the policymaking process. National policies need to be truly flexible and provide scope for recognizing and being adapted to local conditions.
- Good policies are a necessary but not a sufficient condition for the enhancement of community based resource management. For government and nongovernment development agencies, decentralization of decisionmaking authority is essential to the enhancement of community participation. Policies need to be organically reflected in the organizational structure and institutional capacity of implementing agencies.
- The formation of groups has often become a synonym of participation in resource management, though groups can be formed without enhancing participation, and participation can take place without forming groups. Thus, if a strategy towards community participation is based upon group formation, it is essential for policies and guidelines to go beyond specifying their organizational structure: the rights and function of groups need to be specifically spelled out.
- The concepts of "community" and "community participation" tend to neglect issues of social stratification as well as the rural power structure. Unless the tendency of influential people to gain control over common resources is recognized in the policymaking process and limited by all implementing agencies, attempts to introduce community based natural resource management approaches are likely to be hijacked by the rural elite.
- The construction, operation and maintenance of public water management infrastructure may

change the potential use and the balance between categories of natural resources such as fisheries. The planning and implementation of large-scale water management infrastructure need to take more systematically into account its potential effect on the availability of, access to and control over common property resources.

- Policies towards people's participation in water development projects need to build upon the recognition that water management infrastructures have multiple functions and accordingly serve different categories of stakeholders. The narrow focus on agriculture and its requirements has to be replaced by an integrated water management approach that takes account of the requirements of different categories of users. This implies that the process of water policymaking, including the preparation of guidelines on planning and management of water development projects, needs to involve all agencies (government organizations and NGOs) concerned with the management of resources and people potentially affected by water development projects.

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CBFM Approaches and Case Studies

Organizing Fishers for Community Based Fisheries Management: Caritas Approach and Constraints

ANWARA BEGUM SHELLY, S.M. NAZMUL ALAM and MARCEL D'COSTA
Caritas, 2 Outer Circular Road, Shantibagh, Dhaka–1217, Bangladesh

SHELLY, A.B., S.M.N. ALAM and **M. D'COSTA.** 1999. Organizing fishers for community based fisheries management: Caritas approach and constraints, p. 85–93. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Caritas is working in Bangladesh with the Department of Fisheries to mobilize the poorest members of the fishing communities living adjacent to five waterbodies. Caritas's Development, Extension, Education Services approach is described. The rural poor form a federation of primary groups which is an independent, legally recognized cooperative society; and then support from Caritas is withdrawn in a phased process. Progress in forming groups and providing training and credit is described. Constraints encountered fall into three categories: institutional (e.g., existing lease agreements), social conflicts (e.g., opposition by local elites), and technical (e.g., seasonal beels that dry up during the dry season). A process of empowering fishers, and of disempowering those interest groups that previously denied fishers opportunities and rights, is recommended.

Introduction and objectives

In Bangladesh, Caritas, the Latin word for "love" or "charity", is the name of a non-profit, non-government organization (NGO) established by the Catholic Bishops' Conference of Bangladesh, to work to enhance human welfare and contribute to the national development of Bangladesh. It has a decentralized structure with seven regional offices, each headed by a regional director. Currently Caritas has 43 major projects in progress in 11 sectors, including cooperative and extension service and rural development, agriculture and irrigation, fisheries development, vocational training, drinking water and sanitation, community health, and family planning. Caritas uses a common "people-centered approach" to all its development activities, known within Caritas as Development, Extension, Education Services (DEEDS).

Caritas has been actively encouraging integrated aquaculture since 1980 to enhance economic, nutritional, social and national development, to replace the shortfall in wild-caught fish, and to create job opportunities for the rural poor. At present it is working in 79 thanas, with 5 625 individual fisheries projects or activities (mostly involving fish farming in ponds and support activities for fish farming) which directly benefit 46 615 poor people. Of these beneficiaries 35% are female (Caritas 1996).

In addition to its own initiatives, Caritas has since 1987 been a regular partner of the Government of Bangladesh in implementing national fisheries development projects. Whilst government departments plan and initiate large, nationwide or regional-based development programs, the staff of the Department of Fisheries (DOF) have said that they are unable to develop the kind of "people's participation" that many of these programs require for their success (M.M. Hossain, pers. comm.). NGOs, with their field experience, regional and field offices and their freedom to recruit short-term project staff, are ideally suited to working with government programs. For example, from 1991 under the Third Fisheries Project, Caritas worked with DOF to mobilize community support for its plans to develop 10 000 ha of land under shrimp cultivation in southwest Bangladesh.

In 1992 Caritas involved itself in two waterbodies under the "Improved Management for Open Water Fisheries Project" (IMOF, phase II) of DOF, which continued up to 1994. However since there was no

financial support or staff available specifically for this project, significant results could not be achieved. In 1995 Caritas agreed to work with DOF in the Community Based Fisheries Management (CBFM) Project, with Ford Foundation funding, to support the mobilization of five fishing communities for CBFM in five openwater fisheries in four districts in central and northwest Bangladesh (Table 1).

This paper describes the experiences of Caritas during the first year of field work and highlights the achievements, problems and constraints that Caritas and local fishing communities encountered in attempting to initiate CBFM. The objectives guiding Caritas's involvement in and development of CBFM in each of the five fisheries fall broadly under five headings (listed below in approximate order of achievement):

- to organize and motivate fishers in the communities surrounding each waterbody towards a greater understanding of CBFM, and development of initiatives to implement CBFM practices in their particular fishery;
- to generate savings accounts with each organized group to ensure their participation in the development of the water resource;
- to diversify occupations of fishers through the creation of new income-generating opportunities, particularly during the lean period;
- to form women's groups and through these groups to raise awareness of women's rights and gender issues and involve the groups in income-generating projects, and
- to strengthen the process of community development, through the formation of a larger people's organization (*sangathan*) in each thana, through which community access to the local fishery and CBFM will be enhanced.

Methods

Development Extension Education Services

The philosophy that guides all aspects of Caritas's development interventions, whether it works independently or in association with government, is the Development Extension Education Services or DEEDS policy framework. DEEDS is a "people-centered approach" to development whose basic tenet is the promotion of social change through the empowerment of disadvantaged or marginalized people (including the landless and disadvantaged women and men). The implementation of the DEEDS approach focuses on four key stages: awareness, organization, self-finance and leadership (Caritas 1997).

Caritas field staff work with selected individuals with a common interest in society. The roots of these persons' own poverty are traced through oral histories. This generates awareness that the roots to poverty are discernible events (for example the loss of land, death of the head of the family, successive crop failure) and not simply the results of chance or the will of God. Direct relationships with community members are established and opportunities for change are explored, especially the idea that positive change is possible through group action because a group of individuals is stronger than any one individual standing alone. After a consensus has been reached on common objectives and goals, a group is formed. The group then provides a focus for saving schemes (towards self-finance) and training in leadership, literacy and numeracy, the environment, gender issues, and other relevant matters.

Group savings generate a financial resource for the group's future activities and ensure group

Table 1. Fisheries in which Caritas has undertaken activities to implement the CBFM Project.

Fishery	Thana	District	Type of waterbody	Area (ha)*
Ashurar Beel	Nawabgonj	Dinajpur	Open perennial lake	400[a]
Digshi Beel	Chatmohor	Pabna	Open mostly seasonal lake	14[b]
Hamil Beel	Modhupur	Tangail	Semi-closed perennial lake	16
Rajdhala Beel	Purbadhala	Netrakona	Semi-closed perennial lake	53
Ubdakhali River	Kalmakanda	Netrakona	River (seasonally partly dry)	87

* *Publicly owned area (*khas *land)*

[a] *Approximate monsoon season area (from Third Fisheries Project field survey)*

[b] *In the monsoon season the lake is much larger; the other beels increase in size during the monsoon but show less seasonal variation.*

cohesion through regular meetings and contributions paid by each group member. As the capital assets of the group grow, so does the level of trust and cooperation. The need to administer the group's activities forces members to take on the responsibility and develop the skills of group management. In addition Caritas provides training in group management and organization. The savings scheme creates a need for skills in literacy and numeracy. With a strongly directed need of this kind it is easier for Caritas's field staff to introduce literacy and numeracy courses for group members, whose time is short and for whom the relevance of reading, writing and arithmetic were hitherto unknown. Awareness raising, group formation, savings and literacy are all part of the process of empowerment.

As the group grows in confidence, consensus grows both in terms of its objectives and the means to achieve its goals through collaboration. Caritas initiates additional training programs (in income-generating activities) and through regular weekly meetings introduces related social, political, ecological or economic issues for debate and discussion. These often focus on the contemporary situation faced by the group concerned, for example constraints facing fishing communities in their attempts to introduce CBFM.

The DEEDS approach is appropriate for any community of poor people, including fishers. It gives poor fishers the skills, resources and power to take up management of fishery resources for their own benefit, and this has been achieved by forming close links between the basic fisher groups so that they can act in a coordinated way to manage shared fisheries. A key part of this approach is the aim of forming sustainable local people's organizations which can manage these resources when Caritas phases out its work in any area.

People's organizations (apex)

In 1986 Caritas developed the idea of *sangathan*, which loosely translated means "people's organization", and here means the apex body of a heirarchical federation of groups of poor people. If an individual's strength and capacity are enhanced through group action, the groups themselves will be better able to achieve their goals through collaboration. A sangathan comprises a number of partner groups, each of which elects a representative to a union committee, which in turn elects a representative to the Executive Body of this thana-based organization. The Executive Body is the implementing agency for the policymaking General Body. Members of the General Body are elected directly from the partner groups. Currently 24 sangathans are operating in 24 thanas with the support of Caritas. Their aim is to achieve the social changes identified by the members of the partner groups to alleviate the material causes of their poverty. The process of handing over development activities to a further 27 sangathans is underway. This policy of handing over all responsibilities to the beneficiaries is a unique aspect of the DEEDs approach to empowerment and developing poor people's capabilities. It is particularly appropriate for CBFM, which aims to devolve fishery management to the fishers.

The groups formed by Caritas under the CBFM project, through the adoption of the DEEDS approach to community development, exist not in isolation but within the context of the community—a heterogeneous mix of individuals with a multitude of social, cultural, economic and political allegiances. For a group to be able to change its economic position within a community and within society, groups must establish and maintain links with organizations and institutions beyond themselves, such as the DOF and Union Parishads (local government councils). Caritas and the sangathans play an intermediary role in this regard, initiating dialogue, arranging opportunities for discussion, and representing the rights or desires of groups to authorities beyond the reach of the groups themselves. At all times, though, the focus of any activity is on the needs expressed by the people—a people-centered approach to development.

Results

Activities seldom focus on a single group, but often tackle a single issue. Caritas field staff initiate dialogue between groups within a locality. In the case of CBFM in openwaters, the necessary collaboration between individual groups of fishers is made easier by their sharing a common and

Table 2. Groups formed by Caritas under the CBFM Project in 1996.

Fishery	Gender	Number of groups	Membership	Savings (Tk)
Ashurar Beel	Male	16	360	27 150
	Female	1	17	800
Digshi Beel	Male	7	159	17 088
	Female	3	45	4 180
Hamil Beel	Male	6	138	44 460
	Female	1	17	2 920
Rajdhala Beel	Male	4	89	10 684
	Female	0	0	0
Ubdakhali River	Male	6	134	29 525
	Female	5	83	19 780
Total	Male	39	880	128 907
	Female	10	162	27 680

interdependent interest: successful management of the fishery.

Following the DEEDS approach, 39 fisher groups were formed between January and December 1996, with a total membership of 880 fishers. Ten women's groups were also formed in the same period, representing 162 women from the fishing communities (Table 2). By December 1996, the 39 fisher groups had accumulated savings of Tk 128 907, whilst the women's groups had saved Tk 27 680 (in 1996 approximately Tk 43 = US$1). Caritas completed six interlinked training programs within each of the five project areas, and completed longer adult literacy courses (Table 3).

So far Caritas has disbursed credit totaling Tk 478 000 to the groups formed under the project (see Appendix). Of this amount, 69% was for fisheries-related activities of groups and individuals, particularly for purchase of nets (all waterbodies), for stocking in Hamil Beel, and for a fish aggregating brushpile (*kata*) in the Ubdakhali River. The remainder was for other economic enterprises at the household level which could supplement the incomes of poor fishing households.

Constraints to developing CBFM and their solutions

The problems and constraints affecting Caritas's efforts to mobilize fishing communities for CBFM in five openwater fisheries fall into three categories: institutional, social and technical. As the problems and constraints found in each fishery are different from one another, the problems and solutions are discussed on a fishery-by-fishery basis.

The common key issues relate to fisheries tenure, particularly leasing, and poor coordination between the Ministry of Land and the Ministry of Fisheries and Livestock. The former is responsible for public lands, including fisheries or *jalmohals*, and their management for revenue collection. The latter is supposed to take responsibility for project waterbodies under the CBFM Project, and is responsible for pro-

Table 3. Number of participants in Caritas training programs in the five project areas.

Training	Ashurar Beel	Digshi Beel	Hamil Beel	Rajdhala Beel	Ubdakhali River	Total
Awareness building	131	182	60	60	60	493
Leadership	47	27	58	50	60	242
Accounts	29	24	60	46	49	208
Women's development	–	–	30	–	31	61
Professional	37	29	30	60	–	156
Adult literacy	124	40	80	60	100	404
Follow up	26	–	30	25	30	111
Total	394	302	348	301	330	1 675

moting biologically sound fisheries management, but has no direct say in management of fisheries leased out directly by the Ministry of Land.

Ashurar Beel

Site background

The beel is 10–15 km long and is bounded by a sal *Shorea robusta* forest west of the headquarters of Nawabganj Thana. In the past, people from other parts of the country settled there, destroying the forest to the north of the beel. In the dry season the beel almost dries up, leaving just six deeper parts (locally known as *daha*) with permanent water. Naturally occurring fish include major carp and catfish (notably boal *Wallago attu*, tengra *Mystus tengara*, shol *Channa striata*, taki *Channa punctata* and shing *Heteropneustes fossilis*). The beel was renowned for large tasty boal and tengra. A wide range of fishing gear is used. The beel was previously included under the New Fisheries Management Policy (NFMP) and the DOF Third Fisheries Project.

Nature of the problem

Both social and technical constraints affect the introduction of community management of this beel. Few of the fishers were initially willing to consider the concept of CBFM, and most are opposed to the idea of stocking the beel. This attitude arose almost entirely from the experiences of the fishers with a program of stocking major carp carried out in the previous two years under the Third Fisheries Project. Under that project, the beel was stocked by DOF, but without participation of, or accountability to the fishing communities which the project had been intended to benefit. Furthermore, after stocking the beel, that project attempted to recover 20% of the stocking costs from the fishers by increasing their license fees. Yet high water levels and the numerous outlets from the beel meant, according to the fishers, that most of the stocked fish moved out of the beel (a technical constraint for stocking-based management). The name "Ashurar Beel" is derived from the Bangla word *ashi* meaning 80; there are 80 channels leading in and out of the beel. As there are no restrictions to the movement of fish into or out of the beel, there is no guarantee that stocked fish will remain in it.

Solution to the problem

Caritas staff were able to reassure local fishers that the concept of CBFM is radically different from that of the Third Fisheries Project, and with these assurances fishers accepted the formation of groups. Already local agreements have been made within the organized fishing community to cease fishing at the peak of the breeding season for the natural fish populations, and to keep one deep part of the beel as a permanent sanctuary. There was no artificial stocking in 1997.

Digshi Beel

Site background

The beel is located 14 km from the headquarters of Chatmohar Thana. In the monsoon this seasonal floodplain is reported to cover 240 ha. Over time it has been converted to agriculture and only 3.5 ha of government land are reported to remain in the beel. The beel is connected with the river Chiknai by a canal. It is inhabited by resident native fishes; once it was famous for large koi (*Anabas testudinus*). The government gave *khas* lands in the beel in *pattani* (permanent settlement) to individuals who dug many *kuas* (ditches/ponds) to catch the native fishes as the beel dries up. The ditch owners totally drain the ditches to catch all the fish, leaving no broodfish. Also, fisher representatives and other influential people were active under the NFMP. They paid the license fee on behalf of all fishers, controlled part of the fishery for themselves, and also collected high taxes from the fishers.

Nature of the problem

The continuing existence of a lease agreement governing the rights to exploit the fishery in Digshi Beel posed a major institutional constraint to the introduction of CBFM in the beel. In addition, there was strong opposition to the concept of CBFM of Digshi Beel from the local Union Parishad chairman and other influential local people, who had hitherto had an association or interest in the management of the fishery. This created a social constraint on Caritas's field staff seeking to introduce CBFM. Fishers living around the beel were enthusiastic about CBFM, but repeatedly referred to institutional and social constraints on their participation.

Solution to the problem

Mobilization by Caritas of local support among fishers for CBFM led to the formation of seven fisher groups around the beel. Although local elites and influential people were excluded from these groups, support for the groups and the ideas behind CBFM was generated among respected members of the local communities such as teachers and community workers. Through meetings and discussions within and between groups, a better understanding of the fishery was generated among the fishers. The concept of participation of all fishers in managing the beel was emphasized and explained to the different stakeholders, along with the concept of conservation of habitat for native fish.

Working with local and national DOF project staff, actions were taken to ensure that when the existing lease agreement ended, the beel would be transferred from the Ministry of Land to the Ministry of Fisheries and Livestock; this was confirmed in January 1997. However, the fishers organized for CBFM face continued aggression and intimidation from local influential individuals and their representatives, who remain strongly opposed to the transfer of the fishery to the fishers.

A community based stocking program is not possible in this beel because much of it is seasonal and under private ownership. Instead it is planned to lease two to three private kuas as sanctuaries for conserving the native fish. Above all the plan is to form a beel management committee of the fishers, which will then decide on appropriate development activities.

Hamil Beel

Site background

Hamil Beel is a semi-enclosed waterbody located in Dhanbari Union in Modhupur Thana. It retains water throughout the year and is surrounded by five villages. Alam et al. (this vol.) give further details of the beel.

Nature of the problem

From 1987 to 1995 Hamil Beel was under the jurisdiction of DOF, under the NFMP. A single fisher's cooperative society (FCS) with a membership of up to 130 fishers was then in control of the beel, with the individual members licensed to fish in the beel by DOF. During initial discussions between Caritas staff and local fishers about the possibility of introducing CBFM in the beel, little if any interest was shown by the fishers. Exploring the underlying reasons behind the fishers' apparent apathy towards CBFM, it was found that under the existing FCS, the fishers felt strongly that they were being unfairly deprived of a considerable part of their income from the fishery by mishandling on the part of senior FCS leaders. Not all of the members of the FCS were active fishers and extortion and intimidation were a familiar part of genuine fishers' lives. The problems impeding the introduction of CBFM in Hamil Beel were, therefore, largely social. In addition technical problems in the beel included previous stocking without following proper guidelines with respect to density, size and species composition; and the occurrence of the fish disease Epizootic Ulcerative Syndrome (EUS) during November–December 1996.

Solution to the problem

Caritas formed fisher groups using the DEEDS approach to community development. Membership was limited to identified fishers from the communities adjacent to Hamil Beel, essentially the active fishing members of the FCS. Six fisher groups were established, federated into a single beel management committee comprising 138 local fishers. Since the introduction of CBFM the FCS no longer has an active function in managing Hamil Beel.

Caritas convinced the participants of its support, and at the same time the local DOF staff reassured the fishers that the introduction of CBFM would receive local government support. The fishers were gradually convinced that the new system would have greater transparency than the preceding one, thereby reducing opportunities for the misappropriations which had previously been prevalent. The formation of six independent fisher groups quickly initiated the "opening up" of management practices within the beel, giving greater control over fisheries management to the fishers themselves and initiating a process whereby government officials would deal with several genuine representatives of the fishing community, not just the chairman and secretary of the earlier FCS.

The obstacle to improved fisheries management had been the lack of control felt by fishers over fishing activity in the beel. With the introduction of the CBFM project and the transfer of beel management to the combined six fisher groups, fish were stocked by those groups. Lime was applied to the beel to combat disease. Caritas motivated the fishers to make the beel suitable for stocking and helped them calculate the appropriate number of fingerlings, told them where fingerlings could be obtained, and arranged fingerling transport. In consultation with group members and the beel management committee, a consensus was reached to observe a "no fishing" period and develop a continuous guarding system. Following these guidelines the fishers achieved excellent production in 1996–1997, breaking past records and using a system for equitable distribution of the profit and its re-investment. Full details of this experience are given by Alam et al. (this vol.).

Rajdhala Beel

Site background

Rajdhala is semi-enclosed beel, 53 ha in area, in Purbadhala Thana, Netrokona District. Traditional Hindu fishers live around it. The beel is famous for producing large chapila (*Gudusia chapra*). Gears used include mosquito nets, traps, seine nets, cast nets, gill nets and spears. The previous leaseholder stocked major carp in the beel.

Nature of the problem

The principal constraint to CBFM in Rajdhala Beel was that the beel was leased to one outsider who controlled access to the fishery. The leaseholder stocked the beel and kept 70% of the fish caught; the fishers contributed their labor and were left with the remaining 30%. The lease was due to expire in 1998, and until then the likelihood of implementing CBFM practices in the beel was low.

Solution to the problem

Caritas was able to mobilize support amongst the local fishing communities for the introduction of CBFM. In an attempt to subvert the existing management system, the fishers initiated a non-cooperation movement in the beel, refusing to fish on behalf of the leaseholder. This resulted in an influx of migrant fishers from outside the fishing community, who fished the beel on behalf of the leaseholder. However, in the face of continued pressure, the leaseholder then offered to give up his lease. Through efforts of DOF and the organized fishers, and finally by personal persuasion from Caritas, the district administration and Ministry of Land were convinced to hand over responsibility for the beel to DOF for management by the fishing community. Eventually the lease fee was paid by Caritas on behalf of the fishers as a zero interest loan.

Ubdakhali River

Site characteristics

Ubdakhali is part of a flowing river 87 ha in area located in Kalmakanda Thana in Netrokona District. Islam and Thompson (this vol.) describe the fishery, which is based on building brushpiles (katas) in the river, and the 11 fishing villages along the river.

Nature of the problem

Both institutional and social problems face CBFM in this fishery. Ubdakhali River remains under the stewardship of the Ministry of Land, as there has been no agreement for its transfer to the Ministry of Fisheries and Livestock. Present government policy is that flowing rivers are a free-access fishing resource, and the relevant ministries have failed to make any clear decision whether, in a river under a CBFM project, the local community working with DOF will be allowed to make management decisions and rules. As a result of this confusion, a number of influential local people continue to press for sole access rights to the fishery, claiming it to be a closed waterbody (which could then be leased to them).

The previous licensing system under NFMP on this portion of the Ubdakhali River expired in 1995. Immediately thereafter the thana fisheries officer collected license fees from fishers as revenue for the government. This was followed by a petition presenting a case against the local DOF staff for alleged embezzlement of the fees collected. Six fisher groups have been formed by Caritas but they lack the authority, power and representation of the full fishing community to take up control

and management of the resource. The past and present access arrangements and conflicts regarding the river are discussed in more detail by Islam and Thompson (this vol.).

Solution to the problem

During the first year of the project, little progress was made towards overcoming institutional and social constraints to implementing CBFM of the river. No obvious solutions were apparent that fell within the scope of Caritas or other project staff at a local level. The fishers have been organized, but, in the absence of a legal framework giving any rights for the fishers to manage flowing rivers in general, it has been impossible to prevent attempts by rich individuals to control the fishery.

Conclusion and recommendations

One year is a short period from which to draw conclusions but it appears that the DEEDs approach is appropriate for mobilizing fishing communities in support of introducing CBFM. However, problems have been encountered where the fishers do not have clear rights, or where the organized groups form only part of the fishing community. Over time it is expected that the fishing communites will reach a stage where they can manage these fisheries themselves supported by the relevant Apex bodies

By the end of the first year, 49 groups had been formed. The savings accrued by each group are one indicator of the growing cohesiveness of the groups (as group savings require shared trust and regular meetings) as well as of the income of the group members. On this basis, the fisher groups in Hamil Beel can be considered to have made most progress, and among women's groups those in Ubdakhali River did best (see Table 2). In terms of coordinated actions to manage the waterbodies, the fishers of Hamil Beel and Ashurar Beel have made the most progress. Based on this group cohesion, more credit will be disbursed in the second year (a condition attached to Caritas loans is that only 80% of the cost of an activity can be given on credit, at least 20% has to come from the participants). Ultimately the revolving loan funds established for CBFM with donor grants will be handed over to the relevant Apex bodies (within which the fishers will be represented).

Experience at Hamil Beel has shown that increased production through stocking, and equitable distribution of the profit, are possible through community management of perennial semi-closed waterbodies. In the future, hatchery and nursery pond development may be added. This would enhance the possibility of timely stocking of waterbodies with quality fingerlings, and make possible year-round partial harvesting and re-stocking in perennial beels (Middendorp et al. 1996; Hasan et al., this vol.).

The process of empowerment that accompanies the growing awareness of fishers of opportunities previously denied to them must of necessity also involve a process of disempowerment of those who have traditionally denied the fishers such opportunities. To be successful, CBFM must therefore focus on both the empowerment of fishers and the mechanisms and means of removing the power of interest groups likely to oppose CBFM. Similarly, full participation of women should be incorporated in CBFM, because women in these communites have scope to earn an income from fisheries-related activities such as net making and nursery development.

Long term leasing of the waterbodies to the community is a pre-condition for sustainable development of the resource and for community management. Waterbodies should be vested with DOF, as it is the appropriate government agency to support CBFM. This should be done promptly so that projects can be executed without undue delays.

The planned fishery management actions are based on limited information. Regular studies should be carried out jointly by project-related staff and the organized fishing community on biodiversity, production capability and the impact of stocking. Education of the community on fish species conservation and habitat restoration should be an integral part of the project activity.

The initiation of a new approach to the management of openwater fisheries in Bangladesh has got off to a good start. Commitment, in terms of resources, to the continuing development of these groups needs to be ensured, in order to sustain the benefits gained by the fishing communities so far through CBFM.

Acknowledgements

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Appendix

Loans taken for income-generating activities in the five CBFM project areas and amount recovered (all figures Taka in 1996–97).

Activities	Ashurar Beel	Digshi Beel	Hamil Beel	Rajdhala Beel	Ubdakhali River	Total
			Fisheries			
Fish trading	32 000		2 000			34 000
Boats	18 000	10 000	15 000		12 000	55 000
Nets	31 500	35 000	4 000	27 000	38 000	135 500
Fingerling purchase			30 000			30 000
Kata placing					50 000	50 000
Fish drying					5 000	5 000
Liming			20 000		20 000	
Total	81 500	45 000	71 000	27 000	105 000	329 500
			Non-fisheries			
Plant nursery	8 000					8 000
Small business	68 000	6 000				74 000
Wheat culture	16 500					16 500
Goat rearing		16 000				16 000
Rice husking			10 000		15 000	25 000
Carpentry			2 000			2 000
Rickshaw/van			2 000			2 000
Other			2 000	3 000		5 000
Total	92 500	22 000	16 000	3 000	15 000	148 500
Total loans disbursed	174 000	67 000	87 000	30 000	120 000	478 000
Amount recovered	26 332	5 420	36 898	2 800	13 537	84 987

Social and Economic Profitability of Community Based Fisheries Management: A Case Study from Hamil Beel

S.M. NAZMUL ALAM and ANWARA BEGUM SHELLY
Caritas, 2 Outer Circular Road, Shantibagh, Dhaka–1217, Bangladesh

MOZAMMEL HOSSAIN KHAN
Department of Fisheries, Modhupur, Tangail, Bangladesh

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Abstract

Hamil Beel is a 16-ha semi-enclosed beel brought under the Community Based Fisheries Management Project in January 1996. Six groups of fishers were established by Caritas, representing 138 local fishers (one per household). The nucleus was the fishers' society which had previously leased and then licensed the beel, but which was dominated by a few influential fishers. The beel was stocked with 62 000 carp fingerlings by a beel management committee representing the six fishers' groups. A total of 17.79 t of carp were caught by the fishers, generating an average net income of Tk 4 900 per fisher. Fish production was almost four times greater than the previous maximum reported. Management, guarding, harvesting, and income were shared equally among the group members.

Introduction

There is growing acceptance in government policy in Bangladesh that the rural poor should be active participants in planning of development and in management of the resources they depend on. Fisheries are government property, and have in the past been leased out for revenue collection (Capistrano et al. 1994; Toufique 1997). This case study reports on successful enhancement of a *beel* fishery (in this case a shallow but perennial lake) managed by the local community. The community of part-time fishers living around the beel already had experience of managing the beel and was relatively homogeneous. Already there was a tradition of collective ownership of fishing gear (boats and seine nets), and of annual stocking with carp, but in the past, production levels were unsatisfactory, and control of the resource and of distribution of income was held by only a few people. The case study demonstrates the potential for NGOs to develop local common property resource management systems which are both more efficient and more equitable than previous systems.

Hamil Beel is a semi-enclosed waterbody located in Dhanbari Union under Modhupur Thana in Tangail District in central Bangladesh. The beel covers a maximum water area of just under 16 ha during the monsoon season; it is horseshoe shaped with a maximum length of 1.5 km. The beel retains water throughout the year, and the water depth never falls below 1 m, even in the dry season. The beel is connected with the Bangsi River in the monsoon through a canal. "Hamil" is a local word meaning "coalesce", and was applied to the confluence of two rivers (the Bangsi and a branch of the Jamuna). Over time the courses of the two rivers shifted, and closing of the confluence resulted in the horseshoe shaped beel known locally as Hamil Beel. Five villages around the beel are inhabited by people of a mixture of occupational groups including farmers, sharecroppers, government employees, small traders, daily wage laborers and people who derive an income from fishing in the beel.

Between 1958 and 1971, the Department of Fisheries (DOF) held sole responsibility for management of the fishery in the beel. Between 1962 and 1971 the beel was leased to private individuals through open auction for Tk 200–300 a year. The naturally occurring fish stock was harvested in large numbers. From 1972 until 1987, the beel fishery was leased by the government to a

cooperative society for Tk 700–12 000. One man was General Secretary of the society throughout this period; he is well acquainted with the laws concerning public leasehold fisheries (*jalmohals*), and has good relations with local leaders and elites. The ordinary members of the cooperative society did not show much interest in its management, possibly for fear of the local power structure to which the General Secretary belonged, and thus fishers were exploited.

The New Fisheries Management Policy (NFMP) of DOF was introduced in 1986, and in the later part of 1987 two fishers took over control of the beel. In 1988 the beel was brought under a licensing system as part of the NFMP, and the General Secretary of the cooperative society managed to be included in the management committee and effectively controlled the fishery. In 1988, 141 fishers obtained licenses. The lease value increased from Tk 13 200 to Tk 21 300 under the NFMP until 1995 (as a result of fixed annual 10% increments). DOF implemented a stocking program in Hamil Beel from 1988 until 1995. In 1992 Caritas joined the Improved Management of Openwater Fisheries Project, in support of the government's policy, and agreed to work for the development of the local fishing community in the beel. Having no budget for the project, Caritas used its own resources to do the following in one year:

- organization of seven fisher's groups (141 identified licensed fishers) and three women's groups;
- collection of savings of Tk 4 478 from the 10 organized groups;
- organization of training courses on awareness building, skill development and beel fishery management; and
- organization of one course on leadership and group management.

Despite stocking during this period, there were poor financial returns. Maximum production (in 1990–1991) was only 291 kg/ha. After stocking of the beel in 1995, a severe flood resulted in the escape of the stocked fish. Epizootic Ulcerative Syndrome (EUS) played havoc with beel fish populations after the flood. People from surrounding and more distant areas started fishing sporadically in the beel and at the end of 1995 the people lost interest in stocking it.

In 1996 Hamil Beel was selected to become a part of the Community Based Fisheries Management (CBFM) Project of DOF. Under this project local fishers are encouraged to take over the management of fisheries themselves. Caritas is a partner in the project and is responsible for supporting both the government in implementing the project and the local fishing communities in adopting and introducing CBFM practices in Hamil Beel. The fishers were reorganized in six groups and Hamil Beel was stocked in May 1996 by a beel management committee representing all six groups. This paper outlines the social and economic gains made by the fishing community around Hamil Beel during the first year of implementation of CBFM.

Social mobilization

Caritas field staff, adopting the Development, Extension, Education Services (DEEDS) approach to community development (Shelly et al., this vol.), began to mobilize support for CBFM in Hamil Beel in January 1996. In February six groups of fishers were formed, with at least one group in each of the five villages surrounding the beel (see Table 1). At the time the fishers' groups were established, the combined membership was 144 fishers. By December 1996 six fishers had left the groups, leaving 138 actively participating. (The fishers who left did

Table 1. Fishers' groups (Matshyajibee Purush Samity—MPS) organized in Hamil Beel.

Group name	Village	Membership Feb. 1996	Membership Dec. 1996	Savings Dec. 1996 (Tk)
Satata MPS	Bilaspur	18	16	4 960
Akota MPS	Ramkrishnabari	27	27	8 370
Rupali MPS	Gobindacharan	23	21	7 035
Pubali MPS	Bilaspur	20	20	6 090
Bhumihin MPS	Bilaspur	29	28	8 620
Sonali MPS	Gobindacharan	27	26	7 930
Total		144	138	43 005

so because of either irreconcilable differences of opinion with their group or a lack of commitment to group activities—for example guarding the beel.) To encourage the groups to be independent and cohesive, Caritas field staff encouraged each fishers' group to begin a savings scheme. By December 1996, Tk 43 005 had been saved by the six groups (Table 1) (in 1996 US$1 was worth about Tk 43).

During 1996 the fishers attended training courses in leadership and management, accounts, skill development, gender awareness, and adult literacy. This resulted in raising of consciousness and developed strong cohesion among the group members. The groups have received credit from Caritas for five fisheries-related and four non-fisheries-related activities (Table 2). These loans are conditional on the group members' savings, a maximum of 80% of the budget for a given income-generating activity of a group comprises credit from Caritas.

Under CBFM, one women's group has been organized with a membership of 17 destitute women of the community. The group has saved Tk 2 800. Women participated with fishers in training courses on awareness building, leadership and management, account keeping, skill development and gender sensitivity. Income- generating activities are due to be introduced for these women.

Table 2. Loans for income-generating activities in 1996.

Fisheries activities	Amount (Tk)	Non-fisheries activities	Amount (Tk)
Fish trading	2 000	Rice husking	10 000
Boats	15 000	Carpentry	2 000
Nets	4 000	Van	2 000
Fingerling stocking	30 000	Grocery	2 000
Liming	20 000		
Total	71 000		16 000

Grand total of loans disbursed: Tk 87 000; loans reimbursed: Tk 36 898

Group organization for CBFM

Following the formation of the fishers' groups, inter-group dialog was started to build a consensus and work towards the initiation of CBFM in Hamil Beel. An inter-group forum led to the formation of a beel management committee (BMC). Each fishers' group was obliged to elect three representatives to the committee, who would ensure that the interests of the group were considered at its meetings. The BMC elected a president, a secretary and a vice president, as well as a general secretary, joint secretary and treasurer. At its first meeting (1 May 1996) it decided that it would meet monthly and that a general meeting of all members of all six groups would be held quarterly. In addition, the committee could be summoned at any time to discuss issues of local importance.

The BMC immediately decided to stock Hamil Beel in the coming monsoon season. At the same time the committee, with the support of all its associated members, decided that following stocking, a ban on fishing in the beel would be enforced. The committee introduced a rota to ensure that once the beel was stocked it would be effectively guarded from poaching.

Stocking and guarding

The BMC decided to stock seven species of carp fingerlings. Between 25 May 1996 and 15 September 1996 a total of 1.86 t of fingerlings were released (average fingerling weight 30 g). Details of the species stocked are shown in Table 3.

No paid guards were employed to protect the fish against poaching; members of the groups performed this duty as a common obligation. Fourteen

Table 3. Carp fingerlings stocked in Hamil Beel in 1996.

Species		Size range (cm)	Number	Value (Tk)
Catla	*Catla catla*	10–13	21 564	11 435
Rui	*Labeo rohita*	7–14	14 124	14 880
Mrigal	*Cirrhinus mrigala*	10–15	8 865	7 172
Grass carp	*Ctenopharyngodon idella*	10–18	7 640	4 512
Silver carp	*Hypophthalmichthys molitrix*	10–18	8 150	5 240
Common carp	*Cyprinus carpio communis*	7–10	1 385	1 118
Mirror carp	*Cyprinus carpio specularis*	7–10	350	355
Total			62 078	44 712

Table 4. Fish species harvested from Hamil Beel by fishers' groups in 1996–1997 season.

Species	Size (cm)	Number	Weight (kg)	Value (Tk)
Stocked species				
Catla	38–50	8 732	6 596	250 298
Rui	30–48	7 259	3 390	124 380
Mrigal	30–48	6 893	4 438	172 082
Grass carp	38–50	1 202	944	35 359
Silver carp	38–45	1 571	1 392	51 504
Common carp	30–45	993	585	22 815
Mirror carp	30–45	256	444	15 540
Total		26 906	17 789	671 978
Non-stocked species				
Boal (*Wallago attu*)	75–90	12	57	2 565
Guji (*Aorichthys seenghala*)	22–38	2 302	1 073	34 336
Raj puti (*Barbodes gonionotus*)	22–30	190	48	1 536
Others	na	na	1 131	34 998
Total		2 504	2 309	73 435
Grand total		29 410	20 098	745 413

na: not available

teams (each of 9–10 members) were formed by the BMC from the six groups of fishers. In each of these teams there was at least one member from each of the six groups. Each team was expected to guard the beel for one 24-hour period every 14 days. Two members of the guarding team ensured that no poaching took place in the beel during the day and the remaining eight undertook night guard duty. The beel was protected in this way from May until September 1996.

From October 1996 to February 1997 (the harvesting period) the guarding system changed and nine harvesting teams were formed. These new teams consisted of 14–15 members, and at least one member from each of the six fishers' groups belonged to each harvesting team. Two of the nine harvesting teams were active in each 24-hour period. Two to three members of team I were assigned to guarding while the other members of the team fished during the day; the members of team II followed the same procedure during night fishing.

The pattern of the BMC and of the guarding and harvesting groups is shown in Figs. 1, 2 and 3, respectively.

Results

Fisheries impact

Between 27 September 1996 and 10 February 1997 a total of 2 9906 fish weighing 17 789 kg were harvested from fish stocked in Hamil Beel by the six fishers' groups. An additional 2 309 kg of non-stocked fish were also harvested from the beel. A breakdown of the catch by species is given in Table 4.

Catla and rui were numerically the dominant two species caught in the beel, accounting for 32% and 27% of the catch, respectively. These two species accounted for 58% of the number of fingerlings stocked (Table 5).

Social impact

It is more difficult to quantify the social benefits gained by the six fishers' groups than to directly measure the fishing or economic impact. Five indicators are presented below, which reflect the social impact of CBFM in Hamil Beel.

Table 5. Stocking and harvesting ratios for the seven carp species stocked in Hamil Beel.

Species	Stocked (%)	Harvested (%)
Catla	35	32
Rui	23	27
Mrigal	14	26
Grass carp	12	4
Silver carp	13	6
Common carp	2	4
Mirror carp	1	1
Total	100	100

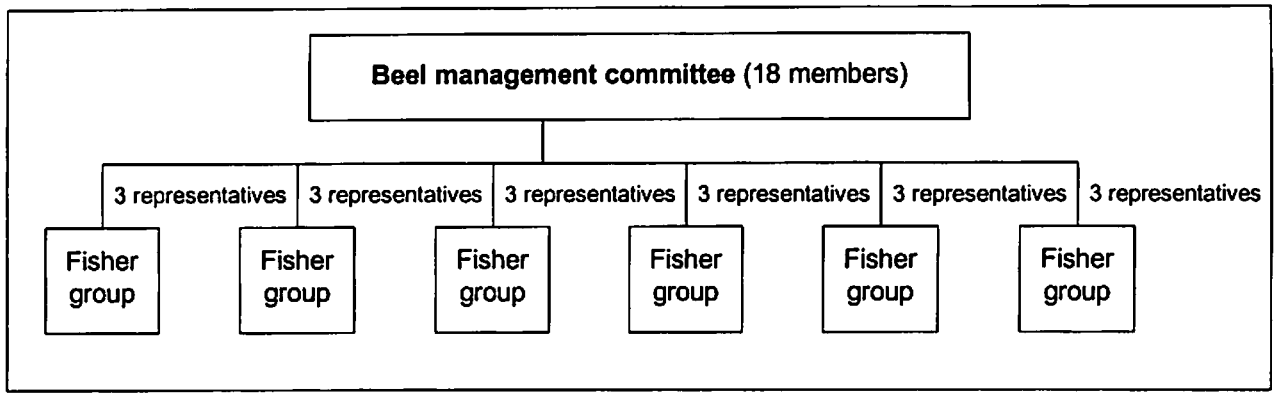

Fig. 1. Beel management committee.

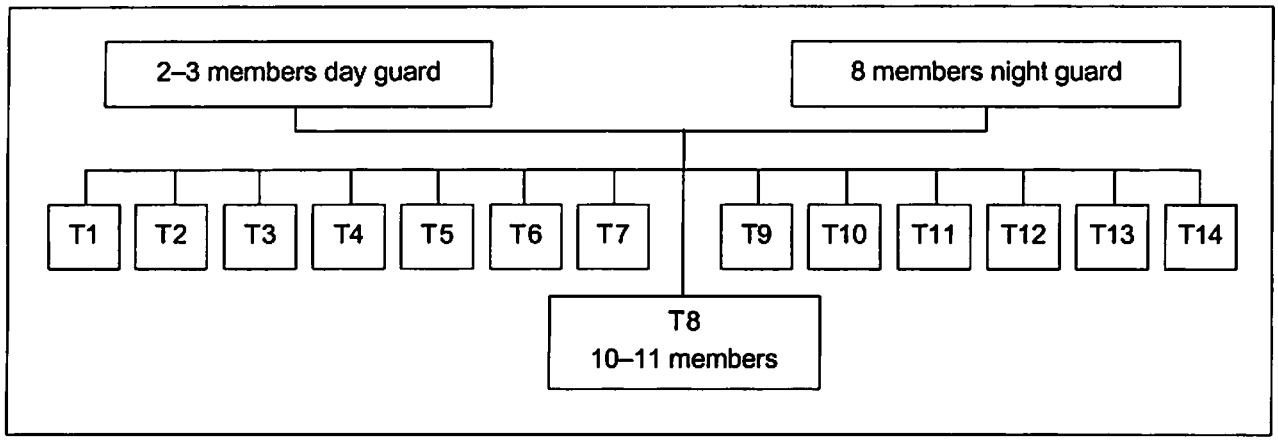

Fig. 2. Beel guarding team before harvesting.

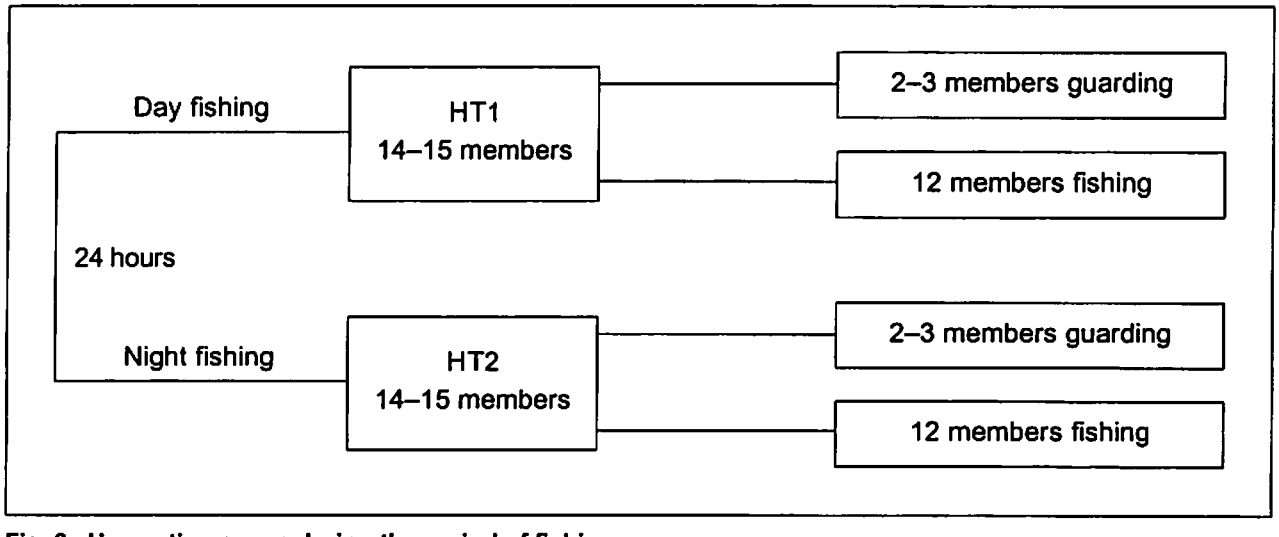

Fig. 3. Harvesting group during the period of fishing.

Equitable harvesting

From 27 September 1996 harvesting took place, twice daily (from 9 A.M. to 2:30 P.M. and from 10 P.M. to 5 A.M.). After the catch was landed, a representative from each group oversaw the sale of the catch. The income generated from selling the harvested fish each day was distributed evenly among the representatives of the six groups at the point of sale. The representative of each group then returned to his own group to share out the proceeds of the day's fishing. In addition, each member of the harvesting group active that day received 1 kg of harvested stocked fish and 0.5 kg of non-stocked fish, to increase

protein intake for the families of fishers participating in beel management.

Repayment of stocking loan

The initial cost of stocking the beel was raised by the BMC from two sources: a Tk 5 000 loan by Caritas to each of the six fishers' groups, and a Tk 100 contribution from each member of each group. Thus in total Tk 30 000 was raised as credit from Caritas and Tk 14 400 by the fishers themselves.

The mode of loan repayment was agreed with Caritas in advance: six monthly repayments incorporating a service charge based on an annual rate of 12%. Each group thus undertook to repay Tk 861 per month. Each group fulfilled its repayment commitment within the allotted time. The amount raised by the fishers was also repaid by the fishers to themselves, at the same rate of interest. In total the fishers repaid Tk 14 840 to themselves from the income generated from fishing in the beel.

Repayment of loans for boats and nets

The six fishers' groups each took out a loan of Tk 2 500 (total Tk 15 000) to repair and service two fishing boats which are owned in common by all the participating fishers. This loan also carried a service charge based on a rate of 12% a year; it was repaid by the six groups in four successive installments. In addition the six groups jointly bought two seine nets 138 m and 77 m long, at a cost of Tk 10 500 and Tk 8 000, respectively, using money raised by contributions from the fishers themselves. The costs were recovered by the fishers' groups from income from the sale of fish.

Social participation

The financial and material benefits of CBFM in Hamil Beel were experienced not only by the members of the fishers' group who managed the beel fishery in 1996–1997, but also by those outside the groups. The BMC donated Tk 800 for the development of the local mosque. On several occasions it allocated a portion of the day's catch to some destitute people in the villages surrounding the beel. Fish were also provided free for the marriage of a daughter of a group member, and Tk 1 000 was donated to each of three other marriages of group members. The committee provided Tk 500 to cover the hospital bill of one fisher, injured while fishing in the beel; another group member also received Tk 300 for medical expenses.

Attitudinal changes to stocking

Before the introduction of CBFM in Hamil Beel, the beel was stocked with uncounted numbers of undersized fingerlings, which resulted in a poor return on the investment. Under CBFM, as a result of social and technical training, fishers were more conscious of the importance of knowing how many fish were stocked and of stocking the correct size. In addition more than 100 kg of common and mirror carp were released back into the beel after catching to form a broodstock. Some of those fish bred naturally in the beel in the 1997 monsoon.

Discussion

The first year following the introduction of CBFM in Hamil Beel, incorporating a community stocking program, was an economic and social success for the fishing communities involved. The stocking program generated a net income of Tk 4 943 for each of the 138 fishers. The social organization both within and between groups has increased social cohesion within the participating fishing communities. This was most clearly reflected by the unpaid day and night guarding successfully organized by the BMC, and the equitable distribution of the profits from the catch. The philanthropic attitude of the committee towards fisher group members and the wider community living around the beel is a further demonstration of the social benefits that emerged as a result of CBFM.

It is also instructive to compare the productivity achieved under stocking organized by the BMC with the results of similar efforts organized by DOF. Fish production was more than three times greater than the maximum reported for earlier stocking programs (Table 6): a production of 17.78 t was achieved from the stocking of just 1.86 t of fingerlings, and the fishers believe that 10% of stocked fish may still remain in the beel.

Table 6. Productivity of Hamil Beel from stocking fish, 1988–1997.

Year	Number of fingerlings stocked	Fish harvested (kg)	Beel productivity (kg/ha)[a]
1988–1989	25 000	2 140	133
1989–1990	100 000	4 386	274
1990–1991	119 180	4 651	291
1991–1992	150 000	3 344	209
1992–1993	80 000	3 616	226
1993–1994	100 000	4 004	250
1994–1995	107 680	3 285	205
1995–1996	60 000	na	na
1996–1997	62 078	17 789	1 112

Sources: DOF records under NFMP (1988–1995); BMC records (1996)
na: not available
[a] based on beel area of 16 ha

Table 7 shows the costs incurred and the benefits derived as a result of the stocking programs in Hamil Beel between 1988 and 1997. Once again the results indicate that under the management of the BMC the returns on investment were two and half times higher than the previous most profitable stocking. The net return to fishers under the committee (Tk 671928) was more than three times greater than had previously been achieved. The recorded "income per fingerling stocked" was almost five times greater than under earlier management regimes.

Analysis of the expenditure and income from the stocking in 1996-1997 shows that each fisher earned a net income of Tk 4 943. The return on investment was 1 078% and the benefit–cost ratio (BCR) 10.8:1 (Table 8).

Problems and recommendations

One major problem is the conflict between fishers and people who have taken land for cultivation inside the beel on lease from the government. The water area is becoming smaller, due to gradual siltation and conversion to paddy cultivation. During the monsoon, when paddy fields inside the beel are flooded, lessees of this land start catching fish without the consent of the BMC. In addition the lessees have built bunds around their fields and catch fish as the water recedes.

So far the concerned officials in local government have cooperated well with the organized fishers in mitigating these conflicts on an *ad hoc* basis. However, in the long term the area of the beel needs to be clearly under the control of the BMC, which could then decide if other people could take fish.

Water use as well as land use brings conflicts. Paddy is widely cultivated around Hamil Beel, using water pumped by villagers from the beel. Thus irrigation reduces the water level. A forum is needed for reaching a water sharing agreement as a compromise between fishers and farmers.

EUS has broken out in the beel for several years. In 1996–1997, due to motivation from Caritas, the fishers for the first time limed the beel to save their fish. It is believed that this prevented the disease from breaking out, and the good income achieved should encourage similar management with liming in future years.

The fact that there have been no government revenue payments for the beel since 1995 has

Table 7. Costs and benefits of stocking Hamil Beel, 1988–1997 (fingerlings only).

Year	Number of fingerlings stocked	Assumed cost of fingerlings (Tk)	Reported value of catch (Tk)	Net return to fishers (Tk)	Income per fingerling stocked (Tk)	Net return on fingerling investment (%)
1988–1989	25 000	33 000	54 933	21 933	2.19	66
1989–1990	100 000	27 300	156 294	128 994	1.56	472
1990–1991	119 180	29 345	189 647	160 302	1.59	546
1991–1992	150 000	30 400	145 383	114 983	0.97	378
1992–1993	80 000	47 000	139 510	92 510	1.7	196
1993–1994	100 000	36 000	159 720	123 720	1.60	343
1994–1995	107 680	na	111 131	na	1.03	na
1995–1996	60 000	na	na	na	na	na
1996–1997	62 078	44 712	671 978	627 266	10.82	1 403

Sources: DOF records under NFMP (1988–1995); BMC records (1996)
na: not available

Table 8. Expenditure and income for Hamil Beel fishing in 1996–1997.

Total expenditure					Total income		
Item	Quantity (no.)	Total cost (Tk)	Economic life	Cost/year (Tk)	Item	Quantity (t)	Total (Tk)
Fingerling purchase	62 078	44 712	na	44 712	From stocked fish	17.78	671 978
Boat purchase	2	15 000	5 yrs	3 000	From non-stocked fish	2.30	73 435
Net purchase	2	18 500	2 yrs	6 167	Total	20.08	745 413
Service charge @ 12% p.a. against total cost		9 385			Net profit (Tk)		682 149
					Net profit/fisher (Tk)		4 943
					Return on investment (ROI)		1 078%
Total		78 212		63 264	Benefit–cost ratio		10.8:1

Note: Costs not discounted; 1996–1997 investment costs with lives of over 1 year calculated on a yearly basis for annual returns.
na: not applicable

caused uncertainties over the fishers' rights to the fishery. In 1997, having received a good income, the fishers paid the government lease money to secure their legal rights to the beel, and the beel has been handed over to DOF supervision for the purpose of community management. To sustain this situation, a system is needed whereby communities which manage and invest in fisheries have recognized long term legal rights over the fishery. Moreover, government revenue demands should be fair, bearing in mind the limited resources of poor fishers.

In view of the experience in Hamil Beel, Caritas encouraged the participants to elect a BMC under a fair democratic process in 1997. Training and awareness raising by Caritas are expected to make it easier for the participants to make their organization more accountable. In 1996 there was a shortage of fingerlings in the dry season; this will be mitigated by renovation of a nursery pond. In future the participation of women's groups in beel-related activities, such as nursery development, net making, and the raising of poultry and other livestock, will be encouraged.

Conclusions

The results of the first year following introduction of a new approach to management of an open waterbody has got off to a good start. But too much should not be read too soon into the "success" that has been achieved. Commitments, in terms of availability of resources and genuine cooperation and support from local government institutions to the continuing development of the groups, need to be ensured in order to sustain the advances made by the fishing communities through CBFM practices.

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Community Based Fisheries Management Experience with Fishing Communities along Rivers: Proshika Approach and Constraints

MD. FAZLUL HUQ, MD. ALTAF HOSSAIN and PROHLAD CHANDRA DEY
Proshika, I/1-Ga, Section 2, Mirpur 2, Dhaka, Bangladesh

HUQ, M.F., M.A. HOSSAIN and P.C. DEY. 1999. Community based fisheries management experience with fishing communities along rivers: Proshika approach and constraints, p. 103–109. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Under the Community Based Fisheries Management Project, Proshika is working in eight rivers in Bangladesh to enhance fisher incomes, develop their capabilities, and encourage them to limit fishing so that stocks do not decline. A total of 173 groups including full-time fishers had been formed up to December 1996 and 2658 fishers attended skills or human development training courses. Tk. 7.87 million of credit was disbursed for fishery inputs to reduce dependence on credit from moneylenders, and Tk 30.4 million for additional income earning activities. However, the Ministry of Land has not given fishing rights in rivers to communities; instead they have become free access resources. This makes it impossible to develop local management plans. Lack of support from the government gives the powerful an opportunity to exclude poor fishers by building *katas* (brush piles) that attract fish and from which fishers are excluded. Complete harvesting of katas is eliminating the natural breeding stock. Local agreements to control their numbers are recommended, along with conversion of some of them into fish sanctuaries by the communities.

Introduction

Proshika Manobik Unnayan Kendra, in short Proshika, is one of the largest private voluntary development organizations in Bangladesh. It has taken up development activities for the poor since its establishment in 1976. The goal of Proshika is to promote sustainable development for a poverty-free, productive, environmentally sound, democratic and just Bangladesh.

Proshika's development activites aim at addressing the needs and priorities of rural and urban poor, including low waged landless laborers, poor farmers (including tenant farmers), weavers, fishing communities and petty traders, and the urban poor primarily engaged in the informal sector. Proshika programs have been operating in 110 area development centers, and cover 8907 villages in 953 unions under 140 thanas in 46 districts. To empower poor people, Proshika has formed 26245 male groups and 33027 women's groups with 509036 and 551389 members, respectively (Proshika 1996).

Proshika's fisheries development program is one of 13 programs and has the following aims:

- to organize and mobilize fish farmers and fisherfolk through educational and motivational work;
- to improve technical and management capacities of the rural poor fish farmers and fisherfolk through training;
- to create scope for employment and income-generating opportunities for the rural poor fish farmers and fisherfolk;
- to increase the capacity of fish farmers and fisherfolk to gain access to government (*khas*) ponds and openwater fishery resources to ensure their proper management;
- to increase fish production and raise the nutritional status of the poor;
- to develop appropriate technologies in fisheries and disseminate them, and
- to increase the production of fingerlings of desired species in order to meet the requirement of fish farmers.

Proshika has five collaborative research/demonstration projects in fisheries, working with government, national and international agencies:

- fish culture technology transfer and feedback to research (International Center for Living Aquatic Resources Management [ICLARM]);
- pond re-excavation project (with World Food Programme/Integrated Food Aided Development Project-2);
- community-based fisheries management and habitat restoration project (with the Center for Natural Resources Studies);
- the Community Based Fisheries Management (CBFM) Project with the Department of Fisheries (DOF) and ICLARM—the subject of this paper; and
- cage culture—at Kali nodi (CBFM site) Proshika is experimenting with cage culture. The CAGES project of CARE is providing training and technical support.

Proshika undertakes group formation with poor fishers and non-fishers. Once groups have been active for at least 9 months and satisfy various formalities, they qualify for training from Proshika to improve their skills and knowledge so that they can enhance their incomes and employment by undertaking small employment and income-generating (EIG) projects. Training is a vital part of all Proshika's programs. Training is organized at central and regional training centers and at village level. The trained group members are then provided with credit from Proshika's Revolving Loan Fund (RLF) to implement their own projects, using the skills they have learnt. Credit is provided for a modest service charge, but with strict repayment schedules.

Proshika's community based fisheries management activities

Past policies and projects

In Bangladesh there are more than 13 000 separate waterbodies defined as fisheries or *jalmohals* including rivers, canals, haors, baors and beels, which occupy over 8% of Bangladesh and cover about 90% of the area of inland waters (DOF 1986). For inland openwaters, the government introduced in 1986 the New Fisheries Management Policy (NFMP) which allowed fishing access only through licensing to the "genuine" fishers instead of leasing the fisheries; the aim was to reduce exploitation by middlemen and maintain fisheries productivity on a sustainable basis. To study the feasibility and effectiveness of the NFMP, and how NGOs could assist these genuine fishers, Proshika and other NGOs were involved with DOF and ICLARM in the project Improved Management of Openwater Fisheries (IMOF) during 1992–1995 (Ahmed et al. 1997).

In 1995 the NFMP effectively ended when all flowing waters, whether they had been licensed or leased, were declared free of revenue requirements and consequently free access resources (Farooque, this vol.).

Community based fisheries management

Based on the results and feedback from the earlier IMOF, a new project, the CBFM project, started in 1995 as a collaboration of NGOs, DOF, ICLARM and the Ford Foundation (Hossain et al., this vol.). For Proshika, given the general goals referred to earlier, the main objectives of the CBFM project are to:

- develop a framework for community based fisheries management;
- promote equitable distribution of benefits to community people;
- provide alternative incomes for poor fishers and thereby reduce pressure on the fisheries (linked with conservation measures) and enhance lean season incomes;
- eradicate illiteracy among fishers by providing adult literacy courses, and
- ensure natural recruitment of indigenous species to the fisheries for the next generation by encouraging fishers to comply with the Protection and Conservation of Fish Act, 1950.

Under the project, Proshika has continued activities in three rivers where it started to work with the fishers when they were licensed under the earlier IMOF project (from 1992), and has added another five rivers (Table 1). All of these

Table 1. Rivers where Proshika has CBFM activities.

Jalmohal	Thana	District	Fisher groups organized since
Tetulia Nodi	Bhola Sadar	Bhola	July 1995
Boyrala Nodi	Madan	Netrokona	July 1995
Bancha Mora and Jari Jamuna Nodi	Daulatpur	Manikganj	July 1995
Titas Nodi (Block-Ka)	B. Baria Sadar	Brahmanbaria	July 1992
Titas Nodi (Gokan ghat–Goshaipur)	Nabinagar	Brahmanbaria	July 1992
Dhaleswari Nodi	Nasirnagar	Brahmanbaria	July 1995
Kali Nodi	Kuliarchar	Kishoreganj	July 1992
Kali Nodi	Bhairab	Kishoreganj	July 1992
Moisherkandi–Bompur River	Mithamon	Kishoreganj	July 1995

sites are flowing rivers, since Proshika was already working with fishing communities along flowing rivers and believes these are the common resources where poor fishers are most disadvantaged within its working areas. Leasing of these rivers ended in 1995 so they have not been transferred from the Ministry of Land (MOL) to DOF, and there is no immediate prospect of this taking place. Their uncertain status and access rights mean that fisher groups have no formal rights (short or long term) as a basis for management activities in rivers.

Progress in rivers under CBFM

To date Proshika has focused on enabling fishers to earn higher incomes from alternative or additional activities or by offering credit at lower cost than traditional sources, on reducing illiteracy, and on training and awareness raising to encourage voluntary compliance with laws to conserve fish stocks.

Under the CBFM Project, up until the end of 1996 Proshika had formed 173 new groups (Table 2) involving fishers. In addition, at some sites there were already groups of fishers formed during the IMOF project, or as part of normal rural development activities. The last two columns of Table 2 are based on definitions of the community and groups covered under the project at the time of the baseline survey. Most of the households totaled in the table fish for a living (full or part time) in the project waterbodies (the remainder process fish) and were living in villages adjacent to these waterbodies as of August–November 1996. It should be noted that some groups formed after the survey are not included. It is difficult to define the community fishing in part of a river when it is a free access resource and most rural households fish at some time in the year. Hence many people who are subsistence fishers (occasionally fishing for food only) and who are members of Proshika groups are not included in Table 2. Moreover fishers who are members of

Table 2. Group formation during July 1995–December 1996.

Jalmohal	New groups involving fishers	Fish for income[1] (number)	Non-fishers or less dependent (number)	Total new participants (number)	Total groups mainly fishers[2]	No. of fishing households in these groups[3]
Tetulia Nodi	8	60	95	155	17	311
Boyrala Nodi	4	28	72	100	3	37
Bancha Mora and Jari Jamuna Nodi	30	67	453	520	3	45
Titas Nodi (Block-Ka)	9	115	40	155	13	274
Titas Nodi (G–G)	24	205	60	265	12	161
Dhaleswari Nodi	86	650	1 299	1 949	23	362
Kali Nodi (Kuliarchar)	11	185	30	215	14	250
Kali Nodi (Bhairab)	0	0	0	0	9	187
Moisherkandi–Bompur River	1	7	18	25	35	442
Total	173	1 317	2 067	3 384	129	2 069

[1] Defined by Proshika as participants who fish for their main income source for 8 or more months a year
[2] New and old groups combined; mainly comprised of people who fish for a living in the project waterbody
[3] Number of households covered by groups in previous column (see note 2)

Table 3. Training and awareness raising July 1995–December 1996.

Jalmohal	Number of professional fishers trained		Fisher rallies	Community meetings
	Human development	Skill development	(no.)	(no.)
Tetulia Nodi	90	92	3	70
Boyrala Nodi	60	56	1	21
Bancha Mora and Jari Jamuna Nodi	50	18	11	358
Titas Nodi (Block-Ka)	268	138	8	39
Titas Nodi (G–G)	57	88	4	11
Dhaleswari Nodi	314	215	6	31
Kali Nodi (Kuliarchar)	157	169	1	10
Kali Nodi (Bhairab)	321	285	8	48
Moisherkandi–Bornpur River	142	138	3	72
Total	1 459	1 199	45	660

mixed occupation groups formed by Proshika were difficult to identify and some were not included.

Table 3 summarizes progress in training these communities and raising their awareness of fisheries issues during the first 18 months of the CBFM Project.

In general, once group members have been active in meetings and saving for nine months, they receive training and credit from Proshika to implement EIG projects for their economic betterment. As a special case for some newly formed groups under the CBFM Project, Proshika shortened the minimum requirement for group membership from 9 to 6 months to meet professional fishers' needs for credit support identified during surveys. This is part of the general Proshika development program in which non-fishers get support for other alternative EIG projects. Professional fishers also get support to take up alternative EIG projects during the lean period when fish stocks are low in the rivers and when fish should be conserved so that they can breed and grow. A range of fisheries-related credit is provided by Proshika (Table 4). Proshika makes group loans; to cover all the members of a group, two to three loans are extended to one group at a time. Proshika's approach to credit is termed "credit plus plus", i.e., credit plus training, extension and marketing support, plus social development. The system of tying loan repayment with income flows from investment encourages the hard core poor to join the program.

Support for a wide range of alternative livelihoods is available to professional and part-time fishers in the CBFM areas through the general program of Proshika. EIG projects include livestock raising, rice husking, various small businesses and handicrafts, farming and homestead gardening (including organic methods, sericulture and apiculture), purchase of farm equipment, and redemption of mortgaged land. EIG projects taken up in the eight CBFM project sites where Proshika is working are summarized in Table 5. Of the total credit of Tk 38 million disbursed in these areas, just under Tk 14 million can be regarded as having been related to the CBFM Project. Of this, 56% has been in loan categories related to riverine fisheries activities (78% of this went to traditional fishers), and the remaining 44% was credit to these traditional fishers for diversifying their incomes.

Example of development among women fish processors in Kuliarchar

Chandni women's group (Mohila Samity) has 20 members and was formed in August 1994 in Daspara village (a traditional Hindu fishing community) next to Kali Nodi in Kuliarchar Thana.

Table 4. Types of fisheries-related credit provided by Proshika.

Fisheries-related loan categories linked with flowing waters	Fisheries-related loan categories not linked with flowing waters
Boat and net (with engine)	Pond fish culture
Fishing	Fish nursery
Fish processing (drying and salting)	Mini hatchery
Cage culture (experimental)	Integrated fish farming
Net making and repairing	Joint cultivation of rice and fish
Leasing haors and beels	Prawn/shrimp culture

Table 5. Summary of EIG projects in Proshika CBFM sites, July 1995–December 1996.

Item	Flowing water-related EIG project	Not flowing water-related EIG project (alternative)
No. of projects	120	544
No. of fishers	1 640	1 932
No. of non-fishers	443	7 915
Total beneficiaries	2 083	9 887
Total credit disbursed (Tk)	7 866 200	30 400 827
Credit to fishers	78%	20%
CBFM project-related credit	100%	20%
Average credit (Tk/person)	1 946	3 075

At that time, eight women could write their names and read a little, but 12 women could not write their names and could not count up to 100. They used to borrow money from the local *mohajans* (moneylenders) at an interest rate of over 4% per month to fund fish processing. They had no knowledge or concept of health education, and five of the women's families used traditional latrines. The role of these women was insignificant within their male-dominated families and they never left their home.

Having received training, education and credit for their fish processing business, all the women can now write their names and maintain accounts. All their family members use sanitary latrines and drink tubewell water. They are all more aware of health issues and can make oral rehydration saline. Children of the women study in the non-formal primary schools of Proshika. The women have a more active role in village society than before, exemplified by their organizing village dramas. They contribute more to household incomes through fish processing. Proshika provided them with Tk 75 000 credit for fish processing (drying) in November 1995, but due to *hartal* (political disturbance) they made a profit of Tk 8 775. They obtained further loans for the same purpose of Tk 180 000 in December 1996 and Tk 279 000 in November 1997. With the credit they bought fish processing materials and fresh fish, mostly small fishes which are locally available in abundance and at a low price from Kali Nodi in the peak fishing season, and processed, dried and packed the fish in earthen containers and sacks. In 1997-1998 they reported making a better profit from fish processing but could not give detailed accounts.

Problems and recommendations

Table 6 summarizes the key issues and problems involved in introducing community participation in river management in Bangladesh. Although the eight rivers concerned were included in a DOF project (in partnership with Proshika), MOL has not handed them over for community management and they are now free access fisheries. This makes it impossible to develop proper local management policies and plans. The exemption of revenue requirements from flowing rivers was supposed to help poor fishers; instead it gives an opportunity for the powerful to exclude poor fishers by attempting to have rivers declared closed waterbodies and gaining a lease, or by building brush piles, or simply by force. For example, local associations of Freedom Fighters (organizations for the welfare of veterans of the Bangladesh war of liberation which have strong political connections) are taking this opportunity to exploit the

Table 6. Issues and problems for CBFM in rivers.

Fishing rights and fishing pressure
- Government declared free access in 1995.
- Fishers report more people fishing in project areas.
- Powerful groups trying to take control of fisheries.
- More than 80% of fishers concerned at declining catches in project sites.
- No incentive for sustainable management.

Katas (brush piles)
- *Katas* officially illegal, yet a common way for richer people to get a large share of total catch.
- With free access more katas being built in project rivers.
- Katas harvested completely, so no safe refuge areas for fish in dry season.
- Credit for fishers to invest in katas can redistribute benefits.
- Some sanctuaries needed or kata fishing unsustainable.
- Cage culture of fish could compensate fishers for restrictions.

Handover of rivers and CBFM
- Ministry of Land did not hand over waterbodies to DOF for project.
- No incentive or administrative basis for organizing fishers to manage rivers.
- Only group formation, EIG and awareness raising possible so far.
- Indecision gives opportunity for rich to exclude poor fishers.

resource, and the genuine fishers are excluded from areas that they have taken over (this occured in Boyrala River in 1996).

Further, the fishers report that there are more people fishing and more fishing units operating since the government ended leasing and licensing systems in flowing rivers in 1995. In Dhaleswari River, for example, it is reported that landless non-fishers have been provided with gear by wealthy people, who then take much of the resulting benefits. This is providing competition for traditional fishers, who are concerned at what they perceive as declining fish stocks in all the waterbodies. There are increasing numbers of brush piles (*katas*) in many of the eight rivers, even though they are banned. These fish shelters are now harvested totally up to three times in a year, so it is thought that few broodstock are left in the deeper areas of the rivers for the next generation of fish. Katas are invested in by local landowners and wealthy people, who thus stake a claim on fish resources; they then hire professional fishers on a share arrangement to harvest the fish. Thus, even in a supposed free access regime, professional fishers are still not free of exploitation since they are not free to fish in some places and the rich are able to stake claims to parts of the resource, attract fish into the katas, and so earn a resource rent at the expense of fishers, who get only a share. Moreover it is reported (MacGrory and Williams 1996) that the local DOF staff also benefit from this arrangement, so officials have no interest in limiting the number of katas.

Who has authority to limit or regulate fishing? There has never been a strict catch-based management system for riverine fisheries in Bangladesh. Under leasing systems in the flowing rivers, the lessees, sub-lessees and their agents collected tolls or license fees from fishing units, either directly or deducted from tied sales combined with the share taken for use of the lessees' gear and boats. Fishers were then free to fish as much as they wanted in the open part of the river within a specified period (usually a year or 6 months). Only in a few cases were openwaters managed locally, following commonly accepted rules agreed to by the community rather than set by a lessee. Because of local power struggles and lack of support from MOL, resulting in uncertainty over secure access to these rivers even for a government project, local Proshika and DOF staff lack the incentive, security and authority to encourage fishing communities to adopt better management policies. In any case the fishers would face difficulty enforcing any management plans and fishing restrictions on which they could agree, as they have no clear rights to do that in these fisheries.

Cage culture is one possible way of enhancing fish production in rivers. However, the feasibility of cage and pen culture in rivers is still uncertain in Bangladesh (Ireland, this vol.). Cages operated by fishing teams could help compensate them for loss of income if the number of katas is reduced, but introduction of exotic species should be avoided.

Providing alternative sources of low interest credit is expected to reduce the share of fishery income going to local moneylenders, traders and influential people. Evaluations of similar Proshika programs have indicated that such benefits have been achieved (Proshika 1995). So far, however, credit has not been directly linked with measures for fish conservation. When local conservation/management rules are developed—which requires that communities have rights to take management decisions over access to these rivers—it is recommended that EIG activities be linked with compliance with fish conservation rules.

If there was administrative support, sanctuaries could be introduced by the communities for natural recruitment of indigenous fish. The system of building many katas and completely harvesting them threatens the natural breeding stock. Rather than an unenforced ban, local (thana or union council-level) agreements to control kata numbers are needed; some should be converted into fish sanctuaries by the fishing communities.

In summary the following management measures for river fisheries are recommended. Several already have the support of the fishing communities covered by the project (Hossain et al., this vol.), but the communities, as well as DOF and Proshika, lack the right and authority to formally introduce them.

- Limits on the number of katas, to be agreed between all stakeholders, and an end to the ban on katas in community-managed rivers (katas could be taxed by the management committee

to fund the demarcation of sanctuaries or patrols to enforce conservation measures).

- Declaration of marked sanctuary areas; locations to be decided and guarding done by the fishing community.
- Enhanced compliance with fish conservation legislation, through community agreement and encouraged by training and by credit to generate supplementary incomes for fishers who comply with the law.
- Credit support for new gear to apply only to gear that conforms to legislation on mesh sizes.
- Continued and expanded provision of credit and training for additional incomes for fishers, especially in the lean season.
- Experiments with technologies to enhance production, such as cages, but with careful monitoring and evaluation of financial, economic and social performance.

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Experience of Community Managed Wetland Habitat Restoration

MOKHLESUR RAHMAN
Center for Natural Resource Studies, 4/6 Lalmatia, Block B, Ground Floor, Dhaka 1207, Bangladesh

DORIS A. CAPISTRANO
Ford Foundation, 55 Lodi Estate, New Delhi 110003, India

STEPHEN F. MINKIN, ANISUL ISLAM and SACHINDRA HALDER
Center for Natural Resource Studies, 4/6 Lalmatia, Block B, Ground Floor, Dhaka 1207, Bangladesh

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Abstract

A participatory action research approach to community based wetland habitat restoration and fisheries management is being tested in a wetland in the Dhaleswari River floodplain in Tangail District. The local community participated in planning rehabilitation of a silted-up canal to re-establish fish migration, fish conservation, and establishment of small fish sanctuaries. These are all low-cost activities managed with full community participation.

Comparison of data from the year before and year after canal excavation shows an increase in the catch from 2 481 kg to 12 222 kg in *beel* and floodplain and from 1 451 kg to 5 182 kg in *pagars* (ditches and ponds used to trap fish as water levels recede after the monsoon). There was a dramatic increase in the catch of major carps (from 29 kg to 1 221 kg) in pagars, along with an increase from 46 to 59 in the number of species recorded; this indicates that the canal rehabilitation facilitated migration of carps and other species into the floodplain. Community based wetland habitat restoration is an ecologically sound and cost-effective way of improving floodplain resource management. Benefits include conservation of fish biodiversity and sustainable (even enhanced) production of fish in Bangladesh floodplains.

Introduction

Covering over a third of the country's total area, Bangladesh's freshwater marshes, lakes, rivers, estuaries and floodplains make up a complex ecosystem that supports a diversity of aquatic species and 120 million of the world's poorest people. An estimated 300 species of fish, more than 20 species of prawn, and many other species (plant and animal) are found in these wetlands. Two million people rely on fishing for employment, and another 10 million are engaged in fish-related trading and processing (BBS 1995; Islam, this vol.).

Even more important is the wetlands' largely undervalued direct contribution to household nutrition and well-being. About 75% of all rural households engage in seasonal subsistence fishing (DOF 1989). The subsistence catch of these households is an ecological subsidy provided by the country's extensive aquatic common property resources. As food, fish is second only to rice in importance and represents 80% of animal protein consumption. In the course of a year, households typically consume more than 50 fish species, taking advantage of patterns of seasonal abundance, this smooths out their nutritional intake (Flood Action Plan 16 1995). More than 70% of the inland fish catch comes from inundated floodlands and perennial waterbodies in floodplains which, from the standpoint of human nutrition alone, are arguably the country's most important aquatic resource base (Minkin and Boyce 1994).

Recurrent monsoon flooding which inundates more than half of Bangladesh is the key to maintenance of the wetlands, their productivity and, ultimately, the sustenance of the human communities they support. Most of the country's inland fish species are migratory (Flood Action Plan 17 1993). With the onset of the rains, many species start their spawning migration from the rivers to the floodplains which serve as nursery and feeding

grounds for their young. The fish move back to the rivers through canals (*khals*) with the receding waters. Some get trapped in low-lying areas and deeper pockets of the floodplain (*chawks*), in the deepest perennially inundated portions (*beels*), and in man-made ditches and ponds (*pagars*) within the floodplain. There they become more vulnerable to fishing pressure than in the open floodplain during the monsoon. Those able to return to the rivers have far greater chances of reaching maturity, returning to the floodplains to spawn, and thus repopulating the fisheries.

Unfortunately, an expanding network of flood control and irrigation structures, roads and highways built over the last two decades is seriously interfering with the delicate cycle of fisheries regeneration. Typically these structures block fish migration pathways and degrade natural spawning and feeding grounds. They exacerbate siltation, facilitate conversion of wetlands to agriculture, and lead to widespread loss of aquatic habitats. As a consequence, some migratory fish species have disappeared from the floodplains and many resident species may be at risk of local extinction. Yet, the Bangladesh Government plans to build more such structures. The implications of continuing large scale wetland habitat destruction would be devastating. Per capita rural daily fish consumption could drop even lower than the current average of 22 g (Ahmed and Hossain 1983), already considered low by international standards, as wetland productivity and fish diversity further deteriorate.

Indeed, in past decades the productivity of Bangladesh's floodplain fisheries has dropped significantly. Apart from disruption of the natural cycle of fish migration, reproduction and growth, agricultural expansion and agro-industrial pollution have contributed to this decline, estimated in Department of Fisheries annual reports of 1983–1992 to be 3–10% per year. To counter this trend, the Bangladesh Government has adopted a two-pronged strategy of aquaculture promotion in private ponds and, for the floodplains, restocking with fast-growing, usually exotic, fish species. Funded by the World Bank and the Asian Development Bank, floodplain stocking programs have been credited by the government with helping increase production and fishing income (Ali and Fisher 1995).

However, serious concerns have been raised about the ecological and social equity implications, as well as the cost-effectiveness and sustainability, of stocking programs (Kremer 1994; Minkin and Boyce 1994; Naqui et al. 1994). The seasonal moratorium on fishing imposed by the government to allow stocked fish to grow to harvestable size effectively denies the poor access to the fisheries during the monsoon season. By the time they are ready for harvest, many fish have aggregated in private ponds or deeper waterbodies controlled by rich and influential people, beyond the reach of the poor and the landless. Widespread introduction of commercially valuable exotic fish species and attempts to give them a survival edge over indigenous small fish species, so important to the diet of rural households, has troubling implications for both fish diversity and human nutrition.

This paper presents results of an action–research project on fisheries habitat rehabilitation in a wetland in central Bangladesh, which demonstrates an alternative approach to arresting the declining productivity of the country's floodplain fisheries.

The project

The Community-based Fisheries Management and Habitat Restoration Project is a collaborative project of the Center for Natural Resource Studies (CNRS), Proshika Manobik Unnayan Kendra (Proshika) and the Ford Foundation. CNRS is a relatively young Bangladeshi resource management research organization, Proshika is one of the country's largest private voluntary development organizations, and the Ford Foundation is an international funding and development agency.

The project, which started in mid-1994, aims to promote sustainable use of floodplain fisheries through community based management arrangements that encourage resource conservation and at the same time promote equity in resource access. Since the maintenance of floodplain fisheries greatly depends on the cycle of flooding and fish migration between floodplains and river systems, the project encourages use of management interventions that are consistent with this natural

ecological process. The project has tested strategies for floodplain fisheries productivity and species diversity enhancement, which minimize the potential for adverse social and biological impacts. By working collaboratively with fisher and resource-user communities—from project design and site selection to implementation and monitoring—the project hopes to further develop local capacity for community based fisheries management.

Project site

Singharagi Beel was selected from among several possible sites identified through maps, satellite imagery and field verification visits. The main criteria for selection were the presence of wetlands of manageable size with fish migratory pathways obstructed by siltation and other infrastructure; minimal adverse impacts of project intervention on the locality; and local community interest in undertaking the project.

Singharagi Beel, a crescent-shaped wetland of about 10 ha which is about 8-m deep in the monsoon and 4-m deep in the dry season, was selected as a pilot site. Settlements within the site are arranged in cluster and linear formations on the northern, western and southern borders. Located in the Elasin Union (village cluster) of Delduar Thana (sub-district) in central Bangladesh, the Singharagi wetland used to be linked to the Dhaleswari River to the west through canals (khals), the most important of which is the 1.5 km long Hajibari Khal (Fig. 1).

With the onset of monsoon rains in May,

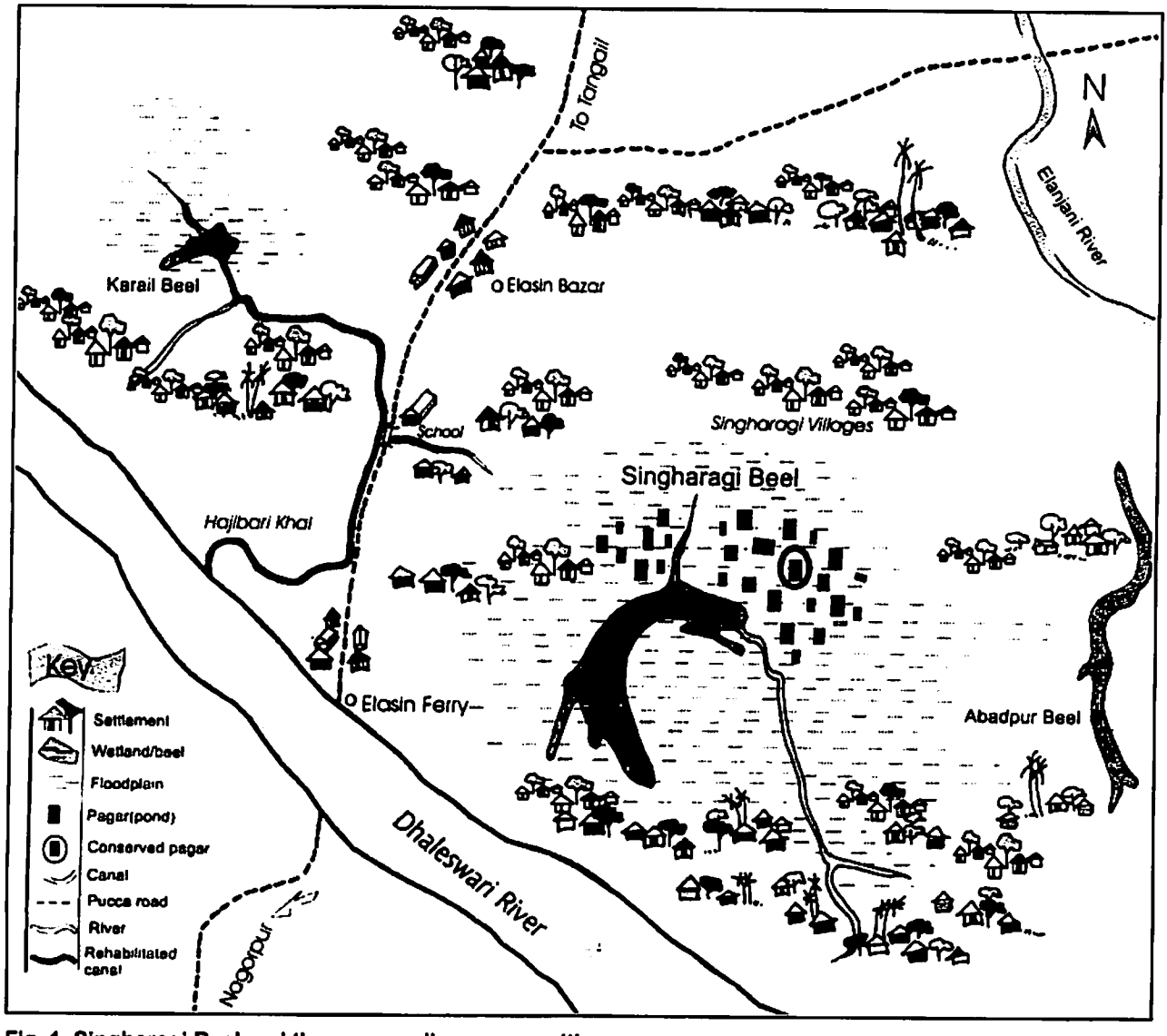

Fig. 1. Singharagi Beel and the surrounding communities.

Singharagi Beel inundates adjacent paddy lands and starts to expand. Surface flow over the low-lying land (chawk) to the east connects it to Abadpur Beel, another wetland about 3 km to the south. In late June, floodwater from the Dhaleswari River enters the chawk and, about a week later, flows to the beel through a small canal. The meeting of the expanding beel and the river flood creates a vast continuous wetland. Most of the canals linking the wetland to the river system are now no longer functioning due to siltation, subsequent human encroachment, and conversion to farmland. In Hajibari Khal, heavy silt deposition has obstructed and delayed the flow of water from Dhaleswari River to the wetland in the early monsoon, and also causes waterlogging in the chawk at the end of the monsoon.

There are 990 resident households in the project area. Average household size is 5.6 members. As in the rest of rural Bangladesh, agriculture is the main occupation, although households typically have multiple income sources including fishing, petty trading, wage labor and services. Land ownership distribution is similar to that of Bangladesh as a whole. Households are classified into landless (0–0.2 ha, average 0.12 ha), small (0.2–0.6 ha, average 0.5 ha), medium (0.6–2.0 ha, average 1.3 ha) and large (>2.0 ha, average 3.7 ha) according to their homestead and cultivable landholding. The majority (57%) of households in the project site are landless and a quarter (25%) are small farmers; medium and large farmers make up only 16% and 2%, respectively. Since croplands turn into fishing grounds during the monsoon season, household access to fishing areas is closely linked to land ownership.

Project intervention and implementation mechanism

Adopting the role of outside facilitator, project staff made every effort to ensure active broad-based local participation at each step of project planning and implementation. When differences of opinion arose among stakeholders, project staff helped clarify positions, mediate conflicts and find common ground, thus helping consensus or compromise solutions to emerge. While most concern centered on the project's likely impacts on the poorest households, the reality of local power politics and the need to be inclusive rather than exclusive were recognized.

To facilitate community participation and ensure smooth project planning and implementation, CNRS and Proshika facilitated the formation of a project implementation committee (PIC) consisting of 30 members representing farmers, fishers, local leaders and professionals selected by inhabitants of the four villages in and around the floodplain. The PIC also includes Proshika and CNRS field staff. Currently, the PIC is headed by a chairperson popularly elected during an inter-village meeting. The mechanism for future PIC chairperson selection will be developed and formalized as the project evolves. The chairman of Elasin Union Council, the local government leader at the project site, serves as adviser to the PIC (Fig. 2).

The first main task of the PIC was to plan and implement re-excavation of Hajibari Khal. PIC members were involved in canal rehabilitation and other project-related tasks strictly on a voluntary basis. On the suggestion of the Union Council chairman, two local supervisors were temporarily engaged to supervise the work on behalf of the PIC. The Hajibari Khal re-excavation brought immediate benefits to the communities through the employment it created. A total of 62 people (44 men and 18 women), drawn from among the poor, were hired as laborers to remove 4730 m^3 of silt from 794 m of canal (width 3–8 m). The work was undertaken in 1995 during the dry season months of February to April, and created 1500 person-days of emplyment. These people were paid for their work mainly with project funds managed by Proshika. The objective of allowing water from Dhaleswari River to flow more freely into the Singharagi wetland when the monsoon rains started in June was achieved: before the re-excavation, water entered in July, at least two weeks later than it was reported to have entered in earlier times, but in 1995, water again entered in June.

The first major test of the PIC's ability to manage was the issue of compensation for losses arising from project intervention. Parts of the canal had been encroached upon and some local farmers had been raising crops there. The encroachers demanded compensation for their standing

crops affected by re-excavation. The PIC agreed to compensate one farmer who had the largest standing crop and had suffered the greatest crop loss. Others who suffered only minimal losses did not receive any compensation. This decision by the PIC, perceived by local villagers to be both fair and practical, served to defuse tensions during the crucial early stages of the project. This highlights the importance of flexibility and pragmatism in mediating conflicts among stakeholders that will surely arise in projects of this kind.

Monitoring of social and biological parameters

To assess the impacts of intervention, a system of monitoring social and biological parameters was designed to allow for a comparison of pre- and post-intervention values. Data collection on biological parameters started in mid-December 1994 and on socioeconomic parameters in February 1995. To ensure that comparable data are used, the biological monitoring results reported in this paper cover the 6.5 months from 16 December to 30 June for 1994-1995 and 1995-1996, representing the pre- and post-intervention periods, respectively. The social monitoring results cover the 5-month period from February to June 1995 and 1996. The intervention was undertaken from February to April 1995. Because 1994 was a drought year, the baseline data may reflect a lower than usual level of wetland productivity and fishing activity, and perhaps tend to overestimate changes attributable to the intervention.

Social monitoring

Fifty-six households were randomly selected for monitoring. The sample households were classified based on their landholding into: (1) landless, (2) small farmers, and (3) medium and large farmers. Information on fish consumption, diversity of species consumed, fishing rights and access to fishing grounds, and household member participation in fishing was regularly collected from these households. Five village women with basic literacy and numeracy skills were selected as the project's resident monitors (RMs) and trained in the use of structured monitoring forms and simple weighing instruments. The RMs visited the sample households for 5 consecutive days each month and collected data through interview and direct observation and measurement.

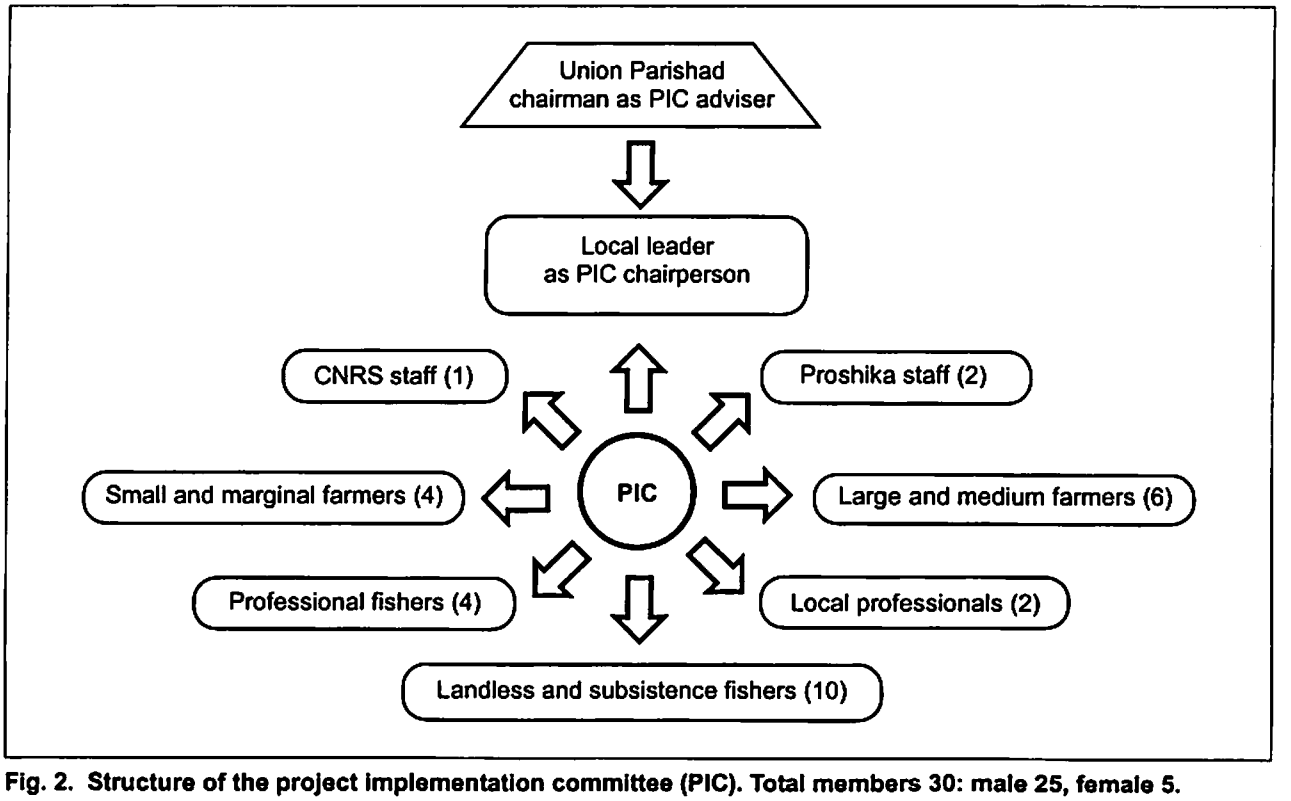

Fig. 2. Structure of the project implementation committee (PIC). Total members 30: male 25, female 5.

Biological monitoring

Three distinct fish habitats were defined: (1) beel, (2) chawk, and (3) pagar. Beels are deeper, perennially inundated areas; while chawks are shallower, seasonally inundated lands which are usually cultivated during the dry season. Pagars are ponds and ditches within the chawks dug by landowners in order to trap fish. The timing of peak fishing activity varies across the three habitats. In the chawks, fishing is most intense during the monsoon season, lasting up to the late monsoon when floodwaters begin to recede. In the beels, peak fishing takes place after the monsoon, when chawks start to dry up and fish move to deeper waters of the beels. In the pagars, peak fishing occurs during the dry season, when it is easier to drain the pond and harvest all the fish that have aggregated there.

A fisheries biologist and a local assistant regularly collected data on catch, fish migration and species diversity, fishing intensity, methods employed by different categories of fishers, and institutionalized sharing arrangements in each of the three habitat types. Baseline information was collected from 27 pagars before intervention; 19 of the pagars were monitored following intervention. The results reported in this paper pertain only to these 19 pagars for which comparable pre- and post-intervention data are available. Total fish harvest from the monitoring sites is calculated as the sum of the catches from each fishing habitat. To facilitate analysis, fish species were grouped into 10 broad categories based on their biological characteristics, size and commercial importance.

Findings

Fishing activity

The fishers

Based on survey results, fishers in Singharagi wetland can be categorized into three types: full-time professional, part-time professional, and subsistence fishers. Professional fishers sell most of their catch, while subsistence fishers, who live close to the wetlands and fish with small gear, mostly consume their catch. Full-time professional fishers depend solely on fishing for their income throughout the year, while part-time professional fishers derive only part of their income from fishing. Part-time fishers are also wage laborers and farmers. They turn to fishing during the monsoon season, a time when alternative employment is scarce and returns from fishing are relatively attractive, particularly when regulations on fishing activity are minimal.

Almost 40% of fishers in Singharagi wetland are subsistence fishers. About 36% are part-time professional fishers and 24% full-time professional fishers. Fishing is an activity in which female involvement is low (7.4% of fishers) and mainly limited to girls below 15 years of age fishing for home consumption. Overall, 28% of all fishers are children below 15 years, half of whom fish mainly for subsistence. In contrast, the adults mostly (66–76%) engage in full-time or part-time fishing for sale.

Fishing participation

Before the intervention, fishers spent a total of 690 person-days fishing, the greatest fishing effort being expended by fishers from landless households. Fishing intensity increased following the intervention, presumably in response to greater fish availability in the wetlands (Table 1). Total fishing effort more than doubled to 1302 person-days in the same period (February–June). The greatest increase in fishing effort was observed among small farmer households, which spent almost four times as many days fishing after the intervention.

Fishing grounds

The beels, chawks and pagars represent three distinct fishing grounds where different institutional arrangements apply. While the beels and chawks are essentially open-access fishing areas for inhabitants of the surrounding villages for at least part of the year, the pagars can be fished

Table 1. Fishing days by household type.

Household type	Fishing person-days	
	Pre-intervention (Feb–Jun 1995)	Post-intervention (Feb–Jun 1996)
Landless	434	624
Small farmer	118	450
Medium and large farmer	138	228
Total	690	1302

Table 2. Yield and species composition of beel and floodplain catch.

Species group	Pre-intervention (Dec 1994–June 1995)			Post-intervention (Dec 1995–June 1996)		
	Weight (kg)	%	No. of species	Weight (kg)	%	No. of species
Small fish	830	33.5	25	4 548	37.2	33
Prawns	709	28.5	1	4 052	33.1	2
Snakeheads	305	12.3	3	1 626	13.3	2
Eels	417	16.8	4	657	5.4	4
Small catfish	143	5.8	7	434	3.6	7
Major carps	4	0.2	1	375	3.1	3
Large catfish	1	0.0	2	345	2.8	3
Exotic species	42	1.7	2	135	1.1	2
Knife fish	29	1.2	1	34	0.3	1
Minor carps	–	–	–	16	0.1	2

only by the owners, lessees or their designated users. Customarily, poor households have been allowed to catch residual fish after the pagars have been fished by their owners and lessees. They have also been allowed to fish in fallow, low productivity pagars (for example pagars not receiving sufficient floodwater during the monsoon) whose owners do not bother to fish. Through these practices, landless households (often also the poorest households), have had some access to privately held fishing grounds.

Data from household monitoring show that most of the household catch during the observation period came from beels rather than from chawks and pagars. Landless and poor families fished mostly in the beels, while large farmers got their fish mostly from pagars which they either own, lease or share. Following the intervention, which has helped raise the productivity of the pagars, there are indications that landless households may lose their limited access to these private fisheries as the resources become more productive. Post-intervention data show a decreased proportion of landless households' catch coming from pagars, with beels as the source of a major part of their catch.

Yield, diversity and distribution of catch

Yield and species diversity of chawk and beel catch

Comparison of pre- and post-intervention data shows a five-fold increase in the catch from the chawks and the beels (Table 2). This dramatic increase in catch (from 2481 kg to 12222 kg) indicates an underlying increase in wetland productivity following the intervention. Fish species diversity in the catch increased by 25%. The species group composition of total catch remained more or less unchanged: small fish, small prawns, snakeheads and eels made up the bulk of the catch in both periods. However the relative abundance of major carps, large catfish and minor carps following canal rehabilitation indicates successful recruitment of these riverine species into the floodplain.

Evidently, the rehabilitated canal provided these migrating species with a favorable habitat during the early monsoon. The re-opened canal not only facilitated fish migration but also allowed more river water into the floodplain than would otherwise have been available. Thus, habitat for fish in the Singharagi wetland was expanded both spatially and temporally. This also provided fish with a longer period for nursing, feeding and growth in the fertile floodplain.

Distribution of chawk and beel catch

Before the intervention, total catch from the chawks and the beels was divided almost equally between part-time (41%) and subsistence (42%) fishers, only 17% going to full-time fishers. The full-time fishers expended a low fishing effort in the wetland during the base period when it received little flooding; they are likely to have fished instead in rivers and other waterbodies. Subsistence and part-time fishers evidently continued to fish in nearby waters of the wetland. After the intervention, catch increased substantially in absolute terms for all types of fishers (Table 3). It rose by 538% for part-time fishers, 781% for full-time fishers and 87% for subsistence fishers. In relative terms, professional fishers (both full- and part-time) got the larger share of the increased

Table 3. Fish catch (kg) from chawks and beels by type of fisher.

Period	Fish catch by type of fisher			Total
	Full-time	Part-time	Subsistence	
Pre-intervention	435 (17.5%)	1 010 (40.7%)	1 035 (41.8%)	2 480 (100%)
Post-intervention	3 835 (31.4%)	6 447 (52.7%)	1 940 (15.8%)	12 222 (100%)

catch—31% and 53%, respectively. This is partly because more professional fishers were fishing in the wetland and for longer than before, as they were attracted by the increased catches.

Yield and species diversity of pagar catch

Total yield from the 19 pagars monitored increased by 287% from (1451 to 5183 kg) after the intervention, and average yield per pagar similarly increased from 76 kg to 273 kg (Table 4). Major changes were observed in both species composition and the relative contribution of species to total yield. Prior to the intervention, commercially valuable major carp species represented less than 2% of the catch and ranked only seventh in terms of contribution to yield; after the intervention, they made up almost 24% of the catch and ranked first in contribution to yield. Similarly, large catfishes which were previously absent from the pagars made up about 8% of the catch following intervention. Exotic species (which include common carp, grass carp and tilapia) also increased their contribution to catch, in both absolute and relative terms. Among the exotic species, common carp was most abundant, representing 68% of the exotic catch. This species seems to have adjusted well to conditions in Bangladesh's openwaters and appears to have naturalized in beels.

Before the intervention, no minor carp or large catfish were found in the pagars. Following intervention, the catch included eight additional species: one minor carp, two major carps, one small catfish, and four large catfish. However, while the species composition changed, the total number of species represented in the pagar catch remained at 58.

Fish consumption

Per capita consumption

The data show an increase in daily per capita fish consumption for all types of household, although the increase was only marginal for landless households. Average daily consumption increased from 24 g to 30 g (Table 5). These figures compare favorably with the national average, which was estimated in 1991 at 22 g per capita per day (Bangladesh Bureau of Statistics 1992).

The increase in fish consumption was smaller than the increase in fish catch. The modest rise in consumption by landless households may be due to the fact that they fish relatively less intensively during the dry months under observation. Landless households tend to fish most intensively during the monsoon season, when access to the floodplain becomes more open.

Table 4. Species composition of catch of 19 pagars.

Species group	Pre-intervention			Post-intervention		
	Rank	Weight (kg)	%	Rank	Weight (kg)	%
Snakeheads	1	597	41	4	569	11
Small catfish	2	393	27	5	509	10
Small fish	3	177	12	2	1 120	22
Knife fish	4	113	8	9	77	1
Eels	5	86	6	7	256	5
Exotic species	6	31	2	3	744	14
Major carps	7	29	2	1	1 222	24
Prawns	8	25	2	8	254	5
Large catfish	9	–	–	6	431	8
Minor carps	10	–	–	10	0.3	0
Total		1 451	100		5 183	100

Table 5. Fish consumption by household type.

Household type	Per capita fish consumption (g/head/day)	
	Pre-intervention	Post-intervention
Landless	18	22
Small farmers	26	42
Medium and large farmers	40	43
All types	24	30

Species consumed

During the monitoring period the sample households consumed more than 60 species of fish. Small fish species are eaten more than any other species group. They represent about 22% and 35% by weight, respectively, of all species consumed before and after the intervention (Table 6). The composition of consumed species reflected the observed change in catch composition. Major carps and prawns were the second and third most consumed species following the intervention, each accounting for about 12% of all species consumed. These two species groups ranked only fourth and sixth in terms of share of consumption prior to the intervention, when snakeheads and exotic species (mainly purchased, but some caught in the beels and floodplain, having possibly escaped from ponds) were more often eaten by sample households.

Sources of fish consumed

Before the intervention, on average about 73% of fish consumed by households (by weight) were purchased; own catch represented only 27% of consumption (Table 7). Small farmer and landless households especially relied on the market for around three-quarters of the fish they consumed during the months under observation. Increased fish production and catch following the intervention made it possible for both small farmer and landless households to reduce the proportion of purchased fish to less than 55% of their fish consumption. More than 51% of landless households' post-intervention fish consumption came from their own catch, as opposed to about 25% prior to the intervention. Overall, more of the benefit went to landless and small farm households as there are more of these households in the area.

Conclusion

Based on 2 years of action–research in the Singharagi wetland in central Bangladesh, data indicate a tremendous potential for community based and community managed wetland habitat rehabilitation.

Broad-based consultation and consensus building during the early stages encouraged greater participation and continuing community interest in this project. By recognizing the structure of local power politics and attempting to be inclusive rather than exclusive, the project helped the community identify and implement a possible "win-win" strategy for managing the Singharagi wetland on which they all depend to varying degrees. Pragmatic solutions to conflicts as they arose, and tangible employment benefits during the crucial stages of implementation, added fuel to this interest.

The participation of community members as resi-

Table 6. Relative ranking of fish species consumed.

Species group	Pre-intervention		Post-intervention	
	Percentage of consumed species	Rank	Percentage of consumed species	Rank
Small fish	22.6	1	34.9	1
Snakeheads	17.0	2	6.9	8
Hilsha	15.5	3	8.8	4
Exotic species	13.9	4	6.8	9
Major carp	9.5	5	11.9	2
Prawns	9.2	6	11.8	3
Small catfish	7.0	7	8.6	6
Dry fish	1.7	8	7.4	7
Eels	1.5	9	2.4	11
Large catfish	0.9	10	6.1	10
Knife fish	0.5	11	0.0	0
Minor carp/other	0.5	12	1.8	12

Table 7. Sources of fish consumed by household type.

Household type	Pre-intervention		Post-intervention	
	Caught (%)	Bought (%)	Caught (%)	Bought (%)
Landless	25.2	74.8	51.6	48.4
Small farmers	22.3	77.7	46.0	54.0
Medium and large farmers	34.2	65.8	37.5	62.5
All types	27.0	73.0	46.1	53.9

dent monitors and research assistants in monitoring the social and biological impacts of the project intervention has proven to be a low-cost means of reliable data collection and a channel for sharing information with the community. The deliberate selection of women as resident monitors has helped highlight the value of literacy and elevate their status in the community where, as in the rest of the country, women are largely invisible.

Data from the first year after the intervention indicate increased productivity and fish species diversity in the wetland following re-establishment of the main fish migration route between the wetland and the proximate river system. Canal rehabilitation facilitated migration of fry and fingerlings of carps and other species from the river into the floodplain in the early monsoon. The increase in production is ascribed to growth of juvenile fish which entered the beels through the canal. The re-excavated canal also helped increase the flooded area, and conservation measures agreed upon with the fishers also helped the survival of fry to larger sizes. The increased productivity was matched by increased intensity of fishing by all types of fishers. However, the increase in productivity apparently exceeded the increase in fishing effort. Per capita fish consumption increased in all types of household, as did the diversity of fish species consumed. So far, the intervention, which served to expand fish habitats both temporally and spatially, seems to have been overwhelmingly beneficial from the biological point of view. Moreover, the benefits seem to have been broadly distributed among fisher groups and social classes.

Factors leading to success

The following features made the Singharagi wetland especially suitable for the project and contributed to its success:

- There are both perennial and seasonal waterbodies in the area, and fishing is a major economic activity for many during a significant part of the year. The wetlands are used by local communities as a common property resource to which all have access.
- The Dhaleswari River still carries fry of riverine fishes, including major carp, which were only prevented from entering the wetland by the canal being silted up.
- Proshika had operated in the area for about 5 years and provided a vital entry point for developing local contacts. Self-help development groups organized and assisted by Proshika were already established in the villages around Singharagi. This facilitated consultations with various local stakeholder communities and simplified project planning and implementation.
- There was a consensus, forged in a series of community meetings, that intervention was needed to rehabilitate the wetland. At these meetings, local government officials, village leaders and CNRS and Proshika staff agreed on the need to reopen Hajibari Khal in the belief that this would benefit both agriculture and the fishery. At the meetings (sometimes attended by more than 100 people), project objectives were clarified and alternative courses of action discussed in detail. The consensus developed in these discussions lessened the potential for conflict and increased the chances of project success.
- The local government (Union Parishad or Council) was supportive of the project and the proposed canal re-excavation at the time of site selection. The chairman and council members, as well as the thana nirbani officer (chief government administrative officer at the subdistrict) and the thana fisheries officer, were all consulted from the very early stages of

project planning and played an important advisory role in implementing the agreed intervention. Their cooperation and active support were crucial to the smooth implementation of the project. The Union Council even provided counterpart funding for the canal re-excavation costs.

Future activities

Encouraged by the positive results in 1995-1996, fishers and pagar owners have subsequently agreed with project staff to maintain a fish sanctuary in the middle of the beel to help conserve a broodstock of resident floodplain species during the dry season when fishing pressure is greatest. The project agreed to lease a 0.1-ha pagar which the community will protect and maintain. The hope is that eventually the community can take over the lease of this conservation pagar.

Based on data from catch monitoring, it is estimated that the conservation pagar would yield about 80 kg of parent stock of a variety of fish species. With the onset of early monsoon rains, this stock would disperse to the floodplain and release millions of eggs even before river waters enter the floodplain through the canals. To increase the chance of fish survival to maturity, the fishers, pagar owners and other members of the community decided to stop the use of fine mesh nets and other destructive gear for two months during the monsoon season in 1995. With the help of information generated by the project, it is hoped that the community can continue to develop and gradually institutionalize participatory and negotiated approaches to the management of its floodplain fisheries.

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Group Management of Small Beels for Enhanced Production*

S.D. TRIPATHI
International Center for Living Aquatic Resources Management, House 75, Road 7, Block H, Banani, Dhaka, Bangladesh

M.V. GUPTA
International Center for Living Aquatic Resources Management, 205 Salcedo Street, Makati City, Philippines

D. MAZUMDER
International Center for Living Aquatic Resources Management, House 75, Road 7, Block H, Banani, Dhaka, Bangladesh

M.A. MAZID
Bangladesh Fisheries Research Institute, Mymensingh, Bangladesh

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Abstract

In Bangladesh, group management is an effective tool for enhancement of fish production from the stocking of small beels, as indicated by the results of an experiment in three beels in Bhaluka (Mymensingh) where an average increase in production from 120 kg/ha to 982 kg/ha was registered in the first year. Despite high initial costs of management, each group member earned Tk 1 400–4 200 from fish culture alone without detriment to rice cultivation. Returns were 167–182% on total investment and 233–264% on operating costs.

Introduction

Beels (shallow depressions which permanently or seasonally hold water) in Bangladesh are known to be a capture fisheries resource. Separate statistics on the total area covered by beels are not available as they are grouped with *haors* (large depressions in northeast Bangladesh which are bounded by natural levees, and which fill with water in the monsoon but partly dry up leaving one or more beels in the dry season). The two collectively cover about 114 161 ha or about 2.6% of the total inland water area of the country (BBS 1994). Small beels (<10 ha) comprising privately owned land are easily amenable to management for production enhancement through aquaculture. As the natural fisheries are common property resources where fish are caught by the local community, these beels can be managed either collectively by the landowners or, where the owners are absentee landlords or not interested in aquaculture, leased out to fishers or groups of people from nearby villages. Group management of such beels is a means of raising fish yields and thus improving the socioeconomic condition of the landless, marginal or small farmers and/or fishers. An experiment to enhance production from three beels was undertaken in collaboration with the Bangladesh Fisheries Research Institute, Mymensingh, and Proshika, a national NGO, by organizing the farmers in a group for each beel. The objectives were:

- to develop an environment-friendly, low-cost beel aquaculture system without hampering the existing rice cycle in beels;
- to develop beel aquaculture not only as a subsistence activity for improving the nutritional intake of the lessees but also as a commercial enterprise for increased income; and

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- to develop a sound mechanism for dissemination of beel aquaculture technology through NGOs.

Materials and methods

Three beels located in Bhaluka Thana of Mymensingh District were selected for the experiment. These were all saucer-shaped depressions in highlands without any connection to rivers or streams. These beels are normally fully inundated from rainwater during the monsoon and retain about 1 m of water over 10–15% of their total area in summer. Rice is cultivated during the *boro* season (winter to spring) on the land exposed as the water level falls. Proshika organized groups for the management of the beel fisheries through fish culture (Table 1). Group I (Ashar Alo Male Society), the smallest group with just seven members, owned the beel that it fished; Group II (Nooten Pather Sandhan) and Group III (Jubo Kalyan Society), with 21 and 24 members, respectively, had the beels they fished on lease. Group II leased its beel for the whole year for both rice and fish culture, whereas Group III had only a seasonal lease for fish culture alone.

Management measures by Proshika included training of all group members in fish culture; facilitating input procurement through information and advice on fingerlings, feed and fertilizers; controlling access of non-group members for fishing/poaching; negotiating the lease of beels; and providing credit (Groups II and III only).

Based on the technical information and advice provided, the groups stocked the beels with fingerlings of catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*), Thai sharputi (*Barbodes gonionotus*) and common carp (*Cyprinus carpio*) at 10 000–13 000/ha. They also undertook feeding and other operational measures such as application of lime and fertilizers. When available, only on-farm resources were used as inputs. Cow dung and poultry litter were applied at irregular intervals, the total quantity being 2 t/ha. The fish were occasionally fed on rice bran, the quantity varying from 350 kg/ha to 1400 kg/ha in the three beels.

Results

Fish production from the beels ranged from 794 to 1107 kg/ha, with an average of 982 kg/ha (Table 1). Group I made the highest profit per person as it had the lowest number of farmers per hectare (Table 2). The total cost of fish production per hectare was highest with Group II, owing to initial investments in dike construction and for the lease (Table 2). The returns on total investment and operating costs were 167–182% and 233–264%, respectively.

Discussion

As a result of management through stocking, fish production increased by a factor of 7–12: from

Table 1. Fish production from experimental beels in Bhaluka (Mymensingh) during 1995–1996.

	Group I (Ashar Alo Male Society)	Group II (Nooten Pather Sandhan)	Group III (Jubo Kalyan Society)
Total area of beel (ha)	2.4	2.8	6.0
No. of beneficiaries	7	21	24
No. of members/ha	2.9	7.5	4.0
Water area (ha)	1.7	2.0	3.4
Fish yield before experiment (kg/ha)	90	150	120
Average fingerling size (mm)	100	100	100
Stocking density (fingerlings/ha)	13 000	12 000	10 000
Production (kg):			
Introduced carp	1 680	2 083	2 497
Other fish	95	130	204
Total	1 775	2 213	2 701
Production (kg/ha)	1 044	1 107	794

Average production before experiment 120 kg/ha, in experiment 982 kg/ha.

Table 2. Production costs and profits from experimental beels during 1995–1996.

	Group I (Ashar Alo Male Society)	Group II (Nooten Pather Sandhan)	Group III (Jubo Kalyan Society)
Culturable water area (ha)	1.7	2.0	3.4
No. of beneficiaries	7	21	24
Total culture period (months)	8	8	7
Costs (Tk):			
Fingerlings	22 100	24 000	34 000
Lease	8 850*	12 000	15 000
Embankment and sheds	3 500	3 305	3 200
Feed, fertilizer and transport	5 600	5 830	4 540
Harvesting	3 400	7 483	1 706
Total cost (Tk)	43 450	52 618	58 446
Total cost (Tk/ha)	25 559	26 309	17 190
Total fish production (kg)	1 775	2 213	2 701
Gross income (Tk)	72 775	92 976	106 477
Net profit (Tk)	29 325	40 358	98 031
Net profit (Tk/ha)	17 250	20 179	14 127
Net profit (Tk/person)	4 189	1 422	2 001

**Owned by participants; the assumed lease value of Tk 8 850 is based on the average per hectare lease value of the other two beels.*

an average of 120 kg/ha to 982 kg/ha (Table 1). While good management involves proper pre- and post-stocking operations, these could not be fully adopted. For example, total eradication of wild fish to avoid both competition with and predation of stocked fingerlings was not possible, so their numbers had to be controlled through netting alone. The groups' poor understanding of the necessary management measures was another factor that restrained increase in production. Close monitoring and repeated instructions are necessary in the initial stages to drive home the "do's and don'ts" of management. Middendorp et al. (1996) have reported a steady increase in fish yields over a period of 3 years, even from large oxbow lakes: from 137 kg/ha in 1991–1992 to 565 kg/ha in 1994–1995; introduced carps alone contributed 520 kg/ha. With gradual understanding and experience in management, much higher yields are also expected in the course of time from the three small beels that are the subject of this paper.

Group II, which leased its beel for raising both fish and rice, registered a higher yield than Group III, which had a seasonal lease for fish culture alone. Although Mazid and Hossain (1995) have indicated that silver carp does not perform well in beels, this experiment indicated good growth (an average of 600 g), probably owing to the application of manures. Growth of rohu (average 700 g) and catla (average 500 g) was also found to be quite good. Production per hectare appears to be relatively more sensitive to differences in the quantity of rice bran than to other inputs (Table 3).

Since fish culture in rice fields not only results in an additional yield of fish but also enhances rice production by controlling pests and weeds, thus saving expenses on pesticides and weedicides (Gupta et al. 1997), its use in beels would help improve the rural economy and the socioeconomic condition of fishers and fish farmers.

Because only 20–30% of the members of large groups get actively involved and feel committed, it is suggested that as an incentive they should receive benefits in line with the effort they make. This would ensure the continued success and sustainability of such ventures as those described in this paper.

Since stocking of larger fingerlings is advantageous from the viewpoint of both survival and growth, fingerlings should be raised locally in pens to reduce the high cost of purchasing and transporting them and the heavy mortality associated with their transport. Further, as grass carp are known to damage rice seedlings, it is necessary either to prevent their access to the fields or to avoid stocking them when the plants are young.

Table 3. Quantities of inputs used in experimental beels during 1995–1996.

	Group I (Ashar Alo Male Society)	Group II (Nooten Pather Sandhan)	Group III (Jubo Kalyan Society)
Culturable water area (ha)	1.7	2.0	3.4
Cost of fingerlings stocked (Tk)	22 100	24 000	34 000
Total inputs used (kg/ha):			
Lime	59	105	59
Cattle dung	1588	150	1764
Poultry droppings	141	450	59
Rice bran	1412	960	312
Total production (kg/ha)	1044	1106	796

Besides the stocked Indian major carps, indigenous medium carps such as *Labeo bata*, *L. gonius*, *Cirrhinus reba*, *Barbodes sarana*, and the catfishes *Clarias batrachus* and *Heteropneustes fossilis* constitute valuable stocking material. As these high-value species are known to normally reproduce in enclosed waters, taking advantage of them would make the beels self stocking and provide the farmers with fish for both consumption and income. At the same time the beels would serve as sanctuaries for conservation of biodiversity.

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Use of Multimedia for Promotion of Community Based Fisheries Management

NARGIS AKHTER
FemCom, Batayan-1, House 500/A, Flat 1/A (Ground floor), Road # 8, Dhanmondi R/A, Dhaka 1209, Bangladesh

AKHTER, N. 1999. Use of multimedia for promotion of community based fisheries management, p. 127–129. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Linked with community based fisheries management initiatives, audiovisual media have been developed in Bangladesh to raise awareness of fisheries management issues in a mass audience. Video dramas and songs have been found to be more attractive media than documentaries in conveying messages to fishers and the general public. It is proposed that they are a cost-effective means of reaching a wide audience.

Introduction

Established in early 1992, FemCom Bangladesh is a media group initiated by women developmental media workers to promote social and development issues, especially issues affecting women, through video and other media services for training and awareness. "People of the Flood" is one of two projects being implemented by FemCom Bangladesh under a grant from the Ford Foundation.

Types of multimedia used

Under the "People of the Flood" Project, FemCom has been providing media assistance to the Community Based Fisheries Management (CBFM) Project (Hossain et al., this vol.); and to the work of the Center for Natural Resource Studies (CNRS) in fish habitat restoration (Rahman et al., this vol.), through video documentation of the present condition of openwater fisheries and issues associated with their management. FemCom has worked to identify messages which could be highlighted in various media and the ways of conveying those messages to a mass audience.

Fisheries activities were documented each season in selected waterbodies to produce a documentary video on openwater fisheries in Bangladesh. However in its work with fishing communities, FemCom soon realized that a documentary would not be very attractive to the general public, and so would be ineffective in raising their awareness of existing realities in fisheries and the potential benefits of improved management undertaken by community initiative. Instead, FemCom decided through consultations with the Department of Fisheries, CNRS and NGO partners in the CBFM Project, and on the basis of experience with recent public-awareness films made on non-fisheries issues, that use of folk media and drama would be more effective. Drama videos, live drama and songs would both entertain and inform, and the use of well known actors would help to strengthen the messages imbedded in the drama. For maximum flexibility, FemCom decided to make short video dramas which would each carry a particular main message, but would also form episodes in a series, so that they could be shown separately in short television slots and also as a longer film.

Three video drama episodes have been produced so far, on separate but interrelated issues. One was premiered in the 1996 Fish Fortnight (an annual event highlighting all aspects of fisheries), and two were premiered in March 1997 at the National Workshop on Policy for Sustainable Inland Fisheries Management. These dramas deal with conservation of broodfish, hatchlings and fry; the importance of fish for

nutrition; and problems of access to fisheries and the impact of *pagar* (floodplain pond/ditch) and *kata* (brush pile) fishing.

Additionally, a *baul* song (folk song) focusing on the issue of fry catching in openwaters, and urging fishers to refrain from catching fry and broodfish, was recorded. A new drama in traditional style was also developed on the theme of conserving fish to enhance natural production; it was staged at the 1996 Fish Fair and made into a video.

These videos are being used by the NGO partners and government in the CBFM Project working areas to raise general awareness, and have also been shown on Bangladesh television.

Examples of the content of video dramas

Short summaries of the subject matter and screenplay from two episodes of video drama are given here to illustrate the approach adopted to deal with two important issues in openwater fishery management. It is hoped that through increased awareness and through projects for community based fisheries management, communities can reduce overfishing.

"Do not catch brood fish, save the hatchlings"

This story centers on a traditional fisher family. For various reasons the traditional fishers' catches have declined and, like many others, the family in the film has switched to casual labor for a living. But day laboring work is not always available. The main character, a fisher in his mid-thirties, has failed to earn a living in day laboring, and cannot even provide fish for his small son to eat. He is reminded by his father of his early years, when fish were abundant. The main character goes to catch fish to eat, but fails to catch any using a large mesh cast net. Another fisher using a *current jal* (nylon monofilament gill net with small mesh) offers him a few fish, but the main character refuses them as they are broodfish, and releases a fish full of eggs back in the water. He says "Look, you are catching mother fish with this devil net. This mother fish will release eggs very soon and the beel will be full of fishes in the coming months. But you are spoiling our destiny." The other fisher, however, says that he cannot do anything as he has no other job and if he does not catch these fish his family will go hungry.

Nearby the main character and his son see fishers using *savar jal* (very fine mesh nets used to catch fish fry); they are catching many hatchlings, and many non-target species are also killed in the process. The main character tries to explain to them the potential loss of fish which they cause by destroying hatchlings, but he fails to convince them. The episode ends with a wandering mystical minstrel passing by, singing a message to refrain from wrongdoing or you will have to repent in the future.

"We will not pump out all the ditches, we will not catch mother fishes"

The focus of this episode is a drama of the conflicts and realities of fishing using fish aggregating devices. This is part of raising awareness and preparing communities for the alternative of community based management, which could limit this type of fishing which otherwise benefits rich people at the expense of poor fishers. *Pagars* are ponds or ditches located in seasonal floodplains (beels); as water levels fall, fish take refuge in them and are trapped there. The pagars are owned by local landowners, who harvest them by pumping out all the water. As a result all the fish are caught, leaving none to reproduce next year. This adversely affects floodplain fisheries and fisher incomes in the long term. The episode shows a conflict over dewatering a pagar, and contains the message to preserve one or two pagars and their fish each year so that there are more fish in the following year.

The episode also shows kata fishing. Katas are brush piles in a river where tree branches are piled up to attract fish. As water levels fall after the monsoon, fish move back into the rivers from the floodplains and congregate in katas to overwinter. Kata fishing requires considerable capital, large gears and boats, organizing skill, and links with local government officials. Since katas are illegal, without influence and links with the local power structure, it is not possible to build

them in a river. So in most cases, katas are owned by influential people, and fishers work to harvest them as day laborers. Much of the fish catch from rivers in winter is from katas, and fishers have few places where they can fish in their own right. The video highlights this issue, with the aim of encouraging enforcement of the ban on katas, or of limiting their number and encouraging fishing communities to press for leaving some unexploited each year, to protect some fish which can then reproduce in the following year.

Recommendations

Based on experience so far in developing media, especially video, related to openwater fishery management, and on feedback from the fishing community audiences, it is recommended that:

- For sustainable fisheries management by communities of poor fisherfolk, awareness of the present problems and of potential ways for communities to solve them needs to be raised on a mass scale among rural people.
- To raise awareness among fisherfolk and the general public, video dramas and songs using well known artists are very effective, since the message is presented in an entertaining way.

Videos shown on television reach a wide audience. It is hoped that this will create a demand among communities for help from government and NGOs to address the fisheries issues highlighted.

The videos and other media produced are not commercial, and require close cooperation between media workers and fishery workers (from both government and NGOs). Even non-commercial drama videos, where actors donate their time, may appear to be quite expensive (costing an average of more than US$4 500 for 10–12 minutes). However, in 1997 there were more than 590 000 licensed TV sets in Bangladesh (according to the license department of Bangladesh Television), and there are many more unlicensed sets. Moreover, in rural areas the audience for a single set can be large, and changes frequently. Thus videos are a resource which can be shown repeatedly on television by NGOs, and have the potential to reach a mass audience.

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OLP II Fisheries Management Model and Case Studies

Secchi Disc as a Tool to Determine Stocking Density and Predict Fish Yield in Culture Based Fisheries

M.R. HASAN[1], NITYANANDA BALA and HANS A.J. MIDDENDORP
Oxbow Lakes Small Scale Fishermen Project, Second Phase, Department of Fisheries, BRAC and Danida Technical Assistance, Matshya Bhaban, Arabpur, Jessore, Bangladesh

HASAN, M.R., N. BALA and H.A.J. MIDDENDORP. 1999. Secchi disc as a tool to determine stocking density and predict fish yield in culture based fisheries, p. 133–139. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Average annual production of carp during two years (1994–1995 and 1995–1996) from 17 lakes in Bangladesh stocked under the Oxbow Lakes Small Scale Fishermen Project, Second Phase, was analyzed. A significant regression model was developed, where yield (kg/ha) is negatively associated with Secchi disk depth (a measure of water transparency) and positively associated with stocking density. Other parameters were not found to be significant. Two simple regressions can be used as operational tools by fishers managing these lakes: Secchi disk depth indicates potential yield, and to achieve this yield the required stocking density can be determined. Causal relationships are unclear, but as turbidity in these lakes is low, water transparency appears to be directly related to primary production.

Introduction

The Oxbow Lakes Small Scale Fishermen Project, Second Phase (OLP II) is a social fisheries project in 23 natural oxbow lakes (*baors*) in southwestern Bangladesh along the border with India (West Bengal). Fisheries management in oxbow lakes implies converting openwater capture fisheries into culture based fisheries, through regular fingerling stocking and screening of inlets and outlets (Middendorp et al. 1996).

The objective of OLP II is to transfer and institutionalize the fisheries management of oxbow lakes to the fishers themselves, through (a) participation of poor people in management of inland aquatic resources to enhance their social and economic well-being; and (b) increasing fish yields in order to maximize socioeconomic benefits. The project attaches special emphasis to research assessing the dynamics of fish production in oxbow lake fisheries. Six carp species are regularly stocked and harvested almost throughout the year: rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*)—Indian major carps; silver carp (*Hypophthalmichthys molitrix*) and grass carp (*Ctenopharyngodon idella*)—Chinese carps; and common carp (*Cyprinus carpio*). The average yield of stocked carps from 20 oxbow lakes under culture based fisheries management increased from 121 kg/ha/year in 1991–1992 to 473 kg/ha/year in 1995–1996 (Oxbow Lakes Project II 1996).

The objective of this study was to establish the regression relationships between water transparency (Secchi depth), stocking density and combined carp yield. A practical model consisting of two operational equations was then derived, to estimate the appropriate stocking density of an oxbow lake from the yield prediction based on water transparency. Further, species interdependence and their interaction were examined with particular reference to physical and ecological characteristics of oxbow lakes.

Materials and methods

Data collection

Standard water area (SWA) is the reference water area (ha) of each oxbow lake actually under water on 31 December 1994, based on a field survey conducted in early 1995 (Oxbow Lakes Project II 1995).

[1]Present address: Department of Aquaculture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

Daily fish yields are routinely recorded in Lake Record Books with the help of lake monitors from Danida Technical Assistance (DTA) and program assistants (BRAC). The annual harvest is the recorded total harvest of all stocked carp species combined. Catches of wild fish ("non-stocked species") are recorded occasionally only and are not further considered here. Total carp yield (kg/ha) was calculated by dividing total annual harvest by SWA. Species yield (kg/ha) was the total annual harvest of a species divided by SWA. Stocking density (fingerlings/ha) is the number of carp fingerlings stocked annually in each oxbow lake.

Secchi depth (cm), as an index of water transparency, was measured once every week by Secchi disc at three fixed locations in each oxbow lake between 8 and 10 a.m., and subsequently averaged. Water temperature (°C) and water depth fluctuation (cm) were also measured from one fixed location of each lake once weekly. Annual average Secchi depth, annual average water temperature and annual average water depth were calculated from these weekly measurements. Rainfall (cm) was recorded at the fish landing center of each lake every day during the rainy season, and the total amount of rainfall was calculated. Percentage of water area covered by aquatic macrophytes (macrophyte coverage) was quantified quarterly by eye estimation.

Data were collected from July 1994 to June 1996. All computations in this study are based on annual average values (July 1994–June 1995 and July 1995–June 1996), and the means of two years' data were used in order to reduce variation. Although 20 oxbow lakes are under culture based fisheries management through OLP II, complete data sets were not available for three of those lakes; in this report we used the data from 17 lakes only, thereby limiting the analysis to average stocking densities varying between 1000 and 5000 fingerlings/ha.

Modeling by regression analysis

To select the significant parameters, all of the above-mentioned parameters were included as co-variables in a multivariate regression on carp yield. Based on the co-variables which were found significant, two models were developed. Firstly, a yield descriptive model was obtained by a linear regression of Secchi depth and stocking density

Table 1. Summary of independent variables tested in the multi-variate regression on carp yield—mean of two seasons' data (1994–1995 and 1995–1996).

Lake	Yield (kg/ha/year)	Water area (ha)	Secchi depth (cm)	Stocking density (no./ha/year)	Water depth (cm)	Water temperature (°C)	Rainfall (cm)
Nasti	1 008	54	50.9	3 500	222	26.5	126.3
Marufdia	875	25	61.4	4 970	220	26.1	126.0
Sarjad	820	9	61.6	3 189	139	27.0	185.0
Saganna	738	35	76.0	4 895	230	26.3	152.3
Hariharnagar	648	30	37.9	2 611	201	26.6	85.9
Benipur	613	45	97.9	3 075	258	25.8	133.0
Porapara	514	88	79.6	2 763	205	26.1	95.0
Kaliganga	483	28	112.3	1 979	202	26.0	153.3
Bahadurpur	468	110	186.0	2 721	200	26.7	230.0
Khedapara	453	45	91.5	3 198	254	26.4	88.4
Bukbhara	417	138	139.9	2 325	256	26.3	148.3
Ujjalpur	354	34	102.5	2 769	117	26.8	72.4
Hamidpur	334	13	46.1	1 850	104	26.4	147.2
Bhanderdah	321	48	115.3	1 824	174	27.5	85.3
Saster	232	140	68.9	1 288	147	27.4	131.5
Khatura	213	68	150.7	1 545	335	26.5	87.3
Kayetpara	146	116	140.5	1 056	129	27.8	107.0
Average	508	60	95	2 608	199	26.6	126.7

(independent co-variables) on annual carp yield of all stocked species combined (dependent variable). Secondly, an operational model for estimating stocking density from annual average Secchi depth was derived, consisting of two regression equations: (a) linear regression of Secchi depth on carp yield, and (b) linear regression of stocking density on carp yield.

Species interaction

Interaction between yields of various carp species (kg/ha) and between carp yields and mean Secchi depth (cm), water area (ha) and macrophyte coverage (% of water area covered) was studied by path coefficient analysis.

Results

The annual carp yields in 17 oxbow lakes averaged 508 kg/ha/year for 1994–1995 and 1995–1996, ranging between 146 and 1 008 kg/ha/year. Average stocking density was 2 608 fingerlings/ha and average Secchi depth 95 cm (Table 1). Secchi depth increased from July–December and decreased again from January–February until June, showing similar trends in 1994–1995 and 1995–1996 (Fig. 1).

In a first screening of possibly significant parameters, the following independent variables were tested in a multivariate regression on carp yield: (a) Secchi depth, (b) stocking density, (c) standard water area (SWA), (d) standard water depth, (e) water temperature, and (f) annual rainfall, as follows:

$$Y = 1477 - 2.633X_1 + 0.125X_2 - 0.538X_3 + 1.09X_4 + 6.548X_5 + 1.913X_6$$
$$(R = 0.906; n = 17; P<0.01)$$

where Y = carp yield (kg/ha), X_1 = Secchi depth (cm), X_2 = stocking density (fingerlings/ha), X_3 = SWA (ha), X_4 = standard water depth (cm), X_5 = water temperature (°C), and X_6 = annual rainfall (cm).

Although the overall regression equation was significant, the partial regression coefficients were significant for Secchi depth and stocking density only. Thus, the following descriptive yield model was derived including only Secchi depth and stocking density:

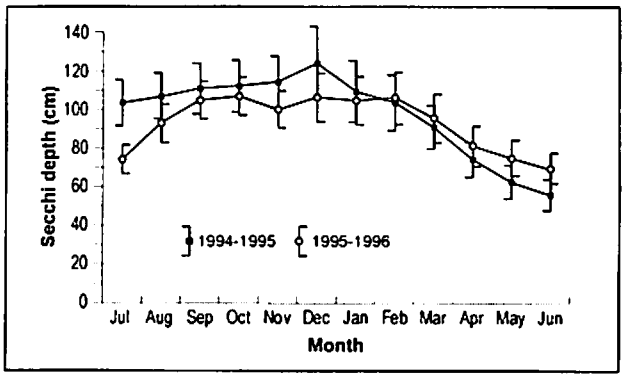


Fig. 1. Seasonal trends of Secchi depth in 17 oxbow lakes during 1994–1995 and 1995–1996.

a. Descriptive co-variate regression model: multiple regression of Secchi depth and stocking density (independent co-variables) on carp yield (dependent variable):

$$Y = 225 - 1.578X + 0.162Z \quad (R = 0.861; n = 17; P<0.001) \qquad \text{...Equation 1}$$

where Y = yield (kg/ha), X = Secchi depth (cm) and Z = stocking density (fingerlings/ha). Carp yields of oxbow lakes may be predicted from the descriptive model provided both Secchi depth and stocking density are known. In practice, however, the descriptive model is not a useful management tool, because the optimum stocking density cannot be calculated from Secchi depth without making assumptions on yield.

b. Operational model: Consequently, two simple yield predictive regression equations were developed from the descriptive co-variate regression in order to approximate optimum stocking density from average Secchi depth, under the assumption that the predicted yields from both regressions are the same or almost the same ($Y_1 = Y_2$):

(i) Linear regression equation between yield Y_1 (dependent variable) and Secchi depth (independent variable) (Fig. 2):

$$Y_1 = 811 - 3.18X \quad (r = -0.536; n = 17; P<0.05) \qquad \text{...Equation 2}$$

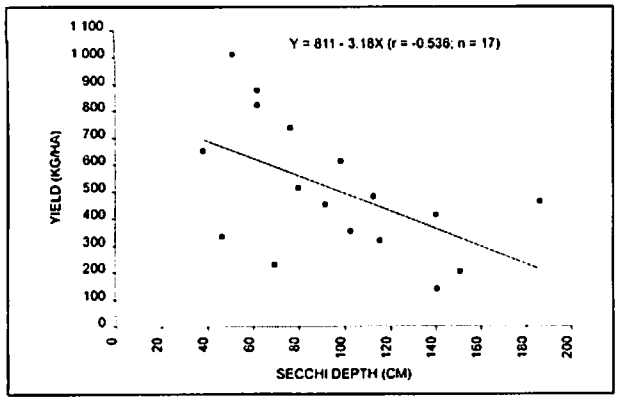


Fig. 2. Relationship between carp yield and Secchi depth of 17 oxbow lakes under OLP II.

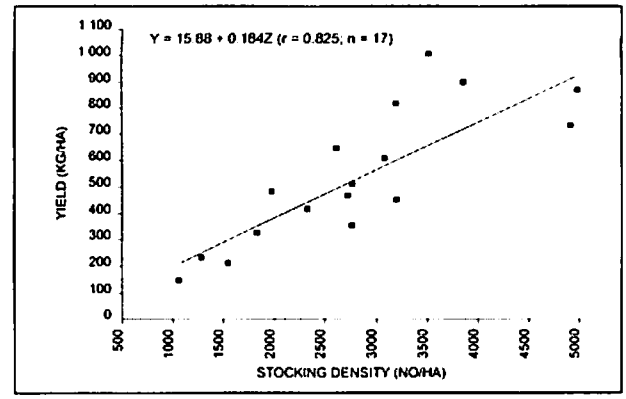


Fig. 3. Relationship between carp yield and stocking density of 17 oxbow lakes under OLP II.

where Y_1 = yield (kg/ha), and X = Secchi depth (cm).

(ii) Linear regression equation between yield (Y_2) and stocking density (Fig. 3):

$$Y_2 = 15.88 + 0.184Z \quad (r = 0.825; n = 17; P<0.001) \qquad \text{...Equation 3}$$

where Y_2 = yield (kg/ha), and Z = stocking density (fingerlings/ha).

Lower Secchi depths are directly related to higher yields (Equation 2 and Fig. 2). Yields also directly increase with stocking density (Equation 3 and Fig. 3).

Total carp yield was negatively correlated with lake area and Secchi depth, but no such relationship was observed between total yield and macrophyte coverage (Table 2). Yields of silver carp and mrigal were negatively correlated with lake area, Secchi depth and macrophyte cover ($P<0.05$). The trend between macrophytes and grass carp yield was positive but not significant ($P>0.05$).

There was also a positive correlation between the yields of silver carp and mrigal, catla and common carp, and between rohu and grass carp (Table 3).

Discussion and conclusion

Modeling of the carp yield in culture based fisheries

Yield predictive modeling is a basic tool for effective management of culture based fisheries. Historically, the morphoedaphic index (MEI: conductivity/mean depth) has been used for yield prediction of deep reservoirs in temperate regions (Ryder 1965, 1982; Jenkins 1982). However, no significant relationship between fish yields and MEI was established in Chinese reservoirs (Li and Xu 1995) nor in Indian reservoirs (Sreenivasan 1992; Hartmann and Aravindakshan 1995). It is generally concluded that fish production in tropical and subtropical freshwater lakes and reservoirs is not correlated with MEI but, however, closely correlated with primary production (Downing et al. 1990).

It is emphasized here that the obtained yield descriptive model using Secchi depth and stocking density is a tool for culture based fisheries management rather than an ecological model of the different trophic levels of an oxbow lake. Secchi depth itself is an approximation of rather complex limnological relationships. Note, however, that generally very low turbidity is observed in oxbow lakes in Bangladesh except for 1-2 months at the beginning of the rainy season; and Secchi depth is therefore considered a reliable indicator of the primary production. Further, the over-simplification of approximating oxbow lake productivity by carp yield alone ignores the yield of indigenous, non-stocked fish and of other aquatic organisms. This at least partly explains the relatively low, albeit significant, value of $r = -0.536$ in Equation 2.

The significance of water area on fish yield in many linear regressions as reported in the literature (Li and Xu 1995; Welcomme and Bartley 1998) is a case in point in the discussion of yield relationships. As also observed in our study, the linear regression of water area on fish yield is significant, while area is not significant in a multivariate regression (Equation 1). It is concluded that water area itself is not an explaining factor; rather the associated limnological parameters may play a major role in determining fish yields.

Table 2. Path coefficient analysis of fish yield (kg/ha) on water area, Secchi depth and macrophyte coverage (1994–1996).

Variables	Water area (ha)	Secchi depth (cm)	Macrophyte coverage**
Silver carp	–0.624*	–0.695*	–0.565*
Catla	–0.121	–0.305	–0.281
Rohu	–0.075	0.304	0.369
Common carp	–0.042	–0.370	–0.263
Mrigal	–0.631*	–0.633*	–0.592*
Grass carp	0.279	0.366	0.458
All carps	–0.487*	–0.536*	–0.394

* *Significant correlation, P<0.05 for coefficient >+0.481 or <–0.481 at d.f. 16*
** *Percentage of water area covered by macrophytes*

Table 3. Path coefficient analysis between yields (kg/ha) of fish species (1994–1996).

Species	Silver carp	Catla	Rohu	Common carp	Mrigal
Catla	0.150				
Rohu	–0.053	0.480			
Common carp	0.333	0.724*	0.317		
Mrigal	0.863*	0.358	0.128	0.476	
Grass carp	–0.118	0.084	0.513*	0.043	–0.058
All carps	0.822*	0.576*	0.418	0.664*	0.863*

* *Significant correlation, P<0.05 for coefficient >+0.481 or <–0.481 at d.f. 16*

To our knowledge, no other relationships between water transparency and yield of stocked fish in tropical freshwater lakes have yet been published. Hardjamulia and Suwignyo (1988) reported an annual fish yield of 380 kg/ha at an annual mean Secchi depth of 129 cm in one of the major reservoirs in Indonesia. However, this was simply an observation and no relationship was established or attempted.

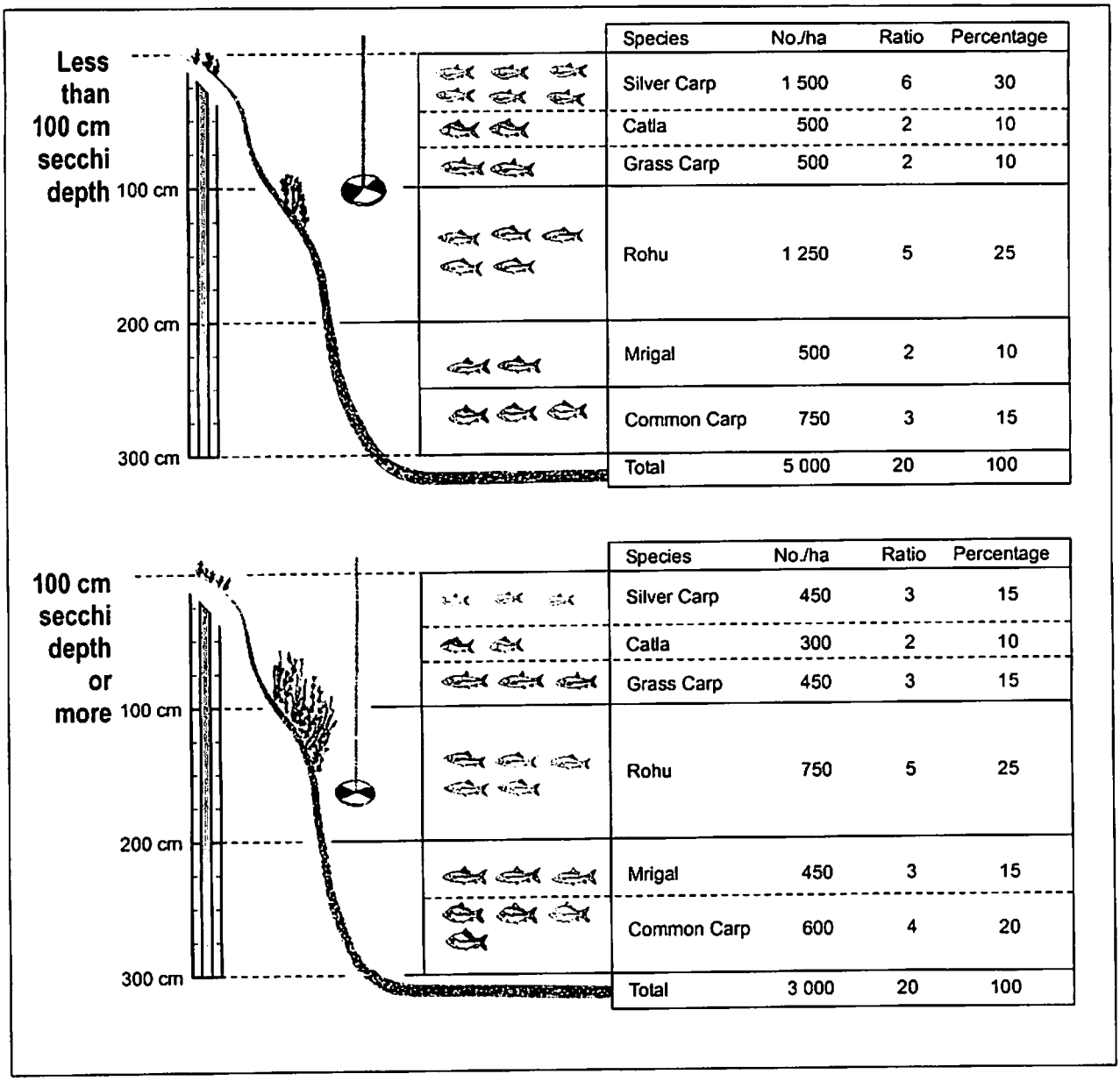
Management of a "carp culture based fishery" for yield optimization

In a culture based fishery in a semi-closed waterbody, one of the few management tools available is the stocking strategy, i.e., choice of fish species stocked, fingerling weight, stocking density and time of stocking. Stocking density (total and by species) is one of the most important factors to be manipulated for increasing fish production, and Secchi depth therefore becomes an important management tool to help fishers determine optimum stocking numbers.

The recommended stocking density and species composition for oxbow lakes in relation to Secchi depth as evolved from experience is shown in Fig. 4. The recommended stocking weight of carp fingerlings in oxbow lakes is 35–45 g (12–15 cm). Experience has shown that recovery of fingerlings decreases drastically at lower stocking weights due to either predation or transport mortality or both. Similarly Li and Xu (1995) recommended stocking reservoirs with fingerlings longer than 13 cm.

In this study of 17 oxbow lakes, the increase in yield (kg/ha) from stocking densities of 1 000 fingerlings/ha to 5 000 fingerlings/ha fits a straight line, with a predicted annual yield of 936 kg/ha at a stocking density of 5 000 fingerlings/ha (Fig. 3). In our earlier analysis of 19 oxbow lakes, a curvilinear relationship with a very low regression coefficient (0.00004) gave the best fit which, however, effectively resembles an almost straight line for stocking densities less than 5 000 fingerlings/ha. This best-fitting curvilinear relationship was clearly the result of overstocking (5 849 and 7 578 fingerlings/ha), suggesting that fish yields may decrease at stocking densities exceeding 5 000 fingerlings/ha (Hasan and Middendorp 1997).

In Nanshahe Reservoir in China, the relationship between stocking density (fingerlings/ha) and fish yield (kg/ha) was also directly proportional (Li and Xu 1995). Similar linear relationships were obtained for lakes of Sri Lanka and Mexico (Welcomme and



Species	No./ha	Ratio	Percentage
Silver Carp	1 500	6	30
Catla	500	2	10
Grass Carp	500	2	10
Rohu	1 250	5	25
Mrigal	500	2	10
Common Carp	750	3	15
Total	5 000	20	100

Species	No./ha	Ratio	Percentage
Silver Carp	450	3	15
Catla	300	2	10
Grass Carp	450	3	15
Rohu	750	5	25
Mrigal	450	3	15
Common Carp	600	4	20
Total	3 000	20	100

Fig. 4. Recommended stocking density and species composition for oxbow lakes.

Bartley 1998). However, in Sri Lankan reservoirs (Amarasinghe in Welcomme and Bartley 1998) and in Fuqiaohe Reservoir in China (Gangsheng et al. 1992), a curvilinear relationship was found between stocking density and yield. Quiros (1998) used a log–log relationship to describe the relationship between yield and stocking density in 172 waterbodies in tropical Latin America.

Species interaction (interdependence of variables)

There appear to be two distinct dominant species combinations in oxbow lakes: either silver carp and mrigal or common carp and catla, although no definite explanation is available yet. Path coefficient analysis showed a positive correlation ($P<0.05$; $n = 17$) between yields of silver carp and mrigal and between catla and common carp (Table 3). Positive interactions between silver carp and mrigal and between catla and common carp were also found when yield data of 1994–1995 and 1995–1996 for 19 oxbow lakes were analyzed separately (Middendorp et al. 1996; Hasan and Middendorp 1998). Chinese reservoirs are similarly categorized, based on their dominant species: silver carp and common carp (Li and Xu 1995).

These positive species interactions may indi-

rectly confirm that silver carp and catla are competitors, while the same is likely to be true for common carp and mrigal. Silver carp, an efficient filter feeder, had a highly significant correlation with Secchi depth (Table 2; $P<0.01$); while catla, also a filter feeder, had no significant relationship with Secchi depth. The yield of mrigal was also significantly correlated with Secchi depth (Table 3; $P<0.05$), although this relationship may not be directly related to availability of phytoplankton, but rather due to the positive relationship between silver carp and mrigal (Table 3; $P<0.01$).

Further, the positive interaction between grass carp and rohu is probably explained by the fact that rohu graze the aufwuchs from the aquatic macrophytes; i.e., fewer macrophytes for grass carp mean fewer aufwuchs for rohu (Table 3). Moreover, grass carp are usually stocked by fishers in direct relation to the availability of macrophytes in the lakes, so grass carp densities are not statistically independent. The non-significant relationship found between grass carp and macrophytes may be explained by the fact that all aquatic macrophytes were used in this estimation, while grass carp feed mainly on submerged macrophytes.

It must be emphasized again that the derived relationships between species and other variables are apparent relationships only and the causal relationships between these factors in the oxbow lake ecosystem are not known. Fisheries ecology from one oxbow lake to another may differ, as is suggested by a difference in dominant species: i.e., silver carp (top layer)–mrigal (bottom layer) and catla (top layer)–common carp (bottom layer).

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Impact of Carp Stocking on the Abundance and Biodiversity of Non-stocked Indigenous Fish Species in Culture Based Fisheries in Oxbow Lakes

A.K.M. AMINUL HAQUE, HANS A.J. MIDDENDORP and M.R. HASAN[1]
Oxbow Lakes Small Scale Fishermen Project, Second Phase, Department of Fisheries, BRAC and Danida Technical Assistance, Matshya Bhaban, Arabpur, Jessore, Bangladesh

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Abstract

Catches of indigenous wild fish in Bangladesh were studied in two oxbow lakes stocked with carps, and in one lake without stocking, to investigate differences that might be associated with stocking. Total catches of indigenous non-stocked fish were extrapolated to 557 kg/ha in Bukbhara, 593 kg/ha in Kannadah and 529 kg/ha in Rajgonj, i.e., of the same order as the reported annual yields of stocked carps of 367 kg/ha in Bukbhara and 678 kg/ha in Kannadah. The main indigenous fish in the stocked lakes was the migratory chapila *Gudusia chapra*, comprising about 50% of this catch, but it was relatively scarce in the non-stocked lake. Hence screens to retain carp do not exclude the main migratory species. Yields from indigenous fish in the three oxbow lakes in this study were higher and also more indigenous fish species were found, compared with two *beels* (natural depressions) in the floodplains in the same region. Further research is planned in more densely stocked lakes to determine if high carp yields (>1 000 kg/ha) affect indigenous fish species.

Introduction

Twenty oxbow lakes in southwest Bangladesh were successfully brought under culture based fisheries management under the Oxbow Lakes Small Scale Fishermen Project, Second Phase (OLP II). Each oxbow lake is managed by a fishers' group (LFT, lake fishing team). The average yield of stocked carps in these 20 oxbow lakes reached 500 kg/ha/year in 1994–1995 (Middendorp et al. 1996) and 689 kg/ha/year in 1996–1997 (Oxbow Lakes Project II 1997a) and has increased since then. The stocked Indian and Chinese carp are caught by teams of fishers with purse seine nets and by encircling brush parks (Hasan et al., this vol.).

Non-stocked indigenous fish and shrimps are caught individually with small gill nets, shrimp traps and other gear. Indigenous fish are defined here as naturally recruited fish species such as minor carps, minnows, murrels, mullets, pipe fishes, loaches, eels and catfish. Indian major carps are thought to be extinct in southwest Bangladesh (Flood Action Plan 17 1995), but occasionally one or two fingerlings stocked in other stocking programs may reach the lakes.

The objectives of this study were to assess the impact of carp stocking on the abundance and biodiversity of non-stocked indigenous fish species and their contribution to total fish production in a culture based oxbow lake fishery stocked with carp fingerlings (at about 3 500 fingerlings/ha).

Materials and methods

Locations

Three oxbow lakes were selected for this study: two culture based fisheries with carp stocking (Bukbhara and Kannadah, OLP II) and an open-water fishery with no carp stocking (Rajgonj).

Bukbhara Lake

Jessore Sadar Thana, Jessore District. Standard water area (SWA[2]) 138 ha, average water depth

[1] Present address: Department of Aquaculture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

[2] SWA is the reference area (ha) of each oxbow lake actually under water on 31 December 1994, based on a field survey conducted in early 1995 (Oxbow Lakes Project II 1995).

2.4 m, water clear. The lake slopes gently and is connected through channels with the Kapotakhya River. Bamboo screens at inlets and outlets. Carp stocking density was 1 193 fingerlings/ha in 1996–1997.

Kannadah Lake

Sarsha Thana, Jessore District. SWA 23 ha, average water depth 4 m, water clear. The lake has steep slopes and is connected through channels with the Ichamati River. Bamboo screens at inlets and outlets. Carp stocking density was 2 640 fingerings/ha in 1996–1997.

Rajgonj Lake

Sarsha Thana, Jessore District. Estimated water area 18 ha, 75–80% covered with aquatic macrophytes; average water depth 2 m. The lake is in open connection with the Ichamati River via a narrow inlet.

Sampling

Sampling was carried out for 10 months from September 1996 to June 1997. The total catch estimate was calculated from recorded daily catches of the LFTs for carps and non-stocked indigenous fish, plus the estimated catch of individual fishers, based on a random sample of at least 20% of those fishers. In calculating total catch of the individual fishers, three assumptions were made: (a) individual fishing took place every day; (b) all fishers were engaged in fishing for the same number of fishing hours; and (c) all fishers used similar fishing gears.

Sampling frequency was once to twice a week in Bukbhara Lake, once a week in Kannadah Lake and once a month in Rajgonj Lake. All sampling was done in the morning. The total weight for each species was recorded in the fishers' catches. In smaller catches, the fish were counted; while from large catches, sub-samples were taken for estimating the total number of fish from average fish weight.

The total number of fisher-days each month was estimated from the number of fishers actually observed during sampling days. For each sampling day, estimated daily catch was calculated from the number of fishers sampled and the number of fishers observed; this figure was subsequently extrapolated to indicate total monthly catch. The monthly catches for the 10 individual months were summed to obtain the total catch, from which average catch per day and catch per hectare per day were calculated. For comparison, the actual 10 months' catch was also extrapolated to indicate annual catch (12 months).

Fish species

The non-stocked fish and prawns caught from the three oxbow lakes were divided in seven groups of related species (Rahman 1989; Talwar and Jhingran 1991):

Catfish

Aorichthys spp., *Clarias batrachus*, *Heteropneustes fossilis*, *Mystus* spp., *Pseudeutropius atherinoides* and *Wallago atu*.

Murrels (all snakeheads)

Channa spp.

Clupeids

Gudusia chapra, *Tenualosa ilisha*, *Hilsa kelee* and *Corica soborna*.

Minnows, barbs and carps

Salmostoma spp., *Amblypharyngodon* spp., *Puntius* spp., *Rasbora* spp., *Danio* spp., *Cirrhinus* spp. and *Labeo* spp.

Eels and loaches

Mud eel (*Monopterus cuchia*), spiny eels (*Macrognathus* spp. and *Mastacembelus armatus*) and loaches (*Lepidocephalus* spp. and *Lepidocephalichthys* spp.).

Miscellaneous species

Gars, gobies, gouramies, perches, half beaks, puffer fishes and featherbacks.

Prawns

All freshwater prawn species (*Macrobrachium* spp.).

Fish species were also categorized in three ecological groups, according to habitat preference (Flood Action Plan 17 1995):

Riverine species
Species that prefer flowing water, such as *Mystus gulio* and clupeids.

Migratory species
Species that migrate in and out of the floodplains, such as many catfish species and major carps.

Non-migratory species
So-called resident species, which complete their life-cycle in the oxbow lakes.

Historical information on species composition and abundance of indigenous fish species in oxbow lakes is not available. The fish species found in the oxbow lakes in this study were compared with the recent catch survey of the floodplains of southwest Bangladesh (Flood Action Plan 17 1995). Fish species contributing >1% by weight to the total indigenous catch are considered predominant species (excluding *Gudusia chapra* from the calculations as it was apparently not found in the floodplains catch survey, while the high occasional observed yields of *G. chapra* in oxbow lakes would have obscured the weight contributions of all other indigenous species).

Results

In total, 81 days of sampling was done from September 1996 to June 1997. Sampling intensity varied widely and was most intensive in Bukbhara (53 sampling days, average number of fishers sampled = 14 per day). In Kannadah there were 23 sampling days and the average number of fishers sampled was three per day. Fishing was irregular in Rajgonj, so sampling there was much less intensive (5 sampling days, average number of fishers sampled = 10 per day) (Table 1). Fishing by individual fishers for indigenous fish was much more intensive in Bukbhara than in Kannadah.

The total recorded indigenous catch from September 1996 to June 1997 was 463 kg/ha in Bukbhara, 494 kg/ha in Kannadah and 441 kg/ha in Rajgonj (Table 2). The extrapolated (assuming that 10 months are representative of 12 months) annual yields of non-stocked indigenous fish were 557 kg/ha in Bukbhara, 593 kg/ha in Kannadah and 529 kg/ha in Rajgonj. The indigenous catch consisted mostly of clupeids (see below) and non-migratory fish. The extrapolated annual yields of non-migratory fish were 291 kg/ha in Bukbhara, 240 kg/ha in Kannadah and 477 kg/ha in Rajgonj.

Table 1. Summary of sampling and catch estimates of non-stocked indigenous fish of Bukbhara, Kannadah and Rajgonj Lakes by fisher types from September 1996 to June 1997 (10 months).

Lake	Bukbhara		Kannadah		Rajgonj[3]
Fisher type	Fishers[1]	LFT[2]	Fishers	LFT	Fishers
No. of fishing days	272	15	242	89	151
No. of sampling days	53	15	23	89	5
Average no.of fishers sampled/day	14	n.a.	3	n.a.	10
Average no. fishers fishing/sampling day	56	n.a.	9	n.a.	22
Total no.of fisher days	17 330	1 555	2 831	5 696	6 643
Total volume of fish sampled (kg)	1 826	n.a.	105	n.a.	139
Total catch estimated (kg)	35 945	27 942	3 967	7 394	7 935
Catch/ha (kg)	260.5	202.5	172.5	321.5	440.8
catch/ha/day (kg)	0.84	0.67	0.57	1.06	1.45
Catch/fisher/day (kg)	1.90	0.85	1.04	0.38	0.63

[1] *Fishers harvesting indigenous fish individually.*
[2] *Members of lake fishing team harvesting indigenous fish collectively as groups (each group generally consists of 12–18 persons). Total catch was recorded; sampling was done only to establish the species composition.Only fishing days which targetted indigenous fish are recorded here, the LFTs also fished for stocked carp.*
[3] *No organized LFT fishing took place in Rajgonj Lake.*
na: not applicable as total catch was recorded.

Table 2. Yield (kg/ha) of non-stocked indigenous fish and stocked carp of three selected oxbow lakes (two under OLP II and one control) from September 1996 to June 1997.

Fish group	Yield (kg/ha)											
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total	Average
						Bukbhara, 138 ha (under OLP II)						
Non-stocked indigenous fish												
Clupeids	0.9	131.2	4.5	84.1	0.0	0.0	0.0	0.0	0.0	1.1	221.8	22.2
All others	17.5	26.7	34.9	*	16.4	8.4	19.6	33.7	24.3	60.6	242.1	24.2
Total	18.4	157.9	39.4	84.1	16.4	8.4	19.6	33.7	24.3	61.7	463.9	46.4
Stocked carps	2.7	30.8	61.5	21.1	*	*	*	64.7	124.0	42.2	346.9	34.7
						Kannadah, 23 ha (under OLP II)						
Non-stocked indigenous fish												
Clupeids	*	0.4	4.1	60.5	0.2	2.9	78.7	111.0	36.4	0.3	294.5	29.4
All others	*	17.3	45.5	5.0	9.7	8.3	54.4	11.1	12.1	36.2	199.6	20.0
Total	*	17.7	49.6	65.5	9.9	11.2	133.1	122.1	48.5	36.5	494.2	49.4
Stocked carps	*	*	*	*	81.9	89.1	72.9	29.5	109.7	294.6	677.7	67.8
						Rajgonj, 18 ha (openwater: control)**						
Non-stocked indigenous fish												
Clupeids	*	5.5	*	*	*	0.0	0.8	*	0.0	36.7	43.0	4.3
All others	*	55.3	*	*	*	114.5	88.9	*	76.4	62.7	397.8	39.8
Total	*	60.8	*	*	*	114.5	89.7	*	76.4	99.4	440.8	44.1

* *No fishing took place*
** *No carp stocking*

The annual yields of stocked carps were 367 kg/ha in Bukbhara and 678 kg/ha in Kannadah in 1996–1997 (Oxbow Lakes Project II 1997a).

Clupeids averaged 25.8 kg/ha/month in the two lakes stocked with carps, compared with only 4.3 kg/ha/month in Rajgonj. Catfish yield was on average 5.6 kg/ha/month in the two stocked lakes, compared with 1.7 kg/ha/month in Rajgonj (Table 3). Minnows averaged 4.3 kg/ha/month in the stocked lakes, but 14.3 kg/ha/month in Rajgonj, while the group of miscellaneous fish species averaged 2.5 kg/ha/month in the stocked lakes but 15.1 kg/ha/month in Rajgonj. The total indigenous catch (excluding *G. chapra*) was 24.1 kg/ha/month in Bukbhara, 20.0 kg/ha/month in Kannadah and 39.9 kg/ha/month in Rajgonj.

The clupeid catch consisted almost entirely of the migratory chapila *G. chapra*. Clupeids accounted for 22.2 kg/ha/month (48% of total non-stocked indigenous catch) in Bukbhara, and for 29.4 kg/ha/month (60% of total non-stocked catch) in Kannadah, compared with only 4.3 kg/ha/month (9.8% of indigenous catch) in Rajgonj (Table 2). Major catches of clupeids in Bukbhara were

Table 3. Yield (kg/ha/month) and percentage contribution to total yield (by weight) of non-stocked indigenous fish groups in three selected oxbow lakes from September 1996 to June 1997.

Fish group	Bukbhara (OLP II)		Kannadah (OLP II)		Rajgonj (control)	
	Yield (kg/ha/month)	Contribution to total yield (%)	Yield (kg/ha/month)	Contribution to total yield (%)	Yield (kg/ha/month)	Contribution to total yield (%)
Catfish	5.9	12.7	5.2	10.5	1.7	3.8
Murrels	3.3	7.1	1.7	3.4	2.8	6.3
Minnows	2.7	5.8	5.8	11.7	14.3	32.4
Eels and loaches	1.7	3.7	3.5	7.0	3.1	7.0
Miscellaneous*	2.8	6.0	2.2	4.4	15.1	34.2
Prawns	7.8	16.8	1.6	3.3	2.9	6.6
Sub-total	24.2	52.1	20.0	40.3	39.9	90.3
Clupeids	22.2	47.9	29.4	59.6	4.3	9.7
Total	46.4	100.0	49.4	100.0	44.2	100.0

* *Includes gars, gobies, gouramies, perches, half beaks, puffer fish and featherbacks*

Table 4. Fish species by different habitat preference groups in floodplains (Flood Action Plan 17 study), OLP II lakes and control lake.

Habitat preference	Floodplains	Oxbow lakes			Control
	FAP17	OLP II**			
	Andolir and Bagihar Beels*	Bukbhara	Kannadah	Total	Rajgonj
Riverine	1	3	2	3	4
Migratory	8	13	11	13	13
Resident	39	42	39	44	39
Total	48	58	52	60	56

* *Beels are natural depressions, part of floodplains*

** *Identification of different species of prawn was not done and hence individual prawn species were not counted for purposes of species biodiversity. The percentage contribution of prawns is included in the resident group*

recorded in October and December and in Kannadah in December, March, April and May.

Fishers' catches included 58 indigenous fish species in Bukbhara, 52 in Kannadah and 56 in Rajgonj, compared with only 48 species in Andolir and Bagihar *beels* in southwest Bangladesh (Flood Action Plan 17 1995) (Table 4). There were 15, 21 and 21 predominant species (>1% by weight), respectively, in Bukbhara, Kannadah and Rajgonj Lakes, compared with 16 predominant species reported from floodplains in the same region of Bangladesh (Table 5). Prawns were not counted when assessing species diversity.

Conclusions and discussion

Yields of non-stocked indigenous fish

The extrapolated annual yields of indigenous fish based on data from September to June are possibly over-estimated because during July and August (the middle of the rainy season) water levels in the lakes are high and fish are generally difficult to catch. Another possible source of error in estimating yields is that all calculations are based on the assumption that individual fishing took place every day and that fishers were engaged in fishing for the same length of time with similar fishing gears throughout the study period. Apart from these considerations, an extremely limited number of samples (five samplings in the whole study period) were taken at Rajgonj, due to the irregular fishing in this lake.

High clupeid catches, consisting almost entirely of *G. chapra*, were recorded in single days in October and December (Bukbhara) and in December, March, April and May (Kannadah). *G. chapra* are harvested by the LFTs using special seine nets of small mesh size (1 cm), very different from the normal carp purse seines with mesh sizes of 5–8 cm. *G. chapra* swim in schools just under the surface and when the fishers observe them, they rush for the clupeid net. Isolated specimens of *G. chapra* are rarely caught, suggesting that it is a truly migratory species. Given the intensive fishing and guarding of the lake by the fishers, it is unlikely that *G. chapra* enter the lake unnoticed. The bamboo screens of Bukbhara and Kannadah certainly did not obstruct their entry.

As *G. chapra* is a migratory fish caught in big schools entering the lakes, its catch should be excluded from the total estimates of the lakes' natural fish production. The combined annual yield of indigenous fish (excluding *G. chapra*) and stocked carps was 658 kg/ha in Bukbhara and 918 kg/ha in Kannadah, whereas the annual yield of indigenous fish was 478 kg/ha in Rajgonj. No carp stocking takes place in Rajgonj Lake. Nevertheless, even when excluding the migratory *G. chapra* from the catches, all three oxbow lakes in the study appear much more productive than beels in southwest Bangladesh (Andolir Beel, 111 kg/ha, and Bagihar Beel, 202 kg/ha, Flood Action Plan 17 1995). The reason may well be the relatively small size of the lakes, compared to beels and floodplains extending over hundreds or even thousands of hectares.

Although Kannadah and Rajgonj Lakes are both within the same watershed (the Ichamati River), the catch of *G. chapra* in Kannadah was much higher than in Rajgonj. It is reported by the fishers that

Table 5. Diversity of non-stocked indigenous fish in floodplain and oxbow lakes: contributions of dominant fish species (comprising 1% or more of total catch) to annual catch excluding clupeids.

Species name		Contribution by weight to total catch (%)			
Scientific	English	FAP-17*	OLP II**		Control
		Floodplain	Bukbhara	Kannadah	Rajgonj
Riverine					
Mystus gulio	Small catfish	–	–	6.71	–
Sub-total				6.71	
Migratory					
Aorichthys aor	Large catfish	–	4.77	6.79	1.08
Mystus bleekeri	Small catfish	–	7.12	2.56	–
Wallago attu	Giant catfish	1.2	–	5.76	1.73
Salmostoma bacaila	Minnow	–	–	8.94	–
Catla catla	Catla	–	1.90	–	1.08
Cirrhinus mrigala	Mrigal	–	–	–	3.90
Cirrhinus reba	Reba	–	–	–	2.94
Labeo bata	Bata	–	–	–	14.62
Labeo rohita	Rohu	–	–	–	1.60
Sub-total		1.2	13.79	24.05	26.95
Resident					
Amblypharyngodon mola	Minnow	–	–	2.74	–
Mystus tengara	Small catfish	–	–	2.15	–
Mystus vittatus	Small catfish	1.3	7.64	3.48	–
Clarias batrachus	Asian catfish	1.1	–	–	–
Heteropneustes fossilis	Stinging catfish	10.0	2.55	1.06	–
Channa punctata	Snakehead	14.1	9.32	2.35	2.79
Channa striata	Snakehead	7.9	3.03	–	2.50
Channa marulius	Snakehead	–	–	6.06	1.30
Puntius sophore	Barb	16.8	5.62	10.73	2.07
Puntius conchonius	Barb	1.7	–	1.28	2.78
Puntius ticto	Barb	1.3	2.70	2.95	3.03
Puntius terio	Barb	–	1.90	–	–
Glossogobius giuris	Bar-eyed goby	–	7.32	–	1.89
Chanda nama	Glassy perchlet	–	–	1.62	11.15
Parambassis ranga	Glassy perchlet		–	2.33	8.93
Lepidocephalus guntea	Loach	–	2.76	1.36	1.63
Mastacembelus armatus	Spiny eel	–	–	2.24	1.43
Mastacembelus pancalus	Spiny eel	1.2	1.09	5.77	1.22
Macrognathus aculeatus	Spiny eel	–	2.79	8.05	3.47
Nandus nandus	Mud perch	2.4	–	–	–
Anabas testudineus	Climbing perch	13.6	–	–	–
Colisa fasciatus	Indian gouramy	13.8	–	–	–
Trichogaster lalius	Indian gouramy	1.1	–	–	–
Notopterus notopterus	Featherback	2.2	2.20	–	–
Xenentodon cancila	Gar	1.4	–	5.62	13.29
Small prawns	Prawn	2.0	20.89	5.66	6.96
Large prawns	Prawn	–	11.40	2.48	–
Sub-total		91.9	81.21	67.93	64.44
Total		93.1	95.00	98.69	91.39

* *Study period 1 year (March 1993–February 1994) in floodplain of southwest Bangladesh*

***Study period 10 months (September 1996–June 1997)*

G. chapra are never found in the wide, shallow depressions in the floodplains (beels) because they "prefer openwater". The dense cover of aquatic weeds in Rajgonj may hinder the movement of *G. chapra*, while aquatic weeds inhibit phytoplankton production, making the lake less attractive to a phytoplankton feeder like *G. chapra*. It is also possible, however, that the low reported catch of *G. chapra* as well as the relatively high catch of other indigenous fish in Rajgonj is merely a reflection of low fishing intensity or an erroneous effect of the limited sampling. *G. chapra* appear suddenly in the lake, and individual fishers may simply not notice or cannot get themselves organized in time to catch them before they disappear again.

Species composition

The number of indigenous species found in the catch survey, as an indicator of biodiversity in the two lakes stocked with carp fingerlings under OLP II, compared favorably to the number of such species found in a non-stocked lake in open connection to a river and to the floodplains of southwest Bangladesh. Sixty indigenous species were recorded in the three oxbow lakes in this study, compared with 48 species in floodplains in southwest Bangladesh (Flood Action Plan 17 1995) and 43 recorded in 1992–1995 in Chanda and BKSB beels, also in southwest Bangladesh (Hossain et al., this vol.).

Migratory catfish, nearly absent from the floodplains, were common in all three oxbow lakes. Gobies and perchlets have also been found to be absent from floodplains, while large perches and gouramies were absent from the oxbow lakes. Surprisingly, *Anabas testudineus* and *Colisa fasciatus*, which are very common species in Bangladesh and account for 10% of the catch from the floodplains, were not recorded from any of the oxbow lakes in this study. *Labeo bata*, a migratory minor carp, dominated the migratory fish catch in Rajgonj Lake, contributing about 15% of total catch.

Although a shift in species composition was observed, the total catch of indigenous fish is still considerable in the managed oxbow lakes and appears not to be affected by the stocking of carp in Bukbhara and Kannadah. However, carp yields of these two lakes are either below or just near to the project average of 689 kg/ha/year in 1997 (Oxbow Lakes Project II 1997a). It is expected that at substantially higher carp yields, for example above 1 000 kg/ha as in Nasti and Hariharnagar Lakes in 1996–1997 (Oxbow Lakes Project II 1997b), fewer nutrients will be available for indigenous fish and that, as a result, yields of such fish will fall. Further research is necessary to study the impact of carp stocking in intensively managed oxbow lakes where fingerlings are stocked at rates as high as 5 000–10 000 fingerlings/ha/year, and where yields are in the range of 1 000–2 000 kg/ha/year.

Intensive purse seine fishing for carps may explain the apparent scarcity of large species such as featherbacks, although the wide mesh size would not directly affect the indigenous species. The relatively low catches of minnows, barbs, gars, gobies, gouramies, perches, etc. appear directly linked to the regular clearing of floating vegetation (e.g., water hyacinth, *Lotus* spp.) by fishers' groups, effecting a change in habitat by removal of surface cover and turning the water color from clear towards green.

Fishing of stocked carps takes place between November and June and is closed during July–October. Catches of non-stocked fish species appear to be usually higher at those times when catches of stocked carps are low or absent, indicating that fishers switch to individual fishing when the group seine nets are not operated.

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Market Survey of Carp Prices and Estimation of Their Optimum Harvest Size in Culture Based Fisheries

M.R. HASAN[1] and HANS A.J. MIDDENDORP
Oxbow Lakes Small Scale Fishermen Project, Second Phase, Department of Fisheries, BRAC and Danida Technical Assistance, Matshya Bhaban, Arabpur, Jessore, Bangladesh

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Abstract

Surveys of two fish markets in southwest Bangladesh showed that the price per kilogram of carp increases with size for both Indian major carps (i.e., catla, rohu and mrigal) and exotic carps (silver carp, grass carp and common carp). The financial simulation presented in this paper examines the relationship between harvest size, market price, fingerling stocking density, fingerling costs and rearing period. Both income-per-day and benefit–cost ratio (BCR) vary between species and depend on the size of fish harvested. For all carp species, the modeled income per day from a hectare of water area declines with increasing harvest size. Maximum income per day was obtained at harvest sizes of 0.4–0.6 kg and was highest for common carp, followed by silver carp and grass carp. The modeled BCR for a hectare of water area peaked for all six carp species at a harvest size of 1.0–1.5 kg, and was lowest for grass carp and common carp and highest for rohu. Optimizing the fisheries management of an oxbow lake thus depends on a choice between maximizing income per day—what fishers are mostly interested in—and maximizing BCR—the result usually preferred by a government lake manager or a private "local influential" in control of the lake.

Introduction

Oxbow lakes (*baors*) in Bangladesh are essentially managed as culture based fisheries. Large fingerlings of three Indian major carps: rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*); and of three exotic carps: silver carp (*Hypophthalmichthys molitrix*), common carp (*Cyprinus carpio*) and grass carp (*Ctenopharyngodon idella*) are regularly stocked and then harvested (Middendorp et al. 1996). An overview of the importance of the various carp species in oxbow lake fisheries is presented in Fig. 1.

The paper reports the results of a market survey of carps followed by a financial analysis of the optimum harvest size for each species. The survey covered six carp species (Indian major carps and exotic carps) and was carried out at two fish

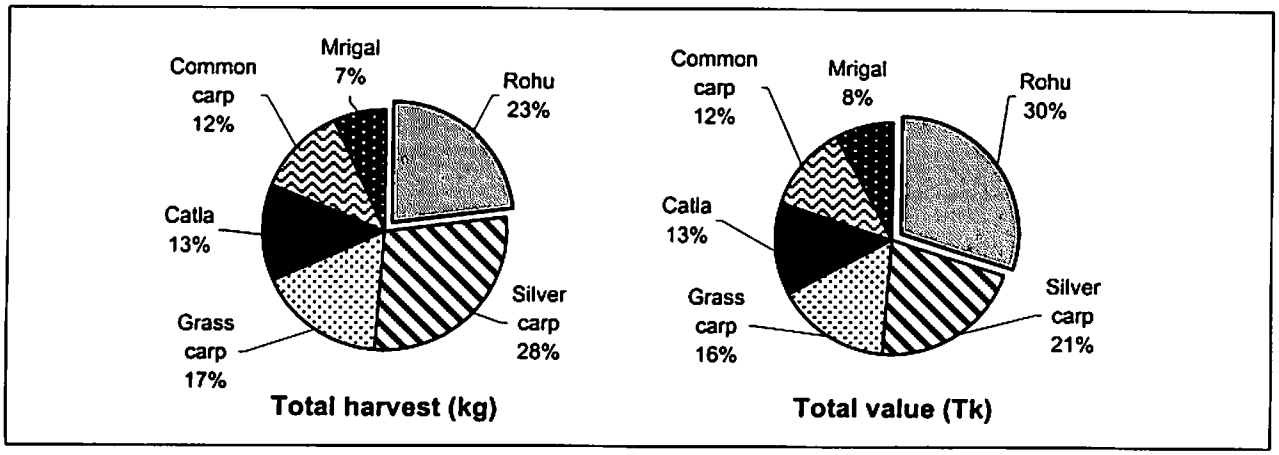

Fig. 1. Contribution of individual carp species to total carp production in oxbow lakes during 1994–1996.

[1] Department of Agriculture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

markets to determine the prices of different size groups. Subsequently, the market price data were used to estimate optimum fish harvest sizes for each of the carp species stocked in oxbow lake fisheries, in relation to fish growth.

Market survey

Methods

The market survey started in July 1996 and continued until December 1996 to observe seasonal trends and/or fluctuations of market price. Oxbow lakes under the Oxbow Lakes Small Scale Fishermen Project, Second Phase (OLP II) are scattered over five districts of southwest Bangladesh. Most oxbow lakes, however, are located in Jessore and Jhenaidah districts, and two important fish markets were selected in these districts: Jhikorgacha market, to cover the oxbow lakes in Jessore; and Kaliganja market, to cover the lakes in Jhenaidah. Retail fish price data were collected twice a week on market days (Jhikorgacha on Sundays and Thursdays, and Kaliganja on Mondays and Fridays).

Data were collected according to a prescribed format. Both retail fish sellers and customers were interviewed. When a customer purchased fish from a fish seller, the following information was collected: (1) cost per kilogram of fish; (2) total (bulk) weight of fish(es) sold; and (3) number of fish in the lot (sample size). If possible, weights were verified by spring balance. Data were collected from different fish sellers in each market. Efforts were made to ensure that, as far as possible, the data covered all the species on sale on that day and included a range of sizes. Raw data were entered in a spreadsheet (MS Excel 5.0), and fish prices (Tk/kg) were sorted according to month, market and average weight. Ten arbitrary size classes were selected: ≤200 g, 201–400 g, 401–600 g, 601–800 g, 801–1 000 g, 1 001–1 500 g, 1 501–2 000 g, 2 001–3 000 g, 3 001–5 000 g and 5 001–8 000 g.

Results

Results of the survey are presented in Fig. 2. The findings can be summarized as follows:

- There is a progressive increase of fish price with increase in fish size. This applies to all carp species, during all six months covered by the survey, and to both markets.
- Of the six carp species surveyed, rohu was found to be the most expensive, followed by catla, mrigal, grass carp/common carp and silver carp.

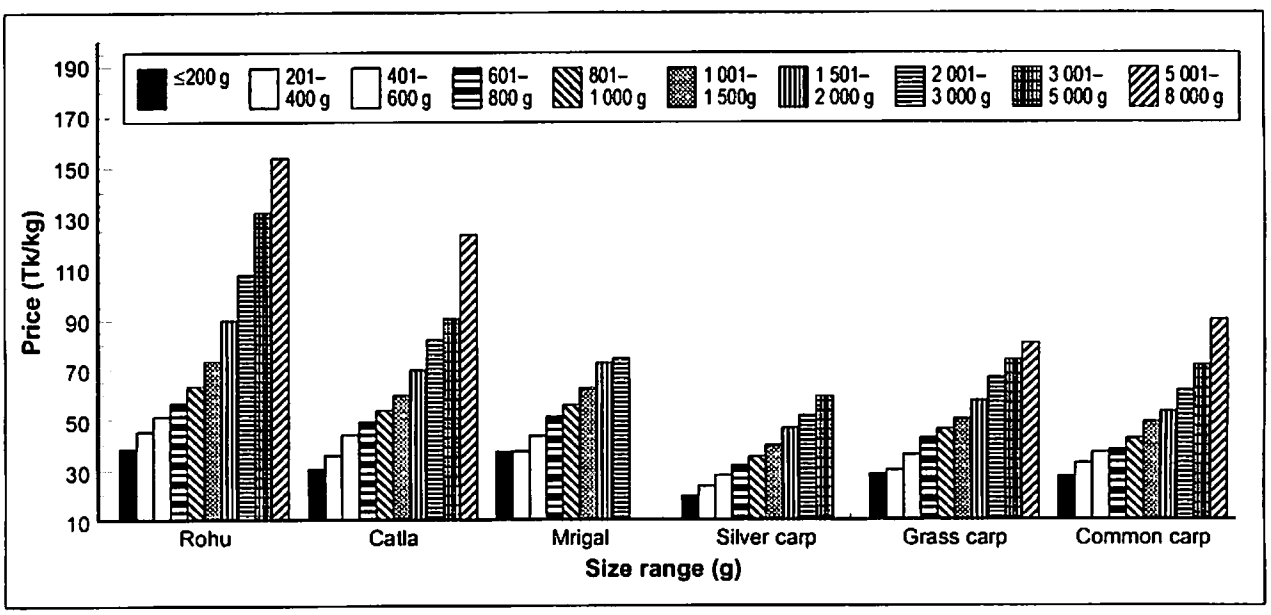

Fig. 2. Average price fluctuation of different size ranges for individual carp species in Jhikorgacha and Kaliganja markets, July–December 1996.

Estimation of optimum harvest size of carps in oxbow lakes

Methods

The optimum carp harvest size, for each of the six carp species commonly stocked in oxbow lake fisheries, was estimated by a financial analysis of the fisheries of 1 ha of water area in relation to pre-determined harvest weight. Market price of fish was estimated from the harvest size. Total quantity of fish sold was calculated from estimates of the percentage of fish recovered for different harvest sizes. Total rearing period was estimated from average growth. Stocking density of 1 ha of water area was chosen in relation to the pre-determined harvest weight, and the resulting fingerling costs were calculated accordingly. The simulation was done assuming an average stocking weight of 40 g. It was assumed that all fish are harvested and marketed after reaching the specified harvest size.

For each species, harvest size and the corresponding rearing period, gross production, gross income per day, fingerling cost, total production costs and benefit–cost ratio (BCR) were calculated, as follows:

a. Fish size: A range of harvest sizes was tested in the financial model as the principal variable.
b. Stocking density: The stocking density was a fixed variable chosen in relation to harvest size. When fish are harvested at low weights, they may be stocked at much higher densities. Fingerling stocking densities thus varied from 1 500 to 10 000 fingerlings/ha.
c. Recovery: Fish recovery was also a fixed variable, based on empirical observations (Oxbow Lakes Project II 1997) and assuming a quite high mortality due to fingerling transport (about 30–35%). Natural mortality up to 1 kg is very low. Serious poaching starts when fish reach a size of 1 kg. The decrease in recovery rates was assumed to be the same for all six species.
d. Fish rearing period: Rearing periods (RP) in days to attain the different harvest sizes in the model were calculated from average growth rates of each carp species obtained from length–frequency distribution analysis conducted previously in six oxbow lakes (Oxbow Lakes Project II 1996c).
e. Market price: Average market price (MP) for each species was estimated from the harvest weight, as found in the market survey (Fig. 2).
f. Fingerling cost: Total fingerling cost (FC) was calculated by multiplying cost per fingerling by the number stocked per hectare: FC = AvFP × SD, where FC = total fingerling cost of each species (Tk); AvFP = average fingerling price (Tk); and SD = stocking density (fingerlings/ha). AvFP was Tk 0.81 (silver carp), Tk 1.11 (mrigal), Tk 1.13 (rohu,), Tk 1.81 (catla), Tk 2.69 (common carp) and Tk 3.49 (grass carp) (Oxbow Lakes Project II 1996b). Fingerling cost per day was calculated by dividing total fingerling cost by the rearing period (in days).
g. Fish production: Total fish production (TFP) at the specified harvest size was calculated from the total number of fingerlings stocked (NF) while taking into account recovery rates, which decrease over time, as follows: TFP = NF × FS × R/100, where TFP = fish production (kg); NF = number of fingerlings stocked per hectare; FS = fish size at harvest (kg); and R = recovery rate (%).
h. Production costs: Production costs (PC: including interest costs) were calculated from the total costs (TC: not including interest charges) plus interest charges on loans to meet those costs. Total costs (TC) were calculated as follows: TC = FC + EC + GC + OC + MC+ LFC.

Where FC = fingerling costs, and all other operating costs were fixed as follows: EC = equipment and repair costs = Tk 2.42/ha/day, GC = guarding costs = Tk 1.05/ha/day, OC = other miscellaneous costs = Tk 3.63/ha/day, and LFC = lease fee costs = Tk 2.12/ha/day. MC = average marketing costs = Tk 1.50/kg of fish harvested (Oxbow Lakes Project II 1996a). However, it was assumed that only 80% of the fish yield was actually marketed (the remainder were assumed to be consumed and/or distributed locally).

Then, to simplify interest calculations over a period of 2–4 years, a flat rate of interest of 20% was assumed: PC = (TC × INT) + TC,

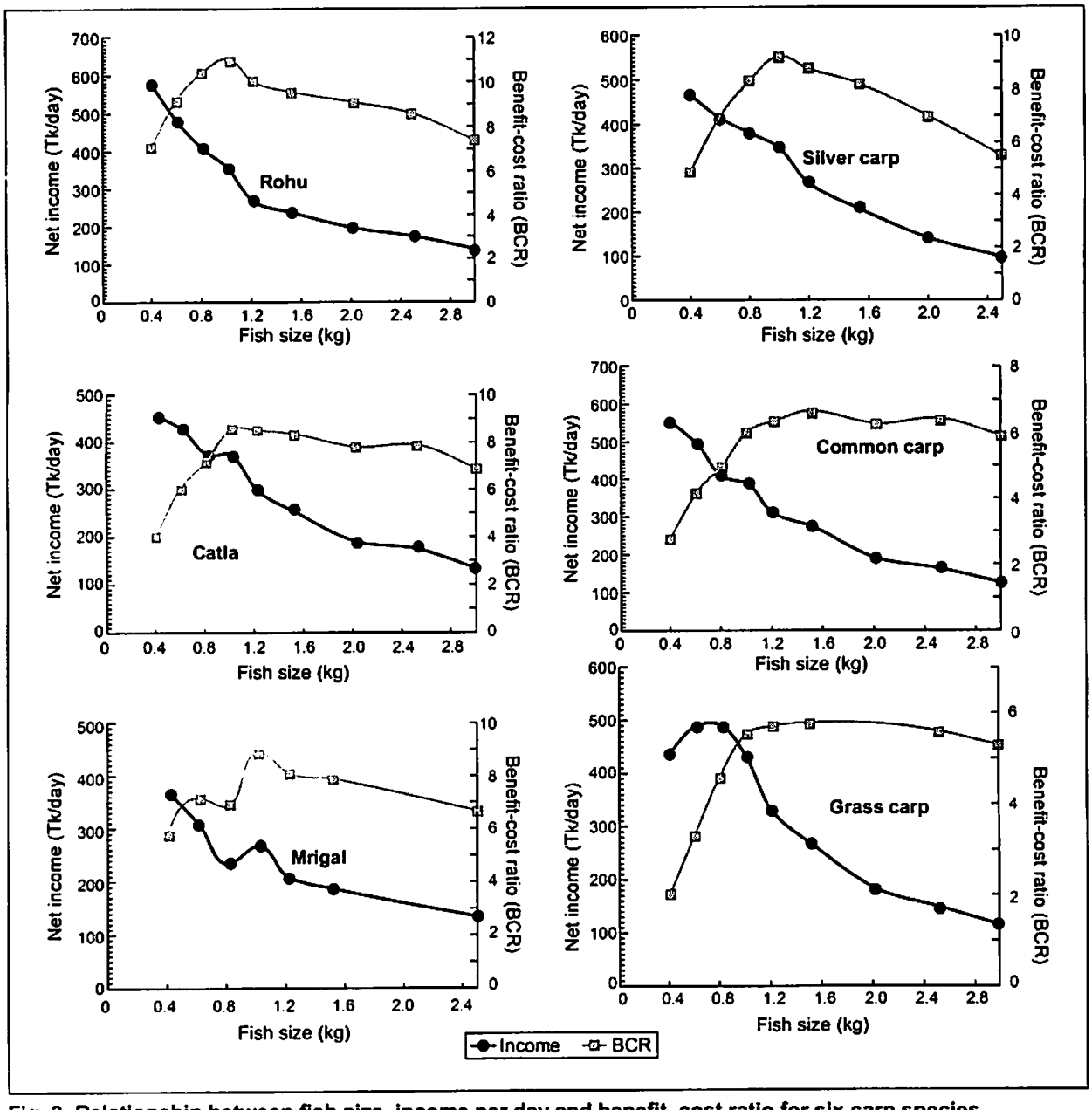

Fig. 3. Relationship between fish size, income per day and benefit–cost ratio for six carp species.

where PC = production costs, and INT = interest rate (20%). Note, however, that BRAC actually charges the fishers under OLP II 15% interest on "reducing balance".

Production costs per day for 1 ha of water area (PC/day) were then calculated by dividing production costs by the rearing period (RP).

i. Income per day: From the calculated total fish production (TFP) and the average market price (MP), total income was calculated. Then, net income/day/ha of water area was calculated by dividing total income (less production costs) by the number of rearing days (RP), as follows: net income/day (Tk/day) = ([TFP × MP] – PC) / RP.

j. Benefit–cost ratio: The benefit–cost ratio (BCR) was calculated by dividing gross income by total production costs, as follows: (TFP × MP)/PC.

Results

The modeled income/day/ha of oxbow lake varies between Tk 98 (silver carp of 2.5 kg) and Tk 575 (rohu of 0.4 kg), depending on the species, harvest size and the resulting rearing period.

Table 1. Relationship between average harvest size, net income and BCR, based on fish growth, recovery, market price in relation to fish size, and total costs (see text).

Fish size (kg)	0.4	0.6	0.8	1.0	1.2	1.5	2.0	2.5	3.0
Stocking density (no./ha)	10 000	7 500	6 000	5 000	4 000	3 500	2 500	2 000	1 500
Recovery (%)	68	67	66	65	60	53	45	42	40
Total production (kg/ha)	2 720	3 015	3 168	3 250	2 880	2 783	2 250	2 100	1 800
Rohu									
Rearing period (days)	188	295	404	535	662	787	932	1 076	1 230
Market price (Tk/kg)	46.5	52.7	58.1	65.0	69.9	74.8	90.7	100.3	109.9
Fingerling cost (Tk/day)	60.1	28.7	16.8	10.6	6.8	5.0	3.0	2.1	1.4
Total costs (Tk/day)	96.6	59.4	44.4	36.2	30.2	27.8	24.2	23.2	22.2
Net income (Tk/day)	575	479	411	359	274	237	195	173	139
Benefit–cost ratio (BCR)	7.0	9.1	10.3	10.9	10.1	9.5	9.0	8.5	7.3
Catla									
Rearing period (days)	167	263	365	422	486	580	730	802	949
Market price (Tk/kg)	37.3	45.3	50.1	55.4	58.1	60.9	70.9	77.4	83.9
Fingerling cost (Tk/day)	108.4	51.6	29.8	21.5	14.9	10.9	6.2	4.5	2.9
Total costs (Tk/day)	150.7	86.4	60.4	50.2	40.7	35.3	28.0	25.6	23.2
Net income (Tk/day)	457	433	375	376	304	257	191	177	136
Benefit–cost ratio (BCR)	4.0	6.0	7.2	8.5	8.5	8.3	7.8	7.9	6.9
Mrigal									
Rearing period (days)	240	374	496	614	730	839	1 027	–	–
Market price (Tk/kg)	39.5	44.8	53.1	56.9	60.4	64.0	74.0	–	–
Fingerling cost (Tk/day)	46.3	22.3	13.4	9.0	6.1	4.6	2.7	–	–
Total costs (Tk/day)	79.2	50.7	39.7	34.1	29.3	27.3	24.1	–	–
Net income (Tk/day)	368	310	236	267	209	185	138	–	–
Benefit–cost ratio (BCR)	5.7	7.1	6.9	8.8	8.1	7.8	6.7	–	–
Silver carp									
Rearing period (days)	112	178	243	307	371	464	623	869	–
Market price (Tk/kg)	24.0	28.7	33.1	36.5	38.6	40.6	46.2	49.6	–
Fingerling cost (Tk/day)	72.3	34.1	20.0	13.2	8.7	6.1	3.3	1.9	–
Total costs (Tk/day)	118.4	70.9	51.9	42.1	33.9	29.4	23.4	22.0	–
Net income (Tk/day)	465	415	380	344	265	214	143	98	–
Benefit–cost ratio (BCR)	4.9	6.9	8.3	9.2	8.8	8.3	7.0	5.5	–
Common carp									
Rearing period (days)	109	176	240	304	365	428	532	638	760
Market price (Tk/kg)	34.4	38.1	39.3	43.4	46.8	50.1	53.9	58.9	64.0
Fingerling cost (Tk/day)	246.8	114.6	67.3	44.2	29.5	22.0	12.6	8.4	5.3
Total costs (Tk/day)	304.0	159.3	105.5	78.4	58.9	49.3	36.0	30.4	25.9
Net income (Tk/day)	555	494	413	386	310	277	192	164	126
Benefit–cost ratio (BCR)	2.8	4.1	4.9	5.9	6.3	6.6	6.3	6.4	5.9
Grass carp									
Rearing period (days)	100	161	222	286	347	435	590	730	866
Market price (Tk/kg)	31.0	37.5	43.9	47.0	49.3	51.6	59.0	63.6	68.1
Fingerling cost (Tk/day)	349.0	162.6	94.3	61.0	40.2	28.1	14.8	9.6	6.1
Total costs (Tk/day)	413.2	212.4	136.4	98.1	71.8	56.8	39.0	32.4	27.5
Net income (Tk/day)	431	490	490	436	338	273	186	150	114
Benefit–cost ratio (BCR)	2.0	3.3	4.6	5.5	5.7	5.8	5.8	5.6	5.1

Note: Fingerling costs are included in total costs; US$1 = 46 Bangladesh Taka (approx.).

Similarly, the modeled BCR ranged from only 2.0 (grass carp of 0.4 kg) to 10.9 (rohu of 1.0 kg) (Fig. 3 and Table 1).

The modeled income/day/ha of oxbow lake stocked with rohu declines from Tk 575 (over a period of 188 days) at a modeled harvest size of

0.4 kg, to Tk 139 (over a period of 1 230 days) at a harvest size of 3 kg. Income per day for common carp decreases from Tk 555 at 0.4 kg to Tk 126 at 3 kg. Income per day for silver carp decreases almost linearly from Tk 465 at 0.4 kg to Tk 98 at 2.5 kg. Income per day for catla decreases from Tk 457 at 0.4 kg to Tk 136 at 3 kg. Income per day for mrigal decreases from Tk 368 at 0.4 kg to Tk 138 at 3 kg. Income per day for grass carp decreases from Tk 490 at a harvest size of 0.6–0.8 kg to Tk 114 at 3 kg. The grass carp fishery, however, largely depends on the presence of soft aquatic weeds in the oxbow lakes, which are quickly depleted when grass carp are densely stocked.

Rohu has the highest modeled BCR of all six carp species: optimum BCRs of more than 10 are observed at rohu sizes of 0.8–1.0 kg, and the BCR only gradually declines as large rohu fetch very high market prices. For silver carp, peak BCR of 9.2 is obtained at a harvest size of 1.0–1.2 kg. Silver carp grow relatively fast at small sizes, while big silver carp do not fetch a much higher market price. For mrigal, a clear peak in BCR at about 8.8 is noticed at a size of 1.0 kg. Optimum BCRs for catla of about 8.5 are observed at sizes of 1.0–1.2 kg, although the BCR does not decrease much at bigger harvest sizes. The BCR for common carp increases steadily to 6.6 at a size of 1.5 kg and decreases only slightly at higher harvest weights. The BCR for grass carp increases to about 5.5 at 1.0 kg, further increases to 5.8 at 2.0 kg, and then slowly decreases to 5.1 at 3.0 kg.

Discussion

In the financial model, benefits were assessed in terms of income per day and BCR for different sizes of fish harvested. Both income per day and BCR depend on the harvest size of the fish and vary among species. Income per day gradually declines with increase in fish size for all species, while BCR peaks for all species at 1.0–1.5 kg harvest size.

The two major variables that influenced financial benefits were the market price of fish and the cost of fingerlings. Market price increased with size, but the increase was more pronounced for Indian major carps than for exotic carps. Since stocking density decreased with rearing period, fingerling cost per day fell as rearing period increased. The recovery rate also has a major influence on the financial benefits, decreasing with fish size, but the rate of decrease is more pronounced after the fish reach a harvest size of 1 kg and above. This is thought to be due to poaching: poachers prefer bigger fish, and such fish are easier to poach by gill netting.

Silver carp size is most sensitive in relation to income per day. In other words, early harvesting of silver carp increases the fishers' benefits; the higher fingerling cost per day as a result of early harvest (at around 1 kg) is offset by the fast growth rate of silver carp in its first year.

Income per day has immediate importance for the fishers' day-to-day life. However, BCR is the yardstick by which an enterprise is normally evaluated by a farm manager. When income per day is a decisive factor for fishers, they should not stock mrigal and should harvest all other carp species at 0.4–0.6 kg. When BCR is the decisive factor, however, the preferable harvest size for rohu, mrigal, catla and silver carp is 1.0 kg, and for common carp and grass carp 1.2–2.0 kg. In fact mean harvest size for all species has decreased since the start of the project and, at present, a general harvest size of 1.0 kg is observed in most of the lakes managed by fisher groups (Oxbow Lakes Project II 1997).

Finally, when evaluating the oxbow lakes fisheries, the following limitations to the model presented should be recognized:

- Carps are not stocked in monoculture but in polyculture, which requires some degree of selective harvesting;
- Optimum species composition and species stocking densities are defined within a broad range (see Hasan, Bala and Middendorp, this vol.); and
- After harvesting of a particular species at its predetermined harvest weight, fingerlings for immediate restocking may not be directly available.

Conclusions

- Evaluating the financial model for an oxbow lake fishery depends on who is in charge of managing the fishery. Benefits measured in terms of income per day for each carp species have immediate importance to fisher groups organized for the lakes

under OLP II. In contrast, a fisheries manager on a government payroll or a private "local influential" managing an oxbow lake, will evaluate benefit in terms of benefit–cost ratio (BCR).

- If income per day is considered to be the main indicator for evaluating fishery performance, optimum harvest size for both Indian major carps and exotic carps should be 0.4–0.6 kg.
- When BCR is the main indicator, optimum harvest size for silver carp and mrigal would be around 1.0 kg, for rohu 1.0 kg but there is still a high return for fish of 2.5–3.0 kg, for catla about 1.0-1.5 kg, and for common carp and grass carp 1.2–2.5 kg.

Acknowledgements

The OLP II (1991–1997) was executed jointly by the Bangladesh Department of Fisheries, BRAC and Danida Technical Assistance. The project was funded through a loan to the Government of Bangladesh from the International Fund for Agricultural Development and through a grant from the Danish International Development Assistance.

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Stocking Strategy for Culture Based Fisheries: A Case Study from the Oxbow Lakes Fisheries Project

M.R. HASAN[1] and NITYANANDA BALA
Oxbow Lakes Small Scale Fishermen Project, Second Phase, Department of Fisheries, BRAC and Danida Technical Assistance, Matshya Bhaban, Arabpur, Jessore, Bangladesh

SENA S. DE SILVA
School of Aquatic Science and Natural Resources Management, Deakin University
PO Box 423, Warrnambool, Victoria, Australia 3280

HASAN, M.R., N. BALA and S.S. DE SILVA. 1999. Stocking strategy for culture based fisheries: a case study from the Oxbow Lakes Fisheries Project, p. 157–162. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Analysis of data from 20 oxbow lakes in Bangladesh indicates that most fish were stocked in July–October and harvested in October–February, with a few harvested later. Most fish are harvested within 12 months of stocking when they are 30–40 cm in length, except that some rohu are harvested in their second year. However, Secchi depth is lowest during February–June, indicating high primary production in this season when there are few fish in the lakes. It is proposed that carp production could be increased 50% by increasing stocking density to an average of 5000 fingerlings/ha by introducing a second stocking season in January–February when mainly silver carp should be stocked, as this species is a filter feeder with a high growth rate.

Introduction

Twenty oxbow lakes located in four districts (Jessore, Jhenaidah, Chuadanga and Kushtia) in southwest Bangladesh were brought under culture based fisheries management through the Oxbow Lakes Small Scale Fishermen Project, Second Phase (OLP II). Since oxbow lake fisheries are essentially carp culture based fisheries, appropriate stocking and regular harvesting are the key management factors in maximizing yield. Stocking largely takes place during July–October and fishing starts from October and continues to June. This study was undertaken to improve the current stocking strategy by means of an analysis of length–frequency distributions of the catch throughout the year and seasonal variations in physical parameters.

Methodology

Oxbow lakes are stocked annually with three Indian major carps: rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*); and three Chinese carps: silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio*). Length–frequency data for all six stocked carp species were collected from samples of fishers' catches in six oxbow lakes from February 1995 to June 1996 (Oxbow Lakes Project II 1996). Based on log–log transformation of mean monthly lengths and weights, mean annual growth rates were then calculated for each species and similarly, mean rearing periods were calculated for each size group.

Harvest data of stocked carp of 20 oxbow lakes are routinely recorded in the Lake Record Books. The monthly proportion (%) of total fish harvest, including all 20 lakes and all carps, from July 1994 to June 1995 (Table 1), was plotted against months to establish seasonal trends in fish harvest (Fig. 1). Secchi depth (cm) and water temperature (°C) were measured once weekly (Thursday) in each lake throughout the year. Mean monthly Secchi depth and mean monthly water temperature of all 20 lakes for 1994–1995

[1]Present address: Department of Aquaculture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

Table 1. Carp harvest status of 20 oxbow lakes during 1994–1995 (total water area = 1 081 ha).

Months	Total fish harvest (t)	Share of annual harvest (%)	Cumulative share of annual harvest (%)
July	8.0	1.7	1.7
Aug	17.6	3.6	5.3
Sep	9.1	1.9	7.1
Oct	36.9	7.6	14.7
Nov	66.3	13.6	28.4
Dec	92.6	19.1	47.4
Jan	59.3	12.2	59.6
Feb	49.8	10.3	69.9
Mar	42.6	8.8	78.6
Apr	39.8	8.2	86.8
May	45.8	9.4	96.3
Jun	18.2	3.7	100.0
Total	486.0	100.0	

and 1995–1996 (July 1994–June 1996) were calculated and plotted against time (Fig. 2).

Results and discussion

Average length–frequency (L–F) distributions of the catch of six oxbow lakes from February 1995 to June 1996 are presented in Fig. 3. The narrow L–F distribution of the catch, consisting mainly of fish of 30–40 cm in length (0.3–1.0 kg), is primarily due to the selectivity of the fishing gears used. In oxbow lakes, most fish are harvested by purse seine (50–80 mm mesh size) and brush shelter (Hasan, Bala and Middendorp, this vol.). The size range of harvested fish is also influenced by the fishers' preference: not-so-large fish are easily marketed locally, while large fish have to be sent to town via a network of fish wholesalers.

All carp species except mrigal grow to harvestable size (0.3–0.5 kg) within 120–150 days after stocking (Fig. 4). Stocking takes place between July and October, so the first fish enter the fishery in November. Rohu shows two clear modes, but catla, mrigal, silver carp, grass carp and common carp constitute a single length class, indicating that the fishery is essentially based on the current year's stocked fingerlings, of which the faster growing individuals enter the fishery within 120–150 days. This is particularly true for silver carp and common carp, which are the two main species of the oxbow lakes fishery. However two length classes of rohu occurred, indicating that a considerable proportion of rohu fingerlings are recruited into the fishery only in the following season (Fig. 3).

Current fish harvesting practices in 20 oxbow lakes are analyzed in relation to water temperature and Secchi depth. Major fish harvesting starts from October and continues up to June, although limited fishing is observed throughout the year. The bulk of the fish (60–70% of the catch) are harvested between October and February, i.e., within 3–7 months after stocking, when Secchi depth is still high (Fig. 1).

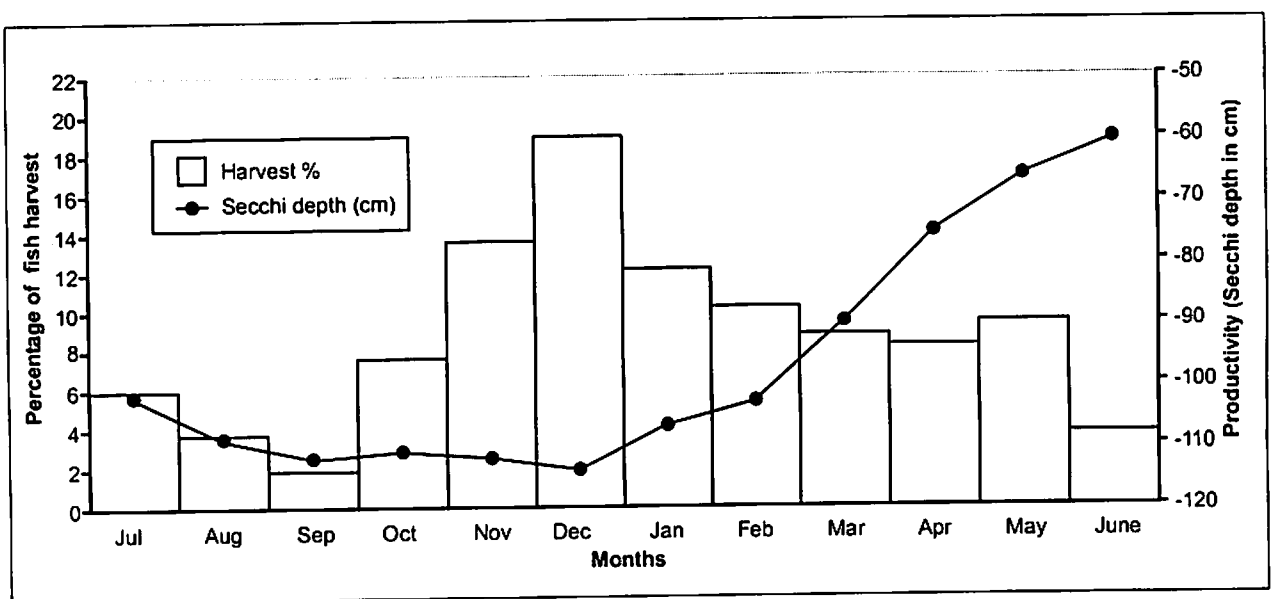

Fig. 1. Status of fish harvest and seasonal variation of water productivity in July 1994–June 1995.

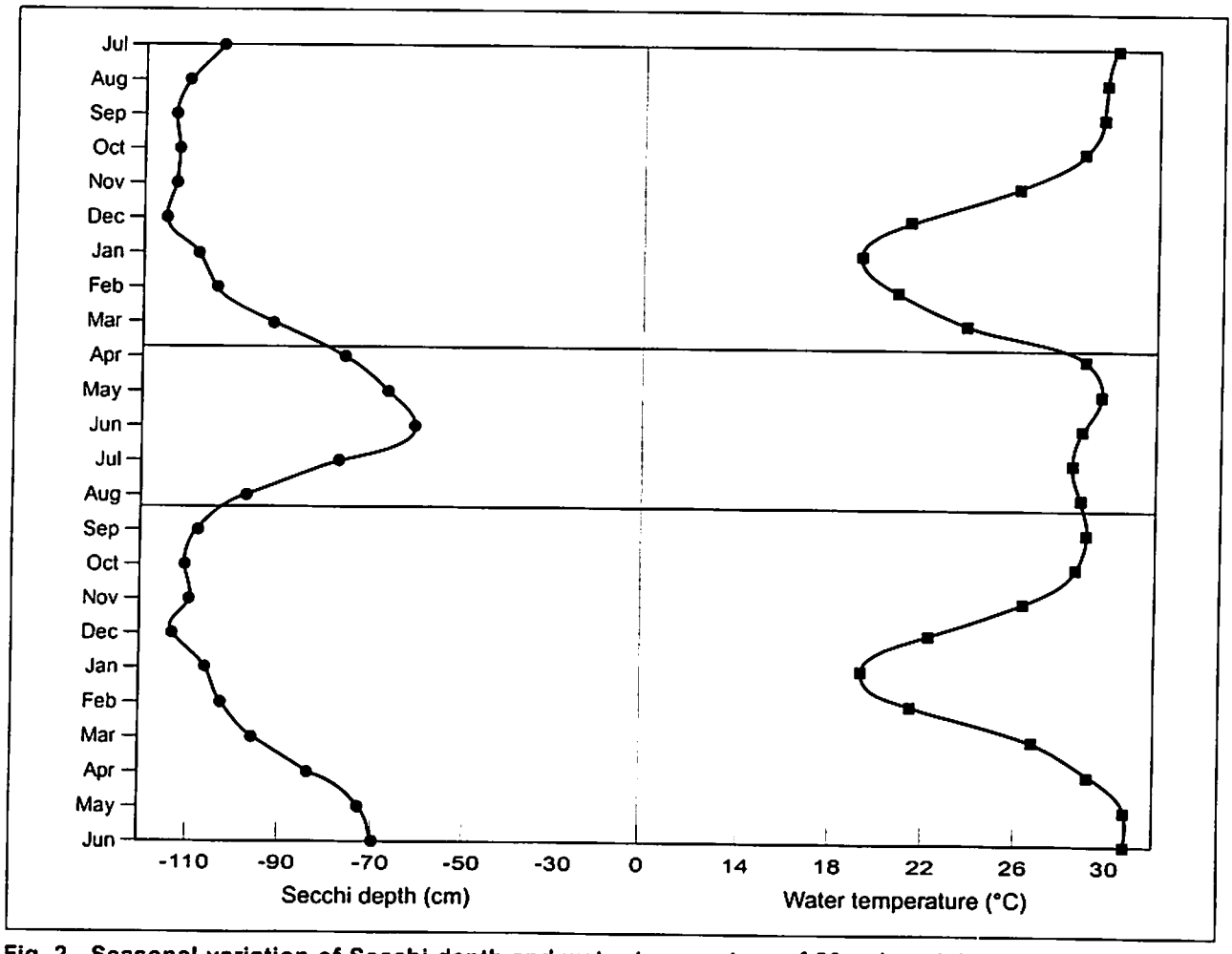

Fig. 2. Seasonal variation of Secchi depth and water temperature of 20 oxbow lakes from July 1994 to July 1996.

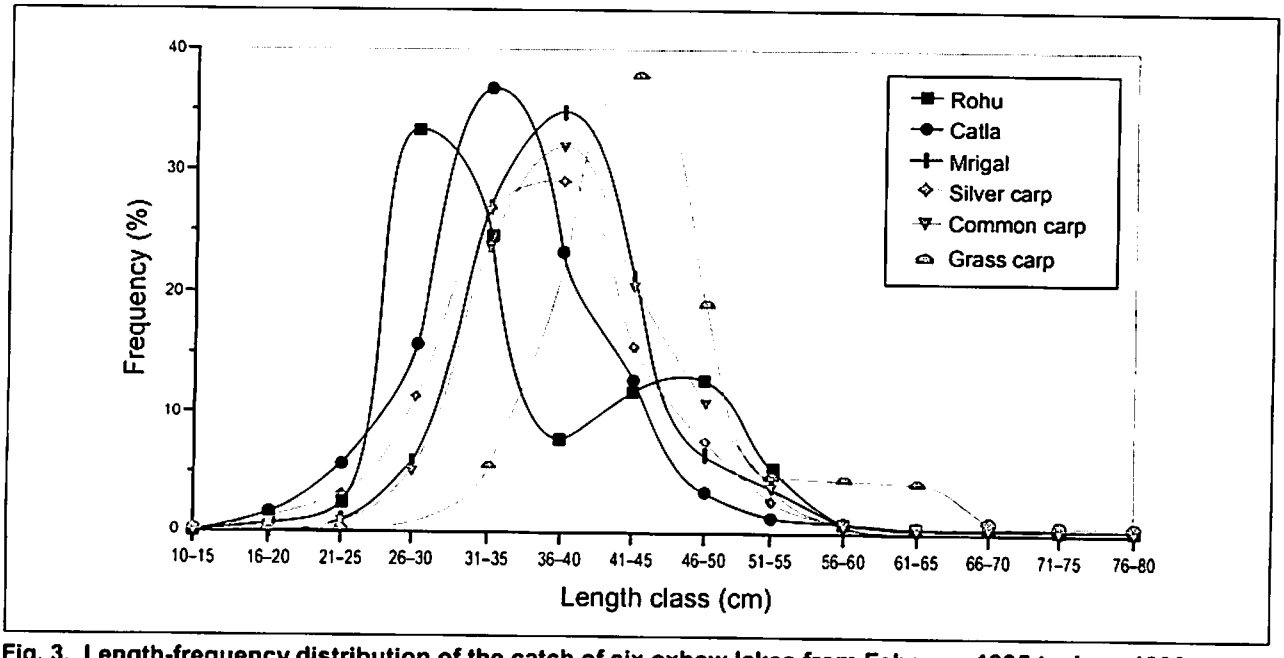

Fig. 3. Length-frequency distribution of the catch of six oxbow lakes from February 1995 to June 1996.

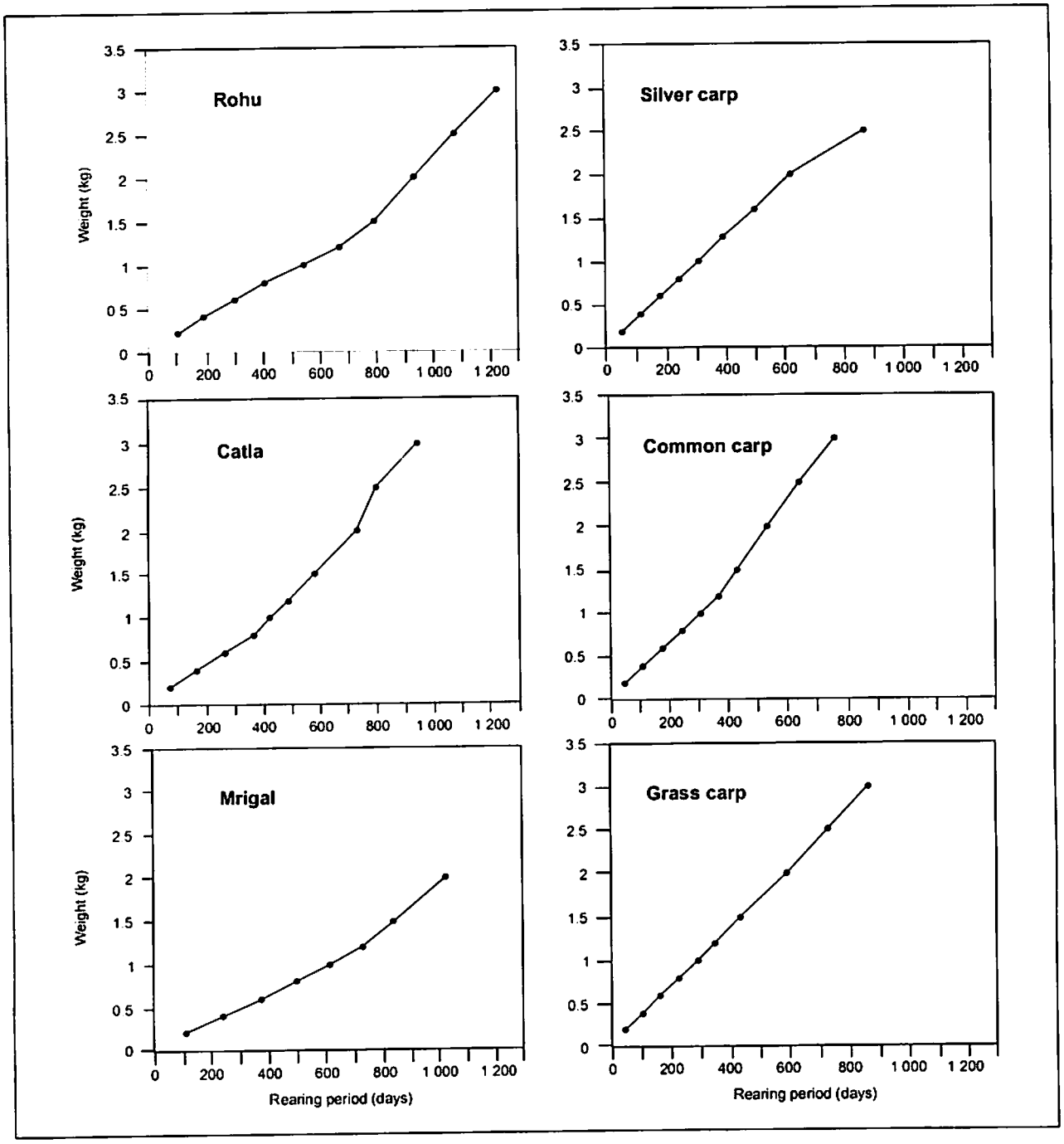

Fig. 4. Growth of six carp species after different rearing periods.

Trends for water temperature and Secchi depth visibility in 1994–1995 and 1995–1996 were almost identical (Fig. 2). Water temperature is generally above 28°C, although a sharp drop is observed between November and March. Secchi depth sharply decreases from February to June, indicating a spring–summer surge in primary production.

It follows from Fig. 2 that natural feed is abundant and water temperatures favor fish growth at precisely the time when carp biomass in the oxbow lakes is low. In other words, the hot season is underutilized under the present management practice. Present stocking and harvesting practices are schematically presented in Fig. 5A, showing fish biomass increasing steadily after stocking and reaching a peak in December, while few fish remain during the hot season (April–June). It is proposed here that fingerlings be stocked twice: (1) in July–October, and (2) in January–February.

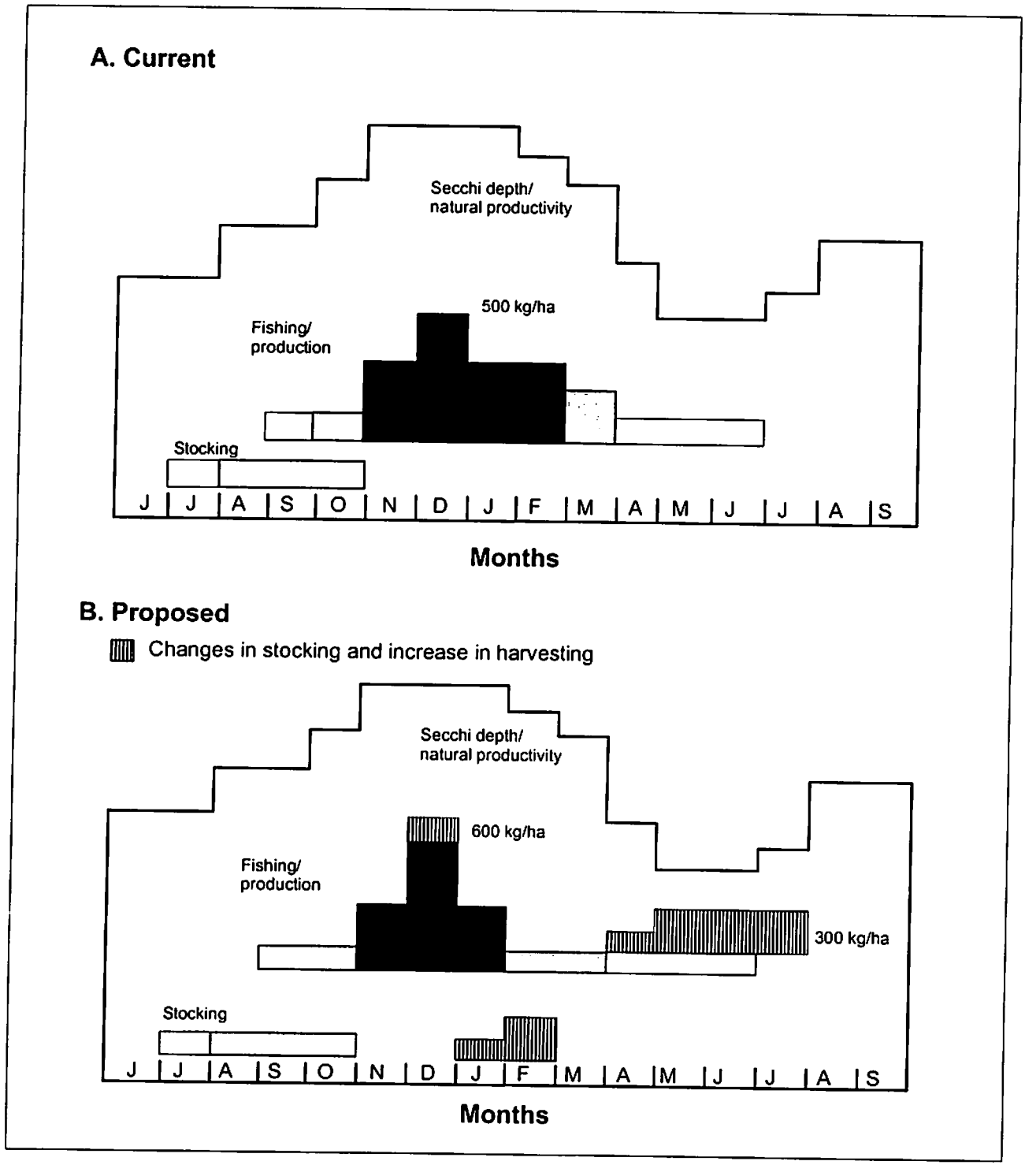

Fig. 5. Current and proposed stocking and harvesting practices in oxbow lakes under OLP II. Rounded estimates are based on field experience. Intensity of stocking and harvesting is shown by the intensity of shading.

Fingerlings stocked in the second period will make optimum use of the surge in primary production from March to June, as well as of the favorable water temperatures, leading to higher fish yields (Fig. 5B).

The carp yield of 17 oxbow lakes included in OLP II averaged about 500 kg/ha/year at an average stocking density of about 2 600 fingerlings/ha in 1994–1996. The relationship between yield and stocking density indicates that the stocking density of carp in an oxbow lake can be increased to 5 000 fingerlings/ha, corresponding to an estimated yield of 900 kg/ha (Hasan, Bala and Middendorp, this vol.). In fact, the four oxbow

lakes with yields exceeding 700 kg/ha all experienced some sort of continuous stocking throughout the year. It is thought that those high yields are realized by more efficient use of the summer surge in productivity, i.e., fingerlings stocked after October will escape the winter fishing season and grow fast during the hot season.

Based on observed yields in 1994–1996, it is postulated that an average carp yield of 600 kg/ha can be attained by stocking fingerlings in a single period, simply by ensuring good quality fingerlings of 5–6 inches (13–15 cm) in size. Subsequently, it is hypothesized that the predicted additional fish harvest of 300 kg (900–600 kg) can be realized over the hot season by stocking fingerlings in two periods and increasing total stocking density. Since the fishery begins to operate within 3 months of the first stocking in July–August, and the bulk of the harvest (60–70%) is obtained by January–February, the recommended double stocking over two periods is unlikely to stress the biological carrying capacity of the system.

For example, at the maximum recommended stocking density of 5 000 fingerlings/ha for lakes with average Secchi depths below 100 cm, in the first stocking period (July–August) 3 250 fingerlings/ha (65%) would be stocked, yielding an estimated 600 kg/ha, and another 1750 fingerlings/ha (35%) in the second period (January–February), yielding an additional 300 kg/ha.

The rearing period after the second stocking is relatively short, 120–150 days, as fishing in oxbow lakes ends in June when the rains start. Silver carp and common carp will reach a harvestable size of 0.4–0.6 kg within this period (Fig. 4) and these should be the main species stocked in the second stocking period. Silver carp especially will benefit from the abundant phytoplankton during the summer months.

Conclusion

The modified stocking strategy proposes a second stocking in January–February to make better use of the natural productivity of oxbow lakes as well as the period of high water temperatures. The key points are:

- Stocking density can be increased up to about 5 000 fingerlings/ha to provide an estimated yield of about 900 kg/ha.
- A second phase of stocking effectively utilizes the spring–summer surge in natural production, and the proposed change in stocking strategy may result in a considerable increase in fish production.
- The numbers to be stocked in each lake should be based on average Secchi depth (Hasan, Bala and Middendorp, this vol.). The second stocking should be about 50% of the first stocking or 35% of the total number of fingerlings stocked.
- Silver carp should be the principal species in the second stocking, considering the short rearing period (March–June) and the abundance of plankton.

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Seasonal Fluctuations in Water Levels and Water Quality in Oxbow Lakes in Relation to Fish Yields and Social Conflict

NITYANANDA BALA and M.R. HASAN[1]
Oxbow Lakes Small Scale Fishermen Project, Second Phase, Department of Fisheries, BRAC and Danida Technical Assistance, Matshya Bhaban, Arabpur, Jessore, Bangladesh

BALA, N. and M.R. HASAN. 1999. Seasonal fluctuations in water levels and water quality in oxbow lakes in relation to fish yields and social conflict, p. 163–169. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Water levels in oxbow lakes in southwestern Bangladesh are linked with rainfall patterns, but peak in October–November, about 2 months after the rainfall peak, then decline to a low in April–May. Water retention structures are left open to permit cultivation of land fringing the lakes. More water could be retained for fish production by delaying draining the lakes, but only if fishers can negotiate with farmers. Most of the lakes are now cleared of aquatic vegetation by the fishers; this has reduced water transparency and changed water color. Those categorized as "green water lakes" have the highest fish yields (due to high silver carp production) and the highest stocking densities. Fishers appear to vary stocking density according to water color.

Introduction

Oxbow lakes (*baors*) are semi-closed water-bodies, cut off from old river channels in the delta of the Ganges. Water levels vary with the seasons and seasonal changes in water level directly affect the total area of shallow fringe lands around the lake where paddy can be grown during the dry season. Rapid drainage of the lakes by paddy cultivators immediately after the rainy season is a cause of conflict with fishers in years with little flooding. Local variations in rainfall influence flooding pattern.

Fish growth is related to water temperature and primary production, as indicated by transparency (Secchi depth) and water color. For instance, the predominant water color appears to be an indicator of fish yield, and empirical evidence suggests that the highest yields of silver carp come from so-called "green water lakes". Data were recorded over a 2-year period to study patterns in the seasonal fluctuations in these parameters.

Materials and methods

The lakes under the Oxbow Lakes Small Scale Fishermen Project, Second Phase (OLP II) are leased from the Ministry of Land to the Department of Fisheries. The "hand-over area" of each lake is the lake area as actually recorded in the lease documents and includes the partially or fully dry public lands (*khas*) around it (Apu et al., this vol.)

An engineering team surveyed six to nine cross-sections (depending on the length of the lakes) of 20 oxbow lakes under OLP II between October 1994 and April 1995. The reference water spread area or standard water area (SWA) is the calculated water area (ha) on 1 January 1995. Maximum water area is the calculated water spread at the "10 years flood level" (highest water level observed in the last 10 years), and minimum water area corresponds to the lowest water level observed during April–May. The reference depth is defined as the layer of water above the central portion of 50 m width of each cross-section

[1]Present address: Department of Aquaculture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

estimated on 1 January 1995. The standard water depth (SWD) is the average reference depth of all cross-sections.

Water transparency, water color, water temperature and water level were recorded at a fixed sample site marked by a bamboo pole in front of the fish landing complex in each oxbow lake at 8 A.M. on the same day every week, from July 1994 to June 1996. Water transparency was measured to the nearest centimeter by lowering a Secchi disk to the point of disappearance. Water color was classified as clear, brown or green from a sample collected in a plastic jar. Water temperature was recorded to the nearest degree centigrade. Water level was recorded to the nearest centimeter. Rainfall was recorded daily to the nearest centimeter at the fish landing complex.

Based on the predominant water color, the lakes are categorized as green water, brown water or clear water lakes, and total stocking densities and fish yields by species were analyzed accordingly.

Results and discussion

Water area and depth

The SWA of 20 lakes averaged 54 ha, ranging from 9 ha (Sarjad) to 140 ha (Saster). The maximum water area averaged 147% of SWA, and the minimum water area 80% of SWA. The SWD ranged from 0.6 m (Hamidpur) to 4 m (Kannadah) (Table 1).

Oxbow lakes are rather small and shallow, flat-bottomed lakes, which vary considerably in water area between the wet season and the dry season. There are approximately 600 oxbow lakes in southwest Bangladesh with an estimated combined water area of 5 000 ha (Hasan 1990). It follows that most oxbow lakes are actually much smaller than the lakes under OLP II.

Average hand-over area was 56 ha, which does not appear very different from the average SWA. However variation was large: for example in Hariharnagar, SWA was 67% larger than hand-over area; while in Bukbhara, hand-over area was 10%

Table 1. Hand-over area, water area and standard water depth of 20 oxbow lakes under OLP II.

Lake	Date of survey	Hand-over area (ha)	Standard water area SWA (ha)	Maximum water area MWA (ha)	MWA as % of SWA	Minimum water area (Min. WA) (ha)	Min. WA as % of SWA	Standard water depth (m)
Nasti	10 Jan 95	66	54	63	116.7	49	90.7	1.8
Saster	17 Jan 95	98	140	174	124.3	117	83.6	1.4
Porapara	12 Jan 95	91	88	95	108.0	75	85.2	1.8
Sarjad	15 Jan 95	10	9	17	188.9	6	66.7	1.3
Kayetpara	25 Feb 95	108	116	151	130.2	87	75.0	1.3
Saganna	22 Feb 95	50	35	49	140.0	27	77.1	1.8
Benipur	12 Dec 94	47	45	72	160.0	37	82.2	1.9
Marufdia	20 Nov 94	26	25	39	156.0	24	96.0	2.0
Bhanderdah	15 Dec 94	37	48	78	162.5	41	85.4	1.3
Ujalpur	23 Feb 95	35	34	75	220.6	24	70.6	0.8
Koikhali	05 Dec 94	27	11	20	181.8	10	90.9	1.3
Bukbhara	09 Feb 95	153	138	184	133.3	102	73.9	2.4
Hamidpur	30 Oct 94	10	13	21	161.5	11	84.6	0.6
Khatura	31 Jan 95	65	69	113	163.8	59	85.5	3.0
Khedapara	29 Jan 95	57	45	47	104.4	36	80.0	2.4
Bakra	14 Feb 95	25	20	31	155.0	12	60.0	2.3
Bahadurpur	27 Feb 95	121	110	118	107.3	95	86.4	2.0
Kannadah	15 Feb 95	40	23	32	139.1	17	73.9	4.0
Kaliganga	11 Mar 95	27	28	46	164.3	24	85.7	1.4
Mean		55.6	54.1	73.0	146.5	43.7	80.0	1.8
± SD**		39.7	42.0	51.1	30.6	34.0	9.3	0.8

**10 years flood level*

***Standard deviation of mean*

larger than SWA. It is concluded that the hand-over areas of oxbow lakes as shown in the lease documents vary too much from the actual water areas managed by fishers' groups to be used reliably for calculating yields (kg/ha).

Rainfall

Average monthly rainfall was highest in August 1994 (25 cm) and in June 1996 (37 cm), while almost no rain was recorded from November to April each year (Fig. 1). Cumulative annual rainfall varied greatly between lakes and between years. The high variation in annual cumulative rainfall between the lakes indicates that big falls come as highly localized storms.

Water temperature

Water temperatures ranged between 29° C and 31° C on April–October and dropped below 22°C in only a few weeks in December, quickly rising again in February (Fig.1). Average monthly water temperature of all lakes was lowest in January (19.5°C in both years), and highest in July 1994 (30.7°C) and May 1996 (30.9°C) (Fig. 1).

The 2-month period of relatively low water temperature from mid-November to mid-January is a period of poor fish growth and of local outbreaks of Epizootic Ulcerative Syndrome (EUS). Fishing is intensive during the annual cold spell, which is also a period of high market demand, and it is hypothesized that chasing carp by purse seine actually increases the occurrence of EUS outbreaks. Of the stocked carps, mostly mrigal and catla are affected. EUS disappears again from the end of January.

Water level fluctuation

Average monthly water depths quickly rose in from July to September, remained high until November, and then decreased gradually from December to May. Overall, water level fluctuations were higher in 1995–1996 than in 1994–1995 (Fig. 1).

The rainy season starts in May and ends in September in this part of Bangladesh, although occasionally some rain is recorded in any of the other months. The water levels in the lakes start rising and falling with about 2 months delay, indicating that the rise largely results from floodwaters upstream and that levels are maintained up to December as a result of slow drainage. Water levels were above the reference depth of 1 January 1995 (SWA) during August–December, and below that depth during January–July in both years. In fact, the average water level of the 20 lakes steadily decreased from November to April, remained low in May and then increased again.

At the end of the rainy season, each oxbow lake is filled to the brim and water is discharged continuously through the outlet. Although many lakes have so-called "water control structures" (WCS), a kind of weir with openings for sluice boards, it is our experience that the WCS are always open, to permit a dry season rice crop (*boro* crop) on as much of the shallow fringe lands of the lakes as possible. If draining is still not fast enough, these WCS are damaged by the paddy farmers. Technically these fringe lands are part of the lake for which the fishers' groups pay the lease fee, but these plots are in fact "informally owned" mostly by non-fishers, who have no interest in maintaining high water levels for the fish (Oxbow Lakes Project II 1996).

In years with good rains, as in 1996, most oxbow lakes maintain at least 1–2 m of water in part of the lake. However, in 1995 many of the lakes dried up almost completely, causing conflict between fishers and the surrounding farmers, including paddy farmers outside the oxbow lake areas (Oxbow Lakes Project II 1996). Fishers cannot enforce their water rights, while paddy farmers need water in order to prevent crop failure. A simple interim solution, like banning the low-lift pumps taking water directly from the lakes in favor of shallow tube wells, reduces social tensions, but water is nevertheless extracted indirectly from the lakes.

While we argue that the general drop in ground water tables in the region due to intensive, large-scale irrigation from shallow tube wells actually is the cause of the steep November–April gradient observed in Fig. 1, it follows from the same graph that the water retention capacity of the lakes can be increased simply by not draining them as early

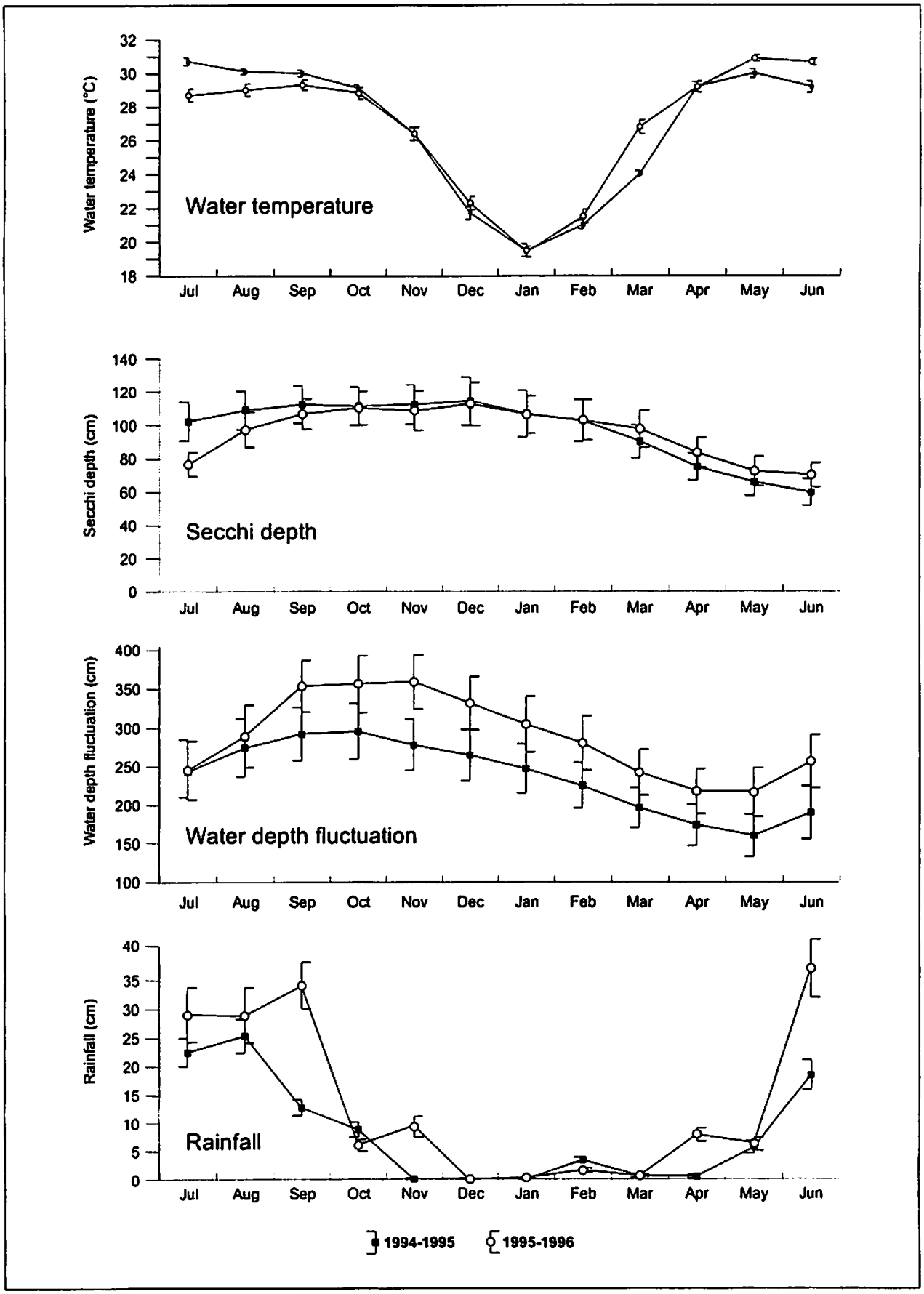

Fig. 1. Monthly mean water temperature, Secchi depth, water level fluctuation and rainfall from July 1994 to June 1996.

as November but only from January. The cost of such a measure would be a reduced area of dry-season rice.

It is concluded that the only solution is to arrive at some kind of water management agreement between the interest groups. Each fishers' group should hold regular consultations with the paddy farmers around the lake, and farmers should be made aware of the consequences to fishers of wasting water taken from the lakes for irrigation (see also Duyne, this vol.).

Secchi depth and water color

Overall average Secchi depth of all 20 oxbow lakes showed the same trend in 1994–1995 and 1995–1996, i.e., increasing transparency in July–October and decreasing Secchi depths again in December–June (Fig. 1). Average monthly Secchi depth was lowest in June and highest in December in both years, although monthly Secchi depths varied widely from month to month and from lake to lake.

Average annual Secchi depth was higher (i.e., fewer algae in the water), with greater average annual water level fluctuation, both in 1994–1995 ($P<0.01$) and 1995–1996 ($P<0.01$). Average annual Secchi depths were generally lower in smaller lakes, both in 1994–1995 ($P<0.01$), and in 1995–1996 ($P<0.05$). Average monthly Secchi depth increased with decreasing water temperature. A similar result was also reported from Kaptai Lake in Bangladesh (Halder et al. 1992). Generally in smaller lakes, Secchi depth is lower than in larger ones.

Secchi depths observed in 1994–1996 were generally two to four times lower than those recorded in 1992 (BCAS 1993). The range of Secchi depths in oxbow lakes was also lower than reported from Indonesian reservoirs (Hardjamulia and Suwignyo 1988) and Sri Lankan reservoirs (De Silva 1992). This suggests that the primary productivity of the oxbow lakes has increased over the last few years, indicating a change in nutrient flow away from aquatic vegetation into phytoplankton. As part of the fisheries management under OLP II, all lakes are regularly cleared of water hyacinth and other floating vegetation, while the submerged vegetation is successfully controlled by varying the number of grass carp fingerlings stocked each year.

Table 2. Apparent water color in 20 oxbow lakes from July 1994 to June 1995 and July 1995 to June 1996 and their classification based on water color.

	Lake	July 1994–June 1995			July 1995–June 1996		
		Green	Brown	Clear	Green	Brown	Clear
		Number of months	Number of months	Number of months	Number of months	Number of months	Number of months
Green	Nasti	10	2	0	12	0	0
	Porapara	10	2	0	8	4	0
	Sarjad	10	2	0	9	3	0
	Benipur	12	0	0	10	2	0
	Marufdia	11	1	0	8	4	0
	Khedapara	9	3	0	9	3	0
	Kannadah	12	0	0	12	0	0
Brown	Sastar	5	7	0	0	12	0
	Saganna	6	6	0	3	9	0
	Hariharnagar	1	11	0	0	12	0
	Bakra	0	12	0	3	9	0
	Kaliganga	0	10	1	0	8	4
Clear	Kayetpara	0	1	11	0	5	7
	Bahadurpur	0	0	12	0	0	12
Mixed	Bhanderdah	2	3	7	4	8	0
	Ujalpur	1	3	8	0	12	0
	Bukbhara	2	1	9	10	2	0
	Hamidpur	3	9	0	9	3	0
	Koikhali	8	4	0	3	1	8
	Khatura	5	0	7	7	0	5

Predominant water color is shown in Table 2. Seven lakes were predominantly green, while water color was mostly brown in another five. Green water lakes are on average green for 10 months and brown for 2 months, while brown water lakes are brown for 10 months and green for 2. Clear water was observed throughout the year in Bahadurpur, and in most months in Kayetpara.

Bhanderdah, Ujalpur and Bukbhara were predominantly clear in 1994 but changed to brown or green in 1995, while in Hamidpur the predominant water color was brown in 1994 and green in 1995. No definite color pattern was observed in Koikhali and Khatura Lakes (Table 2).

Stocking densities and fish yields of each lake are presented by Hasan, Bala and Middendorp (this vol.). Average stocking densities and yields of each species, grouped by predominant water color, are shown in Table 3, i.e., green water lakes (n = 7); brown water lakes (n = 5) and clear water lakes (n = 2).

Green water oxbow lakes have distinct algal blooms as indicated by low Secchi depths and, in general, have little or no floating aquatic vegetation; whereas brown water oxbow lakes have comparatively more aquatic vegetation. Clear water lakes mostly have a comparatively high cover of floating and submerged aquatic vegetation. Observation of clear water usually coincided with water transparencies exceeding 140 cm. Following increased stocking with grass carp, submerged vegetation is quickly reduced, causing water color to turn green.

In order to evaluate the empirical findings that "green water lakes" have good yields of silver carp (a phytoplankton feeder) and low yields of grass carp, while "brown water lakes" and "clear water lakes" have low yields of silver carp but better yields of grass carp and rohu, stocking densities and yields by species were categorized, based on the dominant water color of the lake in Table 3. The average total annual yield was highest in green water lakes (700 kg/ha), followed by brown water lakes (485 kg/ha) and clear water lakes (307 kg/ha). Similarly, total stocking densities were also highest in green water lakes (3 845 fingerlings/ha), followed by brown water lakes (3 337 fingerlings/ha) and clear water lakes (1929 fingerlings/ha).

Based on the present data, however, the effect of water color cannot be separated from the effect of stocking density. It seems most likely that fishers actually stock the lakes in relation to their production capacity: for example "green water lakes" are heavily stocked with silver carp just because they are green. Predominantly green lakes also have low Secchi depths. A significant relationship between Secchi depth and stocking density on annual fish yields of stocked carps in oxbow lakes has been clearly demonstrated (Hasan, Bala and Middendorp, this vol.).

The transformation of an unmanaged oxbow lake, full of macrophytes, to a green water lake with little or no vegetation and with low Secchi depth, resulted in initially high yields of grass carp (pers. obs.) followed by very high yields of silver carp, e.g., average stocking densities of silver carp were twice as high in green water lakes as in brown water lakes, resulting in a doubling of yields (Table 3).

Acknowledgements

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Table 3. Mean stocking densities and yields in green, brown and clear water oxbow lakes*.

	Lake water color	Species						Total
		Silver carp	Catla	Rohu	Common carp	Mrigal	Grass carp	
Stocking density (no./ha)	Green	1 785 (±281)	387 (±101)	519 (±83)	322 (±52)	616 (±231)	216 (±70)	3 845 (±460)
	Brown	997 (±343)	325 (±69)	740 (±207)	634 (±263)	296 (±94)	345 (±95)	3 337 (±837)
	Clear	265 (±229)	197 (±196)	598 (±333)	199 (±17)	247 (±236)	423 (±182)	1 929 (±796)
Yield (kg/ha)	Green	317 (±48)	76 (±26)	99 (±14)	73 (±20)	77 (±16)	58 (±14)	700 (±77)
	Brown	174 (±52)	58 (±12)	101 (±18)	52 (±9)	36 (±10)	64 (±16)	485 (±72)
	Clear	25 (±12)	34 (±7)	115 (±74)	33 (±31)	9.3(±4)	86 (±29)	307 (±157)

Figures in parentheses are standard error of mean.

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Gear-specific Catches in Culture Based Fisheries in Oxbow Lakes

M.R. HASAN[1], NITYANANDA BALA and M. IQBAL HOSSAIN
Oxbow Lakes Small Scale Fishermen Project, Second Phase, Department of Fisheries, BRAC and Danida Technical Assistance, Matshya Bhaban, Arabpur, Jessore, Bangladesh

HASAN, M.R. , N. BALA and M.I. HOSSAIN. 1999. Gear-specific catches in culture based fisheries in oxbow lakes, p. 171-175. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

A study was carried out in two oxbow lakes under the Oxbow Lakes Small Scale Fishermen Project, Second Phase, to compare gear selectivity of purse seine (*kochal*) and brush park (*komar*) for species number and size by analyzing the catch frequencies of various size classes of the six carp species stocked. Length-frequency data collected from Nasti and Porapara Lakes for both types of gear over the same period indicated significant differences in average size harvested for silver carp, catla, rohu, mrigal and common carp between purse seine and brush park. Only grass carp did not exhibit a size difference. In general, fish of all these species caught in the brush park were 40–70% heavier than the catches from the purse seine. Occurrence (all length classes combined) of silver carp (a surface feeder) was higher in purse seine catches, whereas for common carp (a bottom feeder) it was higher in brush park catches.

Introduction

An oxbow lake (*baor*) is a river loop cut off when the river changed course. Twenty oxbow lakes in four districts (Jessore, Jhenaidah, Chuadanga and Kushtia) in southwest Bangladesh were brought under community culture based fisheries management under the Oxbow Lakes Small Scale Fishermen Project, Second Phase (OLP II) (Middendorp et al. 1996). By screening the inlets and outlets of oxbow lakes, and by regularly stocking large fingerlings (10–15 cm; 4–6 inches) of rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus mrigala*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio*), an openwater fishery is converted into a culture based fishery.

In oxbow lakes, just two gear types are used almost exclusively to catch fish: purse seine nets and brush parks. The objective of this study was to compare the gear selectivity of purse seine and brush park by analyzing the catch frequencies of various size classes of the six carp species stocked.

Methodology

Purse seine nets (*kochals*) are set between two boats paddled by 12 fishers each, to encircle a stretch of water. A number of rectangular pieces of net, of different owners, are joined, forming a seine net at least 70 m long. The depth of the net varies between 5 m and 20 m, depending on the depth of the lake, and mesh sizes are 50–80 mm (Oxbow Lakes Project II 1995). In oxbow lakes, purse seines are used nearly every day throughout the fish harvesting season (October–May).

Brush parks (*komars*) are a kind of fish aggregating device (FAD) made of bamboo and tree branches. Brush parks are set in September–October and usually fished every 2–3 months from January to June, by encircling the brush park with a net and removing all the branches. Brush park fishing, popularly known as *kata* fishing, is also widely practiced in rivers and other openwaters in Bangladesh (Huque 1997).

Catch data from purse seine and brush park for all six carp species as available in the catch were collected from Nasti and Porapara Baors (lakes)

[1] Present address: Department of Aquaculture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

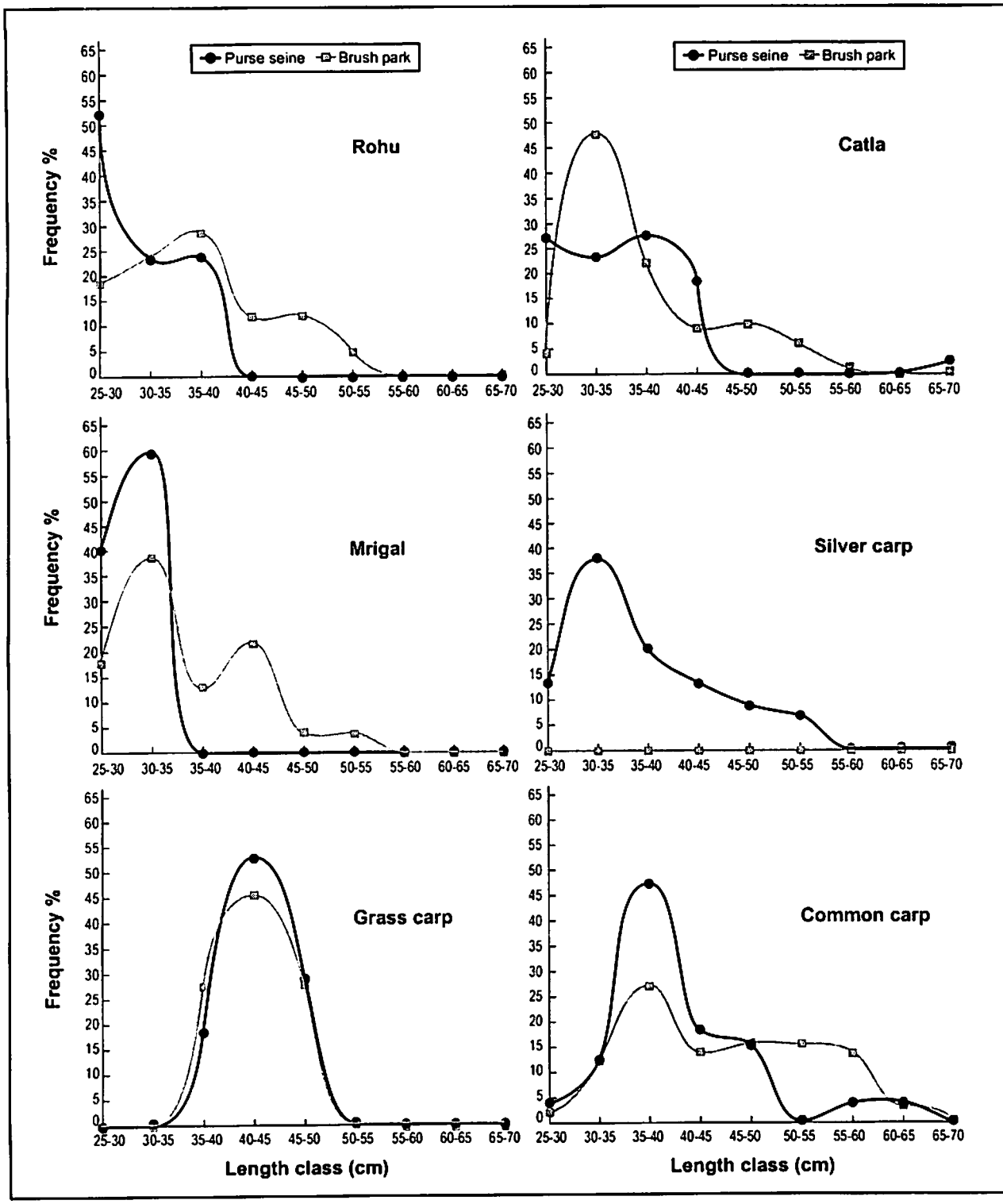

Fig. 1. Length–frequency distribution of Indian major and Chinese carps harvested by purse seine and brush park in Nasti Lake.

in Jhenaidah District at the end of the harvest season in April 1996. Fish of all sizes, including both marketable and undersized fish, were randomly taken from the catch. Total length was measured on a measuring board to the nearest 0.5 cm and individual fish were weighed in a polyethylene bag by spring balance of 1 kg (fraction 5 g) and 5 kg (fraction 100 g). Altogether 738 fish were sampled (390 from Nasti, 348 from Porapara).

Fish were grouped in length classes of 5 cm, starting from 25 cm. Average weight of each species (all sizes pooled) was calculated by gear type separately for each lake, and differences were statistically tested. Occurrence (%) of each species,

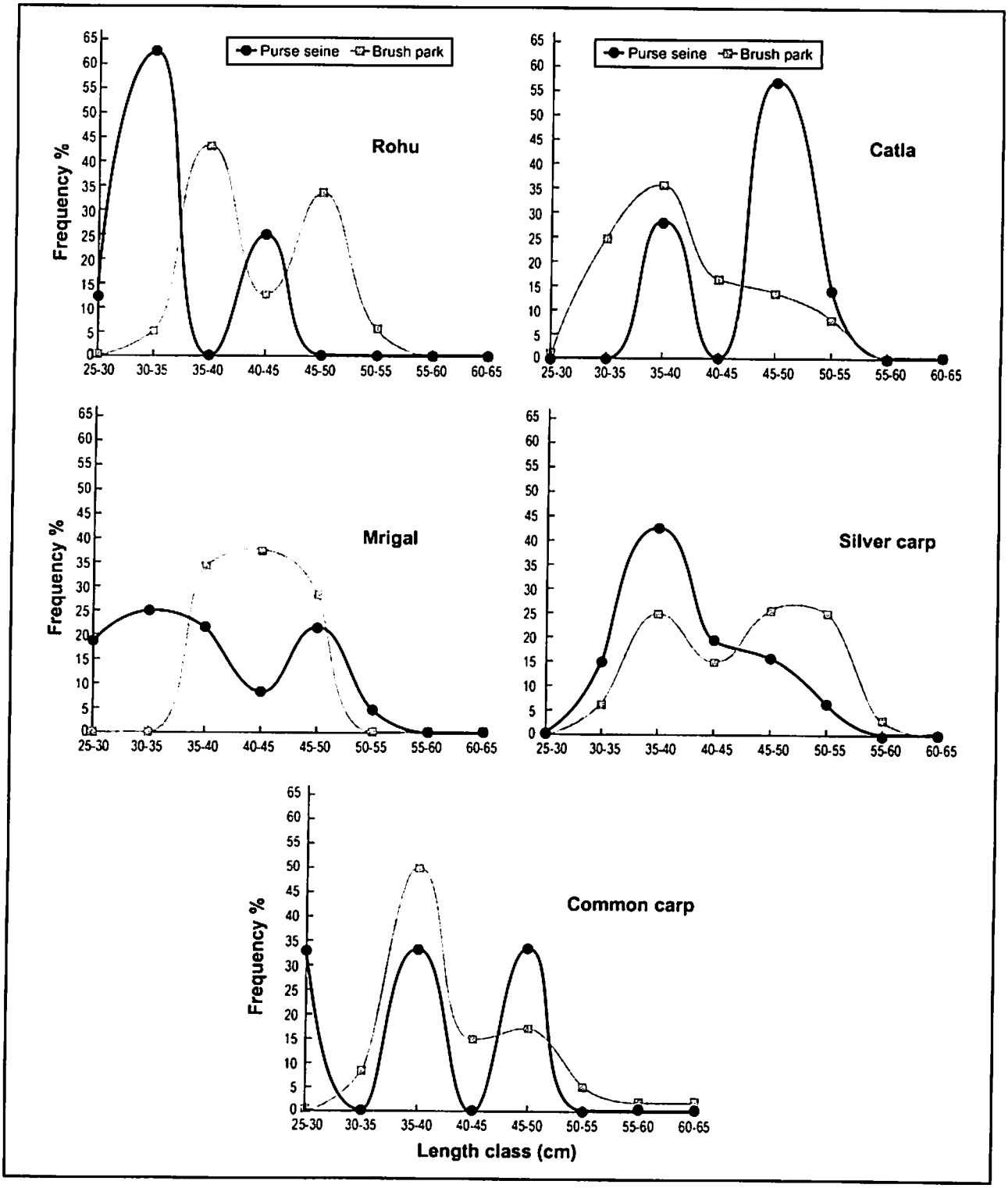

Fig. 2. Length–frequency distribution of Indian major and Chinese carps harvested by purse seine and brush park in Porapara Lake. Catch data for grass carp were not available.

all sizes pooled, was calculated for each lake and averaged over both lakes.

Results

Length–frequency distribution curves for each carp species harvested by purse seine and brush park are presented in Fig. 1 (Nasti) and Fig. 2 (Porapara). Carps of each species and of each size class were caught with both gear types. Length–frequency curves for purse seine and brush park varied widely. In Nasti for grass carp, the catch frequency curves of purse seine and brush park were nearly identical, but in Porapara for rohu

Table 1. Mean weight (g) of stocked carp species harvested by purse seine and brush park in Nasti and Porapara lakes during April 1996.

Species	Nasti Lake				Porapara Lake			
	Purse seine		Brush park		Purse seine		Brush park	
	Weight (g)	n*	Weight (g)	n	Weight (g)	n	Weight (g)	n
Rohu	348[a] (±38.2)	21	629[b] (±56.1)	42	649[a] (±92.9)	10	930[b] (±60.1)	39
Catla	551[a] (±39.3)	46	793[b] (±62.7)	69	1 351[a] (±168.5)	5	1 283[a] (±96.5)	36
Mrigal	264[a] (±13.2)	15	524[b] (±81.6)	23	613[a] (±51.6)	60	878[b] (±40.0)	35
Silver carp	555 (±50.4)	45	–	–	794[a] (±44.6)	56	1 086[b] (±65.6)	52
Grass carp	938[a] (±52.6)	17	904[a] (±57.0)	11	–	–	– –	
Common carp	1 216[a] (±133.4)	34	1 728[b] (±126.4)	67	917[a] (±375.7)	3	1 582[a] (±139.7)	52

Note: Comparing within each lake, values in the same row and with same superscript are not significantly different (t-test, P>0.05). Standard error of the mean is in parentheses.
** n: number of fish measured*

they were completely opposite. In most cases, two peaks, corresponding to two length classes, were found and peaks were, overall, more pronounced in the purse seine curves. Length–frequency peaks were also more pronounced in Porapara than in Nasti.

Mean weights of the six carp species harvested by purse seine and brush park are presented in Table 1. There were significant differences ($P<0.05$) in mean weight of catla, rohu, mrigal and common carp harvested by purse seine and brush park in Nasti Lake (no silver carp were caught in brush parks). In the case of Porapara Lake, significant differences were observed in mean weight of silver carp, rohu and mrigal only; no significant difference in mean harvest weight between purse seine and brush park was observed for catla and common carp. This difference in trend in harvest sizes for catla and common carp between the two lakes was further examined to find out if purse seine and brush park catches for catla and common carp were lake specific. This was done by examining the relationship between the two lakes and two gears with the help of correlation and t-statistics, using the mean harvest weight data from Table 1.

Table 2. Correlation and t-statistics between Nasti and Porapara Lakes, and between purse seine and brush park using mean harvest weight data of stocked carp species from Table 1.

Variables	No. of observations	r-value	t-value
Nasti vs. Porapara	9	0.713*	2.45*
Purse seine vs. brush park	10	0.846**	4.05**

** Significant at 0.05 level of probability*
*** Significant at 0.01 level of probability*

When the two lakes were compared by pooling the data of both gears (Table 2), both r- and t-values were significant ($P<0.05$). This indicates that there was a significant correlation between the two lakes in terms of gear selectivity when mean harvest weight was used as the criterion, although there were significant differences in mean weight between the two lakes. Similarly, significant correlation and mean weight differences were observed when the two gears were compared by using pooled data of the two lakes. This shows that purse seine and brush park catches for catla and common carp were not lake specific, and the apparent differences in fish size caught by purse seine and brush park for these two species were probably due to the relatively small sample sizes from Porapara.

Occurrence (all length classes combined) of silver carp (a surface feeder) was higher in purse seine catches, whereas for common carp (a bottom feeder) it was higher in brush park catches. Differences in occurrence were also observed between purse seine and brush park for rohu (a column feeder), although they were less pronounced than for silver carp and common carp (Table 3).

Conclusions and discussion

Catch frequencies for each size class varied widely between the two lakes sampled. Nasti appeared dominated by a single large size group of each carp species; while in Porapara, two almost equally important length–frequency peaks, suggesting two year classes of each species, were found.

Table 3. Frequency of occurrence (%) of six carp species in purse seine and brush park in Nasti and Porapara Lakes during April 1996.

Species	Nasti Lake		Porapara Lake	
	Purse seine	Brush park	Purse seine	Brush park
Rohu	11.8	19.8	6.0	18.2
Catla	25.8	32.5	5.2	16.8
Mrigal	8.4	10.9	44.8	16.4
Silver carp	25.3	–	41.8	24.3
Grass carp	9.6	5.2	–	–
Common carp	19.1	31.6	2.2	24.3
Total	100.0	100.0	100.0	100.0

Assuming that differences between Nasti and Porapara Lakes in physical characteristics and fingerling stocking are small, more silver carp were caught by purse seine while more common carp were caught from brush parks. On the other hand, it appears that gear selectivity of seine net and brush park is not different for catla and grass carp. In general, carps caught from brush parks, except grass carp, were 40–70% heavier than the same species caught from purse seine nets. Rohu and mrigal caught from brush parks were on average 300 g heavier. Common carp caught from brush parks were on average about 500 g heavier, although variation in mean weight in Porapara is not statistically significant ($P>0.05$). Average weight and catch frequencies for grass carp were remarkably similar, although data were available from Nasti only.

The largest specimens (>50–60 cm, depending on species) were caught mostly from brush parks. Note that sampling of seine net and brush park catches was undertaken during the same short period. The reasons why relatively larger fish are caught from brush parks are not clearly understood, however. Possibly large fish manage to escape the purse seine fishing and take shelter in brush parks. Another factor could be that individual fish regularly taking shelter in brush parks have a much lower exposure to purse seine fishing.

Brush park density averages about one brush park per 10 ha of water area (Oxbow Lakes Project II 1995). Branches used in brush parks also contribute to nutrient inputs and act as substrates for epiphytic algae and aufwuchs grazed by rohu and certain indigenous fish species such as small catfish (*Mystus* spp.) and barbs (*Puntius* spp.). Brush parks merit further investigation as a potential sanctuary for indigenous fish species (Middendorp and Bala, this vol.).

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Financial Performance of Culture Based Fisheries in Oxbow Lakes in Bangladesh Managed by Fishers' Groups

HANS A.J. MIDDENDORP, MD. MOKLESHUR RAHMAN and MD. ABDUS SATTAR
Oxbow Lakes Small Scale Fishermen Project, Second Phase. Department of Fisheries, BRAC and Danida Technical Assistance, Matshya Bhaban, Arabpur, Jessore, Bangladesh

MIDDENDORP, H.A.J., M.M. RAHMAN and **M.A. SATTAR.** 1999. Financial performance of culture based fisheries in oxbow lakes in Bangladesh managed by fishers' groups, p. 177–182. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

The total recorded carp yield in 1995–1996 for all 10 oxbow lakes in the study, covering 441 ha, was 279 t with a recorded sales value of US$247 201. Average carp yield was 669 kg/ha. Carp production increased linearly with lake area. Total operating costs averaged US$309/ha, 58% of which was fingerling costs. Carp sales averaged US$596/ha and carp income averaged US$287/ha or US$119 per fisher in the lake fishing teams. The benefit–cost ratio averaged 2.11 and the return on fingerling costs 474%.

Introduction

The Oxbow Lakes Small Scale Fishermen Project, Second Phase (OLP II) is a social fisheries project in 23 natural oxbow lakes (*baors*) in southwest Bangladesh along the border with India (West Bengal). The objective of OLP II is to improve fish yields in oxbow lakes and to transfer the fisheries management of these lakes to the fishers themselves (Middendorp et al. 1996).

Hindu fishers and landless Muslim laborers from the villages around each of the lakes have been organized in fishers' groups, so-called lake fishing teams (LFTs), consisting of a number of fishing teams of about 16 to 20 persons each. Each LFT is responsible for the implementation of a common property regime, from buying and stocking fingerlings to harvesting and marketing fish and paying the lease fees for fishing rights to the lake (Apu et al., this vol.).

LFT members must participate in carp fishing at least 80% of the time, a provision that is easily enforced as fishing by seine net (*kotchal*) and by brush park (*komar* or *kata*) are the only two fishing methods used and require the presence of a large number of fishers. The lakes are fenced off with bamboo screens at the inlets and outlets and stocked with silver carp (which is actually a hybrid of silver carp *Hypophthalmichthys molitrix* and bighead carp *Aristichthys nobilis*), grass carp (*Ctenopharyngodon idella*), common carp (*Cyprinus carpio*), catla (*Catla catla*), mrigal (*Cirrhinus mrigala*) and rohu (*Labeo rohita*). Wild catla, mrigal and rohu have become very rare in southwest Bangladesh (Flood Action Plan 17 1995), and it can be assumed that all carps harvested from the oxbow lakes were actually stocked.

Project support to LFTs is in three main areas:

- technical training in oxbow lake biology, stocking densities, etc.;
- institutional and management support, for example organizing annual elections, implementing by-laws, audit of LFT accounts, equitable distribution of benefits among fishers;
- credit support, with easy access to credit at 15% interest per annum through a permanent credit institution (BRAC).

It has been observed in OLP II that, when a fisheries lease is transferred to a newly established LFT, two to three seasons are generally required for fish yields to increase to much higher levels; overcoming all the social constraints to implementing a type of common property regime often takes even longer (Apu et al., this vol.). For this reason, it is thought that studying the oldest, most "mature"

LFTs is more indicative of the economics of community based fisheries management in oxbow lakes than averaging new and old LFTs together. The first 11 LFTs under OLP II got underway in 1991 and by mid-1996 had completed their fifth year of operation (July 1995–June 1996).

In this study, carp yields, operating costs, credit needs and economic profitability of 10 of these well-established LFTs are evaluated and compared with the 2-year average values computed for 1993–1994 and 1994–1995 for the same 10 lakes (Middendorp and Rahman 1996). Carp income, operating costs and lease fees of all 20 oxbow lakes under culture based fisheries in OLP II are discussed in detail in Rahman et al. (this vol.).

Materials and methods

The study is based on the annual balance sheets of 10 of the 11 LFTs that were in their fifth project cycle in 1995–1996 (Oxbow Lakes Project II 1996). Daily fish yields and financial data were routinely recorded in the Lake Record Books with the help of staff employed by the Danida Technical Assistance team and BRAC. Data from the LFT of Khatura Lake, also in its fifth cycle, were excluded due to mismanagement.

The lake area used in the study is the calculated standard water area (SWA) of the lakes on 1 January 1995, based on a field survey conducted in early 1995 (Oxbow Lakes Project II 1995). The number of fishers in each LFT is the number of active fishers, including licensed fishers as well as fishers still awaiting their license but regularly participating in fishing.

Annual carp yield is the combined total yield of all stocked species as recorded in the Lake Record Books. Average carp yield is total carp yield divided by SWA (kg/ha). Carp sales per hectare is the total sales value divided by SWA of the lake (Tk/ha). Group catches of wild fish and shrimp ("non-stocked species") are recorded occasionally only and not further considered here, but most LFT members engage in individual private fishing for the non-stocked species.

Fishing income from carp fisheries is defined as carp sales minus operating costs, and is expressed both as carp income per hectare and as carp income per fisher. Operating costs are grouped into six categories: fingerling costs, equipment costs, lease fee, guarding costs, marketing costs and miscellaneous costs.

Credit received and repaid is the total amount of principal received and the total amount repaid, including interest, by the LFT in 1995–1996. All LFTs had loans outstanding at the beginning of the year and BRAC was not able to separate the interest on the old loans from that on the current loan, nor to disaggregate the interest payments from total amount repaid.

The benefit–cost ratio (BCR) is here defined as total carp sales divided by total operating costs, i.e., return on annual cash costs excluding amortization of long term investments in equipment, excluding the interest costs of credit and excluding costs of fishing labor. Return on carp fingerling costs is calculated as carp sales divided by fingerling costs and expressed as a percentage.

Results

The SWA of all 10 lakes combined is 441 ha, on which 1021 fishers were involved in 1995–1996 (2.5 fishers/ha, CV = 33%—Table 1). The total recorded annual carp yield for all 10 lakes was 279 t with a recorded value of US$247 201 in 1995–1996[1]. Total carp yields increased linearly with SWA. Average carp yield was 669 kg/ha (CV = 34%), showing a non-significant trend of decreasing average carp yield with increasing total water area:

Total carp yield (kg) = 560.6 * SWA (ha) + 3176.6; $R^2 = 0.755$ ($P<0.01$).

Avg. carp yield (kg/ha) = −1.852 * SWA (ha) + 750.9; $R^2 = 0.066$ ($P>0.10$).

Total operating costs averaged US$309/ha and total carp sales averaged US$596/ha in 1995–1996. Thus, carp income averaged US$287/ha or US$119 per LFT fisher (Table 2). Fingerling costs averaged US$180/ha, representing 58% of total operating costs (Fig. 1). Overall carp price as estimated

[1] US$1= 42 Bangladesh Taka in 1996.

Table 1. Standard water area (SWA), number of fishers and carp yields in 1995–1996.

Oxbow lake	SWA (ha)	Fishers (no./ha)	Total (kg)	Average yield (kg/ha)
Sarjad	9	2.7	6 310	701
Kaliganga	15	4.5	14 680	979
Kannadah	23	3.1	12 410	540
Marufdia	25	1.7	16 860	674
Hariharnagar	30	2.3	22 530	751
Benipur	45	2.2	25 450	566
Bhanderdah	48	1.8	13 040	272
Nasti	54	1.8	56 820	1 052
Porapara	88	2.3	52 630	598
Bahadarpur	104	2.5	58 270	560
Total	441	1 021	279 000	–
Average	44	2.5	27 900	669
CV (%)	71	33	72	34

Table 2. Carp sales, operational costs and fishing income in 1995–1996.

Oxbow lake	Carp sales (Tk/ha)	Operating costs (Tk/ha)	Carp income (Tk/ha)	Carp income (Tk/fisher)
Sarjad	25 400	17 250	8 150	3 056
Kaliganga	48 365	21 089	27 267	6 105
Konnadah	16 516	16 358	158	51
Marufdia	22 761	15 981	6 780	4 036
Hariharnagar	21 049	10 376	10 673	4 574
Benipur	21 076	9 715	11 361	5 164
Bhanderdah	13 152	5 661	7 491	4 181
Nasti	37 445	17 648	19 797	10 908
Porapara	23 386	10 114	13 273	5 840
Bahadarpur	21 041	5 395	15 645	6 163
Average	25 019	12 960	12 060	5 008
CV (%)	41	42	63	55

Note : US$1 = Tk 42 in 1996.

from the average carp yield (669 kg/ha) and average carp sales (US$596/ha) was US$0.89/kg. The average BCR was 2.11 (CV=37%)—values ranged from 1.01 to 3.90. The return on fingerling costs averaged 474% (CV=97%), with an exceptionally high return on fingerling cost of 1749% for the LFT of Bahadarpur (Fig. 2).

Total credit received by all 10 LFTs combined was US$143 090 (US$359/ha) in 1995–1996, while total credit repaid was US$131 986 (US$304/ha)(Table 3). Almost all credit disbursed and repaid was from and to BRAC; the total disbursed by BRAC was US$142 852 while repayments to BRAC, including interest, amounted to US$127 121 in 1995–1996. At 15% interest per annum and assuming no interest repayments on any of the outstanding loans from previous years, repayments to BRAC in 1995–1996 were 77% of

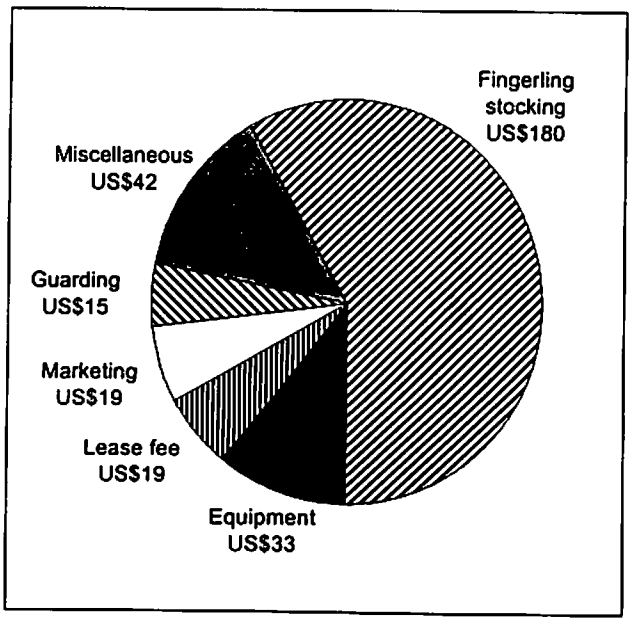

Fig. 1. Operating costs per hectare of fishers' groups (LFTs) in 1995–1996.

Table 3. Total loans received and repaid, including interest, in 1995–1996.

Oxbow lake	Credit received (Tk/ha)	Credit repaid (Tk/ha)
Sarjad	21 778	13 678
Kaliganga	12 800	14 640
Kannadah	23 217	16 361
Marufdia	18 872	11 176
Hariharnagar	14 337	12 790
Benipur	7 700	6 682
Bhanderdah	11 519	12 023
Nasti	13 000	13 280
Porapara	17 455	14 499
Bahadarpur	10 082	12 409
Average	15 076	12 754
CV (%)	34	20

Note: US$1 = Tk 42 in 1996.

the total amount due at the end of the year (principal + interest).

The combined total sales value of the carps declined from US$289 579 in 1993–1994 to US$272 194 in 1994–1995 (Middendorp et al. 1996) and further to US$247 201 in 1995–1996. Average carp income fell from US$385/ha in 1993–1995 to US$287/ha in 1995–1996, but the number of LFT members sharing in the benefits had increased 53%, from 1.6 fishers/ha in 1993–1995 to 2.5 fishers/ha in 1995–1996 (Table 4).

Discussion

Annual carp production was directly correlated to the water area of the lakes, at least in the range of this study (9–104 ha). Total carp harvests of all 10 oxbow lakes combined have been similar over the last 3 years: 269 t in 1993–1994 and 262 t in 1994–1995 (Middendorp et al. 1996) compared to 279 t in 1995–1996, although yields of the same lake varied from year to year. It is concluded that, overall, oxbow lakes in their fifth cycle yield the same amount of carps as lakes in their third or fourth cycle of culture based fisheries management.

Carp yields recorded in the Lake Record Books are considered reliable estimates, as payments to individual fishers are based on daily recorded fish landings. Nevertheless, due to poaching and sometimes non-reporting of catch by the fishers themselves, the recorded carp landings are believed to underestimate actual yields by 10–30%.

The reduction in total sales value of carps from 1993–1994 to 1995–1996 is partly explained by a selling price nearly 10% lower in 1995–1996 (possibly due to a smaller average size at harvest), and partly by the increased exchange rate—from Tk 40 to the US dollar in 1995 to Tk 42 in 1996. Moreover fingerling costs were higher in 1995–1996, so overall carp income per hectare was down 25%. In 1995–1996, carp income per fisher was

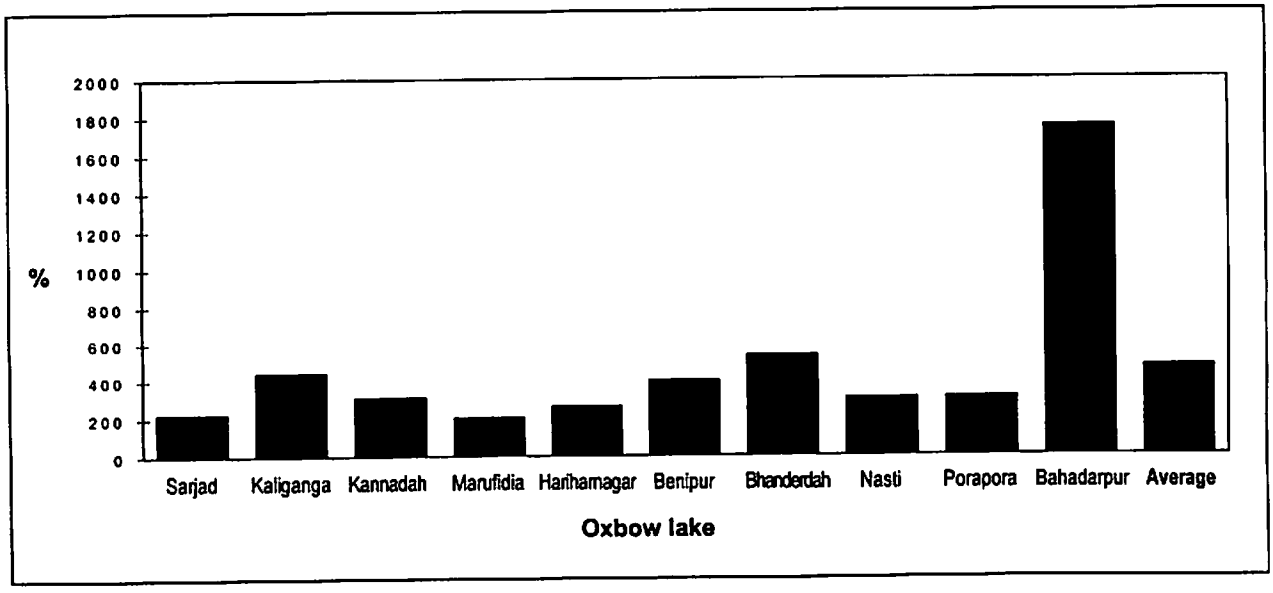

Fig. 2. Return on fingerling costs in 1995–1996.

Table 4. Key parameters of culture based fisheries management in oxbow lakes in 1995–1996 compared with two-year average values for 1993–1994 and 1994–1995 previously reported by Middendorp and Rahman (1997).

Key parameter	Two-year average (10 lakes) 1993–1994 and 1994–1995	This study (10 lakes) 1995–1996
Descriptive parameters		
Total water area of 10 lakes (ha)	441	441
Total number of fishers of 10 LFTs	667	1021
Fishers/ha	1.6	2.5
Economic parameters		
Average carp yield (kg/ha)	642	669
Average carp sales (US$/ha)	632	596
Operating costs (US$/ha)	247	309
Fingerling costs (US$/ha)	123	180
Net carp income (US$/ha)	385	287
Net carp income per fisher (US$/fisher)	262	119
Benefit–cost ratio	2.83	2.11
Return on fingerling costs	6.37	4.74

only 45% of the1993–1995 figure, as the reduction in income per hectare was further aggravated by a 53% increase in the number of LFT members to 2.5 fishers per hectare.

The addition of new members in 1995–1996 was forced upon the existing LFT members by social pressure from non-members demanding to share in the benefits of the common resource. After the number of LFT members was increased, poaching declined considerably (Apu et al., this vol.). The imminent increase in members from July 1995 also motivated existing members to completely "empty" the lakes by June 1995 through intensive fishing, without which the increase in yields in 1995–1996 would have been more pronounced. The yields reported for the following season (1996–1997) clearly exceed those of 1995–1996, resulting in better economic returns for the fishers. Furthermore, LFT fishers are not solely dependent on income from carp, but catch non-stocked indigenous fish from the lake, and occasionally work as agricultural laborers as well (Nathan et al., this vol.).

Recorded carp sales per hectare were very low in Kannadah and Bhanderdah in 1995–1996. In Bhanderdah this was directly related to low stocking densities (reflected in low operating costs), and carp income was still US$178/ha. Operating costs in Kannadah, however, were 26% higher than the average for the 10 lakes, while carp yield was 19% below the average and, in addition, average carp selling price was 20% below the overall average price; as a result, carp income was only US$3.8/ha. If Kannadah is excluded from the calculations, average carp income rises from US$287/ha—the 1995–1996 figure—to US$318/ha (Table 2).

Kannadah is a deep oxbow lake with rather high stocks of large predators, resulting in a lower recovery of stocked carps. More importantly, it enjoys very good runs of chapila (*Gadusia chapra*) which enter the lake to breed (Haque et al., this vol.). Wild fish contributed less than 4% to the overall sales value of stocked carps and wild fish of all 20 lakes under culture based fisheries management in OLP II; however in Kannadah sales of wild fish amounted to US$279/ha in 1995–1996 and accounted for 45% of total sales value of carps and wild fish combined (Oxbow Lakes Project II 1996). The combined fishing income was Tk 3 835 per fisher, compared with just Tk 51 from carp (Table 2).

Credit received by the LFTs averaged US$359/ha in 1995–1996, which is US$50/ha (16%) in excess of average operating costs, indicating over-financing or re-scheduling of existing loans. The overall repayment rate of 77% in 1995–1996 on BRAC credit plus interest, for the 10 oxbow lakes in this study, raises doubts about the future sustainability of BRAC's credit operations in oxbow lake fisheries, given the fact that all BRAC staff costs in OLP II to December 2000 are borne by a grant from Danida. Nevertheless the profitability of oxbow lake fisheries, as confirmed by the average BCR in this study, clearly permits timely repayment of the loans received.

BRAC should aim at minimizing outstanding credit and make the LFTs financially independent by encouraging savings, leading to a reduction in interest costs. If 20% of average profit (i.e., US$57/ha) were set aside in a savings account, each LFT would acquire sufficient working capital to cover all operational expenses in about five years. To wean the well-established LFTs from their dependence on credit, the following credit ceilings are proposed: fingerling costs—US$150/ha; fishing equipment—US$25/ha; lease fee—80% of actual lease fee. All other costs should be covered directly from savings and cash flow (sales of fish).

Investment by the LFTs in fingerling rearing ponds will systematically lower fingerling expenses of the LFTs, resulting in higher fishing incomes. For instance, the considerable difference in return on fingerling costs in Fig. 2 between Bahadarpur Lake and the other nine oxbow lakes in this study is due to the fact that the LFT fishers of Bahadarpur successfully reared 3-day-old spawn, bought from a private hatchery, to fingerling size in fingerling ponds constructed by OLP II on public land by the side of the lake. (The costs of pond construction were however not included in the fingerling costs of Bahadarpur LFT.)

It is estimated that a pond of 1 ha might yield 100 000 fingerlings of 8–10 g ready for stocking at a total rearing cost of approximately US$1 000 (US$0.01/fingerling); most of the cost would be for supplemental feed. At a recommended stocking density of 5 000 fingerlings/ha for oxbow lakes with less than 100 cm average Secchi depth (Hasan et al., this vol.), cash expenses for fingerlings would then be only US$50/ha, compared with the average fingerling cost of US$180/ha in 1995–1996. Although this scenario appears financially viable, the obstacle appears to be that the costs of pond construction most likely could not be recovered within the 12-month repayment period attached to normal NGO credit.

Acknowledgements

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Impact of the Oxbow Lakes Project II on the Fishers and Other Villagers Living around Bahadarpur Lake

DEV NATHAN, NIAZ AHMED APU and HANS A.J. MIDDENDORP
Oxbow Lakes Small Scale Fishermen Project, Second Phase, Department of Fisheries, BRAC and Danida Technical Assistance, Matshya Bhaban, Arabpur, Jessore, Bangladesh

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Abstract

The social and economic improvement of fishers who participated in the Oxbow Lakes Small Scale Fishermen Project II was similar to that of all households. A change in occupation from agricultural laborers to members of the fishers' group was significant in two of the eight lake *paras*, and fisher households are currently better off than landless laborers on most scores. The increase in consumption of fish by the fishers' households, in addition to rice and vegetables, is attributed to easy access to fish on credit against their fishing income. Fishers were less reliant on casual wage labor than agricultural and non-agricultural laborers, a situation that appears to be linked to an increase in fishing employment. Households headed by women were worse off than other households by all economic indicators in this study.

Introduction

The Oxbow Lakes Small Scale Fishermen Project, Second Phase (OLP II) aims at alleviating poverty by transferring the fisheries management of lakes to the genuine poor fishers (Middendorp et al. 1996). Poverty alleviation here means not only an increase in incomes but also an improvement in social conditions, for example access to training, higher social status and better housing conditions. The objective of the study was to assess the impact of transferring fisheries management to the fishers' group on the overall situation of the people living around Bahadarpur Lake.

Since baseline data on the economic and social condition of the households at the beginning of OLP II in 1991 were not available, cross-sectional data on the occupational groups around Bahadarpur Lake were collected. All households in the neighborhoods around the lake were interviewed so as to compare fishers with other occupational categories. Most of the present fishers were agricultural laborers ("landless farmers") before becoming members of the fishers' group.

The main reason for choosing Bahadarpur Lake for the impact study was that it had a fairly large number of fishers, while at the same time the fishers did not form a very large proportion of the population around the lake. With a water surface area of about 104 ha, it is the second largest oxbow lake (*baor*) in OLP II. Bahadarpur is located in Jessore District (Sharsa sub-district) in southwest Bangladesh and is within walking distance of the Indian border.

Bahadarpur Lake is not one of the best performing lakes in OLP II. Annual carp yield was 523 kg/ha in 1996–1997, well below the average of 689 kg/ha for all 20 lakes in OLP II that year (Oxbow Lakes Project II 1997). The fishing operation has been quite unstable due to conflicts with locally influential persons claiming parts of the lake as their private land. Moreover, while in most lakes the fishers' groups have established an equitable distribution of benefits, in Bahadarpur the *kochal* (seine net) fishing teams do not pool their catch with other kochal fishing teams but sell directly to wholesalers in the nearby town, rather than by open auction on the side of the lake.

Methods

The Bahadarpur impact study was conducted in January 1997. In total all 1 162 households in the 12 *paras* (neighborhoods) of the three villages of Bahadarpur, Dhannakhola and Shakaripota around Bahadarpur Lake were interviewed. The data were grouped by para and occupational

category. Three very small paras, which really are only satellite settlements, were grouped together with the main paras, leaving nine different paras in our study. Fisher households were found in all eight paras directly bordering on the lake, while one para not directly adjacent to the lake (Dhannakola West), turned out to have no fisher households.

A household was defined as a unit of people with a separate cooking arrangement (*chulha*). The respondent of the questionnaire was the "head of the household", usually a man. The question of the sex of the head of the household was explicitly posed in the questionnaire in order to identify households headed by females. Landholdings (including the homestead area but excluding the land cultivated under lease or sharecropping arrangements), fish pond area, and number of large farm animals (cattle and goats) of each household were recorded.

The main occupation given by respondents was taken as the basis for classifying households into occupational categories: fishers; agricultural laborers; non-agricultural laborers; small farmers (owning 0–0.4 ha of land); middle farmers (0.4–0.8 ha); large farmers (>0.8 ha); and traders and others, including craft workers, petty businessmen, mechanics, etc. (not land based).

Respondents were asked if they had sometimes performed casual wage labor ("daily work") and the number of months in the last year when they had done one or more days of daily wage labor was recorded.

Food deficit was defined as not enough food available for two meals on the same day. The respondents were also asked to recall the number of months when the household had faced a food deficit of one or more days. In the categorization of nutritional status, those who reported eating "only vegetables and rice" during the last two days were separated from those who had also eaten fish, meat, eggs or more than one of these items ("good food").

Housing status was assessed by the condition of the roof. All non-thatched roofs, whether tin sheet, tiles or concrete slab, were considered improved roofs. Respondents were also asked to recall the type of roof 5 years ago, on the assumption that their recall of such a major item would be reasonably accurate.

Table 1. Households by occupational category.

Main occupation	No.	%
Fishers	197	19
Agricultural laborers	169	17
Non-agricultural laborers	50	5
Small farmers (< 0.4 ha)	167	16
Middle farmers (0.4-0.8 ha)	111	11
Large farmers (> 0.8 ha)	118	12
Traders and others	208	20
Total	1020	100

Total figures for each occupational category were calculated. For the statistical analysis, however, the data by para were used as sub-samples for t-tests.

Results and discussion

Occupational category

There were in total 1020 households in the eight paras directly bordering Bahadarpur Lake (Table 1). The size of the paras ranged from 49 to 255 households. There were 197 fishers' households, representing 19% of all households. Farmers with land represented 39%, and agricultural laborers' households 17%. Traders and non-agricultural laborers, i.e., those with non-land based occupations, represented 25%.

In the eight lake paras there were 197 fisher households (19%) and 167 agricultural laborer households (16%). For comparison with the only para away from the lake (where there are no fishers), the proportion of laborer households was recalculated after excluding fisher households; this gave 20% agriculture laborer households in the lake paras compared with 18% in this non-lake para (Table 2).

Table 2. Households by para (neighborhood).

Para	Total	Fishers		Agric. lab.	
	(no.)	(no.)	(%)	(no.)	(%)
Bahadarpur South	49	14	29	13	27
Bahadarpur West	255	27	11	71	28
Bahadarpur East	182	45	25	19	10
Shakharipota East	106	44	42	4	4
Shakharipota Middle	97	24	25	15	15
Shakharipota West	122	23	19	20	16
Dhannakhola Methapara	82	14	17	15	18
Total lake paras	1020	197	19	167	16
Dhannakhola Middle	142	0	0	26	18

In two paras, Bahadarpur East and Sharikapota East, 45% and 44%, respectively, of households were fishers, and these paras had the lowest proportion of agricultural laborer households (10% and 4%, respectively). The occupational composition of households in these two paras was significantly different from the other six paras ($P<0.05$). It is concluded that in these two paras, successful fisheries management has enabled agricultural laborers to become fishers.

The total number of household members in the survey was 4 677, averaging 4.0 persons per household, well below the thana and national averages of 5.6 and 5.7 persons, respectively (BSS 1991). Further, the fishers' households had on average only 3.8 members, which indirectly confirms that many members of the Bahadarpur fishers' group are still young, with few or no children and most likely recruited from the ranks of landless laborers.

Economic resources and casual wage labor

Overall, 54% of all households owned land (average of 0.70 ha per household). Fewer fisher households owned land than the average, and their landholdings were smaller than average, but land ownership was more common and the areas larger than for laboring households. Of the fisher households, 32% owned land (average 0.16 ha), whereas 19% of the agricultural laborers and only 7% of non-agricultural laborers owned land (average 0.14 ha and 0.07 ha, respectively). Of the fishers 68% were landless, compared with 78% of agricultural laborers. OLP II exercised the criterion that new members of the fishers' group on joining must be "genuinely poor", which was defined as owning less than 0.4 ha of land. Of the 197 fishers in Bahadarpur, 168 (85%) owned less than that amount.

Ownership of ponds and animals showed a clear parallel with landholdings. For example 63% of the large farmers owned a fish pond, compared with only 8% of agricultural laborers. Similarly, nearly all large farmers owned animals as against only about half the fishers, agricultural laborers and non-agricultural laborers. Only traders and others with occupations not based on land did not have as many animals or ponds as expected from their landholding (Fig. 1).

Those with no land or not enough land depend on daily wage labor for their livelihood. Agricultural and non-agricultural laborers were the most dependent on such labor (88% and 54%, respectively), while the proportion of fishers relying on daily wage labor (31%) was the same as for small farmers (Fig. 2).

Previous to OLP II, there were 158 fishers in Bahadarpur, and the estimated number of fishing days did not exceed an average of 30 days in a year, i.e., a total of 4 740 labor days. In 1995–1996, 79 fishing days were counted. Since there were 197 members in the fishers' group, a total of 15 563 labor days can be calculated, assuming that all the fishers actually participated in all the fishing days. The impact of the additional 10 823 labor days

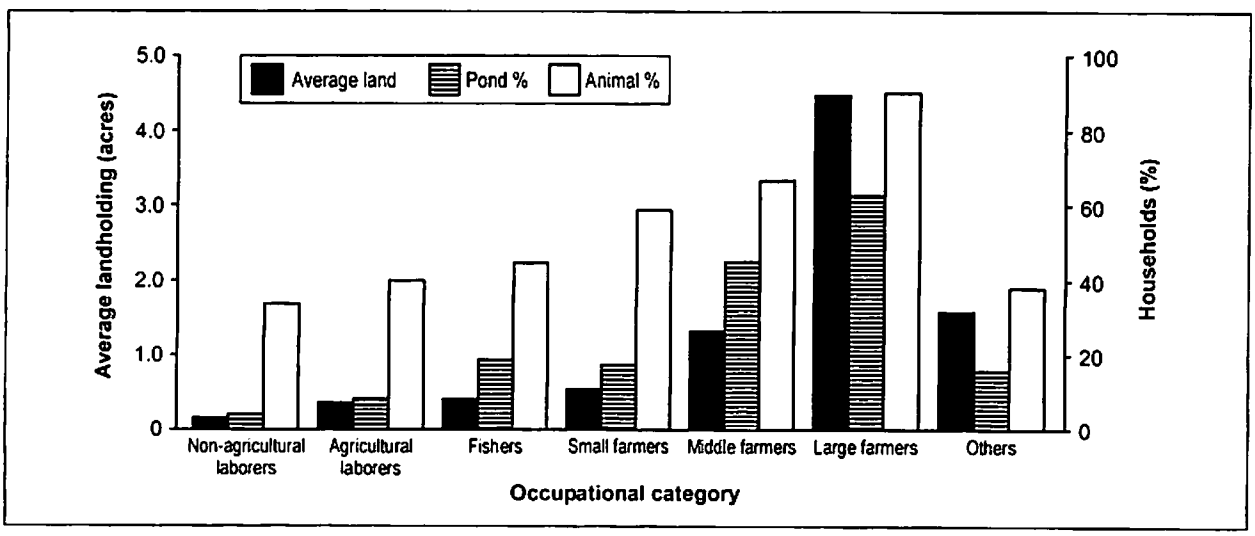

Fig. 1. Landholding, pond and animal ownership by household.

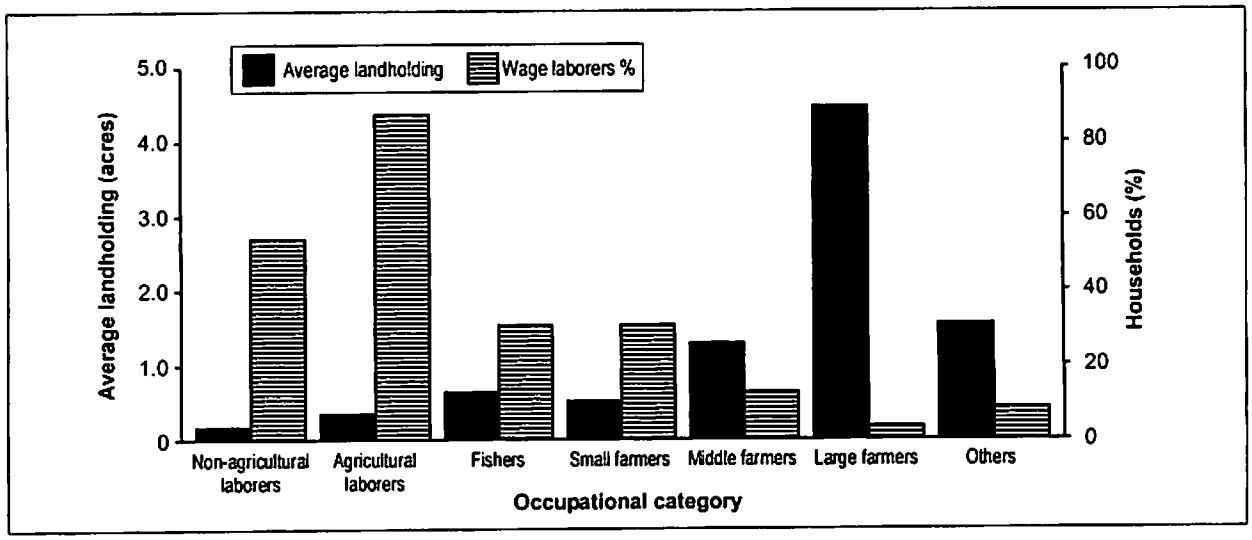

Fig. 2. Landholding and percentage of households doing wage labor.

created (approximately 30 person years) corresponds well with the observed reduction in casual wage labor by the fishers compared with agricultural laborers. Some of the fishers' wives even complained that their husbands nowadays prefer to remain idle rather than work as casual wage laborers. Annual income of fishers averaged US$146 per fisher from carp fishing alone in Bahadarpur in 1995–1996 (Middendorp et al., this vol.), which seems a comfortable income in a village.

Socioeconomic indicators and poverty ranking

To study the impact of OLP II on poverty alleviation by its transfer of fisheries management of the lakes to the fishers as primary stakeholders, three socioeconomic indicators of well-being were considered: food deficit during the year, nutritional quality of the food, and housing status. Other indicators of an improved socioeconomic situation, for example the increase in business volume arising indirectly from construction of the road to the fish landing center or other effects of the improved access road, such as a reduction in travel time, were not taken into consideration.

A very high proportion of fisher households (40%) reported food deficits of one or more days in one or more months of the previous year. Although this proportion is lower than observed for agricultural laborers (60%) and non-agricultural laborers (58%), it is higher than the overall average of the eight lake paras (35%). The percentage of households of each occupational class reporting food deficits showed a clear decreasing trend in parallel with landholding. Apparently fishing income, which is earned during about 7 months of the year (October–April), is only partially saved to provide for lean periods (Fig. 3).

Bahadarpur East, which is located on the road to the Indian border only 0.25 km away, stands out as different from the other paras, with only 13% food-deficient households. This is despite the fact that the landless fishers of Bahadarpur East perform casual wage labor on average during just 4.5 months (the lowest number) compared with the overall average of 6.6 months. There clearly appears to be another important income source which is not land, wage labor or fishing but seems rather to be informal trade across the Indian border (Fig. 4).

Of the fishers' households, 82% had consumed more than only rice and vegetables, i.e., either egg, chicken, meat or fish ("good food"), during the last 2 days at the time of the interview, compared with only 56% of agricultural laborers' households and 72% of all households. The survey was conducted at the height of the fishing season, coinciding with the Ramadan period; not being able to eat fish, meat or eggs during Ramadan is a clear mark of poverty for Muslims.

We have assumed that reporting "good food" (which was mostly fish) indicates a better nutritional status. In Bahadarpur, as in most of the other lakes under OLP II, carp harvested from the lake are sold to the local community at slightly

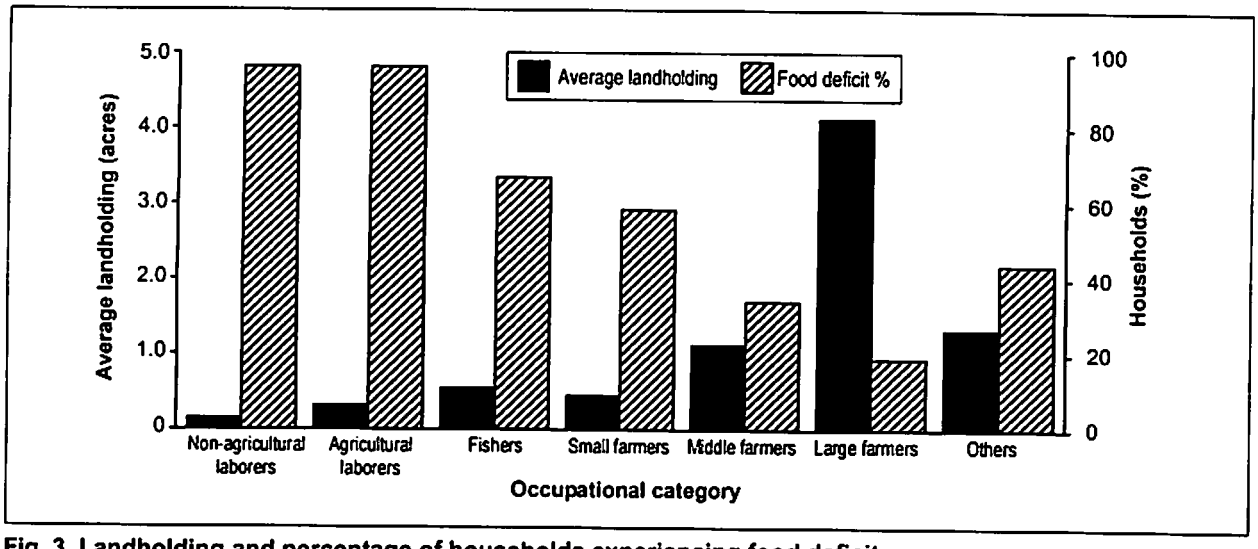

Fig. 3. Landholding and percentage of households experiencing food deficit.

below the market price. The difference between fishers and other villagers who buy fish, however, is that the fishers receive fish on credit against their later fishing income, whereas all others have to pay cash. This facilitates fishers' consumption of fish.

While "good food" is an indicator of present nutritional status, the type of roof (thatched or improved) is taken as an indicator of economic well-being over a longer period. It appears that there has been a general rise in housing status amongst all occupational categories, independent of the project intervention (Fig. 5). At the time of the survey 72% of all households had improved roofs compared with 40% only 5 years before ($P<0.01$). Fishers' households reported more improved roofs (67%), compared with agricultural laborers (53%) and non-agricultural laborers (52%). In a series of case studies undertaken of 25 of the poorest fishers in OLP II, 18 (72%) had improved roofs (Oxbow Lakes Project II 1995).

An improvement such as a tin or tile roof does not require a sustained increase in income but only a seasonally higher income (for example during peak fishing season) which can then be invested in the improvement. On the other hand, a concrete slab roof requires a large investment. However, since the focus of the study is on the impact of OLP II on poverty alleviation, the differences between tin, tiles and concrete roofs have been ignored.

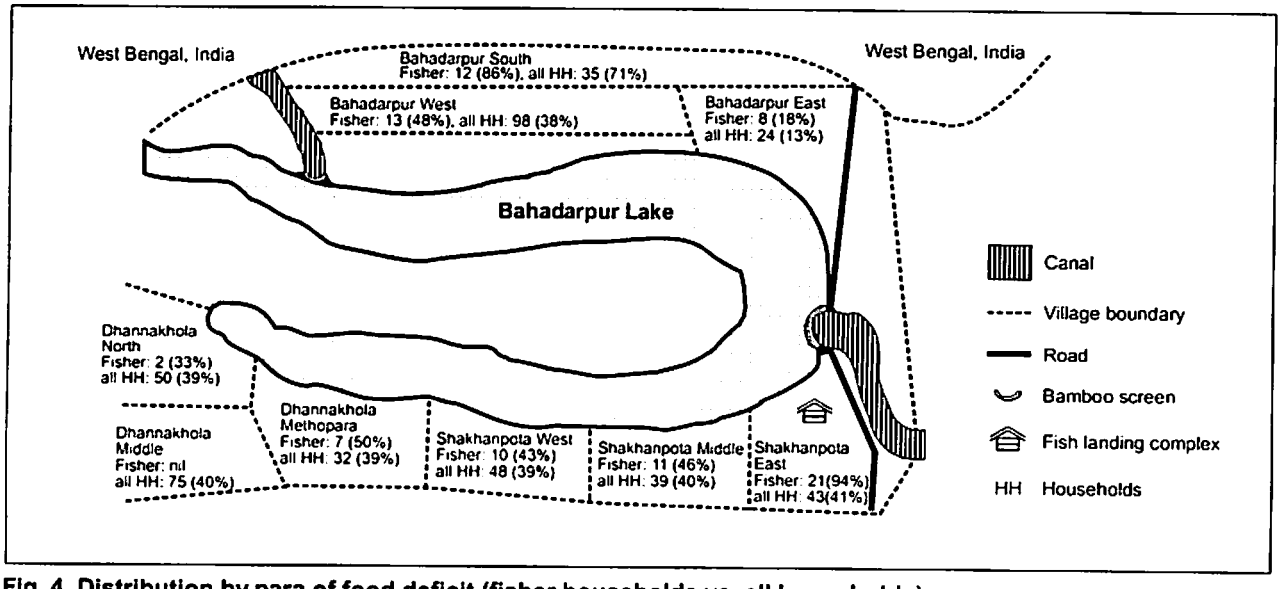

Fig. 4. Distribution by para of food deficit (fisher households vs. all households).

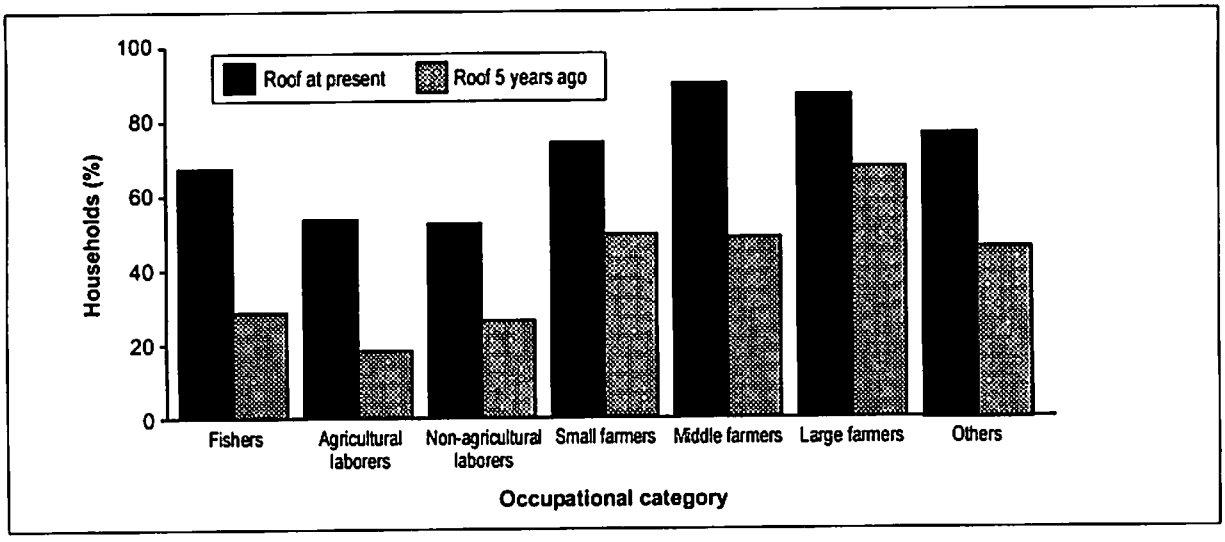

Fig. 5. Percentage of households with improved roof in 1997 and 1992.

For further poverty analysis, the two main indicators of nutritional and housing status in this study—food deficiency and improved roof—were combined to create four socioeconomic categories:

Good	: No food deficit and good roof.
Stable, not good	: No food deficit but no good roof.
Unstable	: Food deficit but good roof.
Poor	: Food deficit and no good roof.

Based on this classification, 64% of all households were ranked either "good" or at least "stable", while 36% were ranked "unstable" or even "poor". Of the large farmers' households, 88% fell into the first two categories compared with only 37% for both the agricultural and non-agricultural laborers. Small, middle and large farmers, traders and others and even fishers stood clearly above both the agricultural and non-agricultural laborers in the poverty ranking. Forty-four per cent of fishers' households were ranked "good" compared with only 20% of agricultural laborers' households, while only 19% of fishers' households were ranked "poor" compared with 30% of agricultural laborers' households (Table 3).

Social development

Social development is not just a matter of higher incomes. The study looked at three non-income indicators: access to skills training; interaction with local government officials; and social relations within the para and the whole village (Table 4).

While 54% of fishers' households reported that they received skills training during the past year, only 9% of the agricultural laborers' and 1% of the non-agricultural laborers' households had received such training. For the fishers, this refers mainly to OLP II training. The rather poor wage laborers apparently do not receive much attention from either government departments or NGOs. However households headed by females—generally perceived as the poorest households—showed a high proportion of participation in training (31%), reflecting the emphasis on destitute women in many NGO programs.

Twenty-four per cent of the fishers reported meeting government officials of the *thana* (sub-district) during the past year, compared with a negligible percentage for agricultural and non-agricultural laborers (2% and 6%, respectively). Large farmers (26%) and traders and others (23%)

Table 3. Poverty analysis of occupational classes (% of households).

Main occupation	Good	Stable	Unstable	Poor
Fishers	44	13	24	19
Agricultural laborers	20	17	33	30
Non-agricultural laborers	16	21	33	30
Small farmers (< 0.4 ha)	52	16	23	10
Middle farmers (0.4 – 0.8 ha)	69	11	13	7
Large farmers (> 0.8 ha)	77	11	7	3
Traders and others	53	18	23	6
Total	49	15	22	14

Table 4. Social development of occupational classes, as indicated by training received, interaction with thana (sub-district) officers and participation in social functions and ceremonies in the previous year.

Main occupation	Skills training received (% of households)	Interaction with sub-district officials (% of households)	Number of social visits
Fishers	54	24	10
Agricultural laborers	9	2	5
Non-agricultural laborers	1	6	3
Small farmers (< 0.4 ha)	14	9	7
Middle farmers (0.4 – 0.8 ha)	12	11	8
Large farmers (> 0.8 ha)	17	26	17
Traders and others	33	23	11
Total	25	15	9
Female-headed households	31	35	3

reported high levels of interaction with government officers similar to those of fishers' households. The fishers regularly deal with officials of the Department of Fisheries (DOF) and the Ministry of Land at the district and thana levels to assert their fishing rights over the state owned (*khas*) oxbow lakes and to counter the various pressures to deprive them of these rights.

In the study, the number of times respondents were invited to or organized social functions and ceremonies ("social visits") was taken as an indicator of their social status. The overall average was nine such social visits per household. Households headed by females ranked lowest with an average of only three visits, and large farmers highest with 17. Agricultural laborers on average reported five social visits, half the number reported by fishers' households (not significant). Although the social status of the mostly landless fishers has risen from the level of agricultural laborers to the level of middle farmers and traders, it is still much below that of the large farmers.

The members of the Bahadurpur fishers' group do not just catch fish; they are actually managers of a fishery resource under a common property regime (Apu et al., this vol.). The social status of the fishers has risen, reflected by the increasing importance of the fishers' group in local social affairs. The fishers' frequent interaction with officials reflects their confidence and social status, demonstrating that the poor fishers cannot be just ignored in official matters and indicating that establishment of the common property regime has been a success.

Female-headed households

Of all households in the eight lake paras, 56 (6%) were headed by females. By all indicators of socio-economic condition, these households consistently ranked lower than the average (Fig. 6).

However, the identification of female headed households on the basis of separate cooking arrangements is problematic, and it is believed that the number identified in this study is understated, comprising mostly elderly women and widows. Deserted women with children will often state that their husband is "away on work", while young deserted girls will simply return to their parents' households.

Conclusions

A comparison between fishers and agricultural laborers revealed the following:

- Fishers and agricultural laborers were not significantly different in their reported food deficits ($P>0.05$). However the quality of nutrition reported during the past 2 days was significantly higher for fishers than for agricultural laborers ($P<0.01$).
- Significantly more fishers than agricultural laborers have improved roofs to their houses ($P<0.05$).
- Fishers interact with local government officials at the sub-district offices significantly more often than agricultural laborers ($P<0.05$).
- Fishers received significantly more skills training than agricultural laborers ($P<0.01$).

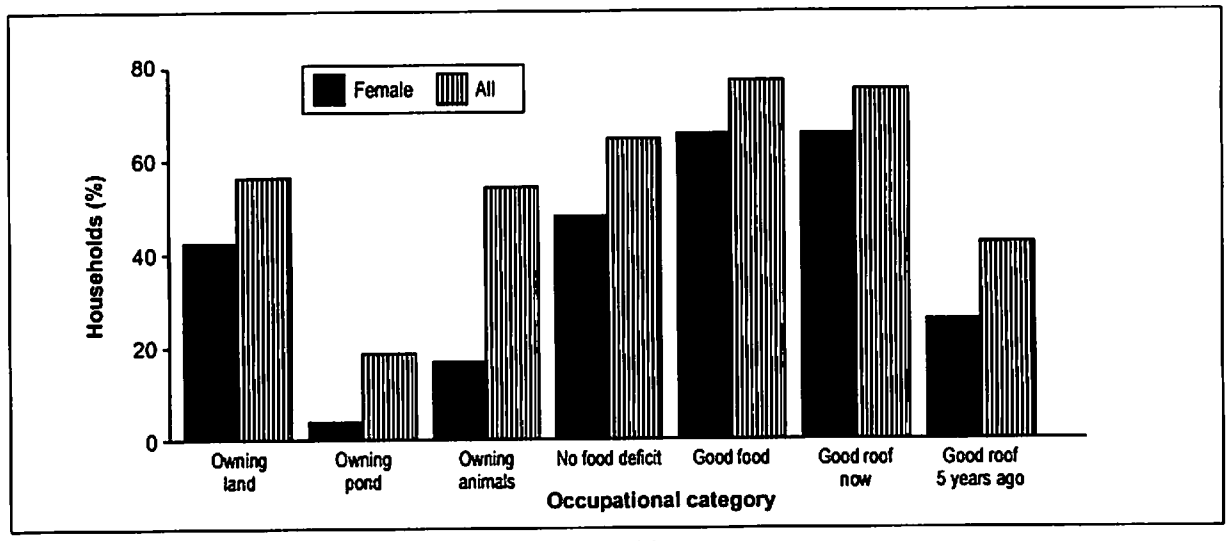

Fig. 6. Households headed by females vs. all households.

- The social relations of fishers, however, have not developed to a level significantly higher than that of agricultural laborers.

The improvement in the economic and social conditions of the fishers was similar to that of all households in the village. Improvements in housing, as indicated by an improved roof, were observed amongst all occupational groups, suggesting an overall reduction of poverty.

Nevertheless, by the time of the survey, fishers' households were better off than landless laborers on most scores. Fishers were comparatively less reliant on casual wage labor than agricultural and non-agricultural laborers, a situation that appears linked to an increase in fishing employment. A change in occupation from agricultural laborers to members of the fishers' group was significant in two of the eight lake paras.

The improvement in consumption of fish and other "good food" by fishers' households is attributed to their easy access to fish on credit against their fishing income. Still, the high incidence of fisher households with a food deficit at some time of the year (40%) shows the need for further improvement.

As a group, households headed by females are worse off than other households according to all socioeconomic indicators used in the study. However, it seems likely that only the more destitute of such households were identified, since many divorced or abandoned women are able to return to their parents and do not maintain a separate household.

Acknowledgements

The OLP II (1991–1997) was executed jointly by the Bangladesh DOF, BRAC and Danida Technical Assistance. The project was funded through a loan to the Government of Bangladesh from the International Fund for Agricultural Development, and through a grant from the Danish International Development Assistance.

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Fish Farming by Women in Common Ponds Constructed along the Shallow Edges of Oxbow Lakes

DEV NATHAN and NIAZ AHMED APU
Oxbow Lakes Small Scale Fishermen Project, Second Phase, Department of Fisheries, BRAC and Danida Technical Assistance, Matshya Bhaban, Arabpur, Jessore, Bangladesh

NATHAN, D. and N.A. APU. 1999. Fish farming by women in common ponds constructed along the shallow edges of oxbow lakes, p. 191–194. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Fish farming groups (FFGs) with 75% women members were formed within lake management groups so that women could participate in the benefits of the Oxbow Lakes Small Scale Fishermen Project, Second Phase. The social importance of giving user rights of FFG ponds to groups of poor women is demonstrated. The economic potential of fish culture could not be realized in the first year due to flooding as a result of poor pond construction.

Introduction

The Oxbow Lakes Small Scale Fishermen Project, Second Phase (OLP II) centered on the transfer of fishing rights to poor Muslim landless people and traditional Hindu fishers living around oxbow lakes in Bangladesh (IFAD 1988). The poor fishers were organized in lake fishing teams (LFTs) to culture fish in the oxbow lakes. OLP II initially excluded women from its purview. The role of women in lake fishing activities was confined to the "invisible" and unpaid jobs of net making and repairing within each fishing household.

The lake management group (LMG), which consists of (1) the fish farming group (FFG) in charge of FFG ponds around the edges of the lake, and (2) the LFT (which includes all fishing teams) pays an annual lease fee through the Department of Fisheries (DOF) to the Ministry of Land. DOF is the formal leaseholder of the lakes. The leases are for 50 years, explicitly including the user rights of the FFG fish ponds, which is long enough to permit comparatively large amounts of capital to be invested and earn a higher per capital income than—for instance—poultry raising or handicrafts (Middendorp et al. 1996; Apu et al., this vol.).

In rural Bangladesh, women's economic activities are mainly carried on in and around the home. Cash investments in economic activities are small, and labor productivity is low as are the returns. While women involved in NGO micro-credit activities are better off than before, there is no radical change in income distribution or class structure in the villages. Women have access to only very small areas of land, typically only that of the homestead. In Bangladesh, rural poor women do not own land and there is hardly any government or *khas* land available over which they could acquire user rights. Waterbodies, as a type of public land, are one of the few government resources still available for allocation to the poor.

OLP II decided to include women in the FFGs for managing fish culture in so-called FFG ponds constructed by the project in the shallow edges of the lake. The objectives for including women in the FFGs were to enable them to acquire property rights as users of a common property resource, and to learn fish farming technology and participate in the benefits of transferring the fishing rights of the lake from the private leaseholder to the LMG.

Initially in 1995, 50% of FFG members were women, this share rose to 75% in 1996. Since then the tendency has been that women prefer to belong to 100% female groups for pond culture; men either dropped out or formed separate male groups for other FFG ponds. OLP II followed the general project poverty criteria when choosing members in the LFTs. In the case of women, preference was given to poor women of so-called female-headed households, either widowed, divorced or abandoned.

Up to June 1997 the project had established FFGs in 14 lakes, including 80 ponds covering a total area of 53 ha. Of the 642 FFG members, 522 were women (81%) of which 160 were single from female-headed households (30%). However, most FFG ponds had insufficiently high dikes and the number of so-called "functional" ponds in December 1996 was only 28 covering an area of 17 ha, with a total of 194 members of whom just seven were men. FFG pond construction was carried out under an agreement between DOF and the World Food Programme (WFP) directly, with only occasional *ad hoc* involvement of BRAC and Danida Technical Assistance (the other members of OLP II).

This paper analyzes the significance of involving women in fish farming activities in 14 FFGs in 14 lakes of OLP II and the problems encountered.

Women acquiring user rights of common property

Starting fish culture in the khas FFG ponds first required issuing user rights to FFG members to use the ponds as a productive resource for fish farming. Since most FFG members were women, the project granted women property rights, which is quite revolutionary in rural Bangladesh. The LFTs in four out of 14 oxbow lakes (30%) opposed the transfer. In fact the LFT members (male fishers) were opposed to transfer of any section of the lake, which they had come to regard as their own, to anyone outside the LFTs, not just to women. However, after campaigning for support among the men, and since the women had already received documents attesting to their user rights, in some cases ponds taken over by men of the LFTs were handed back to the women.

More opposition to issuing legal user rights to women for the new FFG ponds came from prominent members of local villages. These local influential people were mostly former leaseholders, who had earlier opposed the transfer of user rights of the lakes to poor LFT fishers but had failed to restore their control over the lakes. They now thought it easier to wrestle FFG ponds from women. In as many as 11 out of 14 lakes (78%), they opposed the issuing of user rights to women. However, they received little support from the LFTs, as their ulterior motive was clearly understood.

Legal user rights have clearly strengthened the position of FFG members (mostly women) in bargaining with LFT members (all men). For instance, when (due to insufficient dike height) ponds merged with the rest of the lake during flooding in two lakes, women successfully bargained for compensation for their stocking costs from the LFTs; and in one lake they managed to exchange FFG ponds for LFT ponds at the other side of the lake.

It was assumed that if a group of women knew in advance that a khas pond was intended for them, they were more likely to resist attempts by other persons to capture the pond than if the group were formed only after completion of pond excavation. Consequently, in 1996 no excavation started without prior formation of an FFG, while in addition two women were included as members of the project implementation committees (PICs) of WFP responsible for carrying out the excavation. In fact, prior formation of women's FFG groups and inclusion of women in the PICs did indeed facilitate taking possession of FFG ponds: the number of ponds seized by non-target persons dropped from 80% in 1995 to 15% in 1996. However, motivation, prior group formation, and representation in the PICs did not lead to any increase in the number of women employed in excavation work, nor did it improve the overall quality of pond construction.

Labor and management in the fish farming group

In five lakes there were mixed FFGs, while in nine there were all-women FFGs. Culturing fish involves a number of activities and management decisions. What differences were observed in women's participation between all-women FFGs and mixed FFGs?

Women FFG members participated in all pond activities as much as possible. Before OLP II provided each FFG with a small seine net, professional fishers had been hired to harvest fish at the prevailing rate of 25% of the catch. But in eight FFGs, women also got down into the ponds and helped with netting, thereby reducing the proportion of catch to be paid to the fishers. Women also participated in guarding during the day. Guarding at night, however, was done entirely by men, either by male

FFG members or male family members. In a sense, the unpaid labor that women usually perform is now being done by men from their families, since it is the women who own the legal right to culture fish in the ponds. Women fully participated in other pond activities like daily feeding, dike maintenance and growing vegetables on dikes.

Participation by women in buying fingerlings in the market was high, while men mostly sold the harvested fish in the market. In 9 of the 11 FFGs which stocked fingerlings in 1996, women bought fingerlings from the market and/or village-based hatcheries, with OLP II credit provided through BRAC. However, in Nasti, fingerlings were bought by the men from the women's families. In the two other lakes only token stocking was done to establish their rights over the ponds. In two out of the five lakes where FFGs sold fish, the selling was done by men alone, while in the other three it was done by both men and women.

In FFGs where women have to depend on men, women cannot properly monitor financial transactions. Overstating expenditures for fingerlings or understating fish sales are easily done by the men, either by male FFG members or even by the men from the women's own families. The women suspect that the male FFG members conceal part of the income from the sale of fish, so in four of five lakes with mixed-sex FFGs, the women demanded to rearrange the subgroups on each khas pond into separate male and female pond groups. In the FFGs where selling fish was done by men from their own families, the women said they at least were able to control them. Further, women from the mixed groups complained that men not only monopolized all financial transactions, they also took all decisions on stocking and harvesting without consulting them.

Summarizing, in mixed FFGs, male members tend to dominate decision making and the financial transactions. In all-women groups, on the other hand, women took the management decisions but were helped by men of their own families in carrying out tasks like guarding, netting and marketing.

Economics of fish farming groups

At the time of writing this paper, most FFGs have been in existence for just one production year. This is a learning period and the economic results of 1996–1997 should not be extrapolated into the future. More important is the poor construction of most FFG ponds, which makes the 1996-1997 outcome unrepresentative. Many pond dikes were not high enough to prevent flooding near the end of the rainy season, when water levels in the lakes get very high due to general drainage problems in the Khulna–Jessore area. The poor quality of pond construction, in fact, led to financial losses on the part of the FFGs, and all FFG loans up to January 1997 were cancelled from the Danida Loan Guarantee Fund.

Nine FFGs raised fingerlings to table-sized fish for sale in the market. Fish production averaged about 1.5 t/ha in 1996-1997. Although well above average carp yield from the lakes of about 700 kg/ha, it is still far from the targeted 4 t/ha. The relatively short culturing period due to flooding limits production. Once the ponds are rehabilitated to proper standards, fish production is expected to rise.

In four lakes, some of the FFGs stocked fry to be raised into fingerlings for sale to the LFTs. Silver carp and rohu contributed 60% of fingerlings stocked using credit through BRAC. However, where the ponds were of poor quality and the risk of fish escape high, the women stocked cheap tilapia from their own funds.

The price paid for fingerlings by FFGs was on average about 20% higher than that paid by LFTs. The reason may be that FFGs are small buyers compared with LFTs, which stock the lakes. The sale price obtained for fish by FFGs and LFTs was about the same.

All FFGs purchased some inorganic fertilizer. Organic manure is mainly collected from household garbage and livestock excreta. Women usually supplied these materials from their own households or collected it around the village. In three FFGs, organic manure was bought, in these cases the families of the women owned no or very few cattle. Rice bran was supplied from own sources, but feed was mostly purchased. Where the ponds were of exceptionally poor quality, the women fed rice bran only. The easy provision of credit seems to have induced women to take the more risky fish farming approach of buying feed and fertilizer, using more external inputs, rather than the low cost, low risk method of using rice bran and recycling household waste.

Eleven out of 14 FFGs grew vegetables on the dikes as part of their use of the FFG pond. Some of the income from selling vegetables was divided among FFG members, while the rest was used for buying feed and fertilizer. Overall, in interviews, women FFG members stressed the importance of vegetable cultivation on the dikes in increasing the overall income from fish ponds.

Social effects

Through involvement in the FFGs, the formerly landless women have begun to learn fish farming as a new production technology. The learning process is still at the initial stage, and has been hampered by flooding. Besides learning a new technology, the women's possession of user rights of FFG ponds has had other social effects. Women's involvement in labor outside the homestead is usually limited to helping their menfolk carry the harvest home, or collecting fire wood. Other work would be difficult, since the women would be working on their own outside the homestead, which is not culturally acceptable. But in the FFGs women are involved in work on the pond as a group, which gives them strength to resist social restrictions on women going outside the homestead. Their activities have brought them in contact with government officers and NGO staff. A number of the women reported that, while they were formerly shy about visiting offices, now they have gained confidence in dealing with officials.

As leaseholders of the ponds, the women had to learn the management and financial aspects of a commercial operation. Those elected as office-bearers of the FFG also have to deal with purchasing fingerlings, feed and fertilizer, and selling fish. Buying fingerlings and selling fish require contact with the market. The market is an even more public area than the fish pond. Women in Bangladesh usually do not go to markets, but sell produce like vegetables, eggs and chickens directly from their house. Selling fish at the pond side is something in which women could easily participate, but given the small quantities of fish currently harvested from a FFG pond, it is not yet feasible to hold auctions there.

Since the women had user rights in the fish ponds, their status as owners has increased. Eleven out of 160 women in the FFGs either remarried or had their husbands return. This is a clear indicator of change in the social status of the women. While there is no doubt about the economic opportunism of the men in question, there is definitely an improvement in women's status as a result of their higher earning capacity. This improvement is evident even in a situation where the asset for which women have gained user rights is still not yet yielding a regular income, for people in the area know the value of a fish pond.

Conclusions

The experience of OLP II, where women's participation was not clearly envisaged in the original project design, shows that it is necessary to reserve certain components of projects for women in order to ensure access to inputs and benefits.

Acquisition by poor women of user rights over FFG ponds on public land (khas) not only contributes to poverty reduction but also improves their social status; in the case of OLP II, this proved of particular importance to abandoned or widowed women.

The limited experience of OLP II indicates that all-women groups perform better than mixed groups in enabling women to develop managerial and financial capabilities.

The major problem facing the FFGs at present is that the fish ponds were mostly not well constructed. Further, many pond locations around the edges of the oxbow lakes turned out to be less suitable for pond construction than expected, and FFG pond construction around such lakes has proved quite expensive and time-consuming.

Nevertheless, fish ponds can generate higher per capita incomes than family-based poultry raising or handicrafts, and the social impact of organizing women in FFGs is considerable. As an alternative, it is suggested that low-lying paddy land, which is relatively cheap, be excavated for groups of destitute women to be organized in FFGs as under OLP II.

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Mitigation Measures for Environmental Degradation of Oxbow Lakes Caused by Intensive Agriculture and Fisheries Management

HANS A.J. MIDDENDORP and NITYANANDA BALA
Oxbow Lakes Small Scale Fishermen Project, Second Phase, Department of Fisheries, BRAC and Danida Technical Assistance, Matshya Bhaban, Arabpur, Jessore, Bangladesh

MIDDENDORP, H.A.J. and **N. BALA.** 1999. Mitigation measures for environmental degradation of oxbow lakes caused by intensive agriculture and fisheries management, p. 195–198. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

The main, non-reversible interventions threatening the oxbow lake environment in Bangladesh are conversion of the wetland areas to paddy fields and construction around the lakes of embankments that stop nutrients from entering the lakes. The reversible interventions of stocking large numbers of hatchery-reared carp fingerlings, and the regular removal of water hyacinth and other macrophytes as part of the fisheries management of the oxbow lakes, are also thought to have a large impact on species diversity. Four measures that could mitigate environmental problems in oxbow lakes are recommended: micro fish sanctuaries, pipe culverts to permit nutrients to flow into lakes and small fish to move into flooded fields to spawn, replanting of trees, and training to minimize the potential harm from pesticide use.

Introduction

The natural environment of oxbow lakes (*baors*) is threatened by general agricultural intensification due to increasing population pressure. All arable land in western Bangladesh is now under year-round agricultural production. Many shallow lakes and wetlands (*beels*) have been drained and brought under cultivation. Fisheries management practices of the oxbow lakes, notably stocking of fingerlings and annual weed removal, further change the natural environment, though in a less destructive way.

There are roughly two types of wetlands surrounding the oxbow lakes: (1) shallow areas of the original oxbow lake bed of firm, clay-loamy soil, which dry up in the dry season and which are used for paddy cultivation and as common grazing areas; and (2) marshy areas usually at the horseshoe ends of the oxbow lakes, actually in transition to peat bog and consisting of "slushy soil" with high organic content.

This paper presents an overview of environmental impacts of the various interventions, followed by a number of mitigation measures planned for immediate implementation.

Main environmental impacts

Non-reversible environmental degradation

The main, largely non-reversible intervention threatening the oxbow lake environment is agricultural encroachment, which converts the wetland area to paddy fields. Encroachment is hastened by the construction of embankments around the lakes, intended to prevent stocked carps from escaping during the wet season. Embankments, however, also prevent the inflow of nutrients with the monsoon runoff, and prevent indigenous fish from spawning in the temporarily flooded areas cut off by the embankment. Fish ponds constructed in the fringe lands also lead to a direct loss of habitat, but at least maintain the water area and water retention capacity of the lakes.

Encroachment on the public lands inside the lake areas is largely uncontrollable because of the many needy people living around the lakes and because of the weak legal system (false documents, for example, are easily available). As a result, the habitats of plant species, and the feeding and breeding grounds of wild fish and other fauna are lost. Pressure on the oxbow lakes is further increased by the high profitability of pond aquaculture, and numerous illegal

ponds are being constructed by influential persons in oxbow lakes and other public waterbodies.

Environmental impacts of culture based fisheries management

Given the needs of the local people for making intensive use of available natural resources, intensive fisheries management is unavoidable unless the oxbow lakes are declared a nature reserve and placed under permanent guard. The two main management interventions for increasing the fisheries yield of the oxbow lakes are weed removal and fingerling stocking.

Fishers annually remove the floating cover of water hyacinth and lotus, to increase the quantity of sunlight in the water and to reduce the uptake of nutrients by the aquatic macrophytes. Removal of all or most aquatic vegetation leads to a general reduction in abundance and diversity of plant species, followed by habitat loss for small indigenous fish and an increase in phytoplankton, as is shown in the reduced Secchi disk depths, in turn resulting in an increase in yields of stocked carp (Hasan et al., this vol.). Large-scale stocking of hatchery-reared fingerlings (3 000–4 000 fingerlings/ha) actually changes the underwater fauna, and this is likely to have an impact on insects and water plants. Grass carp in particular have a direct effect on the standing biomass of soft macrophytes such as oxygen weed.

The species composition of indigenous fish species in oxbow lakes under culture based fisheries management appears no different from that of a control lake (Haque et al., this vol.). However, the situation has deteriorated since, say, two decades ago: for example, catla, rohu and mrigal (Indian major carps) no longer occur naturally in the beels and baors of southwest Bangladesh (Flood Action Plan 17 1995). It is widely believed that the hatchery-produced fingerlings in Bangladesh show various degrees of inbreeding, demonstrating the limitations of trying to maintain indigenous species through intensive openwater stocking programs.

Environmental impacts of intensified agriculture

Intensification of agriculture has led to increased siltation in some lakes, as a result of plowing the adjacent lands converted to paddy fields. Paddy farmers on the encroached areas aim at maximum lake drainage near the end of the wet season in order to allow paddy cultivation immediately after the rainy season. As a result, water levels are usually very low in the hot season, as demonstrated by the fact that many shallow tubewells in the adjacent areas fall dry at this time.

Intensification of agriculture has also led to increased use of pesticides which, with the monsoon run-off, mostly end up in the oxbow lake and accumulate in the foodchain. Pesticide run-off is widely believed by fishers to make fish more susceptible to fish disease, notably Epizootic Ulcerative Syndrome.

Further, many species of wetland trees have all but disappeared locally over the past 20 years or so, due to indiscriminate felling.

Conclusion

The overall environmental deterioration in and around the oxbow lakes is directly related to the ever-increasing population density, resulting in agricultural encroachment of even the least suitable areas. It is postulated that, as a result of existing tendencies for ever-more intensive agricultural exploitation, similar environmental degradation would likely have occurred in the oxbow lakes even if OLP II had never been implemented.

Nevertheless, the present intensive fisheries management practices in the oxbow lakes also have a negative impact on the natural environment. The overriding concern of all stakeholders (fishers, project staff and government officers) with increasing fish yields from the oxbow lakes and sharing the benefits in a socially equitable manner has until recently obscured the necessity for protection of the environment.

Some of the interventions—for example encroachment, embankment construction and deforestation—are largely non-reversible, although at least some mitigation measures may be taken. Negative environmental impacts resulting from intensified agriculture, including increased lake drainage and use of pesticides, can be reduced by awareness raising and proper training. Large-scale stocking of fingerlings and near-complete removal of all aquatic vegetation are essential components

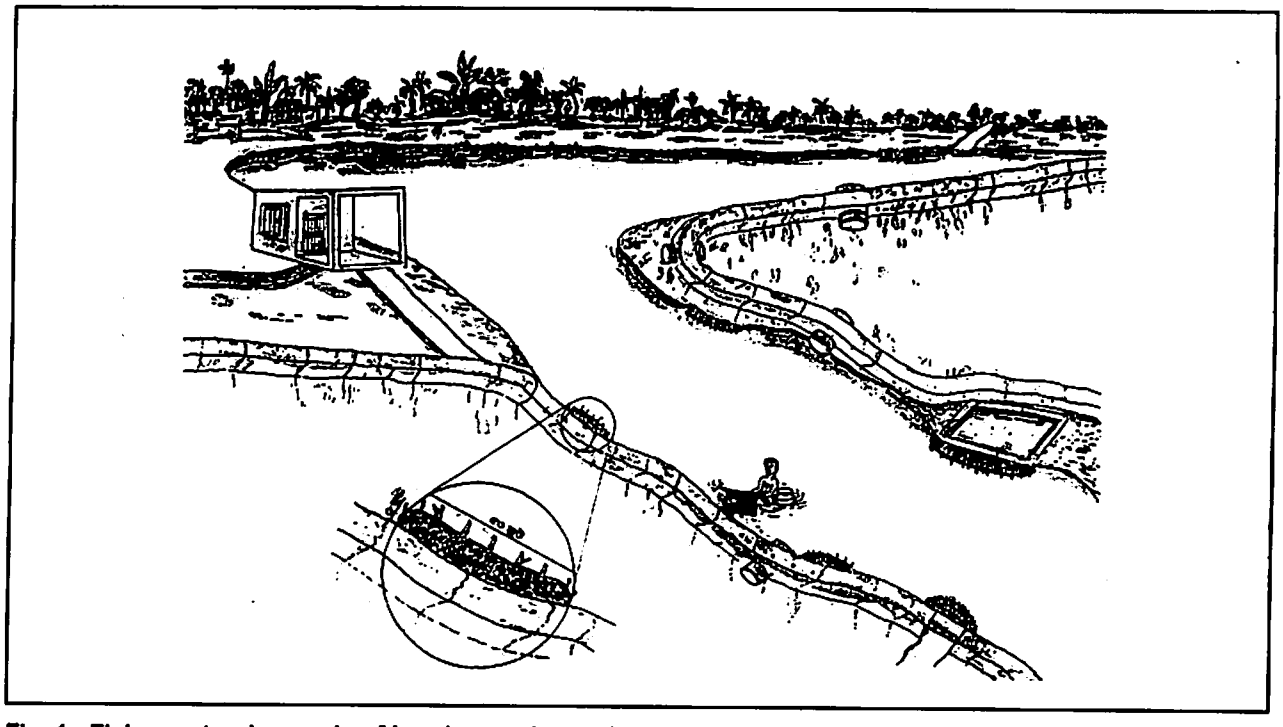

Fig. 1. Fish sanctuaries made of brushes and aquatic weeds should be established along embankments and pond dikes, and culvert pipes placed under embankments.

of intensive fisheries management and, although essentially reversible, are unlikely to be discontinued in the near future.

Recommendations

The protection of the natural environment in and around the oxbow lakes in densely populated Bangladesh cannot be enforced from outside but needs to be maintained by the local community. A community based approach is mandatory to protect the environment of these lakes, involving fishers as well as all other stakeholders living around the lakes. Such an approach requires awareness raising through debate and community implementation of mitigation measures. The institutionalized lake management groups (LMGs) for the fisheries management of the oxbow lakes provide a starting point for community implementation of such mitigation measures (Apu et al., this vol.).

Four mitigation measures are proposed for immediate implementation:

- *Micro fish sanctuaries to be maintained by the fishers along embankments and pond dikes.* Fishers should plant emergent aquatic macrophytes (such as lotus and waterlily) in a small band protected by branches and sticks along the lakeside of embankments and dikes of fish ponds, to reduce wave erosion and subsequent siltation of the lake (Fig. 1). Such "micro fish sanctuaries" will provide a habitat for small indigenous fish and shrimp species, and will have a direct nutritional value for poor people (lotus is eaten as a vegetable).

  The LMGs should be encouraged to maintain larger fish sanctuary areas in some of the shallower parts of the oxbow lakes (Fig. 2), as a fisheries management intervention aimed at enhancing indigenous species, at a proposed ratio of 5% of the total area (1 ha/20 ha). Branches should be placed in the sanctuaries to prevent fishing, and controlled growth of aquatic macrophytes should be allowed to provide microhabitats.
- *Placement of culvert pipes under embankments to allow inflow of nutrients and spawning migration of small indigenous fish.* Simple concrete pipes should be placed as culverts to permit floodwaters rich in nutrients to pass under the already constructed embankments and into the lakes, and to permit indigenous fish species to breed in the surrounding paddy fields (Fig. 1). Concrete pipes can be easily screened to prevent the big stocked carp

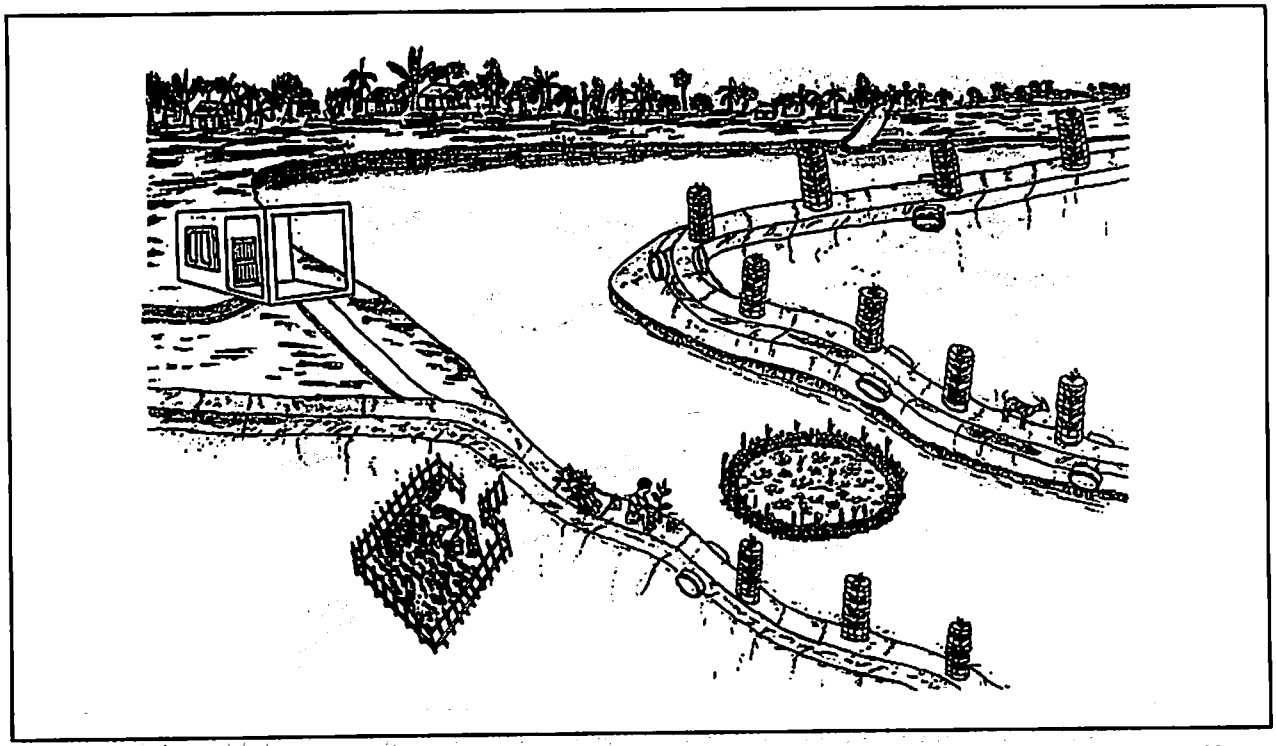

Fig. 2. Indigenous marshland tree species need to be replanted on the embankments and pond dikes, and large fish sanctuary areas maintained in shallower parts of lakes.

from escaping. Although simple pipes probably need to be reset every second year or so, more expensive large concrete culverts appear not to be justified.

Furthermore, the water level of the oxbow lakes during the dry season must be maintained in consultation with all stakeholders rather than quickly lowered by the encroaching paddy farmers. Water control structures usually are opened to the maximum as social consensus cannot be created easily. It is proposed that fixed weirs be installed to minimize conflicts.

- *Replanting of indigenous marshland tree species.* Fishers and others should be encouraged to plant and nurse indigenous trees from locally obtained seedlings in the public land around the lake and on the embankments and pond dikes (Fig. 2). The branches of certain tree species such as hijal (*Barringtonia acutangula*) and tamarind are said to attract fish when used in fish aggregating devices and should be grown by the fishers. Protection of saplings against goats and regular watering in the first year are necessary.
- *Awareness raising and proper training in the use of pesticides.* Awareness raising is needed for fishers, as well as for farmers and agricultural laborers, on the negative impacts of pesticides on fish and people and on how pesticides used to protect the rice crop enter via the oxbow lakes into fish. Proper training should be provided in the use of pesticides (for example timing, dosage, weather conditions), along with an introduction to alternatives such as integrated pest management and culture of carp fingerlings in rice fields.

Acknowledgements

The Oxbow Lakes Small Scale Fishermen Project, Second Phase (1991–1997) was executed jointly by the Bangladesh Department of Fisheries, BRAC, and Danida Technical Assistance. The project was funded through a loan to the Government of Bangladesh from the International Fund for Agricultural Development, and through a grant from the Danish International Development Assistance.

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SECTION 5

Issues in Other Fisheries Enhancements in Bangladesh

Fingerling Stocking in Openwaters

MD. NASIRUDDIN AHMED
Department of Fisheries, Matshya Bhaban, Dhaka, Bangladesh

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Abstract

The Second Aquaculture Development Project tested stocking carp in Bangladesh floodplains by developing nursery beels where fry were raised until natural flooding released them into the floodplain. A maximum of 905 ha of beel nurseries were operated in a year, and in the final year a financial benefit–cost ratio of about 6:1 was achieved. Although fishers gained from the project, more benefits accrued to lessees and middlemen. The technology may be adopted on a larger scale by lessees, or through government programs if fishing communities are involved and protect growing fish. Beel nurseries avoid the problems associated with transporting large quantities of fingerlings, but development work is needed in the beel. Further studies of the impacts of beel nurseries are needed.

Introduction

Bangladesh is endowed with vast inland and marine waters. The openwaters include floodplains (2.83 million ha), rivers and estuaries (1.03 million ha), beels and haors (respectively, natural lakes and large basin-like depressions, 0.11 million ha), and other lakes (including one major reservoir—Kaptai), a total of over 4 million ha. At one time 80% of fish production came from these openwaters. However, while total fish production had been increasing, there had been some decline in the catch from inland openwaters up to 1990–1991 (Table 1). Since that time, the figures show an increase in catch, primarily from floodplains, which is attributed to artificial stocking of some floodplains. The decline in fish catch had been attributed to:

- overfishing
- erection of flood control embankments
- widespread use of insecticides and pesticides
- construction of roads
- water pollution
- siltation of rivers
- use of nylon monofilament gill nets ("current nets")
- capture of undersize fish and of broodfish
- fish harvest by total dewatering
- lack of fish sanctuaries
- lack of a policy for managing waters.

Table 1. Fish production (t) in inland openwaters of Bangladesh, 1983–1996.

Year	Rivers*	Flood-plains	Beels	Kaptai Lake	All openwaters	Overall total**	Openwater (%)
1983–1984	215 549	200 616	51 373	4 057	471 595	753 502	63
1984–1985	219 882	194 130	45 893	2 700	462 605	773 979	60
1985–1986	206 712	187 396	45 258	2 433	441 799	793 923	56
1986–1987	201 152	183 796	42 077	3 981	431 006	814 685	53
1987–1988	191 883	182 037	45 610	4 068	423 598	827 105	51
1988–1989	187 556	186 126	47 019	3 439	424 140	840 926	50
1989–1990	179 803	193 762	46 594	3 713	423 872	855 527	50
1990–1991	142 006	249 083	47 923	4 392	443 404	895 935	49
1991–1992	131 140	295 185	49 201	4 216	479 742	952 079	50
1992–1993	145 685	329 573	53 019	4 142	532 419	1 020 654	52
1993–1994	150 552	360 597	55 592	6 635	573 376	1 090 610	53
1994–1995	152 058	363 750	59 410	6 962	581 180	1 170 365	50
1995–1996	154 601	370 105	63 104	7 449	595 169	1 264 435	47

* *Includes canals and Sundarbans mangrove forest*
** *Combines inland openwaters, inland closed waters and marine fisheries*
Source: DOF (1995) and unpublished DOF data

The main problem has been flood control embankments and conversion of floodplains to agriculture. The Department of Fisheries (DOF) estimated (DOF 1987) that 1.7 million ha of aquatic habitat would be lost in the next two decades, resulting in loss of 0.25 million t of fish per year, or about 147 kg/ha/year. Also, because of flood control structures, many beels and baors no longer have direct open connections with rivers, resulting in low recruitment of commercially important fish species and of other species.

Government response with floodplain stocking

To increase fish production, a fingerling stocking program was initiated under two projects: the Second Aquaculture Development Project (SADP), and the Third Fisheries Project (TFP). The TFP is discussed in detail by Islam (this vol.); the SADP is the focus of this paper. The working area of the TFP was western Bangladesh, while the SADP worked in northeastern Bangladesh: greater Sylhet District, Kishoreganj and Netrokona Districts.

Under the SADP, beels and other depressions were identified and developed as nurseries for raising 5-day-old hatchlings. The criteria for selection of beels as nurseries were that the beels should:

- hold at least 1 m of water during April–May;
- have no connection with other waterbodies or flowing rivers before flooding in the monsoon;
- be within the project area; and
- be of manageable size and condition.

A 4-month lease was taken on the selected nursery beels for the months of January–May or June. To prepare the nurseries so that they would retain fry until they grew to a size at which they had a better chance of survival in the floodplain, it was necessary to delay flooding, so low submersible dykes were constructed around the nurseries. During January–February all predators were removed from nurseries by use of fish toxicants. Weeds were removed by hand or with herbicides prior to eradication of predators, to ensure complete distribution of chemicals. Before stocking the hatchlings, the nurseries were treated with pesticides to kill insects and other pests. They were treated with inorganic and organic fertilizers to stimulate plankton growth. The 5-day-old hatchlings were stocked in the nurseries at the rate of approximately 0.3–0.4 million/ha. They comprised a mix of major carps and silver carp, with Chinese carp making up 40–50% of the total. After stocking, nursery beels were guarded by persons hired locally. The hatchlings grew to a size of 7.5–10 cm after 2–3 months and were automatically dispersed in the floodplains when the nurseries were inundated during annual flooding.

In the TFP (Islam, this vol.), fingerlings were released directly into the floodplain after purchase from a supplier; under the SADP, this system of fingerling stocking was tried in only one wetland (Hail Haor in Moulvibazar district). The quantities of hatchlings and fingerlings stocked under the SADP, and the areas involved, are shown in Table 2. Fig. 1 shows locations mentioned in this paper and in other papers excluding the Community Based Fisheries Management Project and Oxbow Lakes Small Scale Fishermen Project, Second Phase working areas.

Performance of the SADP

Incremental returns from nursery beels

Incremental fish production was calculated on the basis of production in a sample of stocked waterbodies compared with that of similar corresponding non-stocked waterbodies. The average gross value of production estimated in a sample

Table 2. Area and fish stocked under the SADP.

Year	Area (ha)		Quantity stocked (kg)	
	Beel nursery	Direct stocked	Hatchlings	Fingerlings
1989–1990	10	–	12.5	–
1990–1991	25	–	40	–
1991–1992	400	8 093	400	48 870
1992–1993	81	8 093	95	19 295
1993–1994	618	15 755	595	46 718
1994–1995	500	8 095	505	33 365
1995–1996	905	8 093	950	9 920
Total			2 597.5	158 168

Source: Project Management Office, SADP

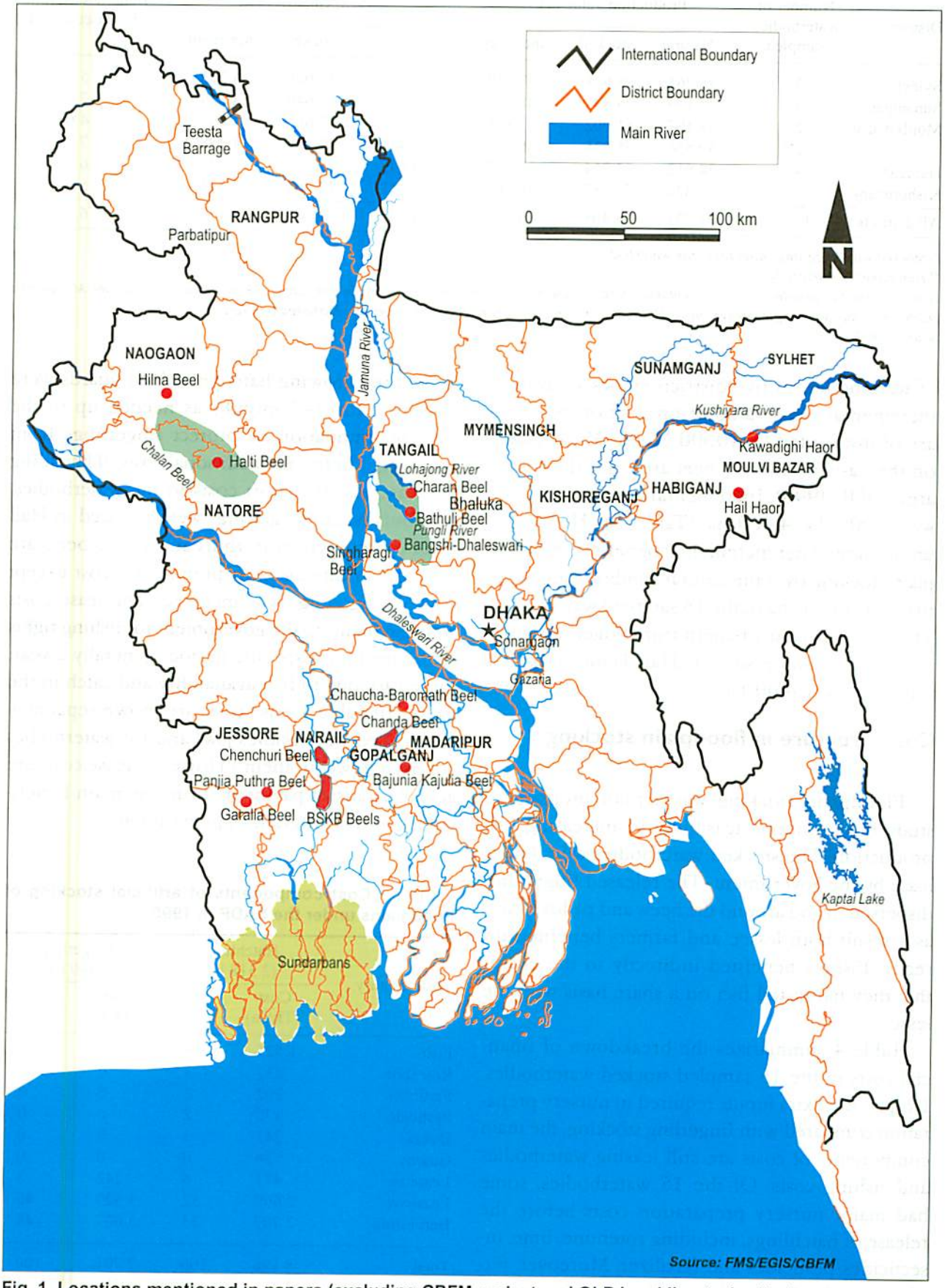

Fig. 1. Locations mentioned in papers (excluding CBFM project and OLP I and II waterbodies).

Table 3. Financial performance of 15 stocked waterbodies in 1995 per hectare of nursery beel.

District	Number of waterbodies sampled	Production value (Tk)			Investment cost (Tk)			Benefit–cost ratio (15% discount rate)
		Natural	Stocked	Increment	Natural	Stocked	Increment	
Sylhet	2	38 265	85 975	47 710	3 808	10 009	6 202	5.1
Sunamganj	4	31 139	79 833	48 695	3 060	7 649	4 589	7.4
Moulvibazar	2*	33 107	51 002	17 895	5 177	7 667	2 491	4.6
	2**	39 556	75 835	36 279	4 441	7 738	3 298	7.6
Habiganj	4	34 612	72 714	38 102	3 641	7 617	3 977	6.5
Kishoreganj	1	38 326	75 087	36 761	7 917	12 261	4 344	5.6
All districts	15	35 735	75 405	39 671	4 647	9 048	4 401	6.1

* *Stocked with fingerlings direct into the waterbody*

** *Hatchlings in nursery beel*

Note: Waterbodies sampled: Sylhet—Cheptakuri, Neazili; Sunamganj—Rangamatia, Dabor, Zinaria, Zinzur; Moulvibazar—Chiruadubi, Marajoinka (nurseries), Burburi, Hogla (fingerlings); Habiganj—Firani, Chotoberi, Baran, Sonamukhi; Kishorganj—Nali

Source: DOF 1996

of waterbodies in five districts shows an average incremental gross value of production per hectare of just under Tk 40000 (Table 3) calculated on the basis of nursery beel area, not floodplain area (DOF 1996). Incremental costs for stocking were only Tk 4 400/ha (Table 3). Hence the undiscounted net incremental benefit from floodplain stocking over the natural condition appeared to be Tk 35270/ha in the 15 sampled waterbodies. The incremental net benefit from fingerling stocking in two sample sites in Hail Haor, however, was only Tk 15400/ha.

Cost structure in floodplain stocking

Floodplain stocking was a pilot program to study the economic feasibility of increasing fish production. The stocked waterbodies were under lease by the government. The released fingerlings dispersed in and around the beels and paddy fields; as a result both lessee and farmers benefited directly. Fishers benefited indirectly to the extent that they harvested fish on a share basis with the lessee.

Table 4 summarizes the breakdown of financial costs in the 15 sampled stocked waterbodies. Despite the extra inputs required in nursery preparation compared with fingerling stocking, the main components of costs are still leasing waterbodies and fishing costs. Of the 15 waterbodies, some had major nursery preparation costs before the release of hatchlings, including rotenone, lime, insecticides/pesticides and fertilizer. Moreover, fertilizer and feeds were delivered two to three times to feed the growing hatchlings. Paid guards were employed for 1–3 months as needed up to the time of inundation to protect fingerlings from poaching. There were additional costs of hatchling purchase and transport costs to the waterbodies. In Moulvibazar, fingerlings were released in Hail Haor (within which Burburi and Hogla beels are located); in this case, no preparation cost except cost of fingerlings was incurred. The lease costs were payments to the government for fishing rights in the beel for a specific period, generally a year; these vary due to fish availability and catch in the beels. (In Table 4 lease costs are shown separately for stocked waterbodies [sw] and for waterbodies connected [wc] to them.) However, lease costs are actually transfer payments from the main beneficiaries of the program to government.

Table 4. Cost components of artificial stocking of floodplains under the SADP in 1995.

Cost category	Hatchlings (2 318 ha)		Fingerlings (340 ha)	
	Cost (Tk/ha)	%	Cost (Tk/ha)	%
Fish	1 525	19	263	3
Rotenone	237	3	0	0
Fertilizer	202	2	0	0
Pesticide	172	2	0	0
Dykes	241	3	0	0
Guards	34	0	0	0
Lease sw	471	6	242	3
Lease wc	2 609	32	3 529	46
Harvesting	2 707	33	3 667	48
Total	8 198	100	7 701	100
Stocking related	2 411	29	263	3

One of the major costs is for harvesting. The lessee, and some fishers who fish under subcontract to the lessee, pay these costs. Harvest cost includes creating shelters where fish are concentrated (*dalls, katas*), removing water weeds, making *kholas* (temporary shelters for hired fishers), purchasing and repairing gear, and paying contract laborers/fishers. Harvest costs varied between 9% and 50% of total costs, depending on the amount of aquatic vegetation.

The hatchling/fingerling cost for the 15 waterbodies was 17% of the overall costs of operating them. However, the contribution of hatchlings to costs varied between 72% in Nali Beel and 4.3% in Neazili-Chandal Beel (DOF 1996).

Financial viability of floodplain stocking

Both systems (nursery beels and fingerling stocking) were found to be profitable and biologically viable. Table 3 indicates that the average financial benefit–cost ratio for the project as a whole in 1995 was 6:1 at a discount rate of 15% (the range for separate beels was 4.6:1–10:1). The lowest returns were from fingerling stocking in Hail Haor (average 4.6:1), where there were relatively low catches of stocked fish per hectare.

It can be concluded that the costs of stocking, especially when fingerlings are stocked directly, are small relative to the total costs incurred by lessees in managing these fisheries, while the benefits reported are large. Given such high benefit–cost ratios, it would appear that private stocking in these floodplains by the lessees would be financially viable without subsidy (under SADP, project costs were borne by government with the help of a loan from the Asian Development Bank). In fact, based on the demonstrated gains from stocking, a few leaseholders are reported to have subsequently stocked nursery beels themselves.

Involvement of people in stocking

The aims of artificial stocking of floodplains are to increase fish production, and to improve the socioeconomic conditions of all people involved in the fishery. Selected private and government waterbodies were used for this stocking program. Most government waterbodies were leased to lessees or middlemen who were not fishers themselves and could afford the substantial costs involved in paying the lease money in advance. Moreover, the lessees sub-lease fishery management within these large fisheries, for example in annual brushpile harvest by contract fishers or by fishers engaged as laborers.

An impact evaluation survey compared the income of fishers before and after the project. There was an overall increase of 44% in income for general fishers: income from fish catching rose 54% and from a share in the harvest by 71% (incomes from some other sources, such as land, fell for these households in the same period) (DOF 1996).

Thus while total financial returns from the beels increased by about six times, after deducting government taxes (lease fees), individual fisher incomes increased by no more than 50%. It may be that more fishers were employed after stocking, thus spreading the benefits. Some lessee costs are not recorded in the total costs; nevertheless, most of the incremental net benefits clearly accrued to the lessees, who in these large fisheries are already rich people and are not fishers. The project did not include cost sharing or cost recovery from these lessees. Government also retained part of the benefit by increasing revenue collected by an average rate in excess of the normal average increase of 10% a year. For example, the lease value of studied stock-influenced waterbodies increased by 40% in 1993 compared with 1992, and by a further 16% in 1994 and 20% in 1995 (DOF 1996).

Floodplain beel fishery tenure

The ownership of floodplain fisheries is typically complex. A floodplain comprises private and government (khas) land, plus openwater (rivers/canals) and closed water *jalmohals* (beels/ponds). Larger jalmohals (20 acres [8 ha] and above) are administered by the Ministry of Land, and smaller ones (under 20 acres [8 ha]) by Thana Parishads. These jalmohals are usually leased to fisher societies or private individuals. The duration of the lease is one year for open jalmohals, and normally three years for "closed" jalmohals, including beels involved in floodplain stocking. So that most of the benefits of a floodplain stocking program will not

go to just a few lessees, an arrangement is needed which transfers rights over these fisheries to fishers and thereby ensures that the fishers enjoy the benefits of stocking. It is proposed that in such situations all the jalmohals within the floodplain should be transferred to DOF on the condition that it then gives fishery rights to the fishing community. To make any stocking program sustainable, it is essential that the fishers, through DOF, have user rights over the jalmohals for 10 years. Projects to introduce stocking technology to the fishing community would be of shorter duration, but DOF would ensure that the lease fee of waterbodies is regularly paid by the beneficiaries after completion of the development project.

Fish conservation and fish sanctuaries

Where floodplains are stocked it is necessary to protect fry and fingerlings from fishing until they reach marketable size. More generally, the Protection and Conservation of Fish Act, 1950, was designed to protect fish stocks from overfishing, but enforcement has been poor due to lack of resources and of authority (Farooque, this vol.). To limit the use of small mesh gear in floodplains in order to prevent capture of fingerlings, there needs to be stricter enforcement using mobile courts.

Fish sanctuaries are a possible conservation measure. There have been repeated recommendations in favor of sanctuaries. For example, a Food and Agriculture Organization/United Nations Development Programme workshop in 1985 recommended carp sanctuaries in the Padma, and in that year a government Gazette Notification prohibited capture of carp in the spawning season (April–June) at 27 sites. The Cabinet Committee on Finance and Economic Affairs in 1993 suggested establishing fish sanctuaries, and sanctuaries are a priority in the draft National Fisheries Policy (MOFL 1997), which states that they would be managed by DOF with the help of fisher organizations and local government if necessary. This may be in response to the lack of sustainability of sanctuaries and of conservation measures established earlier, which were decided centrally without participation of local communities. Such sanctuaries have not continued after the end of project funding, or have not been respected by all fishers (an example being the Integrated Fisheries Development Project which ended in 1995).

Conclusions and recommendations

Although costs of stock enhancement using beel nurseries are higher than those of stocking with hatchery-produced fingerlings, the returns on investment were found to be much higher. However, the release of fingerlings into the floodplains is dependent on nature and, in particular, drought and flood conditions each year. In some years drought is a problem, and in others, flash floods result in escape of fry and fingerlings before they reach a suitable release size. Moreover, some floodplains and beels are remote. Difficult communications mean that fingerlings are expensive when transport costs are included, and are also weakened by travel, which may reduce survival rates.

It can be concluded that the technology of beel nurseries works (this was tested for the first time in Bangladesh by the SADP), and that stocking of beels and haors by this approach is profitable, but the lessees gain most of the benefits. Hence in future, if this approach is expanded, reforms would be needed to ensure that fishers benefit more from enhanced production.

The following recommendations are made:

- Stocking floodplains through beel nurseries is the preferred option, but it cannot be executed everywhere. Where it cannot, direct fingerling stocking is possible.
- Stocking of floodplains from beel nurseries is not feasible where floods release fry/fingerlings before they have reached a size at which they will have a good survival rate.
- For areas difficult of access, transporting spawn for stocking beel nurseries is easier than transporting fingerlings.
- The use of rotenone to kill unwanted fish in nursery beels has been criticized on environmental grounds due to loss of biodiversity. Rotenone is, however, an easily degradable compound so does not have adverse residual effects. Studies are needed of biodiversity in floodplain–beel systems where beel nurseries are developed.

- Fish sanctuaries should be established to protect biodiversity in these areas.
- Stocked fish need to be protected until they reach a marketable size by strict implementation of the Protection and Conservation of Fish Act.
- Government programs to enhance floodplain–beel fish production should address the distribution of benefits, and ensure that the fishers gain rights to the fisheries, with DOF supervision.

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Enhancement of Floodplain Fisheries: Experience of the Third Fisheries Project

MD. ZAHIRUL ISLAM
Department of Fisheries, Matshya Bhaban, Dhaka, Bangladesh

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Abstract

Floodplains comprise 70% of inland openwaters in Bangladesh. Fish production, particularly of carps, has been sharply declining for three decades due to reclamation and reduced recruitment linked with flood protection. Stocking of major carp in up to 43 500 ha of floodplains by the Third Fisheries Project produced about 20 000 t of carps from 1991 to 1996, and the economic rate of return averaged about 30%. The basic assumption was that unexploited niches existed in remaining floodplains due to the decline in natural stocks of carp. In general, exotic major carps were not found suitable for stocking, except common carp (*Cyprinus carpio*) which fishers found to be the most profitable and favored species. Stocking is technically and economically viable, but financial and managerial viability and sustainability of floodplain enhancement have yet to be demonstrated, as costs could not be recovered, and communities were involved in activities only near the end of the project.

Introduction

Bangladesh, due to its favorable location and environment, is very rich in inland openwater fisheries. The economic contribution of fisheries to Bangladesh is currently 60% of animal protein intake (Department of Fisheries estimate based on 26 g/person/day fish intake and 16% protein content of fish), 4.7% of GDP, 14% of agricultural income, 9% of export earnings and 8% of employment (BBS 1995). One person in 10 is directly or indirectly dependent on the fisheries sector. Fish production, particularly of carps, has been sharply declining for the last three decades due to rapid degradation of floodplains and a reduction in natural recruitment of these species. Before 1985 there was no record of the annual catch of wild carp hatchlings, but it fell from 19 362 kg in 1985 to 5 069 kg in 1993 (DOF 1997).

The floodplains of Bangladesh comprise 2.83 million ha of a total inland openwater area of 4.05 million ha (DOF 1986). Floodplains are very rich in nutrients and natural foods which make them fertile feeding grounds, for carps in particular. Due to the absence or scarcity of naturally recruited carp, some ecological niches in the floodplains have become either unused or underutilized. It was believed that an enhanced fish harvest could be produced by filling the vacant niches through stocking these floodplains with fast-growing major carps that could take advantage of this unused natural food. Accordingly the Government of Bangladesh stocked a few sections of some rivers and floodplains with carp fingerlings produced in Department of Fisheries (DOF) fish farms during 1988–1990. The impact of this program could not be ascertained, although a trend to increased fish production in stocked sections of openwaters was reported.

Stocking of floodplains with carp fingerlings on a wide scale was then undertaken under the Third Fisheries Project (TFP), with a view to developing a sustainable model or models of how to adopt a long term strategy for enhancing floodplain fisheries through annual stocking. The TFP operated from 1991 to 1996 with credit assistance from the World Bank and technical assistance from the United Nations Development Program, and the then Overseas Development Administration of the United Kingdom. This paper reviews the experience of floodplain stocking under the TFP.

Assumptions

Under the TFP, the technique of widescale floodplain stock enhancement with carp was based on a number of assumptions and premises. These form the basis for assessing the achievements of

the project at its close (end of 1996), and so are presented in some detail.

Socioeconomic assumptions

In order to achieve viable performance, the financial and economic rates of return of the project should be not less than 25% and 12%, respectively, according to the World Bank Staff Appraisal Report (IDA 1990). Stock enhancement would improve income of fishers in the floodplain area, induce changes in income distribution, and help alleviate poverty in the floodplain community. The floodplain stocking component would allow professional fishers greater access to the floodplain fishery. A large number of additional days of work in the private sector would be created for producing and marketing hatchlings, fingerlings and harvested fish.

Institutional assumptions

The system of leasing public waterbodies in the floodplains would be gradually replaced by a licensing system to establish direct access of fishers to the fishery. The private sector nursery operators would provide incremental production of fingerlings. The private sector traders and contractors would organize nursery operations. Managerial capability to manage a large-scale stocking program in the public sector (DOF) would be developed through technical and management assistance. The Protection and Conservation of Fish Act, 1950, would be strictly enforced to control premature catching of stocked fingerlings, and other conservation measures would be undertaken.

Technical assumptions

Floodplains are rich in nutrients and fish food, and so are naturally the most suitable area for breeding, nursery and growth of fishes which migrate into and out of the floodplain with rising and falling floods. Habitat degradation due to natural causes and development projects has adversely affected the breeding migration of major carps in particular; consequently there is very little recruitment of major carps and of some other fishes into the floodplains. A program of stocking with a suitable balance of fish species was therefore conceived to take advantage of the underutilized nutrients and food available in the floodplains during the flood season (June–November). This intervention was expected to result in an incremental yield of 300 kg/ha in the major floodplains against a reported existing yield of 70–100 kg/ha (IDA 1990). A 12% capture-at-harvest rate for stocked fingerlings was assumed after allowing for fingerling escape. The most important assumption was that vacant ecological niches would be properly used and external stock enhancement would have no negative impact on existing biodiversity. Restocking would compensate for a reduction of natural fish recruitment without affecting the rate of growth of non-stocked species. Baseline data on gear selectivity, fish food availability and limnology would be generated by a research component.

The Project as implemented

The success of a stocking program, as measured through incremental production, economic benefits and improvements in the livelihoods and food security of local communities, depends on many factors. These include productivity of the floodplain, flooding period, selection of species, species composition of fingerlings stocked, stocking density, mortality after stocking (due to transportation stress, predation, disease, escape, and the capture of undersized fish), genetic quality of fingerlings, conservation measures and community participation. Economic benefits are also contingent upon the costs of stocking (including costs of fry), of management, and of harvesting and marketing fish. Project experience with regard to these factors is reviewed below. Data on Project performance are largely derived from DOF (1996a and 1996b), plus unpublished Project data.

The TFP stocking program

Under the TFP, 100 000 ha of floodplains in the western half of the country, particularly in major depressions in the Khulna–Narail, Gopalgonj–Madaripur and Chalan Beel regions, were scheduled to be stocked in phases with 6–12 cm fingerlings of major carps with a stocking density of 20–30 kg/ha, starting with 29 000 ha in 1992. By stocking carp fingerlings at 30 kg/ha, a total

incremental production of 30 000 t of fish was expected to be obtained at 300 kg/ha, representing 10 times the weight of stocked fingerlings.

A pilot stocking program was initiated in 1991 in two minor floodplains: Garalia Beel (1 000 ha) in Jessore District, and Hilna Beel (2 000 ha) in Naogaon District; 73 t of fingerlings were released. The encouraging results provided guidelines in respect to species composition for the major stocking program. In 1992 three major floodplains plus one previously stocked beel were stocked with 392 t of fingerlings. The floodplains comprised the poldered (surrounded by embankments) Barnai–Selimpur–Kola–Basukhali (BSKB) beels with an area of 13 000 ha (effective stocking area 6 000 ha) in Khulna–Narail Region; Chanda Beel (an open system of 6 000 ha) in Gopalgonj; and Halti Beel (a semi-closed beel of 10 000 ha) in Rajshahi–Natore Region. In 1993 stocking was undertaken in BSKB, Chanda, Halti and Garalia with varying stocking densities and species composition, based on productivity of the beels and past experience; 417 t of fingerlings were released. Stocking performance in all the beels except Halti was found to be biologically and economically viable, although the social objectives were not achieved in all the areas. The program for Halti in 1992 and 1993 was not economically viable because of the low productivity of the beel due to ecological conditions, and this beel was dropped from the program in 1994.

In subsequent years, new floodplains were identified for stocking based on the selection criteria. In 1994, 1995 and 1996 floodplains with a total area of 24 000 ha, 32 000 ha and 43 500 ha, were stocked with 417 t, 595 t and 628 t of fingerlings, respectively (stocking density 13–26 kg/ha). Table 1 summarizes the annual performances of the Project in aggregate.

Table 1. Summary result of floodplain stocking by Bangladesh Third Fisheries Project.

	1991–1992	1992–1993	1993–1994	1994–1995	1995–1996	1996–1997	Total
Area (ha)	3 000	23 000	24 000	24 000	32 000	43 500	149 000
Fingerlings stocked							
(t)	73.0	392.0	417.9	417.5	595.8	628.0	2 524.2
(kg/ha)	24.3	17.0	17.4	17.4	18.6	14.4	16.9
Baseline yield (t)							
Stocked species	6.0	183.5	183.5	194.9	129.5	281.8	979.2
Non-stocked species	426.0	4 798.0	5 090.9	4 606.3	2 465.0	1 356.6	18 742.3
Total	432.0	4 981.5	5 273.9	4 801.2	2 594.5	1 638.4	19 721.5
Incremental yield (t) (total – baseline)							
Stocked species	688.4	503.8	2 700.4	3 988.1	5 092.8	6 280	19 253.6
Non-stocked species	-19.0	629.5	2 983.2	2 390.0	2 627.6	4 005	12 617.2
Total	669.4	1 133.3	5 683.6	6 379.0	7 710.4	10 285	31 860.7
Production cost (Tk millions)							
Fingerling	4.7	34.8	52.1	41.5	56.4	48.7	238.2
Other*	0.5	3.7	3.9	3.9	5.2	8.5	25.7
Total	5.2	38.5	56	45.4	61.6	57.2	263.9
Value of incremental production (Tk millions)							
Stocked species	2.07	15.12	81.0	119.6	152.7	188.4	558.89
Non-stocked species	-0.05	1.57	7.4	5.98	6.5	10.01	31.41
Total	2.0	16.7	88.4	125.6	159.2	198.4	590.3
Retrieval rate (%)	10	10	13	15	15	15	

Note: Fish price per kilogram: carp Tk 30, non-stocked species Tk 25.
**Including DOF's administration; fishing costs; and NGO costs (1996 only)*

Preparation of annual program

A committee constituted by DOF prepared and updated selection criteria and the annual program of stocking, based on experience of previous years' stocking and recommendations of field officials, fishers and experts. Selection of beel, species mix, density, species size, stocking points, etc. was made after exchanging and sharing views and ideas amongst field officers of DOF, the Fisheries Research Institute, fishers, NGOs and specialists.

Selection of floodplains

The main criteria and factors considered in the selection of floodplains for stocking were physical and biological condition, limnology, productivity, inundation period, effective water area, coverage of vegetation, accessibility and communications to stocking points, and absence of *khals* (channels) between stocked floodplains and other waterbodies. Most of the floodplains selected were under flood control projects, and were partially or completely diked, with connecting channels closed by sluice gates. These flood control works had ended natural recruitment of Indian major carp. Some floodplains were almost free of vegetation during the monsoon after harvesting *boro* (dry season) paddy, but some were planted with *aman* (monsoon season) paddy. It was intended that selected floodplains have a minimum water area of 1 000 ha during the peak flood, and be inundated for 4–6 months (June–November) with at least 1 m of water, and not be covered by water hyacinth and other thick vegetation that hampers light penetration. However, some of the floodplains were smaller, and some, such as Chanda Beel and BSKB, had water hyacinth problems. Stocking points were accessible by water and road for transporting fingerlings to the waterbodies. The floodplains were to be demarcated by landmarks for the purpose of monitoring.

Species composition, stocking density and size of fingerlings

Success of the Oxbow Lakes Small Scale Fishermen Project, First Phase model of fishery stock enhancement (Sattar and Khan, this vol.) was the basis for undertaking floodplain stocking, so the same species composition and stocking density as in oxbow lakes was planned, except for size of fingerlings. As the oxbow lakes are perennial and have an abundance of predators, they had been stocked with large fingerlings (12 cm and above); the seasonal floodplains were expected to have initially lower predator populations, and so were stocked with smaller fingerlings (7–15 cm). The species composition in oxbow lakes stocking was: 50% silver carp (*Hypophthalmichthys molitrix*), 20% bighead carp (*H. nobilis*), 10% common carp (*Cyprinus carpio*), 10% rui (*Labeo rohita*), 5% catla (*Catla catla*) and 5% mrigal (*Cirrhinus mrigala*). In 1991 two floodplains were stocked with this species composition at the rate of 24 kg/ha, but the survival of silver carp was very poor while common carp did well. The species composition was later adjusted: the proportion of silver carp was drastically reduced for most of the floodplains and even eliminated from some, while the proportion of common carp was increased, and a new species, Thai sarputi (*Barbodes gonionotus*) was introduced. Stocking density was kept within the range of 13–26 kg/ha. The species composition and density varied from floodplain to floodplain depending upon their physical and biological condition. The final stocking proportions were 0–5% silver carp, 25–30% common carp, 16–30% rui, 20–29% catla, 9–16% mrigal, 0–1.6% kalibaus (*Labeo calbasu*) and 10–13% Thai sarputi. All these species are cyprinids.

Procurement of fingerlings

Fingerlings were procured and stocked through contractors pre-qualified by an international bidding system. Contractors entered into subcontracts with fingerling producers. Initially contract lots were comparatively large and competition was restricted to contractors and traders only. Lot sizes were then gradually reduced. From 1994 lot sizes were broadly divided into two categories: lots of 5–10 t restricted to fingerling raisers/nursery owners, and lots of 15 t and above (up to 60 t) for contractors and traders. Specifications and conditions for supply and delivery of live carp fingerlings were rigid. These requirements, along with penalty clauses, were to some extent responsible for

the high cost of the fingerlings supplied. Fingerling cost was very high in 1993 (average Tk 121/kg) due to time constraints and price rigging by the contractors; it gradually decreased to Tk 60–99, Tk 73–93 and Tk 54–77 in 1994, 1995 and 1996, respectively, due to better management of procurement.

Inspection and delivery

The Project provided for inspection of the nurseries which were scheduled to supply fingerlings to the selected suppliers. For quality control, the stocking period was restricted to a maximum of 30 consecutive working days for lot sizes of 15 t and above, and 15–20 days for smaller lots; and all had to be supplied during the period from 15 June to 31 August every year (some slight deviations actually occurred). Fingerlings were transported by truck in drums and tanks and oxygenated by aerator or by hand. Fingerlings were stocked and kept in *hapas* (holding nets to a specification designed by the Project) at least for 1 hour for acclimatization. After checking and sampling at the release platform by a government-constituted interdepartmental committee including representatives from local government and the fisher community, the fingerlings were released to the floodplains. In addition, there was an arrangement for external checking by an independent certifying firm in 1992 and 1993, and in later years by a joint effort of DOF, NGOs and fisher representatives.

Conservation

Conservation of stocked fingerlings was one of the most crucial issues for the success of the program. Size of released fingerlings of major carps was 7–16 cm, and of Thai sharputi 5–11 cm, although the actual size range was slightly adjusted every year according to practical problems and use of water resources. Released fingerlings require at least 3 months to grow to marketable size. Therefore enforcement of the Protection and Conservation of Fish Act, 1950, which sets minimum mesh sizes for nets to avoid capture of juvenile carps, was strengthened in the stocked floodplains by increasing government manpower and logistic support. During the initial years of stocking, DOF had to face social and moral problems when it prevented local fishers from catching undersized fish and from using gears harmful to stocked fingerlings. Gradually the fishers and the local community became motivated and actively involved in the conservation of fingerlings and the reduced use of banned gears. NGO efforts to involve the community in this process were found to be useful, as DOF has limited manpower and limited knowledge and experience of social mobilization.

Production monitoring

Before stocking in each floodplain, baseline data were gathered on fishing gear, species composition and the socioeconomic condition of different types of fishers. A local consulting firm, Bangladesh Centre for Advanced Studies (BCAS), conducted production monitoring for three years (including the baseline survey) for three major floodplains (Chanda, BSKB and Halti Beels). It carried out household surveys and surveys of gear and fish aggregating devices. Thereafter these floodplains and others stocked by the Project were monitored by DOF's own staff through a gear-dependent sample survey system developed jointly by DOF and BCAS (DOF 1996a).

Sustainability

Project design, in general, did not provide any means for ensuring sustainability of the stocking program, except in terms of cost recovery from the beneficiaries. To remedy this situation, 16 NGOs were deployed in 19 floodplains in the last year of the Project (IDA 1995). Beneficiaries were to be organized and motivated by the NGOs so that for smaller floodplains, the beneficiaries would initially share the cost of stocking and gradually take over full responsibility for stocking and management; for larger floodplains, public intervention with community participation was an alternative option.

Results

Benefits of stocking: incremental yield

During six years, 149 500 ha of floodplains were stocked with 2 524 t of carp fingerlings. An

incremental yield of about 20 000 t of stocked species was estimated. Strict conservation measures to protect stocked fingerlings also resulted in incremental production of about 13 000 t of non-stocked fish in the floodplains (according to catch data from preceding years). Yield varied in the range of 49–281 kg/ha, with an average of 214 kg/ha. Average incremental yield was 234 kg/ha if 1992 (an abnormal drought year) is left out of the calculation. The weight of harvested stocked fish, as a multiple of the weight of fingerlings stocked, varied from floodplain to floodplain and from year to year in the range of 1.5-16 times, with an average of 8. For the incremental fish yield of both stocked and non-stocked species of fish from the baseline (pre-Project) year to 1996, see Table 1; the per hectare increase in stocked species (carp) and non-stocked species is shown in Figs. 1 and 2, respectively.

Economic analysis

Stocking of floodplains under the TFP continued for six years. In all, 26 floodplains were stocked in one year or another, including 23 stocked in the final year (1996). Eight floodplains having sufficient and statistically sound data were used for economic analysis. Rates of return were estimated beel by beel for the duration of the Project and for a projected 20-year period; they ranged from 28% to 122% for the 20 years, and from 16% to 123% taking account of just the six years of completed stocking. For the Project as a whole, a standard set of parameters was used for the remaining years from 1998 of the 20-year period (Table 2). On the other hand, assuming that there will be no further stocking after 1996 (because DOF and the NGOs have no resources to stock, and local communities or beneficiary groups are not yet sufficiently organized to continue on their own), the first four years of the Project—which ran at an economic loss—are counted against only the last two years of positive returns, when stocking was reduced but the quantity caught was calculated to be higher, and including assumed values of uncaught fish remaining after 1996 (Table 2). The economic internal rate of return for 20 years was 38% and for the six years of the Project 29.7%. Beyond 1996, it was estimated that the annual investment cost (excluding private costs of fishing) would amount to about Tk 11.8 per harvested kilogram of fish attributed to the Project (see Table 2). The following assumptions were made in the economic analysis:

- Stocking costs are actual costs until 1996, and the forecast stocking quantity and price are the averages of the rates for 1995 and 1996.
- Fishers' costs are based on survey data on actual gear ownership and participation in fishing, together with local estimates of gear costs. These were checked for consistency before being used in the analysis.
- DOF costs are based on staffing, vehicles and equipment (such as computers) used by the Project as reflected in quarterly reports. Costs were allocated to stocking according to the number of stocking points.
- NGO and other supervision costs are taken directly from the relevant support budgets and from the direct cost of fishers' contributions to the stocking.
- Incremental catch uses actual figures up to 1995–1996 and the average of the last two full years' data for future forecasts.

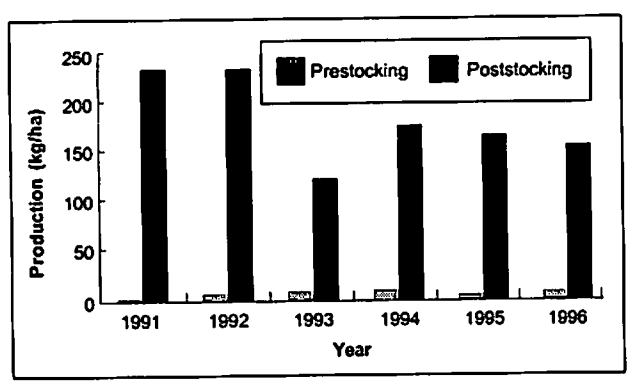

Fig. 1. Increase in carp production due to stocking.

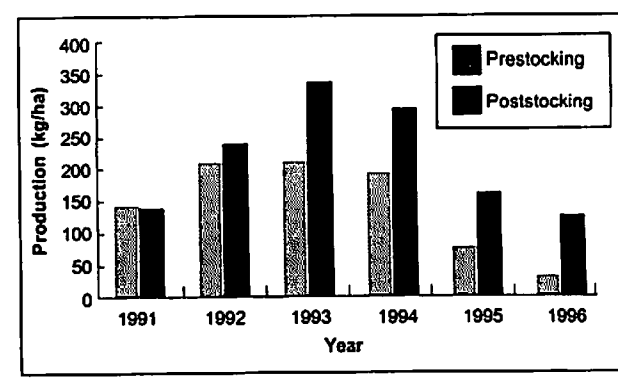

Fig. 2. Impact of Project on non-stocked species.

Cost of fingerlings stocked

The average cost per fingerling stocked (including transport and management) over six years was Tk 0.83 for direct fingerling stocking. Fingerlings raised in beel nurseries automatically disperse when the nursery connects with the floodplain in the monsoon, and being raised in the same environment, should have a better chance of survival than those transported from distant places and released in floodplains. The recovery rate of fingerlings (percentage of stocked fingerlings which are harvested) was estimated by the Second Aquaculture Development Project (SADP) to be 10% when fry were stocked in beel nurseries, and 25% when fingerlings were stocked directly in the floodplain (Ahmed, this vol.); while TFP estimated a recovery rate of 15% when fingerlings where stocked directly in the floodplain. Based on these figures, the cost per fish harvested (4–5 months after stocking, average weight 0.4 kg) has been estimated at Tk 0.78 for beel nurseries, Tk 4.10 for direct fingerling stocking under SADP, and Tk 4.85 for the TFP.

Social impact and benefits

Considering final year stocking in 23 floodplains, it appears that more than 85 000 fishers, each heading a family, benefited from this stocking program. Three categories of fishers are found in the floodplains: full-time (depending mainly on fishing), part-time (partly/seasonally dependent on fishing), and subsistence fishers (who fish seasonally partly for own consumption or/and for sale). Full-time, part-time and subsistence fishers comprise 22%, 28% and 50%, respectively, of all fishers. From socioeconomic and fish consumption studies (BCAS 1995a and 1995b) in three floodplains, it is evident that income, assets of various kinds, and daily fish consumption of local fishers have increased (Table 3). Two NGOs—Pramoda, working in a floodplain in Rangpur; and Pradipon working in BSKB in Khulna—reported improved socioeconomic status of local fishers due to fingerling stocking. Besides, about 2.5 million person-days of casual labor for nursing and raising of fingerlings, and a large number of days of daily labor for transporting and marketing fingerlings and food fishes, were generated by the Project.

Table 2. Economic analysis of floodplain stocking of selected beels (actuals to 1996, assuming stocking ends in 1996).

	1991	1992	1993	1994	1995	1996	1997	Future
Stocking statistics								
Area stocked (ha)	3 700	13 200	14 700	22 200	14 200	22 200		22 200
Stocked quantity (t)	73	253.8	249.1	428.6	265.7	325.5		358.6
Stocking density (kg/ha)	20	19	17	19	19	15		16
Fingerling price (Tk/kg)	66	88	119	99	89	84		87
Incremental catch (t)	0	694.7	511.3	2 180.6	4 372.7	3 338.8	3 707.7	4 116.7
Incremental catch (kg/ha)	0	188	39	148	197	235	167	185
Average catch value (Tk/kg)		26	30	34	34	32	35	35
Costs (Tk × 1 000)								
Stocking cost	4 855	22 419	29 559	42 284	23 624	27 313		31 148
Fisher labor costs	634	5 696	8 645	10 991	9 922	11 591		11 591
Fisher equipment costs	912	8 731	13 458	18 167	14 688	20 026		20 026
DOF administration costs	2 065	9 165	13 987	17 735	7 998	10 195		10 195
NGO supervision	0	392	276	260	3 690	7 124		7 124
Other supervision	0	0	0	17	111	111		111
Total financial costs	8 666	46 403	65 927	89 466	59 936	76 360		80 195
Total economic costs	7 366	39 442	56 036	76 046	50 947	64 906		68 166
Benefits (Tk × 1 000)								
Total financial benefit (incremental catch value)	0	18 086	15 576	73 659	150 336	107 970	128 931	142 369
Total economic benefit	0	15 373	13 239	62 610	127 787	91 775	109 591	121 014
Net economic benefit (Tk × 1 000)	(7 366)	(24 069)	(13 436)	76 840	26 868	41 426	52 848	52 848

Note: Net present value: Tk 42 020 000 (approx US$1 million) in 1996 prices
Economic internal rate of return: 29.7%

Environment and biodiversity

A limited study was made of environmental and biodiversity issues (FRI 1996). It was found that in one floodplain, BSKB, the easy inflow and outflow of water through well managed opening and closing of sluice gates with the help of the Bangladesh Water Development Board, achieved a continuous upward trend in production of both stocked and non-stocked fish. On the other hand, catches of both stocked and non-stocked species have gradually decreased in one floodplain (Garalia) where inflow and outflow of water decreased due to siltation of canals and sluice gates. The Shannon–Weaver biodiversity indices calculated for three floodplains do not indicate any loss of fish biodiversity in terms of richness and evenness due to project stocking (Hossain et al., this vol.). For the first time in Bangladesh, the TFP tried to make the hatchery/nursery operators and owners aware of possible genetic degradation of hatchery produced fry and motivated them to take corrective measures.

Discussion

Stocking of 15–20 kg/ha of an appropriate species mix of fingerlings can profitably produce additional fish by utilizing underexploited nutrients

Table 3. Impact on local fishers of floodplain stocking under TFP.

Indicator	Floodplain		
	Chanda	BSKB	Halti
Land assets (Tk/household)			
Pre-project	60 688	72 644	121 893
Post-project	63 020	83 458	128 751
Increase (%)	4	14	5
"Fishing right assets" (Tk/household)			
Pre-project	3 881	5 209	3 698
Post-project	7 946	6 026	3 967
Increase (%)	104	15	7
Movable assets (Tk/household)			
Pre-project	2 800	3 016	4 580
Post-project	3 451	4 023	5 210
Increase (%)	23	33	13
Fishing gear assets (Tk/household)			
Pre-project	1 896	1 316	1 239
Post-project	2 100	1 346	1 275
Increase (%)	10	2	3
Livestock assets (Tk/household)			
Pre-project	4 678	5 086	4 441
Post-project	6 138	5 136	4 991
Increase (%)	31	1	12
Fishing income (Tk/household)			
Pre-project	1 126	2 822	2 763
Post-project	7 324	5 810	6 843
Increase (%)	550	105	147
Per capita daily fish consumption (g)			
Pre-project	20.3	5.62	8.71
Post-project	48.79	18.11	24.76
Increase (%)	140	222	180
Housing assets (Tk/household)			
Pre-project	11 570	10 361	10 877
Post-project	12 487	11 579	11 176
Increase (%)	7	11	2

Note: *Number of people per family: 6.1*
All pre- and post-project figures in 1994 Taka except fish consumption
Pre-project period: 1991–1992 financial year (July–June)
Post-project period: 1993–1994 financial year (July–June)
Source: BCAS (1995a and 1995b)

and food in the floodplain ecosystem without hampering production of non-stocked fish species or biodiversity. Silver carp was found to be the most unsuitable species because of its high rate of migration out of the stocked area. Common carp was found to be the most profitable and favored species because of its high rate of survival and production. Catches of both stocked and non-stocked fish species have gradually declined in one floodplain where inflow and outflow of water decreased due to siltation of canals and sluices. However, a trend to increased production of both stocked and non-stocked species was found in a floodplain where controlled water exchange continued. By achieving a weight increase of 10 or more times (compared with stocked weight), stock enhancement in floodplains has proven to be economically viable. There are some controversies with regard to effective water area (1 m depth for 4–5 months) as the area could not be measured, but had to be estimated by eye and from secondary sources. In the final year, 12 floodplains were measured using coordinates from a Global Positioning System; half were found to be larger than had been recorded earlier and half were found to be smaller. As a result, density of stocking and yield per hectare stocked are only approximate.

This project is perhaps the first in the world to enhance floodplain fisheries through fingerling stocking to compensate for loss of fish production due to environmental degradation (FAO 1995). The project demonstrated the technical and economic viability of fingerling stocking in floodplains, but financial and managerial viability and sustainability have yet to be demonstrated. Many factors including hydrology, rainfall, floodplain productivity, growth period, stocking density, species mix, conservation measures and effective community participation have been found to determine success and sustainability of stocking.

Involvement of NGOs to mobilize and organize fishers is complementary to the process of transferring the whole management of floodplains, including stocking, to local people, and has had positive impacts. NGO involvement in a good number of floodplains stocked in 1996 resulted in increased participation by the local community, particularly the fishers. Participation has been in the form of sharing costs of fingerling stocking with government. So far as is known, the local fisher community in three floodplains—one in Rangpur and two in Naogaon—plans by itself to stock them during 1997.

Recommendations and conclusions

Future projects and programs in floodplain fisheries in Bangladesh should include both compensatory measures such as stocking of fingerlings and mitigation measures for improving and protecting fish habitat and wetlands. Mitigation measures should include establishment of sanctuaries, re-excavation of canals, stocking mother fish of species whose population has been declining or is under threat, and ensuring suitable structures for easy movement of fish and water. Community participation in public stocking of larger floodplains and in private stocking of smaller and more or less well defined floodplains should continue. Legal and institutional problems of access by fishers to government-owned waterbodies need to be overcome, particularly those related to the scope of common property rights to flooded land, and ways to develop active participation of local communities and local government at thana and union levels. Different bio-socioeconomic fisheries management models for different categories of floodplains should be developed and applied for their sustainable management. Considering the immense scope and potential of floodplains for increasing fish production and alleviating poverty, greater emphasis should be given to enhancement of floodplain fisheries.

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Attitudes of Fishing Communities to Floodplain Stocking in Southwestern Bangladesh

RASHED UN NABI
Institute for Development Policy Analysis and Advocacy, Proshika, Dhaka, Bangladesh

NABI, R.U. 1999. Attitudes of fishing communities to floodplain stocking in southwestern Bangladesh, p. 219–224. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Impact monitoring of floodplain stocking in Bangladesh under the Third Fisheries Project revealed that, in general, 50% of respondents reported a positive impact and over 40% reported improved livelihoods; but in waterlogged beels, casual fishers reported benefits while some professional fishers said stocking adversely affected them. Fishers believe that owners of fish aggregating devices benefit most from stocking. The highest priority for traditional fishers is strengthening their rights; stocking is their second priority. Fishers in non-stocked beels favor stocking, but only half are willing to contribute to the cost, and only then if they receive some benefit. It was concluded that management plans should be designed on a beel-by-beel basis, and balance improving fisher rights and fish conservation with stock enhancement.

Introduction

The Floodplain Fisheries Component of the Third Fisheries Project, undertaken by the Bangladesh Department of Fisheries with World Bank and British funding between 1991 and 1996, was concerned with stocking major carp in floodplain *beels* (large seasonal waterbodies) in the western half of Bangladesh to increase fish production and improve the livelihood of the beel communities. Almost 150 000 ha of floodplains were stocked during six years with 2 500 t of carp fingerlings giving a reported incremental yield of 20 000 t (Islam, this vol.). The Beneficiary Impact Monitoring Study (BIMS) was undertaken to independently assess whether this component of the project provided the social benefits anticipated in the objectives, namely improvements in living standards as a result of increased fish production and increased incomes (World Bank 1990). BIMS took the form of a three round longitudinal sample household survey covering a selection of seven stocked and non-stocked (control) beels in southwestern Bangladesh. Full details of the study are given in its final report (IDPAA 1997).

There had been no community participation in the planning stage of the stocking program and minimal consultation in its implementation. Respondents showed mixed feelings about the impact of stocking on their livelihoods, so it was decided to investigate their attitudes in greater detail as part of BIMS. This paper discusses the results of that part of the study.

Method of study

Study schedule

Three rounds of questionnaire surveys were undertaken, covering the peak fishing period of the stocking cycle of 1995–1996 (November–December 1995), the pre-stocking period before 1996–1997 stocking (July–August 1996), and the fingerling protection period for the 1996–1997 stocking cycle (September–October 1996). During the first round, respondents were asked about the impact of stocking on their livelihoods. Attitudes towards stocking were investigated in the second and third rounds.

Categorization of respondents

BIMS sought to examine two levels of expected benefits to fishers—a high level for those who made a living from fishing, and a lower level for those who fished mainly for consumption. Accordingly, the respondent households were

categorized into "Professional" or "Casual" fishing households. The Professional fishing households were sub-categorized into "Traditional" and "Non-traditional" fishers, where Traditional fishers were defined as those who had depended on fishing for at least two prior generations. The Casual fishing households were sub-divided into "Marginal" (if the household owned less than 0.2 ha of land and received no income from outside) and "Non-marginal" households (all others); these have been consolidated where they had similar responses on attitudinal issues.

Selection of beels

Because of the great diversity of beel characteristics, it was not possible to find suitable pairings of stocked and non-stocked floodplains to make direct comparisons between project and control locations. Instead a selection of stocked and non-stocked beels were taken and grouped according to the topics under investigation. The major factor affecting attitudes towards stocking was whether or not the beels were waterlogged. Waterlogging is a recent artificial phenomenon resulting from the failure of flood control and drainage schemes. It means that the beels are permanent rather than seasonal, with substantial areas of private land under water and no longer suitable for cultivation. The beel groupings used in this paper are shown in Table 1.

Attitudinal questions

BIMS covered a range of topics aimed at identifying changes in fishing patterns and the level of benefits that stocking had provided. This paper deals only with questions that help to understand fishers' attitudes towards stocking. These questions were:

1. What impact has the Third Fisheries Project had on the livelihood of your family members?
2. If the government undertakes any development program in this area, in your opinion which three of the following should be taken up first: strengthen fishers' rights, flood protection scheme, solve waterlogging, floodplain stocking, irrigation scheme, build/repair village roads, health facilities, educational facilities, religious project?
3. What method would you use to improve fisheries resources and beel management?
4. What benefit has your household experienced as a result of stocking?
5. What loss has your household experienced as a result of stocking?
6. Which section of the community benefited most from stocking, in your opinion?
7. Which section of the community benefited least from stocking, in your opinion?
8. Would you agree to pay for some of the costs of stocking? (give reasons)

Table 1. Details of beel groupings and sample sizes used for the attitude survey of BIMS.

Beel groupings		Number of respondents								
		1st round (Nov–Dec 1995)			2nd round (Jul–Aug 1996)			3rd round (Sep–Oct 1996)		
Group	Beel names	Prof. Trad.	Non-trad.	Casual	Prof. Trad.	Non-trad.	Casual	Prof. Trad.	Non-trad.	Casual
Stocked, normal	BKSB, Chanda	81	76	165	76	72	145	78	71	143
Stocked, waterlogged	Panjia Pathra, Garalia	42	80	131	42	80	127	42	80	126
Non-stocked, normal	Chenchuri, Bajunia Kajulia, Chaucha Baromath	104	112	209	101	108	194	103	110	195

Prof.: professional fisher; Trad.: traditional fisher; Non-trad.: non-traditional fisher; Casual: casual fisher

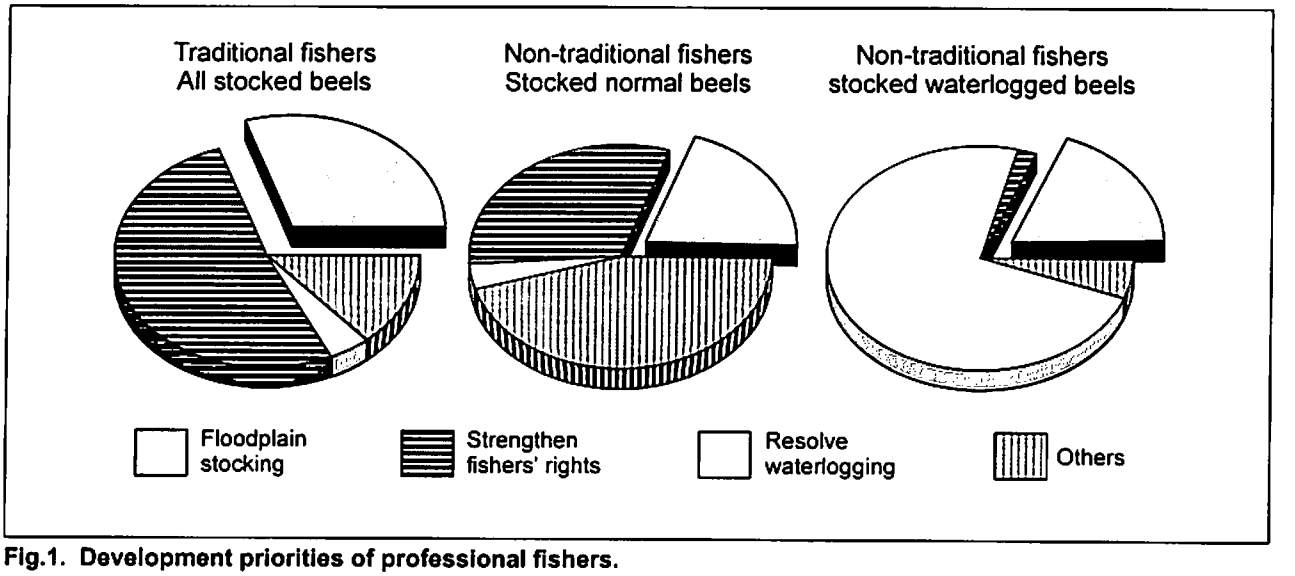

Fig.1. Development priorities of professional fishers.

Results and discussion

Impacts of stocking

There were mixed responses to the question of impact of floodplain stocking. In the stocked beels, about half of all respondents reported a positive impact and nearly 40% reported that stocking had not had any impact on their livelihood (Table 2). In the waterlogged beels, more than three-quarters of the Casual fishers felt that they had benefited, while nearly one quarter of the Professional fishers considered stocking to have had a negative impact on them. Of the latter, the Traditional fishers felt that their access rights had diminished and this had caused them to lose income, while Non-traditional fishers thought that fish production in the beels had decreased. As expected, the major positive impact for Professional fishers was increased incomes, while for Casual fishers it was the increased availability of fish to eat.

Since about half the respondents did not think they benefited, a more detailed investigation of the attitudes of fishers to stocking was made.

Development priorities

Regardless of the floodplain characteristics, the top priority for Traditional fishers was strengthening their fishing rights (Fig. 1). Traditional fishers are low caste Hindus, and BIMS field observations revealed that they felt vulnerable to influential locals and their followers (who include Non-traditional and Casual fishers). They ranked floodplain stocking second and did not place much emphasis on the other development issues listed. This clearly indicates that Traditional fishers are committed to fishing and should, therefore, be regarded as a priority group when projects are planned to improve fishery production or management.

In the waterlogged beels, both Non-traditional Professional and Casual fishers rated the solution to waterlogging as their main development priority. Waterlogging has worsened every year and has prevented crop cultivation on a progressively increasing acreage. The respondents in the Non-traditional category have lost much of their land and want to have it rehabilitated so that they can resume a predominantly agricultural livelihood.

Table 2. Perceived impact of stocking (%).

Beels	Fisher category	None	Positive	Negative	All
All stocked beels	All fishers	38	57	5	100
Stocked, waterlogged	Professional fishers	22	55	23	100
Stocked, waterlogged	Casual fishers	15	83	2	100

Non-traditional fishers in the normal stocked beels favored strengthening fishers' rights and stocking, while in the non-stocked beels they strongly preferred stocking. The respondents were obviously keen that the fisheries should be improved, but those with experience of stocking had learnt that the increased resource could attract powerful competitors who would appropriate part of the increased catch or even their fishing rights.

In the stocked normal beels, Casual fishers did not show any particular preference for any of the development issues suggested. This simply indicates that they represent a good cross-section of the community that is not dependent on fishing for an income. For the non-stocked beels, stocking was the top choice of Casual fishers. In all locations their lack of concern about fishers' rights was most noticeable. This is probably because they do not regard themselves as fishers and many already have free access to fishing: 44% had such access in 1990, and 63% in 1995.

Improved management options

The Professional fishers were asked which practices they thought would best improve beel management. The responses were somewhat different in the three types of beel (Table 3). Stocking was more highly sought after in the non-stocked beels, preservation of sanctuaries was a clear recommendation in normal stocked beels, while no distinct preference emerged from respondents in stocked waterlogged beels.

The higher popularity of stocking as a potential management method in non-stocked beels confirms the high priority given to stocking as a development option in these areas. The fishers have suffered a decline in their catches of indigenous fish and it is understandable that they would wish to compensate for this through stocking. It is also possible that the respondents were influenced by the stocking of nearby beels or that the repeated visits of BIMS interviewers led them to expect a stocking program. Nonetheless, the preferences shown reflect the popularity of stocking among the fishers.

Traditional fish breeding grounds, previously left as informal sanctuaries, have been over-fished in an attempt to maximize catches. The possible damaging effect of this on indigenous species explains the response of Professional fishers in stocked normal beels. Rehabilitation of these fishing grounds and stocks—or creation of new sanctuaries—could be achieved through community participation and, judging by the responses, this would be readily forthcoming.

It was encouraging to note the importance attached by these fishers to the need for a fingerling conservation period (a period when fishing is banned to permit stocked fingerlings to grow to marketable size), even in non-stocked beels. Other suggestions included the need for coordination committees with fisher and NGO membership, various kinds of physical activities such as placing *banas* (bamboo weirs across streams for trapping fish) and removing water hyacinth, and changes in the access system.

Perceptions of benefits

Respondents in all the stocked beels were asked which sections of the community they thought benefited the most and the least from stocking. All categories of fishers believed that the owners of fish aggregating devices (FADs)—*kuas* (ditches) and *ghers* (enclosed areas for shrimp culture)— got the most benefit, followed by owners of larger/more efficient gears (seine and lift nets). Those who did not own large gears were believed to have received the least benefit.

People's perceptions are subjective and may be biased by prejudice or circumstance. For example, kuas are harvested on discrete occasions and the large catches are very noticeable, whereas the

Table 3. Professional fishers' suggestions for fisheries management.

Beels	Stocking	Promote sanctuaries	Fingerling conservation	Resolve waterlogging	Others
Stocked, normal	17	21	24	15	30
Stocked, waterlogged	20	2	24	9	38
Non-stocked	27	7	20	8	39

regular small catches of common fishing gears tend to go without remark. FAD owners undoubtedly benefit from stocking, but other BIMS findings suggest that the gain might not be as much as the respondents perceived (IDPAA 1997). It is important to realize this and to raise awareness of the relative catch levels in order to increase acceptance of equitable cost recovery schemes.

Regarding personal benefits, most Professional fishers stated that their incomes had increased and that they did not feel they had lost anything as a result of stocking (Table 4). Traditional fishers in the waterlogged beels were the exception: nearly 30% reported no benefit and nearly 40% felt there was a loss attributable to stocking. (Note that these responses are to different questions and so do not add up—for example, a respondent could report no positive impact and might or might not then attribute a loss to stocking.) Since waterlogging is fairly recent, there are not many Traditional fishers and they tend to fish in rivers and other waterbodies as well as in beels. It appears that they might not have access to productive fishing grounds, either because they lack the experience to find them (because of a major change in the ecological regime) or because they are pushed out by large gear owners and possibly FAD owners. One third of those from this group who reported losses said that landowners had prevented them from fishing. Most of the other fishers who reported losses cited cash flow problems during the fingerling conservation period.

The Casual fishers stated that their fish consumption had increased, that it was cheaper to buy fish, and that their incomes had increased. In this case, there was a difference between Marginal and Non-marginal Casual fishers: more of the Marginal fishers reported a benefit from selling fish, while the Non-marginal ones appeared more able to buy fish.

Attitudes towards cost recovery

In the final year of the Third Fisheries Project, a management system for the whole of each floodplain was initiated. This was intended to collect a gear-based fee from all fishers. Twenty per cent of the 1996 stocking cost was targeted for recovery, the intention being that the proportion should rise over the ensuing years and eventually lead to a financially sustainable stocking program. Local NGOs were assigned to raise awareness and to prepare an inventory of gears, but there was no community participation in the planning of cost recovery.

After the NGOs had completed the inventories (but before the fee rates were calculated), BIMS asked fishers in the stocked beels whether they would be prepared to pay part of the cost of stocking. All categories of fishers were evenly divided between those who said they would pay and those who did not want to pay.

Those fishers who were ready to pay attached conditions to their willingness: 60% would pay if their catch increased sufficiently, and 40% if their access rights improved. On the other hand, those who were unwilling to pay felt that they had not or would not get enough benefit. In the case of

Table 4. Consequences of stocking (% of households).

Fisher category	Income increase	Consumption increase	No impact	Loss attributed
		Stocked normal beels		
Professional, Traditional	68	9	22	21
Professional, Non-traditional	79	10	16	16
Casual, Marginal	42	48	16	10
Casual, Non-marginal	15	61	14	6
		Stocked waterlogged beels		
Professional, Traditional	45	2	28	38
Professional, Non-traditional	83	6	15	13
Casual, Marginal	48	40	15	0
Casual, Non-marginal	39	70	6	8

Note: The first three columns of data are percentages of respondents giving an answer to an open question where more than one response was possible, therefore the rows do not add up to 100.

Professional fishers, 90% of those respondents unwilling to pay for stocking claimed they did not catch sufficient stocked species, while the Casual fishers felt that they did not fish enough to justify a fee.

Conclusions and recommendations

The Third Fisheries Project stocked a diverse range of beels under a master stocking plan. Although the plan took account of some physical and biological characteristics of individual floodplains, it did not consider the local communities' attitudes to stocking. BIMS has shown that the floodplain communities view stocking positively and rate it highly as a development option. The commitment of Traditional fishers to fishing and their dependence on it should give them priority as beneficiaries of such programs. Given the importance they place on strengthening fishing rights, it is necessary to ensure their access to these fisheries and to the fish stocked in them, as well as an equitable distribution of the catch. Otherwise the investment meant to benefit poor fishers will continue to be appropriated by the resource-rich, such as the owners of FADs and large gear.

The planning and implementation process must give adequate consideration to social factors such as access rights. Where appropriate, community management should be encouraged.

Floodplain communities are capable of suggesting ways to improve their fisheries. Inclusion of their suggestions in stocking plans for individual beels will increase the prospects of success by imparting a sense of ownership. The unwillingness of half the respondents to contribute to stocking costs is a result of their lack of ownership and perceived lack of benefits.

Floodplain fisheries management should be separate for each beel, since fisheries vary in their physical and socioeconomic characteristics. Local fishers and NGOs must be included in the planning process from the outset.

Communities are aware of the benefits of a fingerling conservation period, but reduced income at that time is a significant problem for many Professional fishers.

Measures need to be taken to mitigate loss of income during the fingerling protection period through alternative income sources, thereby increasing the probability that it will be respected.

It seems to have been assumed that all fishers would automatically be able to catch stocked fish, and no initiative was taken to give them any training. In fact a surprisingly high number of fishers stated that they do not catch many stocked fish. Assuming that these fishers *want* to catch the stocked fish (and to pay the relevant license fee), steps should be taken to identify the technical and social reasons for their inability to do so, and to demonstrate to them the best methods to catch stocked fish in their particular circumstances.

Extension support to train all fishers to catch stocked species will improve distribution of benefits. This will make fishers more willing to contribute towards stocking and improve prospects of sustainability.

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Fishing Gear Selectivity Study in BSKB Beels

M.A. MAZID, M.S. HOSSAIN and S. RAHMAN
Bangladesh Fisheries Research Institute, Mymensingh 2201, Bangladesh

MAZID, M.A., M.S. HOSSAIN and **S. RAHMAN.** 1999. Fishing gear selectivity study in BSKB beels, p. 225–228. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Traditional fishing gears are now being used in Bangladesh to catch stocked carp before they attain minimal legal marketable size (23 cm), thus threatening the aims of floodplain stocking. However many people depend on wild fish from these floodplains, so fishing cannot be banned. Gear selectivity in a large floodplain beel in southwest Bangladesh was studied. Several gears are selective and, of these, only two net types and two trap types mainly caught carp, but several common non-selective gears caught more than 25% carp. The non-selective gears generally caught carp below the legal minimum size, while the selective gears (excepting one trap type) caught carp averaging about the minimum legal size. Hence the main gears used for subsistence and commercial fishing of non-stocked species are also the main factor in the capture of undersize stocked carp. Raising fishers' awareness of the benefits of allowing stocked fish to grow to larger, higher value sizes is recommended.

Introduction

Bangladesh is very rich in water resources, having 2.833 million ha of floodplains and 0.114 million ha of beels (Mazid and Hossain 1995). These openwater floodplains and beels were once exceptionally rich in wild fish which contributed significantly to national nutritional requirements. In recent years, fish production from these sources has declined alarmingly, for many reasons (BCAS 1991; DOF 1995). To counter this decline, the Department of Fisheries (DOF) undertook a massive program of stocking carp fingerlings with the objective of augmenting fish production in floodplains (Islam, this vol.).

Many types of fishing gear have been used in Bangladesh to catch wild fish since time immemorial. A number of these gears are now being used to catch stocked carp fingerlings before they attain marketable size (the minimum legal length is 230 mm). Unplanned and unhindered use of a few gear types poses a serious threat to achieving the goals of stocking floodplains (Mazid et al. 1996). However, operation of all types of gear cannot be suspended to allow the stocked fingerlings to grow out, as millions of poor people depend on catching wild fish for their sustenance. Therefore it is important to identify gears which can be operated without catching undersized fingerlings.

The present study was carried out in Barnal–Selimpur–Kola–Bashukhali (BSKB) Beels in Khulna and Narail districts of southwest Bangladesh during 1992–1995. The total area of these beels, including smaller ones, is 26 040 ha; they lie within a flood control polder. Within this area are 127 villages comprising 25 142 households (BCAS 1991). Much of the beel area is cultivated with rice, including deepwater rice during the monsoon. According to BCAS (1991), 55% of households fish for at least part of the year and 27% of households belong to fisher cooperative societies. In general, fishing in these beels starts from late June and continues until early March the following year or as long as water remains, but the peak fishing period is June–October during annual monsoon flooding. The aims of stocking were to increase fish production and consumption, and the incomes of fishers.

The objectives of this study were to determine the catch composition of fishing gears, to determine the species–size (length) selectivity (using $L_{50\%}$) of the gears used, and to recommend model fishing gear regulations for stocked floodplains to safeguard the young stocked carp fingerlings from exploitation before they attain marketable (legal) size.

Materials and methods

From 1992 to 1995, a scientific officer and field assistant of Bangladesh Fisheries Research Institute collected data on gear and catches on a daily basis (morning and evening) from fish landing centers. Catch composition (percentage by number) was observed for each gear. When

Table 1. Fishing gear surveyed in BSKB Beels.

Gear	Type and size	Mesh size (cm)
Punti jal	Gill net of nylon or cotton (10–20 m × 0.6–1.0 m)	1.5–3.8
Koi jal	Gill net of nylon or cotton (10–20 m × 0.6–1.0 m)	3.2–4.5
Fash jal	Gill net of nylon or cotton (10–20 m × 0.6–1.0 m)	4.5–15.0
Ber jal	Seine net of cotton or nylon (50–67 m × 1.5–2.0 m)	0.5–2.0
Bhuti jal	Clasp or bag net with rectangular opening	2.5–4.5
Veshal jal	Large triangular lift net on bamboo frame	0.5–1.5
Jhaki jal	Cast net of 8–10 m diameter	1.0–1.5
Khadom	Large U-shaped bamboo trap	1.5–2.5
Ramani	Rectangular bamboo trap narrower at apex	1.5–2.5
Tubo	Small rectangular trap set using bait in paddy fields	0.2–0.5
Charo	Small rectangular trap with two trapdoors from base to apex, set against current, baited with snail meat	1.0–1.5
Khulson (ghuni)	Rectangular bamboo trap of 25–40 cm in all dimensions	0.2–0.5
Dughair (koi dughair)	Tubular trap, anterior broader than posterior, narrower in middle, unidirectional valves in mouth and middle	0.5–2.0
Chasra	Bamboo hooks baited with grasshoppers	na
Dawan borshi	Long line (over 100 m) with several hundred hooks	na
Dati/nol borshi	Hook attached to middle of a piece of water hyacinth stem or jute stick	na
Spear (koach, juti, jhupi, fulkuchi)	Bamboo or iron shafts with group of iron points	na

na: not applicable

possible, the entire catch was examined, but for larger catches 10–20% was sampled. To determine size selectivity, the total length of individual fish of each species was measured (in millimeters) for each type of gear. The $L_{50\%}$ value was then calculated for each dominant species with the help of probit and linear regression ($L_{50\%}$ is the length at which 50% of fish entering the gear are retained and 50% escape).

Results

Catch composition

Table 1 describes the main types of gear surveyed for catch composition, and the remaining tables show the percentage of total catch which comprised stocked carp, as this was the focus of the study.

Catch composition for selective gears

Catch composition (percentage by number) of carps (stocked fishes) for eight types of selective gear operated in BSKB Beels in June–December of 1992–1995 is presented in Table 2. *Punti jal* is meant to catch mainly punti (*Puntius* spp.) and kholisa (*Colisa fascitus*), and only 0.3–3.8% of the catch ascribed to it comprised carp during 1992–1995, hence this net type—whether made of cotton or monofilament nylon (an illegal gear known as "current jal" in Bangladesh) was not found to be destructive, as a negligible percentage of stocked carp below legal size were caught. Similarly *koi jal* caught only 6.3–16.1% carp during 1992–1995. *Tubo* and *chasra* did not catch any carp.

Almost the entire catch of *fash jal* comprised stocked carp in BSKB Beels during the study period, because of the larger mesh size of this gear. Likewise the entire catch of *bhuti jal* was stocked carp, except for a few snakeheads and boal (*Wallago attu*). Two types of trap (*khadom* and *ramani*) caught mainly stocked carp.

Catch composition for non-selective gears

The non-selective *ber jal* caught a good percentage of carp (18–43%) during the study period (Table 3). The actual catch of this gear type could not be recorded by observation because fishing up to October occurred mainly at night. Fine mesh ber jal caught fishes irrespective of size and species. This gear is very destructive as it destroys habitat and niches for wild species, thus causing multiple harm to the beel fish as a whole.

Veshal jal caught a high percentage (29–63%) of carp but, as in the case of ber jal, actual catch was under-reported. *Jhaki jal* caught a relatively high percentage of carp (19–56%). Although many other fish species are caught with this gear, soon after stocking the carp fingerlings run through channels in the beel area and people living beside these channels use jhaki jal to catch

Table 2. Catch composition for selective gears operated in BSKB Beels during June–December, 1992–1995.

Gear	Target fish	Average % of carp in catch (by number)
Fash jal	Carp	98
Bhuti jal	Carp	89
Khadom	Carp	86
Ramani	Carp	73
Koi jal	Koi	11
Punti jal	Punti	1
Tubo	Punti/shing	0
Chasra	Koi	0

Table 3. Catch composition for non-selective gears operated in BSKB Beels during June–December, 1992–1995.

Gear	Average % of carp in catch (by number)
Spears	67
Veshal jal	41
Jhaki jal	37
Ber jal	28
Dughair (koi dughair)	16
Dawan borshi	9
Khulson (ghuni)	1
Charo	0
Dati/Nol borshi	0

them. One type of fish trap (*koi dugair*) caught a good percentage of carps (19–36%), and there were even higher carp percentages from spears, but the carp catch from *dawan borshi* was relatively low.

Size selectivity of carp

Size selectivity ($L_{50\%}$) of carp in centimeters for the selective and non-selective gears (except spears) operated in BSKB Beels during June–December in 1992–1995 is shown in Tables 4 and 5, respectively. For *Catla catla,* the catches of ber jal, jhaki jal and ramani were below legal size. Similarly the modal size ($L_{50\%}$) of *Cyprinus carpio* caught by bhuti jal during 1994 and jhaki jal during 1995 was far below legal size. *Cirrhina mrigala* caught by different gears in BSKB Beels were all below legal size. *Labeo rohita* caught by spears were above legal size, and those caught by fash jal and bhuti jal were very near legal size, but other gears caught fish of illegal size, particularly ramani, jhaki jal and dugair where the $L_{50\%}$ were between 10.62 cm and 19.48 cm. *Barbodes gonionotus* caught by fash jal were of table size (which is smaller than marketable size for carps), but other gears caught fish 13–14 cm long, except for dugair which caught very small fish of this species.

Conclusions on fishing gear regulation

Many types of gear are used to catch stocked carp before they reach the legal minimum marketable size, since the peak fishing period is when the fingerlings are growing. Protecting the early growing stage of stocked fingerlings is critical to the success of floodplain stocking. Therefore regulations are needed, and fishers should be convinced of the benefits of following those regulations.

Only certain fishing gears catch carp of below market (legal) size and are regarded as detrimental (Table 6). Fishing with ber jal, veshal jal and jhaki jal was found to be highly detrimental to fingerling growth; punti jal, koi jal and fash jal

Table 4. Size selectivity (cm) ($L_{50\%}$) of carp for selective gears operated in BSKB Beels during June–December, 1992–1995 (average).

Species	Koi jal	Fash jal	Bhuti jal	Ramani	Khadom
Catla catla	-	24.9[a]	20.3[b]	7.6[d]	24.0[b]
Cyprinus carpio	-	24.7[b]	16.9[d]	-	-
Cirrhina mrigala	18.2[a]	20.3[b]	19.1[d]	16.9[c]	20.6[d]
Labeo rohita	20.9[a]	22.3[a]	20.3[b]	13.8[b]	18.1[a]
Barbodes gonionotus	13.1[c]	17.4[c]	11.2[d]	-	-

Note below applies to both Tables 4 and 5.

Table 5. Size selectivity (cm) ($L_{50\%}$) of carp for non-selective gears operated in BSKB Beels during June–December, 1992–1995 (average).

Species	Ber jal	Veshal jal	Jhaki jal	Dughair	Dawan borshi	Khadom
Catla catla	19.9[b]	23.6[a]	13.2[c]	-	-	20.5[c]
Cyprinus carpio	22.8[c]	-	10.4[d]	-	-	21.0[d]
Cirrhina mrigala	17.6[c]	18.8[a]	17.5[c]	18.2[a]	18.4[d]	-
Labeo rohita	17.5[a]	19.1[a]	15.2[a]	15.5[a]	17.1[b]	26.6[b]
Barbodes gonionotus		-	-	7.9[d]	14.4[d]	-

Note: Calculations made on yearly basis for species–gear combinations with sufficient data (250+ fish measured) across years, then averaged
[a]4-year average, [b]3-year average, [c]2-year average, [d]one year
- not caught in sufficient numbers.

Table 6. Fishing gears which need to be regulated in stocked beels.

Fishing gear	Detrimental level	Restriction period
Nets		
Ber jal (seine net)	Highly detrimental	June–October
Veshal jal	Highly detrimental	June–September
Jhaki jal	Highly detrimental	June–September
Punti jal	Moderately detrimental	June–September
Koi jal	Moderately detrimental	June–September
Fash jal	Moderately detrimental	June–October
Bhuti jal	Moderately detrimental	June–September
Traps		
Dugair/koi dugair	Highly detrimental	June–September
Ramani	Highly detrimental	June–September
Hook and line		
Dawan borshi (long line)	Moderately detrimental	June–September
Other		
Fishing through dewatering	Highly detrimental	Should be prohibited

(up to 9.0 cm mesh), which are all gill nets, were found to be moderately detrimental, as were clasp nets (bhuti jal) because a relatively high proportion of carp of less than 23 cm length were caught. Similarly dugair, ramani and dawan borshi (traps and hook and line) were found to be detrimental.

In addition, complete removal of water from ditches and canals within the floodplains (dewatering) means that all remaining fish are caught, including the next season's broodstock. This has probably been one of the reasons for the sharp decline in the population of wild fish species in the floodplains, and should be prevented.

The following recommendations are made:

- The legal minimum size for catching carp is set in the interest of fishers, since allowing carp to grow to this size raises the overall income of fishers. However, most of the fishers around the beels are poor and illiterate. Moreover the number of fishers is increasing because of population growth and lack of alternative employment. Education of fishers and clear fishing rights are needed so that communities have an incentive to set their own regulations and understand the need to allow fish to grow to legal size.
- In stocked floodplains, communities should be encouraged to restrict use of damaging gears from June to September–October, because this is the main fishing period and the time when fingerlings are growing.
- Fishers should be given training in fish biology to raise their consciousness of fish conservation benefits, and to help in their economic development and resource management.

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Fish Biodiversity Study of Three Floodplains in Bangladesh

M.S. HOSSAIN, M.A. EHSHAN and M.A. MAZID
Bangladesh Fisheries Research Institute, Mymensingh 2201, Bangladesh

HOSSAIN, M.S., M.A. EHSHAN and M.A. MAZID. 1999. Fish biodiversity study of three floodplains in Bangladesh, p. 229–233. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Fish catches in three floodplains in Bangladesh stocked under the Third Fisheries Project were studied to investigate impacts of carp stocking on fish species diversity. The Shannon-Weaver diversity index was used to determine the diversity and evenness of fish caught. In one beel where stocking ended after two years, diversity (disregarding stocked fish) declined; in the beel where stocking took place for four years, diversity showed no trend. The species caught in most abundance were small resident species. Many species were not caught in all years of the study, indicating very low populations. A ranking of commoner and rarer species was made for each floodplain.The study did not show clear evidence of low diversity in stocked floodplains, but a longer term study is needed to compare stocked and non-stocked floodplain beels.

Introduction

The worldwide loss of biodiversity is widely accepted as a major problem (Moyle and Williams 1990). Though loss of aquatic species is occurring rapidly, aquatic organisms have received comparatively little attention from conservation biologists (Allendorf 1988). A rich diversity of fish species is critical to the ecology and sustainable productivity of the floodplains. Fisheries resources in Bangladesh are under severe threat by environmental degradation which includes human interventions through construction of flood control embankments, drainage systems and sluice gates, conversion of inundated land to crop land—thereby reducing water area—and indiscriminate use of pesticides and insecticides. Pollution from domestic, industrial and agrochemical wastes and run-off has resulted in extinction of a considerable amount of aquatic biota in some stretches of the openwater system (Mazid and Hossain 1995; Alam 1996; Hussain 1997). In this situation it is extremely important to take necessary steps to maintain floodplain environments.

In Bangladesh there has been a considerable effort to enhance fish production in openwaters through release of large quantities of hatchery-raised native and exotic carp (DOF 1995). Therefore an important task is to ascertain whether stocking floodplains with carp fingerlings had any adverse impact on resident fish species. This study deals with the status of fisheries diversity and its dynamics in three floodplains which were artificially stocked by the Third Fisheries Project (Chanda Beel in Gopalganj, Halti Beel in Natore, and Barnal–Selimpur–Kola–Bashukhali [BSKB] Beels in Khulna and Narail).

Materials and methods

The study was conducted from June 1992 to December 1995 in three major floodplains of Bangladesh. These are Chanda Beel of Faridpur–Gopalgonj depression, covering 10 870 ha and with 90% of households in the area fishing; Halti Beel covering 16 770 ha in Pabna–Natore depression with 87% of households involved in fishing; and the 26 040 ha BSKB Beels in Khulna–Narial depression, where 55% of households fish (BCAS 1991). All of these beels are seasonal and contain water for 4–7 months in the monsoon, but during the dry season the water area becomes negligible and the dried-out land is cultivated. However, each floodplain possesses distinctive features. BSKB Beels are completely enclosed by an embankment built in the early 1980s, with water flows regulated by several sluice gates; Halti Beel is semi-open; while Chanda Beel is an open floodplain system without major water control structures.

Catch composition by number for the respective gears was collected weekly from the peripheral fish landing centers. Most of the gears used in the beels were covered during data collection (BCAS 1991); more than 23 types of gear were involved, of which only 11 were selective. To assess fish diversity, data from all gears were combined, giving the following total numbers of fish counted (over the four years): 169 354 in Chanda, 104 639 in Halti, and 100 571 in BSKB. Fish (including shrimps) were identified to species level as far as possible and were counted individually from the sample catches; except that more than one species in some genera such as *Puntius*, *Colisa* and *Chanda/Parambassis* were treated as if they were single species; and that *Macrobrachium* includes all freshwater shrimp species. The Shannon-Weaver index (H′) was used as a measure of diversity. It combines species richness and evenness, and is one of the most commonly used diversity indices in ecology. The formula for calculating the index is:

$$H' = - \Sigma\ p_i.Ln_2(p_i)$$

where

p_i (the proportional abundance of the *i*th species) = (n_i/N)

n_i = number of individuals recorded of the *i*th species

i = the species reference

N = total of individuals in the sample

$Ln_2 = 1.442\ \log_e$

Low values of H′ indicate low diversity and that most individuals are concentrated in a few species, while high values of H′ indicate greater diversity or greater evenness in the distribution of individuals among species. A positive change indicates increased diversity and evenness, a negative change indicates reduced diversity and evenness.

Results

During the four years, 67 species of fish were recorded from the beels. Table 1 shows that only in BSKB was an increase in fish biodiversity recorded during the study. Yearly variation in the Shannon-Weaver diversity index and its trend line for Chanda, Halti and BSKB Beels are shown in Figs. 1–3, respectively, including and excluding stocked fish in the calculation (except that in a year when carp were not stocked in a particular beel they were treated as non-stocked fishes). Stocking increased diversity, as indicated by the index. Chanda Beel showed the highest index (H′ = 5.96) in 1994 (third consecutive year of stocking), when the maximum number of fish species was caught. In 1995 the index was found to be lower (H′ = 4.05) because the beel was not stocked, but overall no trend was apparent.

Table 1. Fish species and diversity indices by beel.

	1992	1993	1994	1995
		Chanda		
Species	43	41	43	37
H′ incl. stocked	4.13	4.27	5.96	na
H′ excl. stocked	3.69	3.55	5.96	4.05
		Halti		
Species	43	45	37	44
H′ incl. stocked	4.27	3.94	na	na
H′ excl. stocked	3.98	3.41	3.41	2.72
		BSKB		
Species	29	35	35	43
H′ incl. stocked	3.5	3.66	3.53	4.14
H′ excl. stocked	2.49	2.82	2.89	3.30

na: not applicable

Halti Beel had its highest diversity index (H′ = 4.27) in 1992. During the study it showed a significant trend of declining fish diversity, although stocking ceased only in 1994. BSKB showed its highest diversity index (H′ = 4.14) in 1995 when the number of fish species was also highest, and the index showed an increasing trend. A continuous stocking program contributed to this: BSKB was the only study site where stocking continued to 1995. Moreover, since BSKB is completely poldered (enclosed by embankments), there is little chance of stocked fingerlings escaping from this floodplain. Also the necessity for a biodiversity study was not realized at the outset of the project, so most data were collected from the gear selectivity study of BSKB Beels, and in the first year some smaller species were not counted. The trend in the index for BSKB can be accounted for mainly by stocked carps.

Tables 2–4 show those species which were recorded in any one year of the survey as being among the most common or rarest five species for each beel, along with species which were not recorded in at least one year. In Chanda only in one year was one of the stocked species in the top five by number in sampled catch, and in Halti no stocked species reached this level of abundance; but in BSKB, stocked rui (*Labeo rohita*) were recorded in each year in the top five species. Most of the commoner species in catches were small fishes: *Puntius* spp. (both *P. sophore* and *P. ticto*) were the most commonly caught fish in all the beels in each year of the study period, except for 1993 and 1994 in BSKB.

"Missing" species in a given beel and year were defined as those which were not recorded there in that year but were recorded in the same beel in some other year of the study. For example, *Osteobrama cotio* was found in Chanda Beel in 1992 only, and so was listed as missing in the other three years; similarly *Chitala chitala* was found in Halti Beel in 1993 only; and *Nandus nandus* and *Mystus cavasius* were found in BSKB Beels only in 1993 and 1994. Those species which were "missing" in at least one year can be labeled rare, and were mostly small indigenous species, a few of which are commercially important, such as *Mystus cavasius*. Tables 2–4 indicate that Chanda Beel had fewer rarer fish species than Halti and BSKB, suggesting less variation between years in the numbers of less common species than at the other two sites.

Conclusions

The diversity index of fish in Chanda Beel and Halti Beel declined when stocking with carp fingerlings ended, while the diversity index for BSKB increased, although the stocking program continued at the same rate, with little change in species composition, over the four years (except that *Hypophthalmichthys molitrix* was not stocked in later years).

This study gives a current picture of fisheries biodiversity as revealed by marketed fish catches from the three floodplains when they were subject to artificial stocking. During the same period, fish diversity declined significantly in one floodplain, remained the same in one, and increased (not significantly) in the third, partly due to stocking.

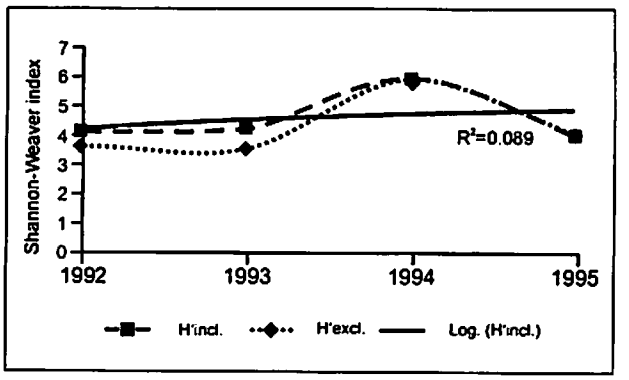

Fig. 1. Yearly variation in Shannon-Weaver index of Chanda Beel and its trend line.

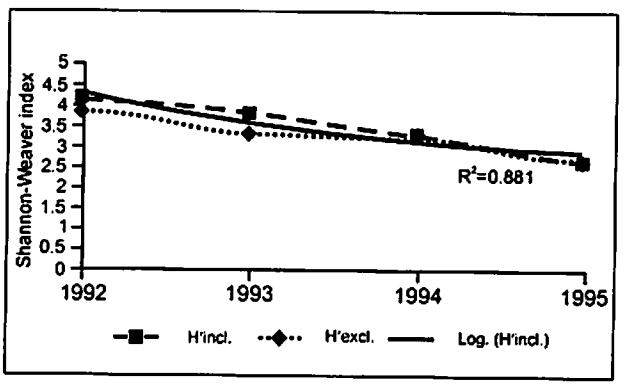

Fig. 2. Yearly variation in Shannon-Weaver index of Halti Beel and its trend line.

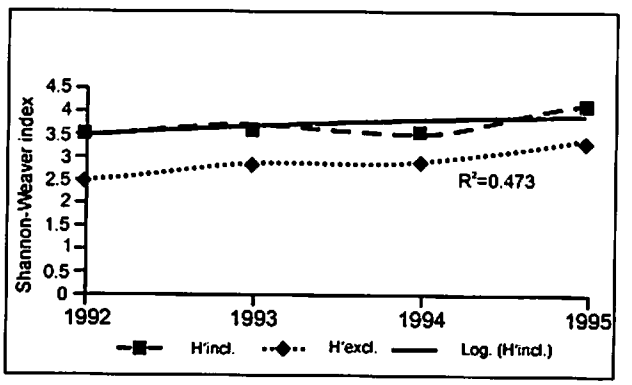

Fig. 3. Yearly variation in Shannon-Weaver index of BSKB Beels and its trend line.

From the study it is concluded that there is no clear evidence of a negative impact on biodiversity of the resident fish species from floodplain stocking. However, more study of this issue is needed, including longer term monitoring of stocked and non-stocked floodplain beels. The present data give a primary picture of floodplain fish biodiversity and could not, within the limitations of the project, be compared with similar but non-stocked floodplain beels.

Table 2. Commoner and rarer fish in Chanda Beel.

Commoner species	Years in top five species	Rarer species	Years in bottom five species	Years not recorded
Puntius spp.	4	*Labeo gonius*	1	0
Colisa spp.	4	*Bagarius bagarius*	1	0
Macrobrachium spp.	3	*Lepidocephalichthys guntea*	1	0
Mystus vittatus	3	*Cirrhinus reba*	1	0
Nandus nandus	2	*Hypopthalmicthys molitrix*	2	0
Heteropneustes fossilis	1	*Aorichthys aor*	4	0
Cyprinus carpio	1	*Clupisoma garua*	1	1
Channa punctata	1	*Corica soborna*	1	1
Xenentodon cancila	1	*Gudusia chapra*	2	1
		Chitala chitala	3	1
		Tetraodon spp.	0	2
		Oreochromis spp.	1	2
		Rasbora daniconius	2	2
		Osteobrama cotio	0	3

Note: Commoner species at top of each section of list, less common at bottom

Table 3. Commoner and rarer fish in Halti Beel.

Commoner species	Years in top five species	Rarer species	Years in bottom five species	Years not recorded
Puntius spp.	4	*Corica soborna*	1	0
Mystus vittatus	4	*Channa striata*	1	0
Chanda/Parambassis spp.	3	*Macrognathus aculeatus*	1	0
Rhinomugil corsula	2	*Silonia silondia*	1	0
Channa punctata	2	*Mystus cavasius*	1	0
Glossogobius giuris	2	*Acanthocobitis botia*	1	0
Gudusia chapra	1	*Botia dario*	1	0
Corica soborna	1	*Hypopthalmicthys molitrix*	1	0
		Barbodes gonionotus	1	0
		Clupisoma garua	1	0
		Catla catla	1	0
		Channa marulius	1	0
		Notopterus notopterus	2	0
		Oreochromis spp.	0	1
		Cirrhinus reba	0	1
		Tenualosasa ilisha	1	1
		Ctenopharyngodon idella	2	1
		Nandus nandus	0	2
		Labeo gonius	0	2
		Aplocheilus panchax	0	2
		Tetraodon spp.	0	2
		Bagarius bagarius	2	2
		Chitala chitala	1	3

Note: Commoner species at top of each section of list, less common at bottom

Table 4. Commoner and rarer fish in BSKB Beels.

Commoner species	Years in top five species	Rarer species	Years in bottom five species	Years not recorded
Puntius spp.	4	*Bagarius bagarius*	1	0
Anabus testudineus	4	*Channa marulius*	1	0
Labeo rohita	4	*Lepidocephalichthys guntea*	1	0
Channa punctata	4	*Cirrhinus reba*	1	0
Cirrhinus mrigala	1	*Hypopthalmicthys molitrix*	1	0
Heteropneustes fossilis	1	*Ctenopharyngodon idella*	1	0
Channa striata	1	*Macrognathus pancalus*	2	0
Mystus tengara	1	*Aorichthys aor*	2	0
		Ompok pabda	2	0
		Amblypharyngodon mola	3	0
		Channa punctata	0	1
		Chitala chitala	1	1
		Mugil corsula	0	2
		Pseudeutropius atherinoides	0	2
		Ailia coila	0	2
		Gudusia chapra	1	2
		Badis badis	2	2
		Nandus nandus	0	3
		Tetraodon spp.	0	3
		Mystus cavasius	1	3

Note: Commoner species at top of each section of list, less common at bottom

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The Vertical Slot Fishpass: A Measure to Mitigate Adverse Impacts of Flood Control Projects on Fisheries

GARRY M. BERNACSEK
Global Aquatic Corporation Pty Ltd, PO Box 666, Rozelle NSW 2039, Sydney, Australia

S.M. NAZMUL ISLAM
Northeast Regional Water Management Project, PO Box 6096, Gulshan, Dhaka, Bangladesh

BERNACSEK, G.M. and S.M.N. ISLAM. 1999. The vertical slot fishpass: a measure to mitigate adverse impacts of flood control projects on fisheries, p. 235-243. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Kawadighi Haor in Bangladesh was of regional importance as a mother fishery, and is now enclosed within the Manu River Irrigation Project. The 60-km embankment effectively blocked natural fish migration in either direction, adversely affecting the fisheries resource. A vertical slot fishpass was constructed on a pilot study basis. A total of 63 species were found to use the structure in both directions—river to haor and haor to river. Fish production of the haor increased from 601 t to 688 t after the first year of operation of the structure. Fish biodiversity in the haor has also increased significantly. Carp and catfish have especially benefited. Further tests of fishpasses should be undertaken as part of mitigation of the effects of flood control projects on fisheries.

Introduction

The construction of numerous flood control embankments to benefit agriculture and protect infrastructure in Bangladesh has had a deleterious impact on floodplain fisheries (Ali 1991). Flood control embankments block fish migration between rivers and floodplains, most importantly during the premonsoon and early monsoon flood surges.

A fishpass of the vertical slot design was constructed across the flood embankment of the Manu River Irrigation Project (MRIP) at Kashimpur in Moulvibazar District in northeast Bangladesh, in order to assess the efficacy of this type of structure for mitigating the adverse impacts of flood control projects on floodplain fisheries. The objective of the Project was to re-establish an open fish migration route between Kushiyara River and Kawadighi Haor. The Kushiyara is the largest river in the northeast region and acts as an important fish migration pathway. Prior to construction of 60 km of full flood protection embankment, Kawadighi Haor, a 11 295-ha seasonal wetland containing several permanent lakes, was a highly productive fishery (known as a "mother fishery") of regional importance (NERP 1994b). The ultimate objective of the Fishpass Pilot Project (FPP) at Kashimpur is to rehabilitate the Kawadighi mother fishery. It was expected that if the fishpass proved successful in enabling fish to migrate across the embankment, and cost-effective in increasing fish production in the haor, valuable lessons would be learnt which could lead to the construction of fishpasses elsewhere in Bangladesh. In addition, during implementation the FPP has expanded and diversified its non-structural components to include fisheries organization and management, fish processing and marketing, and environmental rehabilitation.

Design, construction and operation

The Kashimpur fishpass (Fig. 1) was designed in May–December 1994. The work included site evaluation and a tour to Australia to study successful applications of fishways for warmwater

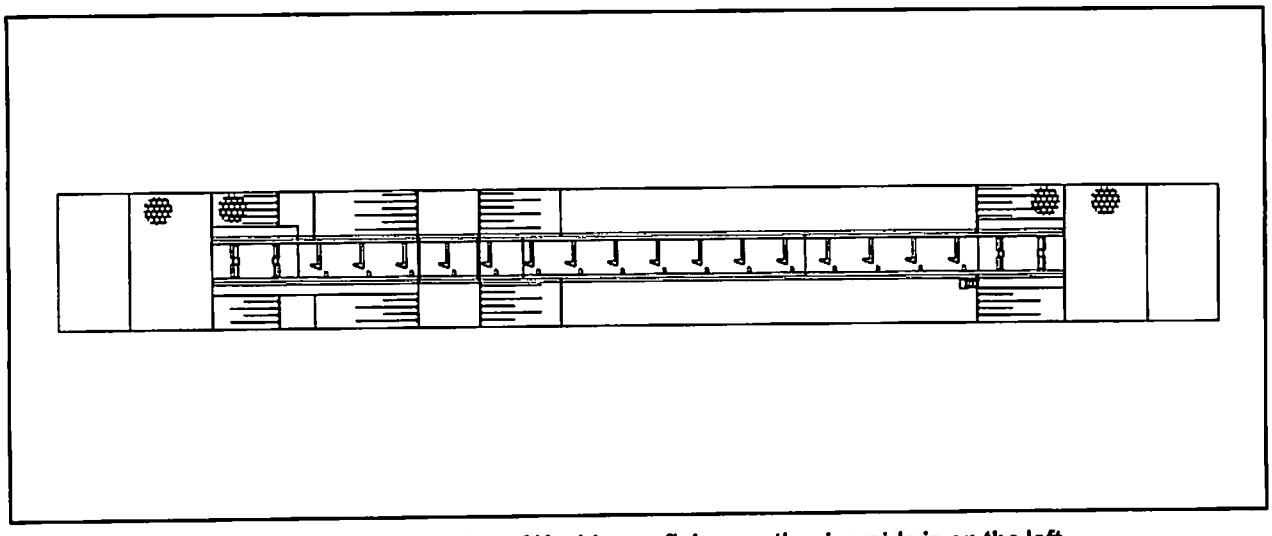

Fig. 1a. Plan view from above of the design of Kashimpur fishpass, the riverside is on the left.

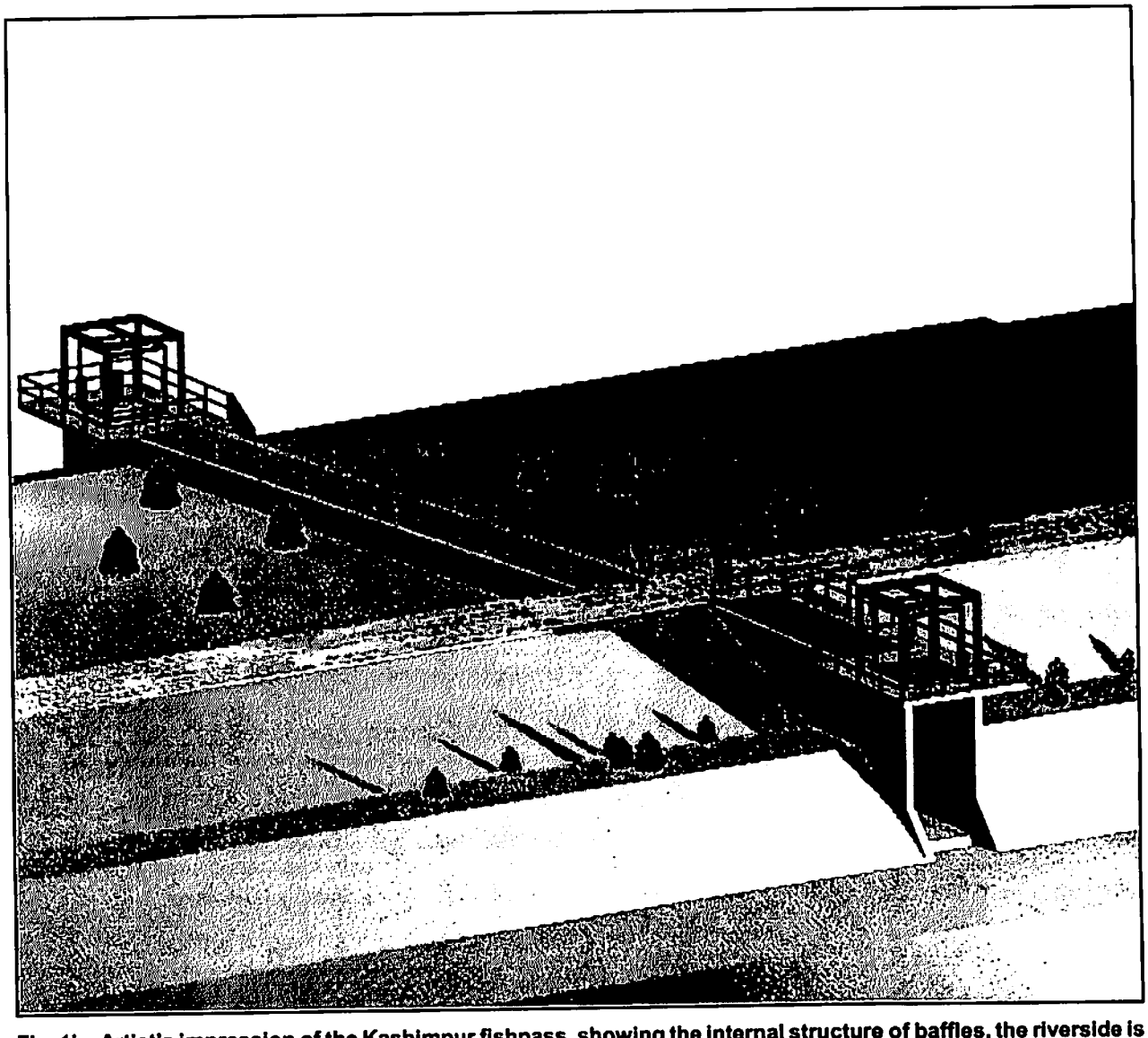

Fig. 1b. Artist's impression of the Kashimpur fishpass, showing the internal structure of baffles, the riverside is in the bottom right corner.

species. General design specifications of the Kashimpur structure are presented in Table 1. Other design types (pool-and-weir and Denil) were rejected as unsuitable for the large headwater and tailwater level variations and flow reversals which exist at flood control projects such as the MRIP. Operational aspects of the Kashimpur fishpass differ significantly from conventional fishpass applications (Fig. 2), and the structure may currently be a unique application worldwide.

Construction was carried out during the winter–dry season period of January–May 1995. Operation of the fishpass began on 24 May 1995. Data from 2 years of operation are presented here, and the FPP ended in December 1997 although the fishpass continues to function.

Methods

A substantial impact monitoring program was put into place for the Kashimpur fishpass. The Northeast Regional Water Management Project (NERP) had previously monitored MRIP as part of its regional water management planning agenda (NERP 1994a). This activity generated a comprehensive baseline database spanning 3 years prior to start-up of fishpass operation (May 1992-May 1995).

The FPP monitoring program focused on two main areas: enumerating fish traffic through the fishpass; and tracking changes in fish production, fish consumption and fishing income from the haor. The program also studied comprehensively the hydraulics of water flows inside the fishpass, the impact of the fishpass on haor hydrology, and the possible hazard to rice cultivation.

Year 1 of operation (1995) was affected by sampling problems due to inadequate sampling devices inside the fishpass and an extended period of shutdown due to protests from rice farmers. In Year 2 (1996) there was a considerable improvement in sampling equipment and increased period of operation due to fewer protests from farmers. Accordingly, the monitoring results and impacts from Year 2 are of greater value for assessing the performance of the structure.

Results and discussion

The results of FPP field studies are summarized from interim reports for Year 1 (NERP 1995) and Year 2 (NERP 1996). The sampling schedules for fish traffic inside the fishpass are summarized in Table 2. Sampling was more comprehensive during Year 2, but the general results of sampling were in agreement for both years:

- All samples contained fish, suggesting continuous traffic during the operational period.
- Fish traffic was simultaneously bi-directional.
- Fish moved both with and against the current.
- Fish traffic was unaffected by flow reversals inside the structure.

Quantitative results for Year 2 are considered more reliable than those from Year 1. The total traffic that negotiated the fishpass during Year 2 was estimated at 0.99–1.30 million fish and crus-

Table 1. Design data of the Kashimpur fishpass.

Parameter	Design
Type	Single-jet vertical-slot
Length	61.85 m (concrete section) 83.85 m (including protective works)
Maximum height	6.54 m
Maximum width	5.00 m
Invert elevation	3.16 m above PWD at C/S 5.46 m above PWD at R/S
Deck elevation	8.16 m above PWD at C/S 11.46 m above PWD at R/S
No. of pools	17 + 2 observation chambers
Pool length	2.90 m
Pool width	2.50 m
No. of baffles	16
Baffle height	4.50 m
Slot width	410 mm
Maximum average velocity (through baffle)	1.62 m/sec*
Maximum velocity at inlet	0.95 m/sec
Maximum total head (R/S wl - C/S wl)	3.78 m
Maximum head per baffle	0.24 m
Maximum total inflow	1.96 m^3/sec

** The design of the fishpass limits the water velocity through baffle slots to 1.3 m/sec and inlet water velocity to circa 0.5 m/sec about 95% of the time. The extreme parameters are predicted from computer simulation of the fishpass using riverside (R/S) and countryside (C/S) hydrographs for March, April, and May recorded over a 12-year period (1983-1994). Actual observed maximum velocities at the slot are higher than predicted.*

PWD - Public Works Datum. wl = water level.

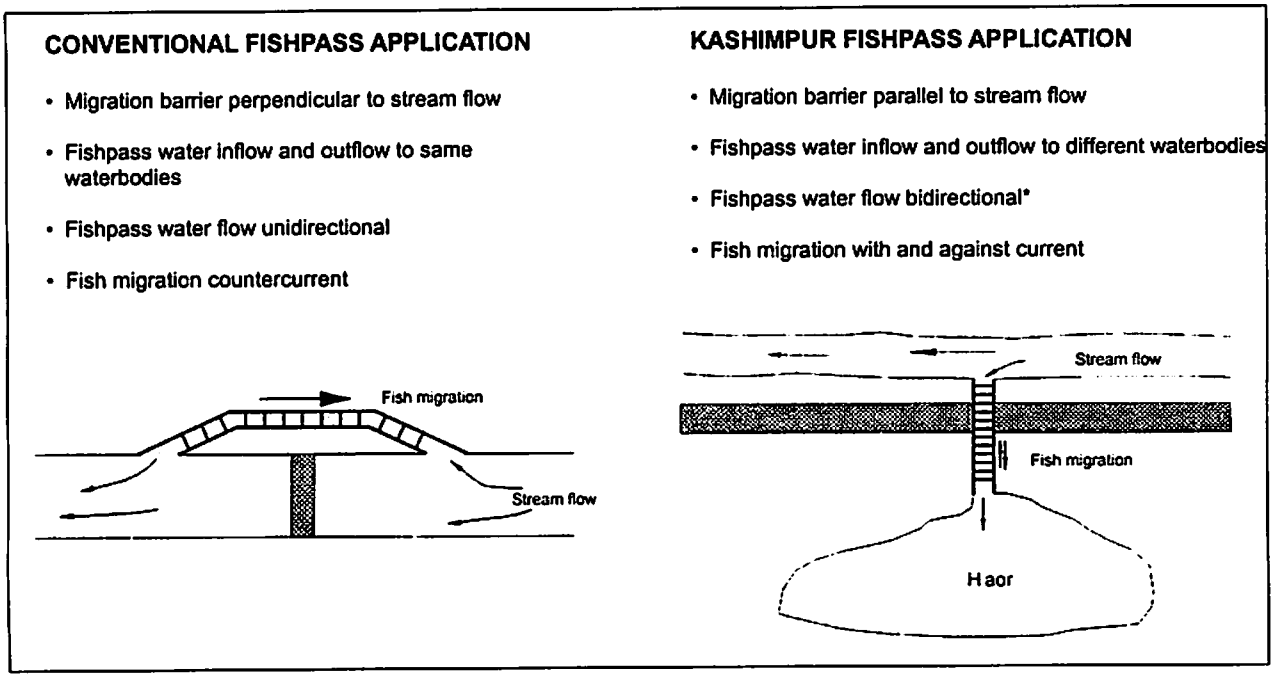

Fig. 2. Comparison of operational features of Kashimpur fishpass with conventional fishpass application.
**Water flow through fishpass reverses during late monsoon due to haor drainage.*

taceans, of which about 58% were finfish and large prawns and 42% were small crustaceans (*icha*). Finfish and large prawn traffic was predominantly in the river-to-haor direction and exceeded traffic in the opposite direction by a factor of four. In weight terms, some 10.7 t of fish and crustaceans moved from river to haor, while 3.0 t moved in the opposite direction.

Water velocities at the slot (the point of highest velocities inside the structure) varied continuously throughout the year depending on total headloss across the fishpass. Direction of water flow inside the structure was dependent on relative water levels in the river and the haor. The highest slot velocities were recorded during premonsoon and early monsoon flood surges and during late monsoon drainage (Fig. 3). A total of 63 species were sampled inside the structure during Year 2 (Table 3). Water velocity had a major effect on the number of species migrating countercurrently (Fig. 4): 36 taxa were recorded when water velocity was less than 1.50 m/sec, but the number decreased at higher velocities. At greater than 2.49 m/sec only three taxa were recorded. Fish swimming with the current appeared to be largely unaffected by water velocity, and 41 taxa were recorded migrating at slot velocities of 2.25–2.50 m/sec.

Table 2. Sampling schedules for the Kashimpur fishpass.

Item	Year 2 (1996)	Year 1 (1995)	Change (%)
Total no. of samples	240	104	131
River to haor migration samples	127	50	154
Haor to river migration samples	113	54	109
Actual operational period (AOP) (hr)	4 398.58	3744	17.5
No. of sampling hours	904.67	403.75	124
Sampling hours as % of AOP	20.1%	10.8%	9.3 percentiles
No. of daytime samples	109	96	13.5
No. of nighttime samples	131	8	1 536
Ratio of daytime to nighttime samples	0.8:1	12.0:1	

Table 3. Fish species composition recorded inside Kashimpur fishpass during monsoon 1996.

Family	Local name	English name	Scientific name	Number	Percentage
Anguillidae	*Bamosh*	Freshwater eel	*Anguilla bengalensis***)	42	0.03
	Bamosh	Freshwater eel	*Ophisternon bengalense*)		
Tetradontidae	*Potka*	Puffer	*Tetraodon cutcutia*	477	0.38
Belonidae	*Kaikka*	Needle fish	*Xenentodon cancila*	202	0.16
Channidae	*Taki*	Shakehead	*Channa punctata*	52	0.04
	Shol	Shakehead	*Channa striata*	1	0.00
Cyprinodontidae	*Kanpona*	Killifish	*Aplocheilus panchax*		
Cyprinidae	*Rui*	Carp	*Labeo rohita*	48	0.04
	Gonia	Carp	*Labeo gonius*	42	0.03
	Kalibaush	Carp	*Labeo calbasu*	79	0.06
	Bata	Carp	*Labeo bata*	5	0.00
	Mrigal	Carp	*Cirrhinus mrigala*	11	0.01
	Lachu	Carp	*Cirrhinus reba*	81	0.07
	Puti	Barb	*Puntius sophore*)		
	Puti	Barb	*Puntius chola*)		
	Puti	Barb	*Puntius gelius*)	3 098	2.49
	Puti	Barb	*Puntius ticto*)		
	Puti	Barb	*Puntius* spp.)		
	Mola	Barb	*Amblypharyngodon mola*	9 009	7.24
	Dhela	Barb	*Osteobrama cotio*	919	0.74
	Chela	Barb	*Salmostoma phulo*)	1 742	1.40
	Chela	Barb	*Salmostoma bacaila*)		
	Darkina	Barb	*Rasbora rasbora*	168	0.14
Cobitidae	*Gutum*	Loach	*Lepidocephalus guntea*	443	0.36
	Pahari gutum	Loach	*Somileptes gongota**		
	Rani	Loach	*Botia dario*	556	0.45
	Matibangra	Loach	*Acanthocobitis botia*	6	0.00
Siluridae	*Boal*	Freshwater shark	*Wallago attu*	62	0.05
	Pabda	Catfish	*Ompok bimaculatus*	36	0.03
Heteropneustidae	*Shing*	Catfish	*Heteropneustes fossilis*	319	0.26
Clariidae	*Magur*	Catfish	*Clarias batrachus*	3	0.00
Chacidae	*Cheka*	Catfish	*Chaca chaca*	18	0.01
Schibeidae	*Garua*	Catfish	*Clupisoma garua*	3	0.00
	Koi bacha	Catfish	*Clupisoma murius*	9	0.01
	Bacha	Catfish	*Eutropiichthys vacha*	772	0.62
	Kazoli	Catfish	*Ailia coila*	803	0.65
	Batashi	Catfish	*Pseudeutropius atherinoides*	3 301	2.65
Sisoridae	*Baghair*	Catfish	*Bagarius bagarius*	55	0.04
	Jainzza	Catfish	*Gagata cenia*	189	0.15
Bagridae	*Air*	Catfish	*Aorichthys aor*	966	0.78
	Guizza	Catfish	*Aorichthys seenghala**		
	Gulsha	Catfish	*Mystus cavasius*	277	0.22
	Bazari tangra	Catfish	*Mystus tengara**		
	Tengra	Catfish	*Mystus vittatus*	1 442	1.16
Notopteridae	*Foli*	Knife fish	*Notopterus notopterus*	35	0.03

Table 3. Fish species composition recorded inside Kashimpur fishpass during monsoon 1996 (cont.).

Family	Local name	English name	Scientific name	Number	Percentage
Clupidae	*Ilish*	Hilsha	*Tenualosa ilisha*	7	0.01
	Chapila	Sardine	*Gudusia chapra*	3 982	3.20
	Ketchki	Sardine	*Corica soborna*	758	0.61
Mastacembelidae	*Baim*	Spiny eel	*Mastacembelus armatus*	234	0.19
	Chirka baim	Spiny eel	*Mastacembelus pancalus*	247	0.20
	Tara baim	Spiny eel	*Macrognathus aculeat**		
Belontiidae	*Boicha*	Gouramy	*Trichogaster chuna*	145	0.12
	Kholisha	Gouramy	*Colisa fasciatus*	77	0.06
	Naptani	Gouramy	*Ctenops nobilis*	96	0.08
Anabantidae	*Koi*	Perches	*Anabas testudineus*	2	0.00
Sciaenidae	*Poa*	Croaker	*Macrospinosa cuja*	1	0.00
Gobiidae	*Bailla*	Goby	*Glossogobius giuris*	737	0.59
Nandidae	*Bheda*	Mud perch	*Nandus nundus*	463	0.37
	Napit koi	Perch	*Badis badis*	26	0.02
Ambassidae	*Chanda*	Glassfish	*Chanda nama*)	36 556	29.39
	Chanda	Glassfish	*Parambassis ranga*)		
Palaemonidae	*Icha*	Small prawns	*Macrobrachium* spp.	54 452	43.78
	Golda chingri	Giant prawn	*Macrobrachium rosenbergii*	993	0.80

* *Species listed with no number were recorded using the fishpass but were not caught during sampling. Numbers only refer to the sampling periods.*
** *Species which are listed with combined total numbers indicated by) were specifically identified using the fishpass but were grouped in the samples.*

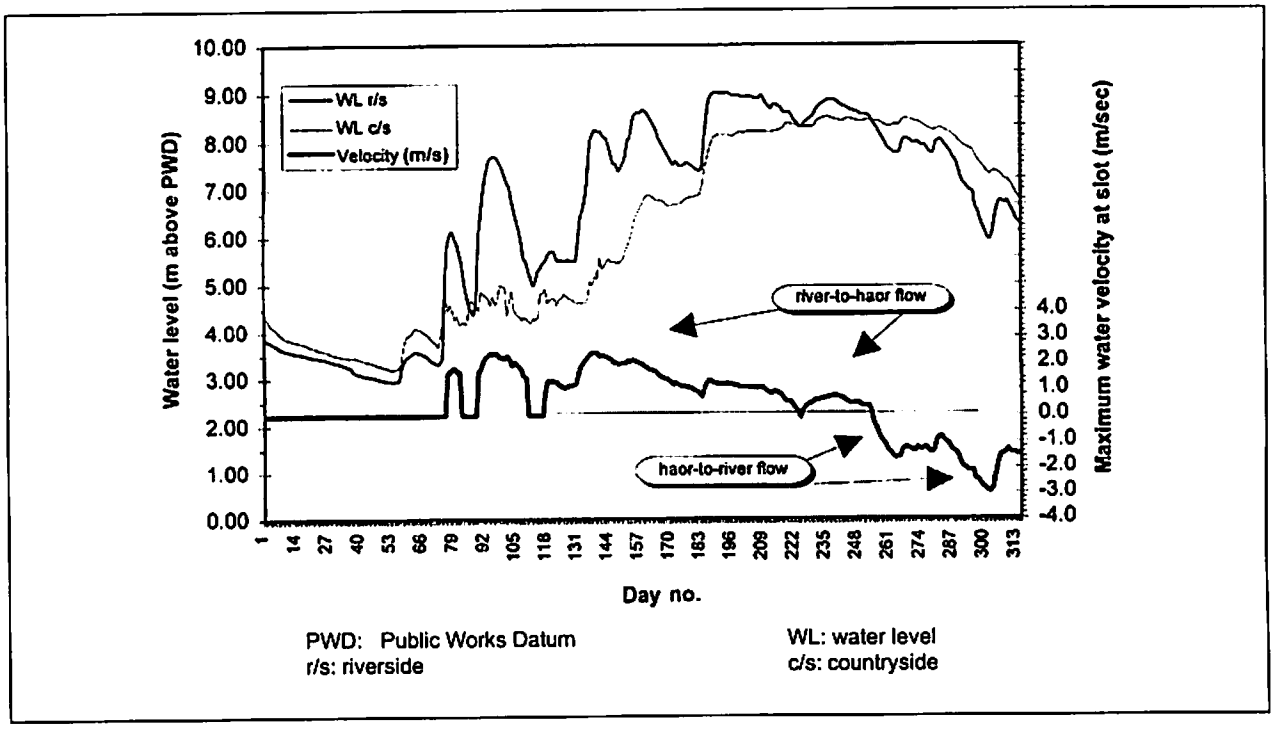

Fig. 3. Water levels in Kushiyara River and Kawadighi Haor and water velocity inside the fishpass in 1996.

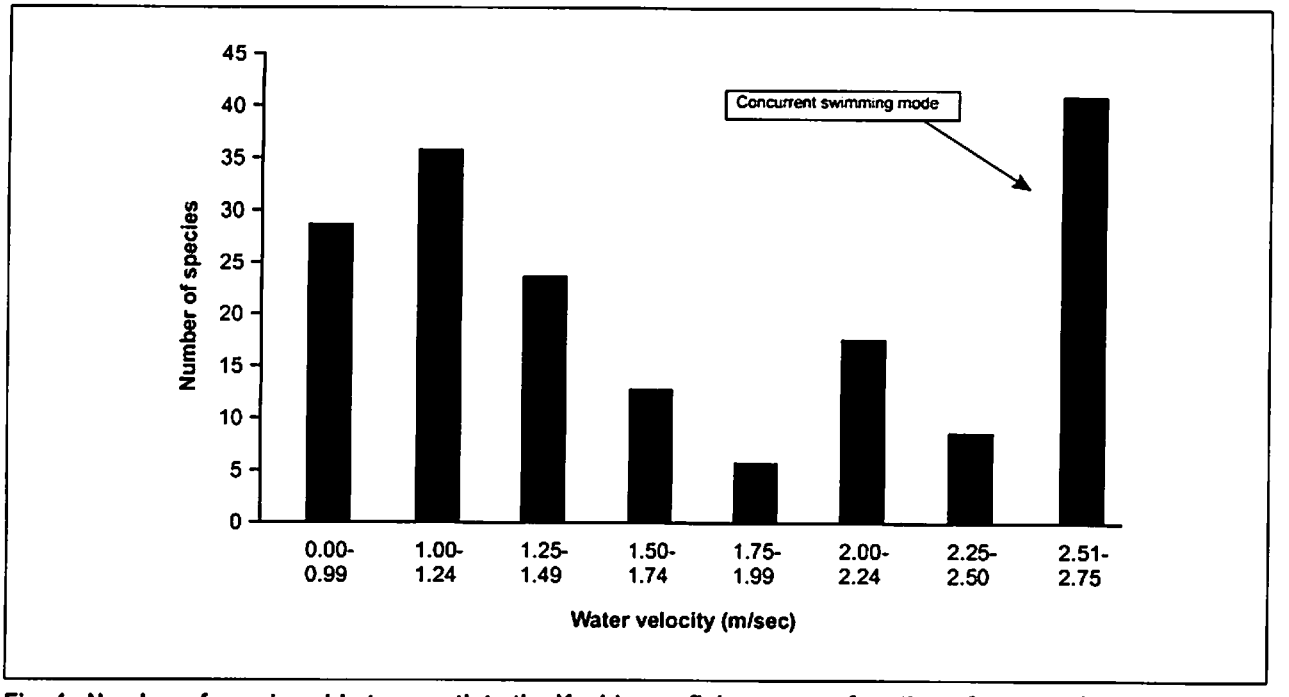

Fig. 4. Number of species able to negotiate the Kashimpur fishpass as a function of water velocity at the slot (countercurrent swimming mode, except indicated bar).

Fish migration from river to haor was strongly correlated to flood surges in the river. The migration rates increased sharply as premonsoon and monsoon flood surges progressed, then fell rapidly after the flood peak was reached (Fig. 5). Haor-to-river migration appears to be triggered by rainfall and run-off inside the haor, and was generally more feeble than river-to-haor migration.

Impacts on haor fish production were positive compared with pre-project baseline levels (Table 4). Monsoon floodplain catches increased by about one-third, while dry season lake (*beel*) production rose

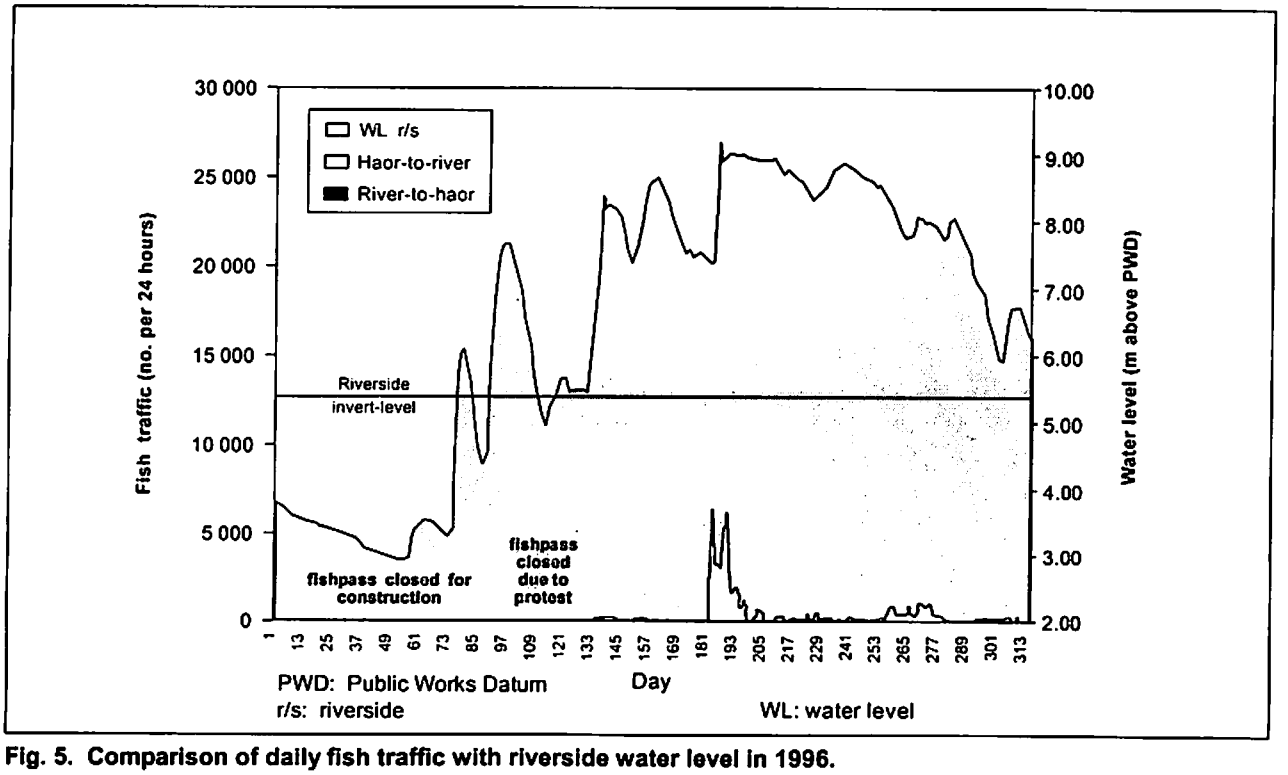

Fig. 5. Comparison of daily fish traffic with riverside water level in 1996.

Table 4. Comparison of fish production in Kawadighi Haor with and without fishpass.

	Without project		With project			Means		
	1992–93	1993–94*	1994–95	1995–96	1996–97	Without	With	Increase (%)
Monsoon floodplain (t)	314	572	509	539	567	412	553	34
Dry season beels (t)	23	229	92	149	189	57.5	165	186
Haor total (t)	337	801	601	688	747	469	718	53
Flood intensity (mcm-months)**	1 790	2 682	1 650	2 037	1 800	–	–	–

Note: monsoon = May-November; dry season = December-April.

* *Exceptional year with massive embankment breaching; not included in without project mean.*

** *mcm-months: million cubic metre months, calculated as the area under the annual flood volume curves, from May to April.*

by 186%, together resulting in an overall average annual increase in catches of more than 50% for the entire haor. Increases in fish consumption and income from fishing were also recorded.

Fish biodiversity increased inside the haor as a direct result of fishpass operation. Prior to FPP operation, 60 fish species were recorded inside MRIP. This number rose to 75 during Year 2 of FPP operation. Several species that were normally absent from the haor appear to be re-establishing themselves (for example the carps, gonia and lachu; and the catfish, baghair and bacha; scientific names of all species recorded are listed in Table 3). A number of other species that were previously present in the haor in small numbers have become significantly more abundant (for example, kalibaush, air and golda chingri).

Despite fears and protests by rice farmers that water entering the haor through the fishpass might pose risks to their crops, it has not been possible to substantiate any damage to rice crops attributable to the fishpass. Six complaints were lodged against the fishpass by farmers during Year 1, but only one complaint was lodged during Year 2, which suggests that a process of acceptance and accommodation of the fishpass appears to be occurring within the farming community.

The increase in fish catches, especially small species, has resulted in a greater supply of raw material for women fish processors. The project has begun a program of training and development to improve the quality and diversity of fish products and increase market penetration.

Fisheries rights for the beels within the haor are leased out by the Ministry of Land to local private investors who contract non-local fishers for dry season harvesting by dewatering (completely draining) the beels. This disenfranchises local fishers, and is highly detrimental to overwintering broodstock. These fisheries management issues are being addressed through the formation of a Kawadighi Haor Fisheries Association (KHFA) to organize and represent genuine fishers and women fish processors. The association is currently undergoing official registration with the Department of Social Welfare, and an application has been lodged to transfer fishing rights for the haor to the association under the New Fisheries Management Policy (*nitimala*). Assistance will be given to KHFA to draw up annual harvesting and long term stock conservation plans.

A fish sanctuary has been established on each side of the fishpass to protect fish migrating along the access channel (*khal*). The KHFA has generally helped to enforce the sanctuary and is agitating for more sanctuaries to be established in the beels in order to protect broodstock.

Conclusions

The vertical slot type of fishpass has been found to be an effective bypass facility permitting fish to migrate across the MRIP flood control embankments. As a consequence of reopening a migration route between river and floodplain, fisheries production, consumption and income have increased inside the MRIP.

The vertical slot fishpass would appear generally to be an effective mitigation measure for the main negative impacts of flood control projects on floodplain fisheries. Construction of more such structures throughout Bangladesh would appear to be justified, based on the results of the Kashimpur fishpass.

Recommendations

Based on the experience of this pilot fishpass, the following recommendations are made:

- Several more vertical slot fishpasses should be constructed and assessed over the next 5 years. These should cover a wide range of flood control project types in order to gain more experience in the possible limits for applications of this type of fishpass.
- Legislation should be prepared that requires all planned flood control projects to include fishery mitigation measures, including fishpass structures.
- Retrofitting of fishpasses in existing flood control projects should be carried out wherever feasible.
- The Department of Fisheries should set national standards for fishpass design and operation, and should also be responsible for reviewing and approving all proposed fishpass construction projects in Bangladesh.

Acknowledgements

The authors are grateful to the Canadian International Development Agency for financing FPP, and for the support received from the Government of Bangladesh, the Department of Fisheries and the Bangladesh Water Development Board, as well as the various contracting firms of NERP (specifically SNC–Lavalin and Northwest Hydraulic Consultants). We also thank the many technical specialists who have worked on FPP and contributed to its success, in particular Tarique Akbar Sonet, Salahuddin Khan, Abdur Razzaque, Abu Sarwar and Mohiuddin Ahmad.

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Depth Preference of Fish Species in Seasonally Inundated Floodplain Habitats: An Attempt at Habitat-based Assessment of Fish Yield and Biodiversity

M. MOKHLESUR RAHMAN[1], A.M. KAMAL UDDIN, MARK T. HILL[2] and DARRELL DEPPERT[2]

Environment and GIS Support Project for Water Sector Planning, House 49, Road 27, Banani, Dhaka, Bangladesh

RAHMAN, M.M., A.M.K. UDDIN, M.T. HILL and D. DEPPERT. 1999. Depth preference of fish species in seasonally inundated floodplain habitats: an attempt at habitat-based assessment of fish yield and biodiversity, p. 245-253. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

A study in three floodplain beels within the Bangshi–Dhaleswari floodplain in northcentral Bangladesh during April–October 1996 demonstrated a depth-based floodplain fisheries assessment methodology. Fish species, numbers and length data were sampled from five flood depth classes. Presence of fish species, fish concentration (no./100 m^3) and biomass (g/100 m^3) were analyzed by depth classes. The highest fish concentration and biomass occurred in the shallowest depth class and declined through the deeper depth classes. A total of 96 species were sampled and categorized into 16 similar groups (guilds). Ranking of concentration by guild resulted in: prawn 44%, perch and gourami 17%, glassfish 12%, barb 11%, cyprineid 6%, snakehead 4%, gobie 3%, eel 2% and cyprinidone 1%. More species were found in deeper waters (depth>90 cm) than in shallower depth classes. Depth classes where guilds were concentrated were mapped throughout the flood cycle.

Household surveys carried out as part of the study indicated that the landless poor obtain about 50% of their fish from markets and 50% from fishing. More than 90% of fishing effort by subsistence fishers occurred in water less than 120 cm deep. Quantifying the depth preferences of fish in terms of concentration of fish at various depths could be used to assess the potentially serious negative fishery impacts of loss of shallow flooded areas caused by flood control and drainage infrastructure and associated agricultural development.

Introduction

The flood cycle is an essential element in the life history of most fishes in Bangladesh floodplains. Inundation of the floodplain provides the spawning grounds, nursery areas, and major feeding opportunities for a wide range of fish and prawn species (Minkin 1989; Ali 1991). More than 256 species of indigenous fish and more than 20 species of prawns have been recorded in the open inland water system (Rahman 1989). Many of these species migrate considerable distances upstream, under the stimulus of rising waters, to reach their spawning areas; the fish then move out over the floodplain as the waters extend laterally (Ali 1991). A direct relationship can be drawn between the magnitude of the annual flood event and total fish production (Flood Action Plan 6 1993), and this relationship has been demonstrated throughout tropical ecosystems (Welcomme 1985).

Breeding, multiplication and sustenance of inland fish and prawn populations are intimately bound to the sequence of annual flooding (Welcomme and Hagborg 1977). Monsoon floods join the primary habitat types (rivers, canals, floodplains, haors, beels and estuaries) of the inland openwaters to produce a single integrated biological production system that allows fish and prawn populations to breed and to grow in numbers and in biomass. Nutrient-rich floodplains provide nursery and feeding grounds for hatchlings, fry and juveniles of a number of river-breeding, estuary-breeding and floodplain-breeding species (Ali 1991).

[1]Present address: CNRS, 4/6 Lalmatia Block B, Dhaka, Bangladesh

[2]Present address: Ecosystem Sciences, 2103 Lemp St., Boise, Idaho 83702, USA

The nature of the fisheries ecosystem, and the movement of fish, are dictated by seasonal changes in water levels and discharge rates in extensive floodplain systems (Welcomme 1985). As the floodplains become inundated by rainfall and overbank flooding, some species of fish, such as major carp, begin a longitudinal migration upstream to spawn. Once rivers begin to flood, most fishes make lateral migrations into the many distributary channels of the rivers. From these channels fish move to the floodplain proper to exploit the food resources of the flooded area, where many species also spawn (Agüero et al. 1989; Minkin 1989). The productivity of a floodplain is directly related to the area inundated (Ali 1991). The flood season represents the major period of growth for all sizes of fish; as the floodwaters recede, fishes migrate from the floodplain. Some fish are retained in low-lying beels as the waters recede. They fall into two categories: those few species adapted to life in these semi-isolated waterbodies; and more mobile species that have migrated to the floodplain but occasionally become trapped in the depressions (CIDA 1989). The dry season is the most critical for all species since the mortality rate is high, populations are at their lowest levels, habitat is limited, predation is at a peak, and growth is slowed (Welcomme 1985). A minimum depth of water is necessary in rivers and canals during the dry season to maintain a healthy population, and to ensure that sufficient parent stock is available for repopulation of the floodplain during the wet season (Hill et al. 1990).

Information and tools for effective planning of use and control of water in Bangladesh are limited. No attempt has been made to establish the water needs of the aquatic environment, and actual water requirements to maintain the aquatic ecosystem and its fisheries are therefore not available. None of the regional flood action plans prepared in the early 1990s—for example Flood Action Plan 2 (1992)—adequately address the water needs of fisheries due to lack of an appropriate methodology; as a result, water planners have used secondary information which often comprises unreliable data on fish catches. Catch-based studies may generate inaccurate figures due to natural variations in fish populations and changes in rate of catch and fishing intensity from year to year.

The purpose of the study reported here was to test a methodology to identify fish preferences for different water depths in a floodplain; it illustrates how to measure fish yield and biodiversity according to water depth. The study approach is *habitat based*, as opposed to the catch-based surveys traditionally used in floodplain fisheries investigation. Simply stated, water creates fish habitat, and without habitat there can be no fishery. A habitat-based method avoids the problems inherent in attempts to use fish catch to quantify fish numbers, by focusing on the concentration of fish by micro-habitat (depth) type. Habitat (in terms of extent of different water depths), contrary to fishing intensity, is generally stable, or at least predictable, from year to year and can be modeled. The amount of water necessary to provide adequate and stable habitat will also provide a healthy fishery. The goal in water planning should be to allocate the minimum amount of water necessary to protect and maintain habitat. By protecting habitat we automatically protect fisheries and fish biodiversity.

Methodology

The study was conducted in three floodplain-beel sites in the Bangshi–Dhaleswari river floodplains:

- the Elasin Beel area, which is directly influenced by Dhaleswari River flooding;
- the Bathuli Beel area, which is influenced by Pungli River flooding, and
- the Charan Beel area, which is influenced by Upper Lohajong River flooding.

Fisheries data collection

Fish samples were collected from seven depth classes (with and without vegetation) from the inundated floodplain. In order to capture the spatial variability of fish dispersion, the whole monitoring area of each beel was divided into several blocks, and samples were collected from each block. The sampling depth classes (to the nearest centimeter) were 1–15 cm, 16–30 cm, 31–90 cm, 91–180 cm and >180 cm. During sampling, data were collected on water depth at sampling points,

number of species, length of fish by species, and total weight of each sample. Data collection began on 16 June 1996 and continued up to 31 October 1996. Sampling was conducted on three consecutive days, followed by a break of three consecutive days, at each of the three sites during the sampling period. The results were then used to classify the floodplain fish habitats in relation to areas used by fish larvae, by the young, and by the adults (or as nursery, growing, and feeding habitats) during the wet season.

The frequency data for the concentration of fish and species in beels and in depth classes do not fit a normal distribution. Non-parametric tests of the difference between three means (each beel), using the Kruskal–Wallis test, indicate no significant difference in fish concentration or species between beels; therefore data from all three beels have been pooled.

Household data collection

Households were monitored in two villages at each of the three study sites. Sample households were selected at random after a village census and a stratification of households based on landholdings (landless; small scale and marginal farmers; medium farmers; and large farmers). The household monitoring program generated information on fish consumption and sources of fish, species composition of consumed fish, participation of households in fishing, and gear use. Data were collected for 7–8 days a month from each of the selected households through observation using structured forms.

Results and discussion

Fishery characteristics and trends during study

The fisheries survey collected more than 3 million fish representing 96 species. Species were organized into 16 guilds (biologically and taxonomically similar groups). Average concentration of fish guilds by depth classes is shown in Table 1, and distribution of fish biomass for each sampling week in Table 2. Multiple regression analysis of water volume change and fisheries data (number of species, concentration, biomass and biodiversity) indicates a highly significant correlation with changes in floodplain water depths. Strong correlation between biological and physical variables allows extrapolation from the micro-scale (individual beels) to the macro-scale (the floodplain).

In this floodplain, exotic species (i.e., silver carp, common carp, grass carp and tilapia) are rare in dry season and wet season habitats. Given the scarcity of exotic species and the large number of

Table 1. Average fish concentration (no./100 m³) by guild and depth class in three Bangshi–Dhaleswari floodplain beels, 16 June–31 October 1996.

Guild	Depth 1 (1–15 cm)	Depth 2 (16–30 cm)	Depth 3 (31–90 cm)	Depth 4 (91–180 cm)	Depth 5 (>180 cm)	All depths
Carp	0.53	0.17	1.38	2.36	0.82	5.26
Exotic species	0.00	0.04	0.00	0.00	0.00	0.05
Barb	120.94	51.56	34.18	26.84	3.51	237.03
Clupeid	0.03	0.07	1.16	5.05	3.64	9.94
Other cyprineid	75.53	16.09	9.15	20.07	12.22	133.06
Small catfish	3.81	1.99	0.98	1.39	2.15	10.32
Large catfish	0.05	0.00	0.00	0.05	0.12	0.22
Snakehead	78.80	8.89	1.75	0.33	0.03	89.81
Eel	17.15	13.36	5.27	1.47	0.42	37.66
Perch and gourami	192.47	103.37	47.83	11.77	1.92	357.36
Glassfish	43.76	34.28	65.22	90.10	33.27	266.63
Mullet	0.00	0.00	0.00	0.01	0.00	0.02
Puffer	3.41	2.93	1.58	0.67	0.24	8.84
Knifefish	0.00	0.00	0.00	0.00	0.00	0.00
Gobies	22.95	16.33	7.85	6.08	2.12	55.34
Cyprinidone	17.43	6.80	1.09	0.75	0.16	26.24

Table 2. Total fish biomass (g/100 m³) by sampling week and depth class in three Bangshi–Dhaleswari floodplain beels, 16 June–31 October 1996.

Period	Depth 1	Depth 2	Depth 3	Depth 4	Depth 5	All depths
Week 4	211	128	77	89	42	547
Week 5	300	132	99	65	31	627
Week 6	351	175	91	71	23	710
Week 7	408	187	103	95	24	816
Week 8	236	142	89	55	25	548
Week 9	157	145	84	88	38	511
Week 10	235	179	93	45	22	574
Week 11	318	184	81	62	27	671
Week 12	280	159	99	50	20	607
Week 13	301	187	84	44	20	635
Week 14	228	149	82	51	22	532
Week 15	286	209	101	58	14	667
Week 16	360	196	106	43	18	723
Week 17	366	211	118	36	14	744
Week 18	408	266	140	39	14	866
Week 19	396	250	126	73	22	866
Week 20	802	499	190	37	17	1 546

native species, this floodplain may represent relatively pristine conditions—as close to natural conditions as possible in Bangladesh today.

Two distinct peaks in hydrology are exhibited in the floodplains. Overland flow from distributary rivers (Dhaleswari, Lohajong, Pungli and Bangshi systems) created the first peak at about week 7 (28 July–3 August). Overbank flooding from the Jamuna River was evident in the floodplain by about week 16 (29 September–5 October). Total water volume was lowest in depth class 1 (1–15 cm), and graduated through the other strata to a maximum in depth class 5 (>180 cm) (Fig. 1). Fish responded to changes in water level with increased movement and a shift in concentration between depth classes (Figs. 2 and 3). There was an increase in the number of species in deeper water during the peak of the monsoon, reflecting movement of fish into the area (Fig. 2). Concentration of fish was greatest in shallower water (Fig. 3); in the last (21st) week of the study the shallower waters dried up and fish moved to deeper water, considerably increasing concentrations. Guilds for barb, other cyprineid, snakehead, perch and gourami, glassfish, gobie, cyprinidone and prawn accounted for the vast majority of the fish present, while the large and small catfish, eel, knifefish, mullet, puffer and clupeid guilds made up a small proportion of the fishery. Exotic species such as silver carp and common carp were rare.

The highest concentrations of fish and biomass occurred in depth class 1. Concentrations declined throughout the other depth classes: the lowest concentrations of fish and biomass occurred in the deepest portions of the floodplain—depth class 5 (Figs. 4 and 5). However, the number of species (Fig. 6) was highest in deep water (depth classes 4 and 5) and lowest in shallow water (depth classes 1 and 2). Distribution of fish concentration (numbers of fish) by depth class was as follows: 44% in class 1; 28% in class 2; 16% in class 3; 9% in class 4; and 3% in class 5. Prawns, at 44% of the total number, were the most abundant group of species.

Spatial distribution of guild preference

The average wet season preference index of the nine important ("primary") guilds recognized in this study is presented in Table 3. The preference index effectively represents the relative concentration and therefore abundance of a guild of fish with respect to depth class, and although expressed as a percentage is not a percentage of the total fish population. It is defined as:

$$P_g = (G_d / \sum_{d=1}^{5} G_d) * 100$$

where P_g = the preference index of guild g and G_d = the concentration of guild g in depth class d in terms of fish/100m³.

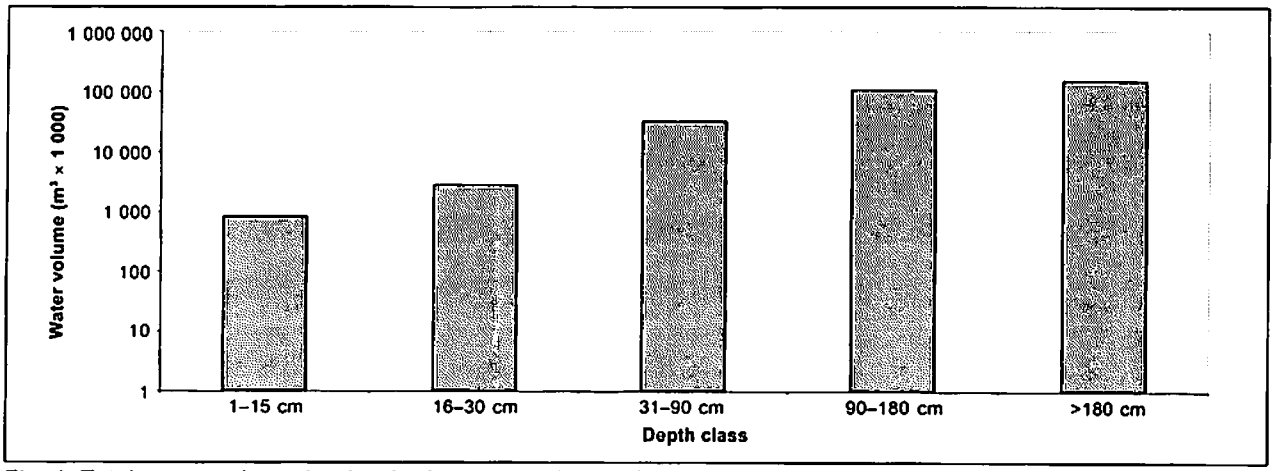

Fig. 1. Total water volume by depth class occurring in the Bangshi–Dhaleswari floodplain (Elasin, Bathuli and Charan Beels); 16 June–31 October 1996.

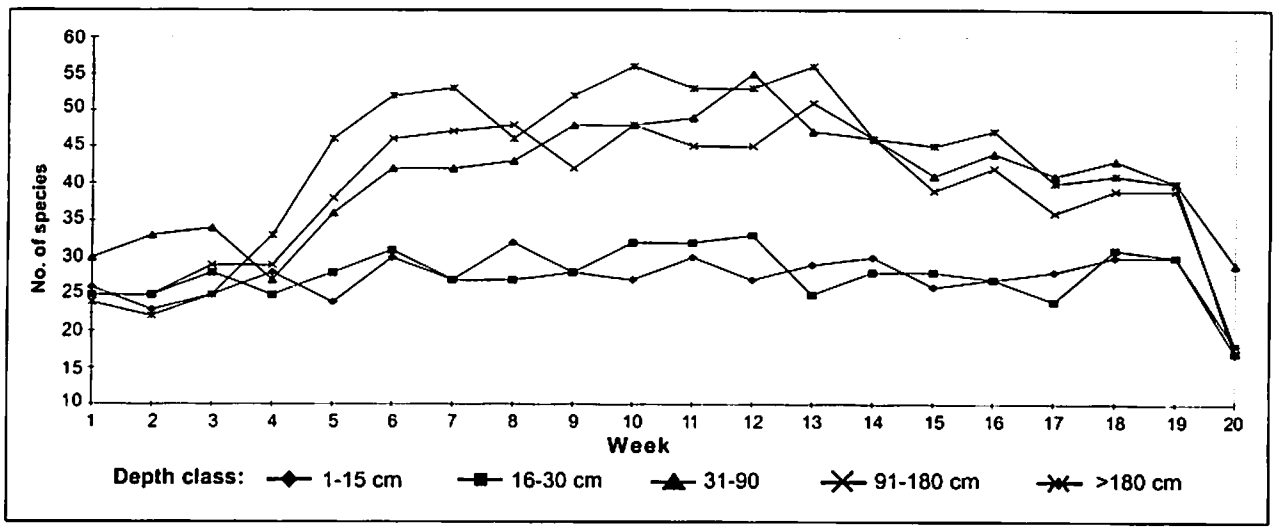

Fig. 2. Habitat–time series of fish species occurring in the Bangshi-Dhaleswari floodplain (Elasin, Bathuli and Charan Beels); 16 June–31 October 1996.

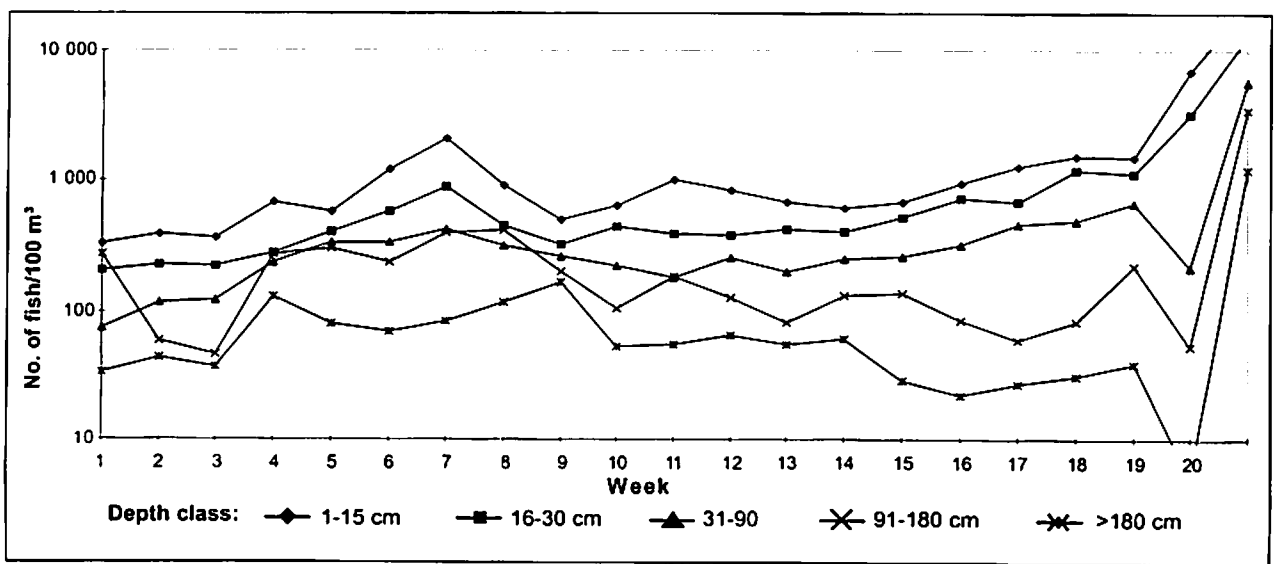

Fig. 3. Habitat–time series of fish concentration occurring in the Bangshi–Dhaleswari floodplain (Elasin, Bathuli and Charan Beels); 16 June–31 October 1996.

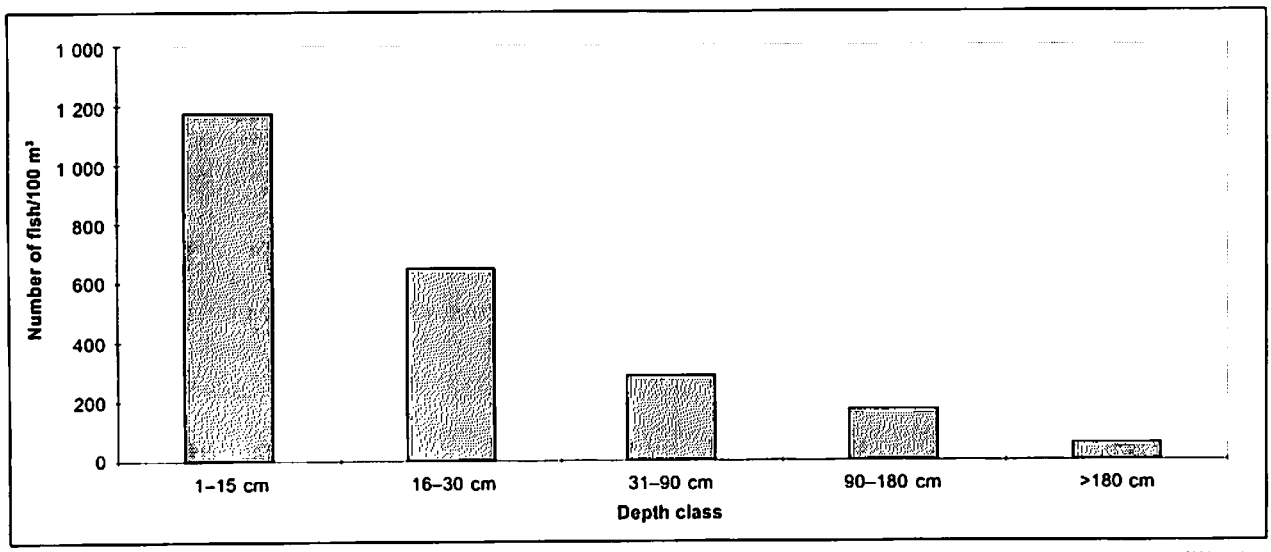

Fig. 4. Average concentration by depth class of fish occurring in the Bangshi–Dhaleswari floodplain (Elasin, Bathuli and Charan Beels); 16 June–31 October 1996.

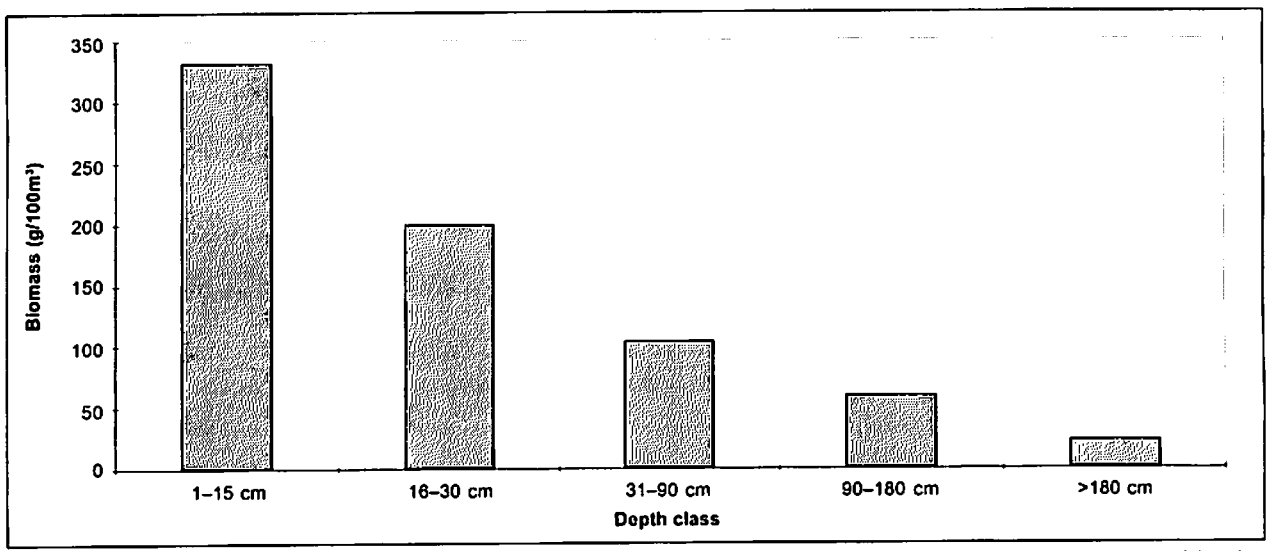

Fig. 5. Average fish biomass (g/100 m³) by depth class occurring in the Bangshi–Dhaleswari floodplain (Elasin, Bathuli and Charan Beels); 16 June–31 October 1996.

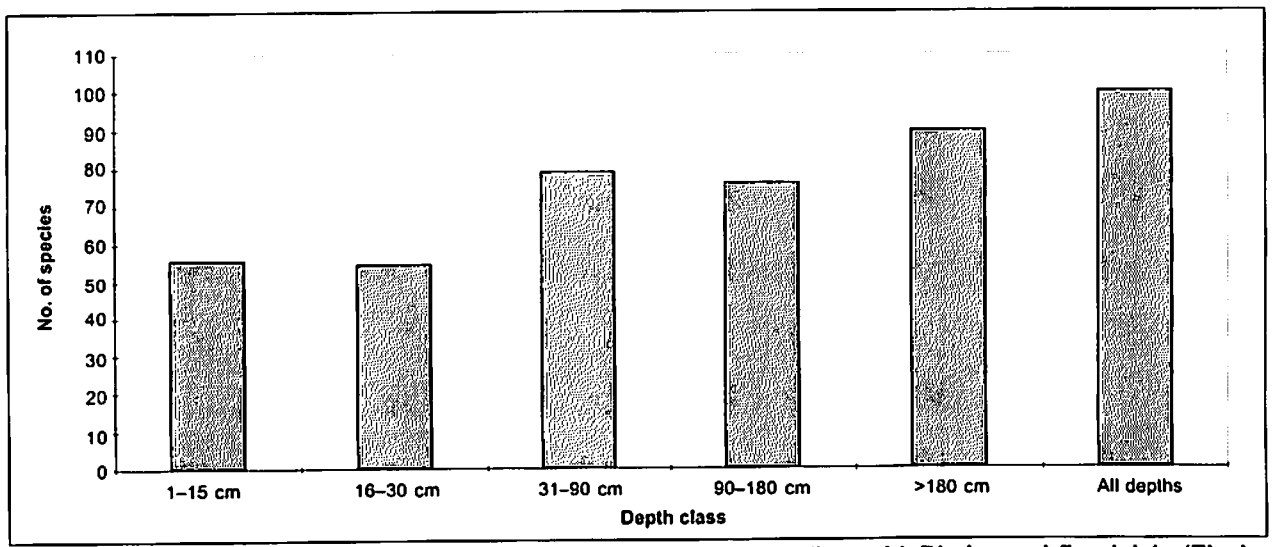

Fig. 6. Total number of fish species by depth class occurring in the Bangshi–Dhaleswari floodplain (Elasin, Bathuli and Charan Beels); 16 June–31 October 1996.

Fish exhibit a preference for a certain depth class (habitat) by concentrating within that depth class. The prawn, perch and gourami, barb, gobie and eel guilds prefer shallow water (depth classes 1 and 2). Glassfish do not show any strong preference but occupy all depth classes. The cyprineid and snakehead guilds show a strong preference for the shallowest depth class (class 1), and the carp guild a strong preference for deeper water (depth classes 3–5).

Of the primary guilds, the prawn, perch and gourami, barb, cyprineid and snakehead species are small (<30 mm in length) and tend to prefer shallower depths. Carp are generally larger (>50 mm) and concentrated in deeper water. Eel and gobie species are generally large (>50 mm), glassfish are small (<30 mm) and all three can be found throughout the depth classes.

Fishing activity and water depth

The household survey indicated that about 90% of fishing effort was concentrated in the shallow water of beels and the floodplain (<120 cm), though about 60% of the floodplain area was flooded to a depth of less than 120 cm. Landless fisherfolk obtained approximately 50% of their fish from markets and 50% from fishing, while small and medium–large farm households obtained, respectively, 32% and 37% of the fish they ate from their own fishing. About 65% of the total fishing effort (person days) was carried out by the landless fisherfolk, who comprised 55% of all households fishing during the study: during the study period, landless households fished on average for 25 days and landed households for just 16 days. Nevertheless, per capita fish consumption was lower among the landless households than in the three landowning categories. Hence the landless, who are the poorest people, are more dependent on the floodplain (and shallow depths in particular) as a food source than are landowners. Because poor people fish mainly in shallow waters and the most abundant fish in depth classes 1 and 2 are species in the prawn, gobie, perch and gourami, barb, eel, and small catfish guilds, it follows that the poor are dependent more on these small fishes for their food. Similar data have been recorded by other studies in the Tangail area, which showed that 57–65% of fish consumed were small fish, snakeheads and prawns (Flood Action Plan 16 1995; CNRS 1996; Rahman et al., this vol.).

Conclusion

The method demonstrated in this study is an initial step in the formulation of a new fisheries management concept in Bangladesh. The floodplain fishery in any tropical ecosystem is a "moving target" because there are numerous species exhibiting different population and production cycles through time and in relation to hydrologic events. Multi-year studies over large geographic areas in numerous habitat types through wet and dry seasons are required to create reliable databases that truly describe the fishery. In addition to these spatial-temporal issues, the problem of quantifying the fishery in Bangladesh is compounded by fishing pressure that increases year

Table 3. Distribution of fish concentrations (preference index) by guild and habitat (depth class) in three Bangshi–Dhaleswari floodplain beels, 16 June–31 October 1996.

Guild	Depth 1	Depth 2	Depth 3	Depth 4	Depth 5
Carp	12	4	44	27	13
Barb	53	22	14	10	1
Other cyprineid	59	13	7	14	7
Snakehead	89	9	2	0	0
Eel	46	35	14	4	1
Perch and gourami	55	29	13	3	0
Glassfish	18	14	26	31	11
Gobie	42	29	14	11	4
Prawn	47	34	16	2	1

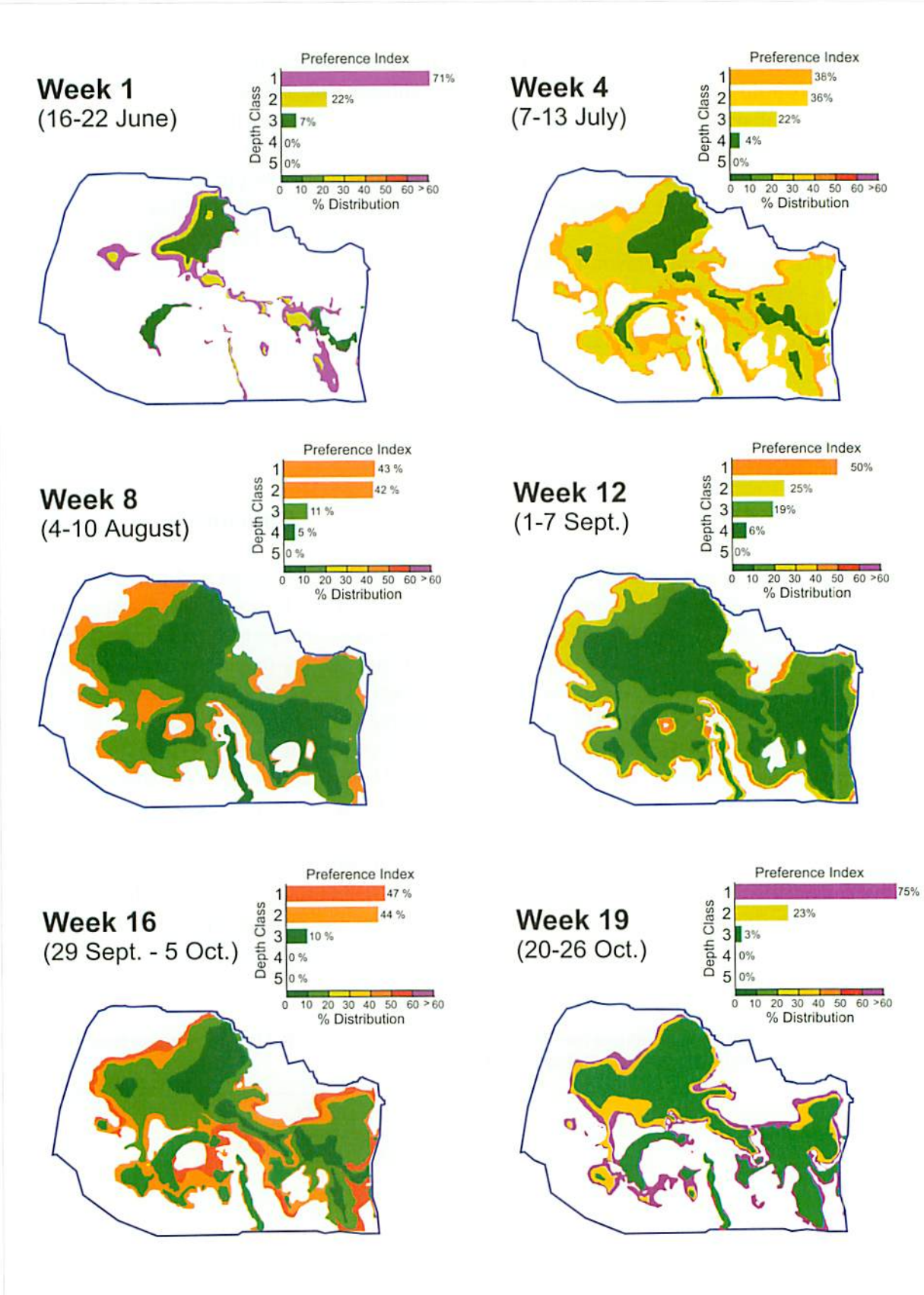

Fig. 7. Time series map of preference index of perch and gourami by depth class in the Bangshi–Dhaleswari floodplain (Elasin Beel), 16 June–31 October 1996.

by year while fish habitat declines. Fisheries management in Bangladesh, in the face of all these natural and anthropogenic conditions, must begin to look for new approaches. Modern fisheries management recognizes the imperative to protect and maintain freshwater habitat for the benefit of native fish stocks. Analysis of the impact of development projects on fisheries is no longer an economic analysis based simply on the number of fish eliminated and the monetary value of fish lost; rather it raises the fundamental question of impacts on fisheries habitat and their relation to sustainability of natural production and harvests from native fish stocks.

There is potential to use the approach followed in this study to estimate the impacts on fish populations of changes in flood extent and depth during the annual inundation cycle. Already by combining the weekly fish concentration data collected by depth with GIS mapping of flood depth based on topographic data and modeling of water levels, it is possible to map the concentration of fish. Fig. 7 illustrates the concentration of one guild of fish (gourami) in selected weeks during the study in one beel (Elasin). The same models are already being used to predict changes in flood regime following interventions such as flood control and drainage (FCD) projects. Therefore a possible reduction in flood level in the same week(s) due to a proposed FCD project could be modeled, the extent of water in different depth classes mapped, and (as the fish concentration in each depth class is known) the reduction in fish population could be estimated (and the distribution of fish mapped). The fact that fish are highly concentrated in shallower waters in the monsoon—as demonstrated in this study—emphasizes the need to maintain extensive areas of shallow flooding in the floodplain. Unfortunately these areas are often the prime target of FCD projects as they show the greatest potential for gains from monsoon season water control, enabling higher yielding transplanted rice crops to be grown.

The study was intended to be a pilot investigation and should be considered only a first example of how fisheries investigation can consider the physical condition (hydrology) of the floodplain. There is potential for using GIS tools for improving the analysis and interpretation of study findings. Based on the findings of this demonstration study and experience gained so far, it is recommended that its scale and scope be expanded. To develop a comprehensive floodplain fisheries assessment model, long-term data collection (for five consecutive years or more) from representative floodplain (dry season and wet season) habitats, is needed so that the complex floodplain fisheries of Bangladesh can be understood in more detail.

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An NGO as Custodian for Fisher Groups in Culture Based Semi-closed Waterbodies: the Experience of BRAC

MD. MOKARROM HOSSAIN
BRAC, Mohakhali, Dhaka, Bangladesh

HOSSAIN, M.M. 1999. An NGO as custodian for fisher groups in culture based semi-closed waterbodies: the experience of BRAC, p. 255–258. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

BRAC has worked in three initiatives to help groups of poor people to take control of semi-closed natural waterbodies and introduce culture based fisheries management. This type of management has succeeded in improving the incomes of poor fishers. The main problems have been difficulty in obtaining access rights for poor fishers (even through the efforts of government in projects of the Department of Fisheries and BRAC), and the lack of security of tenure for the fishers in some of these projects.

Introduction

BRAC—a national private development organization—was formed in 1972 to redress the social and economic sufferings of poor rural people in Bangladesh. It covers 50000 villages throughout Bangladesh and has 1.84 million participants in three main programs. In 1986 BRAC introduced its Rural Development Programme (RDP) as a comprehensive strategy aimed at improving the livelihoods of rural households owning less than 0.2 ha of land; 90% of the 1.5 million participants in this program are women (BRAC 1995).

As part of its strategy of mobilizing poor people to control local resources, BRAC started a fisheries program in 1976, which has since been incorporated within the RDP. There are two main aspects to this fisheries program: pond aquaculture, and culture based fisheries in larger closed or semi-closed natural waterbodies (*beels*—natural wetlands/depressions and lakes, and *baors*—oxbow lakes). The experience of BRAC in working with fishers to manage some of the beels and baors is the subject of this paper. BRAC has had three separate but essentially similar initiatives in this type of waterbody—two working jointly with the government and one independently:

- From 1991 BRAC has worked with the Department of Fisheries (DOF) to jointly implement the IFAD- and Danida-assisted Oxbow Lakes Small Scale Fishermen Project, Second Phase (OLP II), described in detail in Apu et al. and other papers in these proceedings.
- Based on the experience of OLP II, in 1993 BRAC started its BRAC Baor Programme (BBP) in parallel with the DOF–BRAC project.
- Under an initiative of the Ford Foundation, in 1993–1994 BRAC joined DOF and other NGOs in the Improved Management of Openwater Fisheries (IMOF) project, which was assisted by the Ford Foundation and the International Center for Living Aquatic Resources Management (ICLARM). Following this experience, a larger project—the Community Based Fisheries Management (CBFM) Project—was started, supported by the Ford Foundation, and BRAC formally joined the project in 1997.

Obtaining rights over fisheries

Traditionally most of the common waterbodies in Bangladesh were occupied by rich, influential people in society, and fishers were hired by them as labor. Waterbodies are under the control of the Ministry of Land (MOL); on its behalf the district administrations lease them to the highest bidders. In the donor-assisted DOF and BRAC collaborations mentioned above, most effort was devoted to establishing the right of the poor

users over the common waterbodies. In all cases it proved very difficult to ensure access to waterbodies for the poor fishers, although in the long run the goal of BRAC is that the fishers should have secure long term access to them. Fig. 1 shows the areas expected to be and actually in the possession of groups organized by BRAC under the three initiatives (note that IMOF covered only 1993 and 1994, but that the CBFM Project was originally intended to start in 1995).

BRAC's main objective in joining OLP II was to establish the right of poor users over common fisheries resources in order to improve their socioeconomic position in society. OLP II had the greatest success so far among these three initiatives in securing rights over the waterbodies, yet out of 30 baors proposed for the project, only 22 were handed over to DOF. These have been handed over for 50 years so that DOF can give rights through licensing to the fishers. The fishers are approved jointly by DOF and BRAC, organized in groups by BRAC, and then licensed by DOF.

In 1993 BRAC proposed a list of 80 semi-closed and open waterbodies to MOL to be leased long term to BRAC for use by its participants. That proposal is still held in the ministry and has not progressed. In the meantime BRAC arranged leasing contracts between fisher groups and local government for 1–3 years, through open auction, for some semi-closed waterbodies. Waterbodies were taken either by an organized fisher group, or in the name of BRAC on behalf of fisher groups. Some of these BRAC baors became productive and profitable as a result of the effort put in by the fishers. Unfortunately these baors attracted local influential people who outbid the BRAC-organized fishers at auction when the leases expired. In some baors, especially those which were leased for 1 year, the fishers incurred a loss and were reluctant to take the lease again. In 1995 and 1996 the fishers lost 14 and 15 baors, respectively, in this way, reducing the area covered by the BRAC Baor Programme by 467 ha and 316 ha; in early 1997 only 380 ha remained under the program. Linked with this, 255 participants were lost. Hence, taking waterbodies on short term leases is not a viable way of ensuring fisher rights to semi-closed waterbodies when they are suited to culture based fisheries and richer and more powerful individuals can capture the

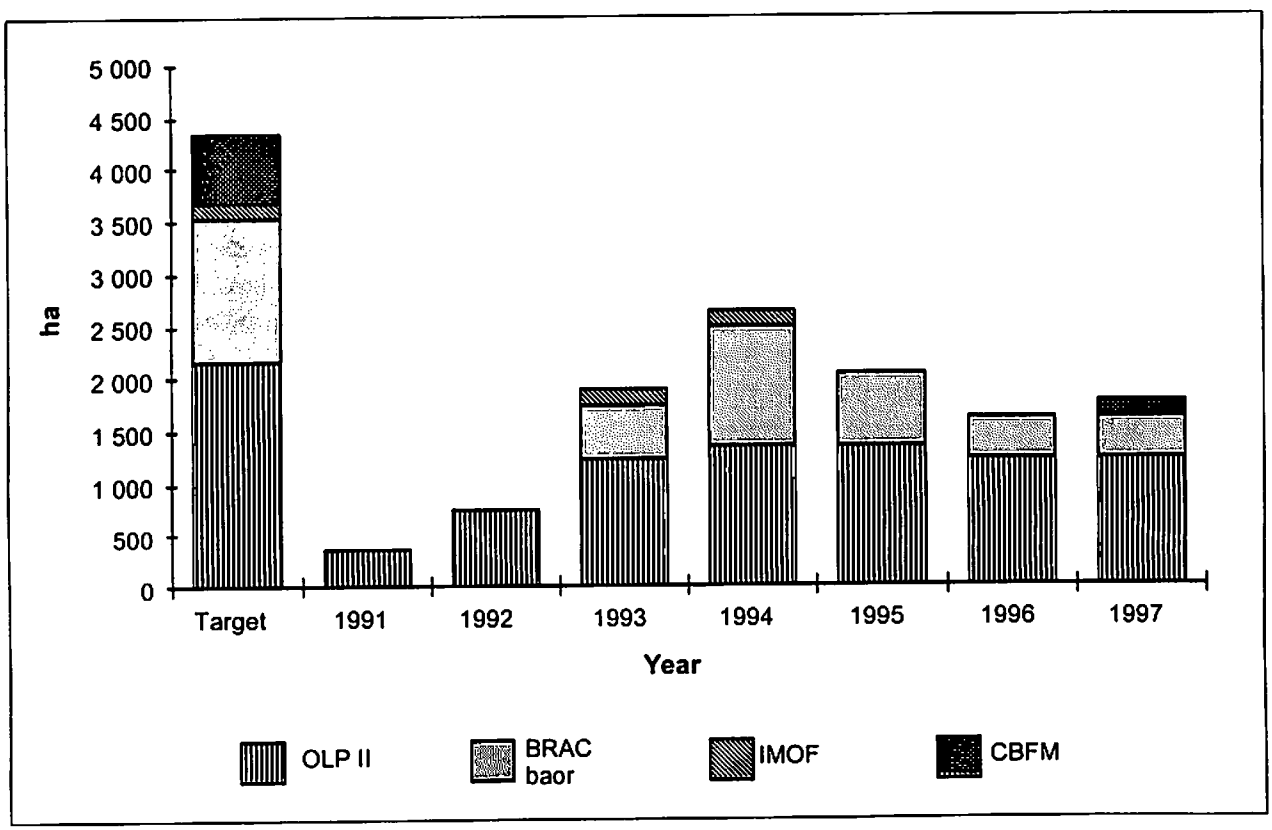

Fig. 1. Target and achievement (ha) of culture based semi-closed waterbodies under different projects involving BRAC.

initial investment made by fishers to adapt such baors to culture based fisheries (for example weeding, and screening small outlets).

After joining the IMOF project, BRAC worked in four waterbodies and organized 363 fishers. However, little could be achieved beyond this due to lack of funds and because the project ended in 1994. For the CBFM Project, with enhanced funding, BRAC proposed to DOF that they work together in 12 waterbodies, but MOL has yet to be convinced fully by the Ministry of Fisheries and Livestock of the necessity of this project. Finally in March 1997, MOL agreed to hand over five of these 12 waterbodies, and BRAC started its work in the project in May 1997. Even so, because of its strength compared with that of the Ministry of Fisheries and Livestock, MOL has insisted on substantial increases in revenue from the poor fishers (25% in the first year followed by annual 10% increases in subsequent years), even in waterbodies not suited to culture based fisheries, and has handed them over for only 3 years.

Impacts of baor management by fishers

There have been positive impacts from OLPII and the BRAC Baor Programme in lakes retained by the fishers, despite the problems of fishing rights. The basis for the gains to the fishers involved has been increased fish production: for example, average yield of baors under OLP II increased from about 150 kg/ha in 1991–1992 to more than 600 kg/ha in 1995–1996 (Oxbow Lakes Project II 1997).

BRAC's Research and Evaluation Division conducted a study of OLP II (Ahmed et al. 1997) which shows that the consumption of carp by participants increased by 360% between 1993 and 1995 (from 65 g/person/month to almost 300 g/person/month). Expenditure per person, which is regarded as a better measure of overall well-being than reported income, rose by 30%. Both increases were statistically significant. Carp in 1995 contributed about a third of participants' fish consumption (a total of almost 1 kg/person/month), while in 1993 they contributed only 9% (Fig. 2). The value of fishing assets owned by participants increased by 37% in this period, and fishers' average yearly income jumped from Tk 4 090 in 1991–1992 to more than Tk 11 000 in 1992–1993. Subsequently, with increasing numbers of participants, it fell to about Tk 8 400 in 1995–1996.

Similarly, in the BRAC Baor Programme, annual income per fisher increased from Tk 3 476 in 1994 to Tk 7 285 in 1996 (unpublished BRAC data). In general, fishers who have participated in these programs for several years have changed from being among the poorest homeless, asset-less and powerless members of society to people who are proud of their profession and who have some assets and a say in their community.

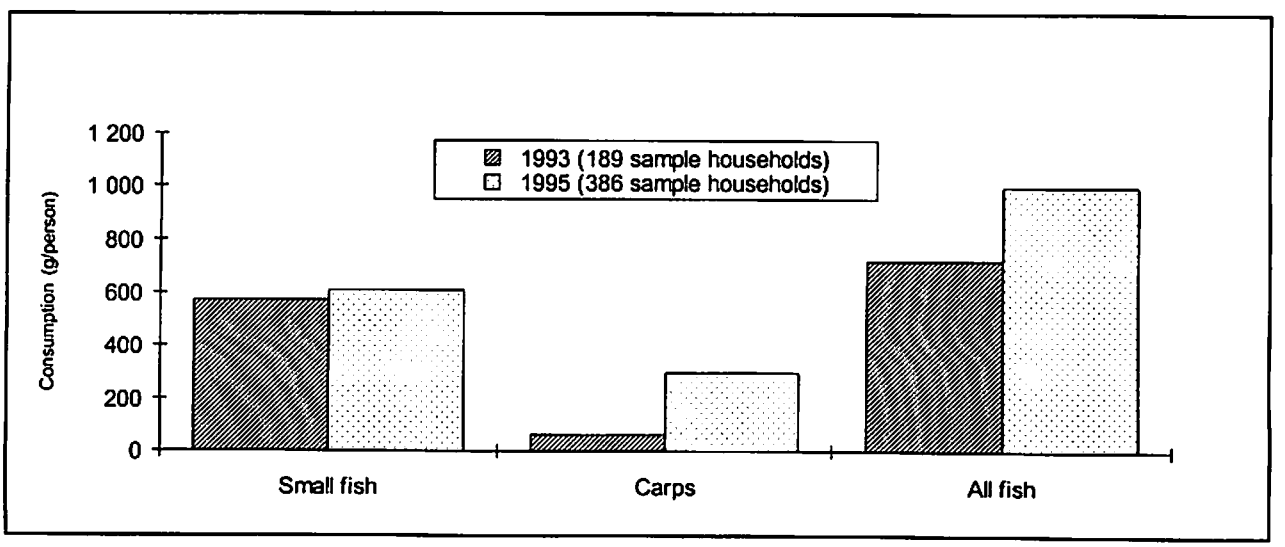

Fig. 2. Monthly fish consumption (g) per person among OLP II fishers.

Table 1. Roles of BRAC in implementing OLP II.

Activity	Involvement
Funding of BRAC's activities	Danida
Selection of fishers according to project criteria	BRAC
Finalization of fisher list for approval	BRAC and DOF
Formation of village organizations	BRAC
Motivation of fisher groups	BRAC
Licensing of fishers	DOF
Preparation of credit applications	Fishers and BRAC
Credit approval and disbursement	BRAC
Lease payment	Fishers
Preparation of training materials	Danida
Meetings and management training	BRAC
Fingerling release, harvesting and record keeping	Fishers, BRAC, DOF
Revision of membership	BRAC and DOF
Leaseholder	DOF

Conclusions

In suitable semi-closed waterbodies, introduction of culture-based fisheries managed by the users can increase waterbody productivity (Hasan et al., this vol.) and hence can improve the socio-economic position of the poor fishers.

However, the main problem is in transferring possession and rights over these waterbodies to the poor fishers for a period long enough for them to be able to invest and to earn an improved income. So far it has not been possible for BRAC to arrange long term leases either in its own name or in the name of its participants. The government has not agreed to test the model of the NGO as a custodian of waterbodies on behalf of the poor; instead under the New Fisheries Management Policy it tested licensing fishers individually, without providing incentives for poor fishers to work together. Leasing has in theory favored co-operatives of fishers, but often these have been dominated by richer and more powerful people. Even if a preference is given to poor fishers, short term leases of 1–3 years (as experienced under the BRAC Baor Programme) do not give the security needed for fishers to retain rights over waterbodies.

In joint projects with government, the model adopted has been for waterbodies to be handed over to DOF, with participants then getting rights to manage the fisheries after the fishers have been jointly approved by BRAC and DOF. In the case where results can be assessed (OLP II), the impact on poor fishers has been significant and positive. BRAC's role was as a facilitator and mobilizer of the fishing community, organizing groups and providing training and credit (see Table 1). It is clear that NGOs can successfully play this role, which complements that of government.

Given the impacts achieved so far, and the need to enhance benefits from the limited fisheries resources of Bangladesh by increasing production and ensuring that some of those benefits go to poor people, major changes are needed in MOL's attitude to and policies for fishery management. This would enable NGOs to work in a wider range of waterbodies and fishing communities, to demonstrate the benefits of management by those communities when supported by NGOs.

Acknowledgements

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Direct Management of Oxbow Lake Fisheries by Government Officers Employing Fishers' Groups on a Catch-share Basis

MD. ABDUS SATTAR and MD. NAZMUL HUDA KHAN
Oxbow Lakes Small Scale Fishermen Project, Phase I, Department of Fisheries
Matshya Bhaban, Arabpur, Jessore, Bangladesh

SATTAR, M.A. and **M.N.H. KHAN.** 1999. Direct management of oxbow lake fisheries by government officers employing fishers' groups on a catch-share basis, p. 259–261. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Six oxbow lakes in Bangladesh are managed directly by the Department of Fisheries, employing the fishers on a 40% catch-share basis. Three-year average carp yield was 361 kg/ha. Three-year average carp sale was Tk 10 627/ha, three-year average market price was Tk 29.4/kg and three-year average annual income per fisher was Tk 5 648 (1993–1996).

Introduction

The Oxbow Lakes Small Scale Fishermen Project, First Phase (OLP I), started in 1978 with funding support from the World Bank, and was completed in 1985. The six oxbow lakes (*baors*) under OLP I were in Jessore, Jhenaidah and Chuadanga districts in southwestern Bangladesh, and included some of the largest oxbow lakes in the country. All six oxbow lakes were retained as a "completed project" by the Department of Fisheries (DOF) and have continued under direct management by government officers, so-called baor managers.

The baor manager and his staff work in cooperation with a group of registered fishers. The number of fishers is fixed for each lake, and both DOF and the registered fishers resist increasing that number on the grounds that income per fisher may become too low. DOF bears all the costs of fingerling stocking, guarding and marketing, while the fishers provide boats, nets and other fishing equipment, and maintain the brush parks in the lakes (*komors*). The fishers do not receive any credit from the government or any NGO.

The baor manager decides when and how to stock the lake with carp fingerlings of different species, and when fish should be harvested; the fishers are responsible for fishing only. A large part of the carps harvested from the lake is sold at government-fixed prices to Bangladesh Fisheries Development Corporation, which trucks the fish to Dhaka, while the remainder is sold by the baor manager directly to local traders.

The catch is divided 60:40 between the Revenue Department of the Government of Bangladesh (for cost recovery) and the fishers' group (for their labor and for maintaining the fishing equipment). The fishers actually receive 40% of the recorded sale proceeds rather than marketing their share of the catch themselves.

Materials and methods

The lake area is as recorded in the handover documents to DOF; the number of fishers is as registered for each of the lakes.

Data on carp yield and carp sale were obtained for the three seasons 1993–1994, 1994–1995 and 1995–1996. Carp catches were recorded daily at the landing complex by the baor manager, who is also responsible for selling the carps. Average carp selling price for each lake in each year was calculated from total carp yield and total sales value.

Income per fisher from carp fishing was calculated as 40% of the recorded sales value of the carp from each baor, divided by the number of registered fishers.

Table 1. Lake area, number of fishers and recorded fish yields of the six lakes of OLP I under direct management of DOF.

Lake	Area	Fishers		Average fish yield (kg/ha)		
	(ha)	(no.)	(no./ha)	1993–1994	1994–1995	1995–1996
Baluhar	282	214	0.8	709	447	461
Joydia	189	136	0.7	434	450	582
Fatepur	47	50	1.1	255	277	596
Morjad	253	120	0.5	162	126	180
Bergobindopur	217	175	0.8	576	184	461
Kathgora	71	47	0.7	282	169	141
Average	177	124	0.7	403	275	403
Coeff. var. (%)	54.7	54.0	25.8	52.0	51.7	48.9

Table 2. Total recorded fish sale and calculated fishers' annual income based on a 40% catch share.

Lake	Total fish sale (Tk million)			Calculated income per fisher (Tk)		
	1993–1994	1994–1995	1995–1996	1993–1994	1994–1995	1995–1996
Baluhar	5.4	3.5	5.6	10 093	6 542	10 467
Joydia	2.3	2.4	2.7	6 765	7 059	7 941
Fatepur	0.3	0.3	0.9	2 400	2 400	7 200
Morjad	1.0	1.0	1.2	3 333	3 333	4 000
Bergobindopur	3.5	1.1	3.0	8 000	2 514	6 857
Kathgora	0.8	0.4	0.3	6 809	3 404	2 553
Average	2.2	1.5	2.3	6 233	4 209	6 503
Coeff. var. (%)	87.8	86.4	84.7	46.4	48.8	43.6

Results

Lake areas range from 47 to 282 ha. The number of fishers ranges from 0.5 to 1.1 fisher/ha, with an average of 0.7. The highest recorded carp production (709 kg/ha) was recorded in Baluhar Lake in 1993–1994 and the lowest (126 kg/ha) in Morjad Lake in 1994–1995. Average carp yield for the three years was 361 kg/ha (Table 1).

Sales proceeds from all six lakes combined, as recorded by the Government of Bangladesh, were Tk 13.3 million in 1993–1994, Tk 8.7 million in 1994–1995 and Tk 13.7 million in 1995–1996. The 3-year average carp selling price for all species combined was Tk 29.4 kg.

The highest annual income per fisher was Tk 10 467 in Baluhar Lake in 1995–1996 and the lowest Tk 2 400 in Fatepur Lake in both 1993–1994 and 1994–1995. The 3-year average annual income was Tk 5 648 per fisher (Table 2).

Discussion

Direct management of the six oxbow lakes by DOF in cooperation with fishers' groups has increased fish production of the lakes. Before project intervention started in 1978, average fish production in oxbow lakes was estimated at 80 kg/ha, compared with the 3-year average of 361 kg/ha in this study. Carp yields per hectare are actually higher than calculated, because the water areas of the oxbow lakes are less than the officially recorded areas.

Further, direct management has provided employment security to 742 fishers' households, whereby one of the sons "inherits" registered membership of the fishers' group. The registered fishers, apart from receiving their 40% share of the carp catch, are also the only fishers allowed to catch non-stocked wild fish. A proper study is needed to estimate yield and income from wild fish in oxbow lakes (Haque et al., this vol.).

Given the high demand for fish in Bangladesh, total income from sale of carp could be increased by marketing them through open auction, rather than largely through BFDC as at present.

Baor managers are often under pressure to donate fish to local "musclemen" (*mastaans*), provide employment opportunities (for example to guard the baors) or make financial contributions to

local politicians. Both small-scale poaching of fish by people living around the lakes and mass poaching by local gangs are common. Mass poaching also used to be a major problem in other oxbow lakes under OLP II, but largely disappeared after the number of registered fishers was increased (Apu et al., this vol.).

Acknowledgements

The six lakes under OLP I are at present managed by DOF through the Project Implementation Unit of the second phase of the project (OLP II).

Cage Aquaculture in Bangladesh: Social Issues Relating to Successful Expansion

MARK J. IRELAND
CAGES, CARE-International, PO Box 226, Dhaka-1000, Bangladesh

IRELAND, M.J. 1999. Cage aquaculture in Bangladesh: social issues relating to successful expansion, p. 263–269. *In* H.A.J. Middendorp, P.M. Thompson and R.S. Pomeroy (eds.) Sustainable inland fisheries management in Bangladesh. ICLARM Conf. Proc. 58, 280 p.

Abstract

Cage aquaculture is a relatively new technology in Bangladesh. While there are technical problems, the way in which cage aquaculture is accepted in the surrounding social environment is critical for its long-term sustainability. Trials with cages managed by groups of landless women have shown this to be a way of improving their production systems. But cages are vulnerable to damage, making group cohesion important. In four out of 13 cage trials, there were conflicts either within groups or with outsiders, of which the most important is related to access rights to the cages. In the longer term, policies to regulate cage aquaculture may need to be developed, especially to enable poor people to retain cage sites.

Introduction

The introduction of non-traditional agricultural or aquacultural technologies to a new country or region is often complicated and risky. Factors that determine the effectiveness and sustainability of a new intervention are multi-faceted. Efforts to understand these factors and the issues underlying them are vital for better development and targeting of the intervention. A proposed technology may be sound, but may not be taken up by target communities because of cultural taboos. For example, in Bangladesh fish farmers are reluctant to deliberately use human excrement as a fertilizer for their ponds. Even when a technology has no taboos attached, to be successful it needs to be accepted into the farming system, and the level of returns must be sufficient *vis-a-vis* risk and opportunity cost.

For the successful development of cage aquaculture in Bangladesh, factors apart from the technical issues have to be carefully considered by agencies wanting to develop and expand this system of fish culture in openwaters. While issues relating to feed, net, species and other technical management issues are important, the way in which cage aquaculture is accepted in the surrounding social environment has been found in this case study to be critical for the long-term sustainability and spread of the technology.

Cage aquaculture is not a traditional form of fish culture in Bangladesh. Recent research efforts have been spurred by the belief that cage culture could have a significant impact on aquaculture production (Golder et al. 1996), and on the nutritional standards of family members if managed by women (Gregory and Kamp 1996). In openwater fisheries there are practices similar to those used in cage aquaculture. In the *haor* basin of Sylhet, fishers hold catches of *Channa* spp. in small bamboo cages for periods of several weeks. In *kata* fishing, feed is used to attract fish to a brush shelter which is then enclosed using a bamboo fence or seine net (MacGrory and Williams 1996). Ideas have been developed from these practices for use in introducing cage aquaculture management concepts to communities (CAGES 1997).

Around the city of Rangpur and the town of Parbatipur in northwest Bangladesh, on-farm experiments with small-scale cage aquaculture started in 1991 and have continued in some form up to the present. It is these experiences from the sites of the Northwest Fisheries Extension Project (NFEP) in the Kakra River, Chiribandar, and ponds around Parbatipur; and from ponds

around Rangpur in the CARE–Rangpur pilot project, together with current lessons from CARE's CAGES project in Gazaria and Sonagaon thanas (about 35 km east of Dhaka), that form the basis of this paper.

The paper presents some of the findings to date regarding households' capability to manage local conflicts involving cage aquaculture and to continue their fish farming enterprises. The aim is to inform institutions and organizations supporting the development and spread of cage aquaculture, under the umbrella of a sustainable fisheries management program, of issues to be considered concerning stakeholders in communities around waterbodies where cage aquaculture may be planned and implemented.

Social issues

The focus in developing cage aquaculture in Bangladesh has been on adapting techniques commonly used in other Asian countries. The technology has been explored recently through NFEP and CARE projects that are committed to working with poor and vulnerable groups. The rationale is that small-scale cage aquaculture presents opportunities to poor households, which do not own ponds or rice fields, to start fish farming activities in waterbodies beside their homesteads. Aside from the need to develop appropriate cage aquaculture management skills, experience has shown that an understanding of the dynamics of the local social context is important to manage the development of cage aquaculture successfully.

Incorporating cage aquaculture into livelihood strategies, and gender issues

If only the technical issues in the development of cage aquaculture, and issues regarding credit, are considered, the wider context faced by project participants would be ignored. It is important to recognize that households manage a *portfolio* of interests and that there are therefore competing demands upon their labor, capital and time (Lewis et al. 1996).

In the Rangpur trials, women were seen to be very capable of managing their cages and introducing better production methods. Management of a small cage situated near the homestead fits well into the household livestock production system. Gregory and Kamp (1996) found that women participants saw their cage as a "bank account" into which daily savings could be deposited (perhaps Tk 2 [US$0.05] spent on feed), and from which food or cash from sales could be regularly withdrawn depending on household needs. The women learnt very quickly from each other about which species and feeds to use, and were a support to each other for security when working and in resisting pressure from male family members wanting to take over the enterprise.

Where the group of participants in a village is of both sexes (or where all-female groups lack cohesion), roles are different. Women are often involved only in feed preparation and sometimes feeding, while the male relatives do most of the feeding, guard the cage and market the produce outside the village area. Women lose control over the activity and over the decision whether the outputs (in terms of fish) are used for home consumption or sale. Interest in the activity by the women involved may wane and, if this is the case, the opportunity to take advantage of rearing fish in cages as an appropriate activity for women (like the rearing of other livestock at the homestead) will be lost.

Working with groups

Cages are vulnerable to damage by outside parties. In three out of four villages where there were unresolved conflicts between cage operators and other water users, the result was damage to a cage and/or the fish stock (see Table 1). The damage may be deliberate (carried out by jealous neighbors, fishers who feel that the cages are impinging on their fishing grounds, others who feel that their rights to water resource use are being affected, or individuals intent on stealing fish); or accidental (caused by over-curious adults or children). Therefore there is value for poor participants in being part of a mutually supportive and watchful group of fish farmers. This is important when working with those who have less power in the community.

Firstly, safeguarding cages in a group adds greater security where individuals lack personal power and influence or the money to hire extra security.

Secondly, because cages are very visible, farmer-to-farmer learning can be very rapid. Cages have the advantage of being small, so it is easy to observe the fish and monitor their growth. In ponds this is more difficult. Participants in all the sites where cage aquaculture has been tested quickly learnt, by comparing the groups' experience, which species and feeds were more economic. There is an indication that farmer-to-farmer learning may be faster in all-women groups; observations in Noagaon have shown some predominately male groups to be competitive (Islam 1997). Intra-group rivalry is reflected by, for example, a case where one participant secretly adopted feeding techniques to make his fish grow faster; he knew that if he worked very early in the morning, few people would observe his innovation. Lack of cohesiveness is also indicated when damage is inflicted on another member's cage due to jealousy of success or of perceived favor from the extension worker. In Kakra River, one motivated woman received more fish on credit than others in the group; subsequently her cage net was cut, allowing fish to escape.

Effects of inter-community conflicts on cage management

The following examples describe two of the cause–effect relationships highlighted in Table 1. The effect of longstanding distrust or disputes between communities is reflected in participants' decisions relating to cage management. This is particularly conspicuous when the site for the cage

Table 1. Source and result of conflicts faced by 13 groups growing fish in cages.

Site	Waterbody	Group composition	Wealth	Source and type of conflict				
				Fishers	Intragroup	Neighbors	Theft/damage to cage	Sustainable access
NFEP sites in Parbatipur								
American Camp	Pond	All f	Landless			Yes	Yes	
Kakra River	River	All f	Landless	Yes	Yes		Yes	
College campus	Pond	All f	Landless					
Kholahati	Pond	All f	Landless					
Monmothpur	Pond	All f	Landless					
CARE Rangpur sites								
Dorsons	Pond	All f	Landless					
Jolkhor	Pond	All f	Landless					
Mohabat	Pond	All f	Landless					
Uttam Barobari	Pond	All f	Landless			Yes		Yes
CAGES sites east of Dhaka								
Rasulpur, Gazaria	River	29% f 71% m	Landless and marginal			Yes	Yes	
Nutun Boisar Char, Gazaria	River	31% f 69% m	Landless and marginal					
Noagoan, Sonagaon	River	9% f 91% m	Landless and marginal					
Nutun Char, Sonagaon	River	31% f 69% m	Landless and marginal					
Sites experiencing social problems while practicing cage aquaculture (%)				8%	8%	23%	23%	8%

f: female, m: male.
Data compiled from CAGES (1997), Gregory and Kamp (1996) and Morrice (1993, 1994 and 1995)

is being chosen. In a small Hindu community in Rusulpur, where CAGES participants were surrounded by Muslim neighbors, the CAGES participants were reluctant to move their cages further into the river, and thus away from perceived safety, as water levels fell. They feared that their cages would be damaged (as opposed to fish being stolen) by Muslim neighbors as part of ongoing small-scale conflicts between the communities. Participants felt that boats would be "accidentally" driven close to the cages, damaging them. Therefore fish were kept in less than ideal conditions, in very shallow water, closer to the homestead. But keeping cages close to the house of the operator still did not protect the fish from being stolen.

Villagers excluded from programs can also cause problems. Inputs provided on credit, in kind or free are perceived as "relief" that a minority are benefiting from. Again this can lead to the cutting of nets. In the American Camp in Parbatipur, sampling (where the fish are in public view for some time) exacerbated the situation: one night following a sampling session, the nets were cut. These problems could be dealt with through a more transparent participant selection procedure, and by creating opportunities to raise awareness about the activity in the wider community.

Property rights and regulation

Tenure and access issues

Establishing access to use a water resource in Bangladesh can be complicated and difficult. In their study of access patterns to fisheries, MacGrory and Williams (1996) reported that in waterbodies leased from the government, disputes between fishers and leaseholders relate mainly to the access fee. Cage aquaculture is different as it is culture based rather than part of the capture fishery, although it may be located within a river or beel, and as such does not compete for scarce openwater fish resources.

If cage aquaculture is developed and promoted as an activity for poor rural households, the question of how this less powerful group can secure and maintain access to the waterbody neighboring their homesteads is probably the most important issue for successful expansion of cage aquaculture, after determining economically viable feeding strategies.

Participants growing fish in cages are generally capable, either as individuals or as groups, of solving minor conflicts within their peer group regarding their cages. A discussion with boat owners can result in either cages being moved away from the village *ghat* (boat landing) or boats taking a wider berth. Conflicts can affect participants through either physically preventing setting of a cage or disrupting a cycle of culture by threatening to damage or actually damaging the cage or the stock. The latter threat can effectively exclude participants.

The experience of a group in Uttam Barobari (Rangpur) demonstrates how a group of cage operators can be powerless against the will of a more powerful group. Jealousy developed between the group culturing fish in cages and another nearby *para* (neighborhood within a village). When the leasehold changed hands, the cage operators were told to remove their cages from the oxbow lake. The operators were surprised, as they had had no problems with the previous leaseholder. It transpired that villagers in the neighboring *para* had reported that the operators were taking fish from the waterbody for stocking the cages. The opposite was true: cage owners lost fingerlings during stocking and harvesting; they also believed that feed falling through the cage would benefit the fish outside it. The NGOs involved tried to support the group by lengthy lobbying of the new leaseholder, but with no effect. This example clearly shows how difficult it can be for the poor, less powerful cage owner to sustain access to part of a leased closed waterbody. So far, cage operators in openwater trials around Parbatipur and CAGES sites near Gazaria have not faced the same problem. While NGOs and other organizations involved in extension have an important advocacy role to play in supporting operator groups, the example cited above shows that they will not always be successful.

Access to a water resource for cage aquaculture, though initially apparently quite easy for poor households, can prove difficult to sustain, especially in smaller leased waterbodies. When the leasehold changes, access can be terminated overnight. Solving conflicts or misunderstanding between groups using what is often a common water

resource is important, but arrangements made on an individual or informal basis may not be sustainable if there is no specification of the rights of the cage owners within the framework of overall property rights to the water resource and fishery. This is particularly important where the water resource in which cages are located is leased through auction, and so the leasehold is subject to change.

Government roles in regulation of cage aquaculture

So far in this paper, the role of the government has not been mentioned. In the New Fisheries Management Policy (NFMP) and various community based fisheries management projects, cage aquaculture has been an unconsidered or small component. While currently there is no pressing need for government to have a policy on regulation of cage aquaculture, the time may come when the existing *ad hoc* system of seeking and granting permission for cage culture needs to be reviewed. Permission for setting cages has been granted by the Department of Fisheries through either the local deputy commissioner and district fisheries officer or directly from Dhaka. Under Oxbow Lakes Projects I and II in Jessore and the Kaptai Lake development plan of Bangladesh Fisheries Development Corporation, provision for cage culture has been incorporated in the project planning process.

There is also a risk that initial agreements may be disregarded when personnel change. The NFEP, working with groups formed by RDRS (Rangpur Dinajpur Rural Services—an NGO) with cages in canals leading from the Tista barrage, had to remove all the cages after the engineer responsible for the canal was transferred (Barman, pers. comm.). The incoming engineer saw the cages as a threat to water movement in the canal rather than an opportunity to take a more holistic approach to maximizing use of the water resources in the canal system.

Regulation and licensing to permit cage culture could be revised in several ways. Areas could be sub-leased for cage culture under the existing *jalmohals* (leaseholds) or NFMP system; individual cages could be licensed; or regulations on the location of cage sites could be developed (i.e., zoning). However, what is apparent is that any system will have to take account of the communities involved in cage aquaculture. Any system that sets out to regulate or license in a way that is unrealistic will fail, given the climate of corruption that mitigates against the enforcement of many existing laws and the traditional patterns of access to common water resources. A positive initiative would be one that seeks the involvement of communities, the government, and non-government agencies that are working for sustainable growth and development of cage aquaculture in the country.

Experiences from other countries

Cage aquaculture is still very much in a developmental stage in Bangladesh; its viability on a large scale still has to be proven. It is opportune to look at the experiences of other countries to learn before expanding cage culture in Bangladesh. Examples in Beveridge (1987) from around the world indicate that cages anywhere are highly vulnerable to poaching and vandalism, which may be such a problem as to preclude their use in certain parts of the world. As cage culture expands, social conflicts affect more people. The two biggest social problems seen in the Philippines—disruption to traditional navigation lanes and fishing grounds (IIRR 1995)—have been experienced in Bangladesh to a lesser extent. Additional social disruption is caused through the collapse of cage culture businesses. In the Philippines, the bankruptcy of small cage farmers, often through losses caused by environmental degradation, has led to the dislocation of the families involved.

Conclusions and recommendations

Summary and conclusions

Experience to date has indicated that development of cage aquaculture in Bangladesh will face problems due to conflicts between interest groups. In most cases, these problems can be solved. The potential for conflict does present risks, so additional costs need to be factored into analysis of the costs and benefits of this activity.

Aquaculture in general, as with other livestock enterprises, is inherently risky. One of the objectives of agencies currently promoting the technology in Bangladesh is to look at both technological and social development strategies to minimize this risk.

An ongoing strategy to further improve the chances of success, that has been adopted by NFEP (with RDRS groups) and CAGES, is to work with already existing groups. These groups, with their support mechanisms, seem to have the potential to generate more solutions to the problems discussed in this paper. Groups that have been brought together at the behest of an extension project, and whose only link is that they live near each other, tend not to support each other in (for example) guarding fish and sharing their learning. Instead NGO-supported village groups, fishing cooperatives/groups, and other village groupings or clubs, which are actively working for self-development and have access to credit, can be supported to develop cage aquaculture in the water resources close to their homesteads.

Before starting cage aquaculture, it is important to understand the way the water resource is used. When establishing the right to put a cage in a waterbody, cage groups will need to negotiate with whoever effectively controls "access" to the waterbody, and other key resource users. This could be the owner, leaseholder or sub-lessee of a river or pond. They should also negotiate with other water users, (boat operators, kata owners and other fishers) when planning the placement of the cages. In the long term, if the technology is taken up on a wide scale, there could be an increasing trend for the best cage aquaculture sites to be taken over by richer, more powerful parties. This trend is seen in many openwater fisheries in Bangladesh where traditional fishers and methods of management are forced out by incoming fishers and agents from other areas, who adopt practices that lead towards maximum returns from the resource in the short term.

This attitude of "short termism" may apply if cage aquaculture proves a viable technology for rural households in Bangladesh. As cage aquaculture spreads, the areas most suited for it may come under pressure from the numbers of cages placed there. These areas will become centers of conflict, within and between communities. As individuals and groups position themselves to take advantage of a new opportunity, community or policy level mechanisms to regulate the expansion will be needed. This may include (for example in Kaptai Lake) some form of zoning of areas for different activities, the zones being agreed among stakeholders within the community.

Areas for future study

During the next few years, studies into the following areas would inform the debate on support and regulation of cage operators:

- effectiveness of resource-poor cage operators in maintaining access to community waterbodies;
- effect of the density of cages in an area of waterbody on the level of conflict between cage operators and others in the community;
- community mechanisms for regulating the number of cages in a waterbody;
- household decisionmaking in the management of small-scale cage aquaculture;
- effect of environmental impacts of cage aquaculture on communities; and
- how regulatory and licensing bodies view cage aquaculture in the context of existing legislation.

Lessons from such studies will help to develop awareness among policymakers in government and NGOs of the issues involved when cage aquaculture is incorporated into community based fisheries management strategies. It should be remembered that there is some way to go before cage aquaculture is adapted to socioeconomic conditions in Bangladesh. It is important at this stage for the organizations involved to collect data that could inform a process for managing cage aquaculture in the inland fisheries in the future.

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APPENDIX I

Sustainable Inland Fisheries Management in Bangladesh: Workshop Recommendations

Introduction

Each day during the workshop, four working groups discussed successes and failures in making inland fisheries management sustainable. Emphasis was on reaching agreement on practical and realistic recommendations for implementation in the near future. The four working groups addressed five policy areas: research; development; fishery tenure and access; legal framework; and institutional strengthening (one group covered both "fishery tenure and access" and "legal framework"). Each had a facilitator and a chairperson/presenter selected by its members. "Card storming" exercises were used to identify specific problems and lessons, and make recommendations based on them. The aim was for participants over a 3-day period to develop recommendations that reflected a consensus and were "owned" by the participants.

In his opening address, the Secretary of the Ministry of Fisheries and Livestock, Government of Bangladesh, asked that special attention be given to the following issues, which are of immediate policy concern to the government:

- appropriate technology (e.g., sanctuaries, stocking, biological management);
- institutional arrangements (e.g., government–NGO–donor) for sustainable participation;
- delivery of inputs (e.g., training packages, credit, fingerlings, disease control);
- legal framework (e.g., tenure, fisher group status, government regulations); and
- enabling environment (e.g., private sector/fishers/entrepreneurs).

Based on recommendations made by the working groups and in subsequent plenary discussions, a summary of the most important working group recommendations was compiled (see below). That list is followed by recommendations for each of five policy areas, presented in detail. The text of the final recommendations was drafted jointly by the working group facilitators and chairpersons, based on the wording presented in the plenary sessions. This text was published and circulated in Bangladesh immediately after the workshop, and is reproduced here with minor editorial improvements.

A new National Policy on Fisheries in Bangladesh was being drafted at the time of the workshop, and the workshop was intended to feed experience and ideas from a wide range of organizations and perspectives into the policy formulation process. The policy was finalized and approved by the Cabinet of the Government of Bangladesh in 1998.

Summary of recommendations for a general sector policy for inland fisheries (excluding private waters)

Any policy statement should cover the following key points:

1. The Ministry of Fisheries and Livestock (MOFL)/Department of Fisheries (DOF) should take the lead in developing a sector

policy for sustainable inland fisheries through a participatory approach with all involved, including fishers.

2. The primary use of wetlands and inland waterbodies should be for fisheries exploitation, with the aim of poverty alleviation rather than revenue collection.

3. Sub-sector policies should be defined for the various types of inland waters, i.e., baors, beels, rivers, floodplains, etc. Legislation should give preference to community management, and define provisions of fishery tenure for community management for all types of inland waters, distinguishing between types as necessary:
   a) Smaller waterbodies, such as semi-closed waterbodies, where culture based management is feasible, should be handed over and managed by the organized fishers involved (community fisheries management).
   b) For larger openwaters and flowing rivers, development of appropriate systems for community participation and co-management is still underway, but where fishing communities are organized, the same principles as for smaller waterbodies should apply.

4. Long-term security of tenure for fishers should be embedded in a legal framework, with specified transfer procedures under DOF supervision. Handover of any inland waterbody should be either directly from MOL to an organized fisher group/community or through a tripartite agreement between MOL, the fisher community and DOF.

5. The fisheries sector policy should clearly indicate strategies for the cooperation of MOFL/DOF with NGOs and the private sector. The roles of government, NGOs, fisher associations, the private sector, and international institutions in inland fisheries should be clearly defined.

6. Measures for habitat protection and restoration should aim at maintaining the remaining wetlands of Bangladesh and their biodiversity. Discharge of chemicals harmful to aquatic life should be banned.

7. Timely availability of quality fingerlings should be ensured through the private sector, from genetically pure broodstock fish obtained from government broodstock farms. Hatchery techniques and marketing practices in the private sector should be improved by providing training and other necessary inputs.

8. Micro-credit for the inland fisheries sector should be provided at low interest rates without the requirement of collateral.

9. An openwater fisheries research and monitoring policy should be drawn up to direct research and data collection to support the needs of the overall national policy and the fishers.

Recommendations on research policy in inland fisheries

Biodiversity and the environment

1. Research is proposed to develop sustainability indicators for incorporation in environmental impact assessment checklists for planning interventions and management, and for monitoring impacts on fisheries and wetlands.

2. Baseline studies of the distribution and abundance of fish and prawn species should be undertaken to determine which are vulnerable or endangered. The biology and ecology of these species should be studied to develop conservation measures to protect biodiversity.

3. Studies should be carried out on the impact of water pollution and other anthropogenic activities, particularly embankments and other infrastructure works, on fish migration and reproduction.

4. Detailed experiments should be undertaken to determine the effect of stocking and the introduction of any species not at present occurring within a region of the country, in accordance with the FAO code of conduct.

Appropriate technology development and transfer

1. Research needs for appropriate technologies in inland fisheries should be determined through consultation and participation of research institutes, government departments, NGOs and fishers.

2. Before dissemination to fishing communities, technologies should be tested by different stakeholders in various ecological regions to determine their sustainability, economic viability and acceptability.

Socioeconomic factors

1. The livelihood strategies of fishing communities in different environments should be investigated in detail, with attention to gender-specific roles and strategies, in order to understand the full impacts (including distributional impacts) of interventions affecting fisheries.

2. Community participation should be supported by research to determine the relative costs and benefits of participatory projects, and thereby develop cost-effective models and strategies.

3. Local fishery knowledge and practices of traditional fishers should be documented, studied and used to guide preparation of fishery interventions and management plans.

Strengthening of research capability

1. Research capability through advanced training in Bangladesh and abroad should be built up by studies in line with national fisheries priorities.

2. Adequate infrastructure, funds and staff should be provided to strengthen existing research institutions, but without spreading resources too thinly.

Recommendations on development policy in inland fisheries

Role of DOF in inland fisheries management

1. MOFL/DOF should take the lead in developing a sector policy for sustainable inland fisheries through a participatory approach with all involved, including fishers.

2. Sustainable management of inland fisheries should be ensured by giving DOF stewardship of all fisheries and the wetland environment, including approval procedures for construction of water control structures and fishpasses by other agencies.

3. To give fisher communities an incentive to cooperate and invest to enhance fish yields, and to develop group entrepreneurship, natural water resources should be identified, and fishing rights subsequently transferred to these groups.

Role of NGOs in community based inland fisheries development

1. NGO interventions in community based fisheries management should follow a definite action plan and be limited in time.

2. Identification of fishers (including landless and poor farmers) by NGOs should be followed by formation of functional groups. NGOs should provide training to fisher groups to enable them to manage the fisheries resource in an economically and environmentally sustainable manner.

3. Credit support should be provided by NGOs at low rates of interest in line with current savings rates.

4. For sustainable management, NGOs should aim at transferring all responsibilities to fisher groups or other people's organizations that are legal entities (for example under the Societies Registration Act).

Technology development and transfer (TDT)

1. All fisheries-enhancement technology should be extended to fishers through demonstrations and training by MOFL/DOF, NGOs, fisher associations and others (as appropriate).

2. TDT requires continuous research and development as well as regular and repetitive training at various levels (i.e., government officers, NGO workers, fishers, fishers' wives, etc.).

3. Apart from technical fisheries training, awareness programs on wetland conservation and fish biodiversity, as well as on legal issues related to security of tenure and fishing rights, should be introduced.

4. Groups should be trained by DOF in appropriate fisheries management and be facilitated by an appropriate organization (e.g., NGO, fisher association).

Recommendations on policy for fisheries tenure and access

User access rights under new legislation should include the following provisions:

1. Fishers' security of tenure and right of access to waterbodies should be ensured through legislation, with specified transfer procedures under DOF supervision. Long-term user rights should be given to organized groups that have submitted management plans; such rights would be for not less than 10 years per term, and renewable.

2. Identification, formation and recognition of user groups should be undertaken with community participation and by involving DOF, NGOs and the relevant jalmohal committee. Access rights should target groups that include poor active fishers, poor people from surrounding villages, and destitute women from the area.

3. Handover of any inland waterbody by MOL should be directly to organized fisher groups/ communities, or through a tripartite agreement between MOL, the fisher community and DOF.

4. Lease fees for community managed waterbodies handed over under the proposed legislation should be at flat rates per hectare. An expert committee should decide on the lease rate for each type of waterbody.

5. Waterbody area should be delimited on maps and demarcated by reference pillars on the ground by the land administration (i.e., the zonal settlement officer) before handover to the fisheries management group.

6. User groups should gain use rights on condition of payment of revenue and preparation of a management plan for the waterbody. This plan should be prepared by the users in consultation with and following the advice of DOF and relevant NGOs or other organizations facilitating group formation. Management plans and their implementation should be checked/ validated by a district-level committee strengthened with NGO representatives.

7. Management plans should cover:

   a) access regulations to avoid over-exploitation of the fishery and any other natural resources within its boundary;
   b) a conservation and enhancement plan for the fishery, with associated rules, and;
   c) a revenue collection plan.

8. Any claims to a waterbody should be resolved through a clear procedure before handover of the waterbody for community management.

Recommendations on policy for the legal framework in inland fisheries

1. The Protection and Conservation of Fish Act, 1950, should be re-examined and redrafted such that:

   a) international commitments signed by the Government of Bangladesh should be translated

into appropriate laws and rules for Bangladesh fisheries, and implemented accordingly;
b) "common property fisheries" should be legally recognized;
c) communities can set location-specific gear and season limits on fishing through approved management plans. Sale and possession of current (nylon monofilament) nets should be banned;
d) new fish species may not be introduced to the country unless they have been shown to have no adverse impact on the indigenous fishery. There should be strict quarantine for all imported fish, and;
e) a statutory authority should be established to authorize fish introductions and maintain strict control of quarantine facilities (which should be developed).

2. Greater compliance with fish conservation rules and laws should be achieved through:

   a) greater effort in raising awareness among fishing communities of the underlying reasons for fishing restrictions;
   b) provision of training in fisheries laws and rules for government and NGO staff, and;
   c) measures to make government officers accountable for timely execution of conservation measures.

3. There should be a legislative ban on possession of chemicals harmful to fish and other aquatic life, complemented by measures to encourage organic farming.

Recommendations on institutional strengthening of the agencies involved in inland fisheries

MOFL/DOF should take the lead in developing a sector policy for sustainable inland fisheries through a participatory approach with all involved, including fishers. The fisheries sector policy should clearly indicate strategies for cooperation with NGOs and the private sector. It should include at least the following elements:

1. The roles of government, NGOs, fisher associations, and private and international institutions in inland fisheries should be clearly defined.

2. Participation of key stakeholders in inland fisheries development activities should be ensured. Women should be specifically targeted, with clearly defined rights of access to *khas* (public) resources (such as fish ponds on khas land).

3. There should be active promotion of equitable local fishers' groups with clearly defined fishing rights and guided by their own by-laws. The legal status of fishers' groups should be ensured, for example by registration (immediate) and through legislation (long term).

4. Banks and NGOs should be designated for delivery of credit to fishers. NGOs should separate their credit operations from other services such as technical, legal and gender-awareness training.

5. Conflicts over resource use should be democratically resolved through locally elected institutions.

6. Representation of fisheries interests in national water sector planning (for example by the Water Resource Planning Organization) should be strengthened, with government, NGOs and fishers represented.

7. In order to take the lead role in inland fisheries development and to ensure environmentally sustainable fisheries enhancements, MOFL/DOF should have a clear overview of all activities and results of related activities by NGOs and projects. To achieve this, monitoring and evaluation capabilities within MOFL/DOF should be improved.

8. Future government fisheries projects should be implemented through existing DOF organizational structures, wherever applicable, rather than through temporary project implementation units.

APPENDIX 2

National Workshop on Policy for Sustainable Inland Fisheries Management: List of Participants

Organization	Name	Designation	Address (Bangladesh unless otherwise stated)
Ministry of Fisheries and Livestock	Mr Satish Chandra Roy	State Minister	Bangladesh Secretariat, Dhaka
	Mr Md Irshadul Haq	Secretary	Bangladesh Secretariat, Dhaka
	Mr B.A. Khan	Joint Secretary	Bangladesh Secretariat, Dhaka
	Mr M.A. Wahab	Deputy Secretary	Bangladesh Secretariat, Dhaka
	Mr S. Ataur Rahman	Private Secretary to State Minister	Bangladesh Secretariat, Dhaka
	Mr A.F.M. Aminul Islam	Public Relations Officer	Bangladesh Secretariat, Dhaka
Ministry of Land	Mr S.M. Mojibur Rahman	Joint Secretary	Bangladesh Secretariat, Dhaka
	Mr Md Ibrahim Khan	Deputy Secretary	Bangladesh Secretariat, Dhaka
	Ms Dilruba Begum	Agricultural Economist	Bangladesh Secretariat, Dhaka
	Mr Sawpan Kumar Sarker	Senior Assistant Secretary	Bangladesh Secretariat, Dhaka
Ministry of Environment and Forest	Dr Mahfuzul Haque	Senior Assistant Secretary	Bangladesh Secretariat, Dhaka
Planning Commission	Mr Abdus Sattar	Joint Chief	Shere Bangla Nagar, Dhaka 1207
Information, Monitoring and Evaluation Department, Ministry of Planning	Mr Jahirul Haque	Deputy Director	Shere Bangla Nagar, Dhaka 1207
Department of Fisheries	Mr Md Liaquat Ali	Director General	Matshya Bhaban, Ramna, Dhaka 1000
	Mr Md Nasiruddin Ahmed	Director (Inland)	Matshya Bhaban, Ramna, Dhaka 1000
	Mr Md Nazrul Islam	Deputy Director	Matshya Bhaban, Ramna, Dhaka 1000
	Mr S.I. Khan	Project Director	Matshya Bhaban, Ramna, Dhaka 1000
	Mr Md Abdul Matin	Principal Scientific Officer	Matshya Bhaban, Ramna, Dhaka 1000
	Mr Siddiqur Rahman	Deputy Director	Matshya Bhaban, Ramna, Dhaka 1000
	Mr Md Tabibur Rahman	Deputy Director	Department of Fisheries, Khulna
	Mr C.K. Shikder	Deputy Director	Department of Fisheries, Barisal
	Mr Delwar Hossain Choudhury	Project Director	Patuakhali Barguna Aquaculture Extension Project, Patuakhali
	Mr Md Zahirul Islam	Deputy Director	Matshya Bhaban, Ramna, Dhaka 1000
	Mr Kanok Barua	Deputy Director	Fisheries Information, Khamarbari, Dhaka
	Mr Md Aminul Islam	Information Officer	Fisheries Information, Khamarbari, Dhaka

Organization	Name	Designation	Address (Bangladesh unless otherwise stated)
Department of Fisheries (OLP II)	Mr Md Abdus Satter	Project Director	Beel and Baor Fisheries Project, Jessore
	Mr Md Abdus Satter	Assistant Director (Extension)	Beel and Baor Fisheries Project, Jessore
	Mr Md Oliur Rahman	Assistant Director (Monitoring and Evaluation)	Beel and Baor Fisheries Project, Jessore
	Mr Md Abdus Sattar	District Fisheries Officer	Department of Fisheries, Jessore
	Mr Sirajul Islam	District Fisheries Officer	Department of Fisheries, Jhenaidah
	Mr Hasanuzzaman Chowdhury	District Fisheries Officer	Department of Fisheries, Chuadanga
	Mr Ashraf Ali Sheikh	District Fisheries Officer	Department of Fisheries, Kushtia
	Mr A.S.M. Jahangir	District Fisheries Officer	Department of Fisheries, Faridpur
	Mr Shahidul Islam Bhuiyan	Baor Manager	Department of Fisheries, Baluhar Kotchandpur, Jhenaidah
	Mr Aminul Haque	Research Officer	Department of Fisheries, Baluhar Kotchandpur, Jhenaidah
Department of Fisheries (CBFM)	Mr Md Mokammel Hossain	Project Director	Matshya Bhaban, Ramna, Dhaka 1000
	Mr Md Shamsul Kabir	Scientific Officer	Matshya Bhaban, Ramna, Dhaka 1000
	Mr Lutfur Rahman	District Fisheries Officer	Department of Fisheries, Netrokona
	Mr Mahbubul Haque	District Fisheries Officer	Department of Fisheries, Kishoreganj
	Mr Mohd. Mohiuddin	District Fisheries Officer	Department of Fisheries, Brahmanbaria
	Mr Abdul Khaleque	District Fisheries Officer	Department of Fisheries, Tangail
	Mr Shahidul Alam	District Fisheries Officer	Department of Fisheries, Narshingdi
Royal Danish Embassy	Mr Wagn Winkel	Counselor	House 1, Road 51, Gulshan 2, Dhaka 1212
	Mr John Stellwagen	Aquaculture Specialist	House 1, Road 51, Gulshan 2, Dhaka 1212
	Mr Faqrul Quadir	Senior Program Officer	House 1, Road 51, Gulshan 2, Dhaka 1212
Overseas Development Administration	Mr Simon Bland	Fisheries Advisor	British High Commission, Baridhara, Dhaka
World Bank	Mr Imtiazuddin Ahmed	Senior Program Officer	3A Paribagh, Dhaka 1000
United Nations Development Programme	Dr Aminul Islam	Sustainable Development Advisor	House 60, Road 11/A, Dhanmondi, Dhaka
World Food Programme	Mr Enamul Haque	Project Officer	House 69, Road 11A, Dhanmondi, Dhaka
UNOPS	Dr PV Ramesh	Project Manager	Wisma UN Block C, Komplek Rejasat Damansara, Jalan Dungun, Damansara Heights 50490 Kuala Lumpur, Malaysia
	Dr Dilip Kumar	Consultant	NACA, PO Box 1040, Kasetsart PO, Bangkok, Thailand
United States Agency for International Development	Dr Azharul H. Mazumder	Food Security Team	U.S. Embassy, Baridhara, Dhaka
	Mr Latifur Rahman	Food Security Team	U.S. Embassy, Baridhara, Dhaka
CARE	Mr Mark Ireland	CAGE Coordinator	CAGE Project, House 66, Road 7/A Dhanmondi R/A, Dhaka 1209
	Mr Greg Chapman	Golda Coordinator	Golda Project, House 66, Road 7/A Dhanmondi R/A, Dhaka 1209

Organization	Name	Designation	Address (Bangladesh unless otherwise stated)
Royal Netherlands Embassy	Mr Joost H.L.M. Andriessen	Development Specialist	House 49, Road 90, Gulshan, Dhaka 1212
Swedish Embassy	Mr Frank Rassmusson	Project Officer	Gulshan, Dhaka 1212
OLP/Danida Technical Assistance	Dr Hans Middendorp	Chief Technical Advisor	PO Box 12, Jessore
	Mr Niaz Ahmed Apu	Socio Economist	PO Box 12, Jessore
	Dr Md Rezaul Hasan	Training and Extension Consultant	PO Box 12, Jessore
	Mr Nittananda Bala	Fisheries Biologist	PO Box 12, Jessore
	Mr Mokhlesur Rahman	Fisheries Economist	PO Box 12, Jessore
	Mr Gauranga Kumar Paul	Accounts and Administrative Officer	PO Box 12, Jessore
	Mr Md Golam Kibria	Training and Extension Officer	PO Box 12, Jessore
	Ms Roucksana Begum	Training and Extension Officer	PO Box 12, Jessore
	Mr Dev Nathan	Consultant	PO Box 12, Jessore
	Mr Akhtar Imam	Advocate	PO Box 12, Jessore
	Dr J.D. Balarin	Consultant	PO Box 12, Jessore
International Center for Living Aquatic Resources Management	Dr S.D. Tripathi	Officer-in-charge	House 75, Road 7, Banani, Dhaka 1213
	Dr Paul Thompson	Technical Coordinator	House 75, Road 7, Banani, Dhaka 1213
	Mr Nurul Islam	Social Scientist	House 75, Road 7, Banani, Dhaka 1213
	Mr Manjur Kadir	Fisheries Biologist	House 75, Road 7, Banani, Dhaka 1213
	Mr Debashish Majumder	Fisheries Biologist	House 75, Road 7, Banani, Dhaka 1213
Ramboll	Mr Gorm Pedersen	Project Supervisor	House 3, Road 25A, Banani, Dhaka 1213
Integrated Food Assisted Development Project	Mr Nazirul Haq	Senior Training Coordinator	House 3A,Road 94,Gulshan 2, Dhaka 1212
Bangladesh Aquaculture Fisheries Resource Unit	Mr Chris Price	Team Leader	House 42, Road 28, Gulshan, Dhaka 1212
North East Regional Water Project	Mr SM Nazmul Islam	Fisheries Specialist	House 3A, Road 22, Gulshan, Dhaka 1212
	Dr Garry M. Bernacsek	Consultant	Global Aquatic Corporation Pty Ltd. P.O. Box 666, Rozelle NSW 2039, Sydney, Australia
Khulna-Jessore Drainage Rehabilitation Project	Dr Anwar Hossain	Consultant	Boyra, Khulna
Systems Rehabilitation Project	Ms Jennifer E. Duyne	Social Anthropologist	Euroconsult, House 40, Road 37, Gulshan, Dhaka 1212
Grameen Matshya Foundation	Mr AZM Nasiruddin	Director	Mirpur, Dhaka 1216
Jamuna Multipurpose Bridge Authority	Mr Ataur Rahman	Consultant	Matshya Bhaban, Ramna, Dhaka 1000
Jalabhumi	Mr Raguibuddin Ahmed	Executive Director	435/C Khilgaon, Dhaka

Organization	Name	Designation	Address (Bangladesh unless otherwise stated)
Bangladesh Environmental Lawyers Association	Dr Mohiuddin Farooque	Director General	House 9, Road 8, Dhanmondi, Dhaka
Bangladesh Centre for Advanced Studies	Dr Youssouf Ali	Director	House 620, Road 10A,Dhanmondi, Dhaka
Community Development Centre	Mr Khorshed Alam	Executive Director	62/B, Road 3, Chandgao R/A, Chittagong
Promoda	Mr Moklesur Rahman	Coordinator	Bishnupur, Dhaperhat, Palashbari, Rangpur
Jatio Matshyajibi Samity	Md Islam Ali	Secretary General	20, Segunbagicha, Dhaka 1000
	Mr Motilal Das	Organizing Secretary	20, Segunbagicha, Dhaka 1000
Bangladesh Journalist Federation	Mr Hasnat Kayum	Journalist	Press Club, Topkhana Road, Dhaka
BRAC	Mr Aminul Alam	Director	BRAC Centre, Mohakhali, Dhaka 1212
	Mr Atiqun Nabi	Program Director	BRAC Centre, Mohakhali, Dhaka 1212
	Mr Mokarram Hossain	Fisheries Sector Specialist	BRAC Centre, Mohakhali, Dhaka 1212
	Mr Shah Alam	Regional Manager	BRAC OLP, Kathaltala, Jessore
	Mr Sultan Ahmed	Fisheries Sector Specialist	BRAC Centre, Mohakhali, Dhaka 1212
	Mr Shamsul Haque	Credit Manager	BRAC OLP, Kathaltala, Jessore
	Mr Mostaque Ahmed Chowdhury	Director	BRAC Centre, 356 Mohakhali, Dhaka
Caritas	Mr J.S. Pereira	Executive Director	2, Outer Circular Road, Dhaka 1217
	Ms Anwara Begum Shelly	Project Coordinator (Fisheries)	2, Outer Circular Road, Dhaka 1217
	Mr S.M. Nazmul Alam	Program Officer (Fisheries)	2, Outer Circular Road, Dhaka 1217
	Mr Marcel D'Costa	Program Officer	2, Outer Circular Road, Dhaka 1217
	Mr Dhiresh Chiran	Field Officer	95/B, Brahmapalli Road, Mymensingh
	Mr Md Shahjahan Ali	Field Officer	Regional Office, PO Box 8, Dinajpur
	Mr Julien Biswas	Field Officer	Box No. 19, Mohisbathan, Rajshahi
	Mr Michael Gomes	Assistant Development Director	2, Outer Circular Road, Dhaka 1217
	Dr Thomas Costa	Development Director	2, Outer Circular Road, Dhaka 1217
Proshika	Dr Qazi Faruque Ahmed	Executive Director	I/1, Ga, Section 2, Mirpur, Dhaka 1216
	Mr Mahbubul Kairm	Director (Programmes)	I/1, Ga, Section 2, Mirpur, Dhaka 1216
	Mr Fazlul Haq	Principal Program Coordinator	I/1, Ga, Section 2, Mirpur, Dhaka 1216
	Mr Prohlad Chandra Dey	Associate Program Coordinator	I/1, Ga, Section 2, Mirpur, Dhaka 1216
	Mr Md Altaf Hossain	Associate Program Coordinator	I/1, Ga, Section 2, Mirpur, Dhaka 1216
	Mr Md Shahabuddin	Head Policy Research	I/1, Ga, Section 2, Mirpur, Dhaka 1216
	Mr Rashed un Nabi	Policy Research Associate	I/1, Ga, Section 2, Mirpur, Dhaka 1216
	Mr Tim Bene	Advisor	I/1, Ga, Section 2, Mirpur, Dhaka 1216
	Mr Md. Abdur Razzak	Fisheries Technical Worker	Brahmanbaria ADC, Brahmanbaria
	Mr Md. Kamruzzaman Mia	Area Coordinator	Kishoreganj ADC, Kishoreganj
	Mr Sunil Bhadra	Area Coordinator	Bhola ADC, Bhola

Organization	Name	Designation	Address (Bangladesh unless otherwise stated)
Centre for Rural and Environment Development	Mr Ruhul Amin	Executive Director	89, Bijoynagar, Dhaka 1000
Banchte Sheka	Mr Atul Chandra Sarker	Coordinator	Shahid Mashiur Rahman Road, Jessore
Bachaw Ziban - Bazi	Mrs Tahmina Majid	Executive Director	Mithun Neer, Bheramara, Kushtia
Centre for Natural Resource Studies	Mr Mokhlesur Rahman	Project Manager	4/6 Block B, Lalmatia (Gr Floor), Dhaka
	Mr Sachindra Halder	Bio-statistician	4/6 Block B, Lalmatia (Gr Floor), Dhaka
FemCom	Ms Nargis Akhter	Director	Batayan-1, Flat A-1 (G.F.),House 500A
	Mr Serajul Karim	Media Organizer	Road 8, Dhanmondi, Dhaka 1205
Bangladesh Fisheries Research Institute	Dr M.A. Mazid	Director	Fisheries Research Institute, Mymensingh
	Dr Gobinda Halder	Chief Scientific Officer	Fisheries Research Institute, Chandpur
	Mr M. Shahadat Hossain	Senior Scientific Officer	Fisheries Research Institute, Mymensingh
Academic and others	Dr Kazi Toufique	Research Fellow	Bangladesh Institute of Development Studies, E17, Agargaon, Shere Bangla Nagar, Dhaka
	Mr M. Sekandar Khan	Professor	Chittagong University, Chittagong
	Prof Aminul Haque	Ex. Vice Chancellor, BAU	5/9 (1st Floor), Block D, Lalmatia, Dhaka
	Dr Muhammad Shafi	Professor	Dhaka University, Dhaka
	Dr Shahadat Ali	Professor	Dhaka University, Dhaka
	Dr A.K.M. Nuruzzaman	Ex Member Director, BARC	5/H Eastern Housing Complex, Siddeshwari, Dhaka
	Mr Keith Thompson	3rd Fisheries Consultant	Fisheries Development Ltd., Birmingham Road, Soltisford Warwick CV34 4TT, UK