The Use of Sluice Gates for Stock Enhancement and Diversification of Livelihoods

Fisheries Assessment and Data Collection Methodologies

Project R8210

Fisheries Management Science Programme
managed by *MRAG*, under the DFID
Renewable Natural Resources Research Strategy

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1. Introduction

This project document outlines the fisheries data collection methodologies to be used in the FMSP project R8210 '**The Use of Sluice Gates for Stock Enhancement and Diversification of Livelihoods**'. This project will involve fieldwork at 3 sluice gates controlling water levels within two separate flood control drainage and irrigation (FCDIs) schemes in Bangladesh, with, as far as possible, similar data being collected at each site, to enable comparative analyses to be made. The data collection programmes outlined in this document will primarily be undertaken by country nationals employed at each site, under the supervision of *MRAG* and local collaborators.

1.1. The data collection programmes

Five main types of data will be collected under the following programmes:

- Catch and Effort Monitoring (CE).
- Mark & Recapture (MR).
- Hydrology and Sluice Gate (HSG).
- Length Frequency (LF).
- Reproductive State (RS).

For each of these five data collection programmes or studies, this document describes:

- Programme purpose / objectives.
- Data to be generated or parameters to be estimated.
- Planning considerations (sampling locations, randomisation, biases....).
- Data collection / sampling methodologies (sample selection, timing....).
- Comments on data analysis.
- Summary of fieldwork activities.

Data collected under these five programmes will be stored and processed in the Project's 'Sluice Gate Project Database' (see Database Manual) and later analysed to generate guidelines and recommendations for improved sluice gate operations and practices that maximise the recruitment of fish to modified floodplains in Bangladesh.

It is also intended that other short experiments or studies will be undertaken to explore associated aspects of fish passage through sluice gates including (i) estimates of larval survival (ii) estimates of the depletion of migrating fish prior to passage and (iii) estimates of the number and biomass of larvae caught in savar net fisheries when time and resources permit. These are described in Section (7).

1.2. Data management

The data collected in these surveys will initially be recorded on paper, as 'hard copies'. Forms are provided for this purpose in the appendix of this document. For computer processing of the data, *MRAG* will provide a database application for routine data entry and reliable backups. Local collaborating staff will be trained in the use of this project database. A second methodological manual will accompany this training.

1.3. Study Sites

In Bangladesh, by far the most common type of sluice gate is the "undershot type" with between 1-6 panels to control the flow rates of water through them. Other designs include flap type and active pump systems. Following the project Field Inception Visit (see MRAG 2003a) the

following sites have been selected for study:

SLUICE GATE NAME	RIVER NAME	FLOOD CONTROL SCHEME	DISTRICT
BAULIKHOLA	NATUABARI CANAL	PIRDP	PABNA
TALIMNAGAR	BADAI RIVER	PIRDP	PABNA
JUGNI	LOHAJANG	CPP	TANGAIL

Sluice gates at Hail Hoar may also be included in year 2 if funding for additional field work can be secured from other locally-based projects or programmes.

1.4. Programme activities in each study site

Depending on site selection and collaborative involvement at additional sites the following data collection programmes and studies will be conducted as indicated in the following table:

Years of Programme Activity

Programmes / Studies	Frequency	PIRDP	CPP	Hail Haor
Routine Programmes				
Catch & Effort (CE)	Daily	2004-5	2004-5	2004-5
Mark & Recapture (MR)	Every 3 weeks	2004-5	2004-5	2004-5
Hydrological and Sluice Gate (HSG)	Daily	2004-5	2004-5	2004-5
Length Frequency (LF)	Monthly	2004	2004	2004
Reproductive State (RS)	Monthly	2004	2004	2004
Ad hoc Studies				
Larval Survival (LS)	*Ad hoc*	2005	2005	2005
Depletion Prior to Passage (DPP)	*Ad hoc*	2005	2005	2005
Savar Fishery (SF)	*Ad hoc*	2005	2005	2005

1.5 Recruitment of local field staff

Shyamal Barman has been recruited as the Senior fisheries Biologist to supervise the yet to be appointed field staff (MSc Fisheries Biologists) at each study site. Field biologists will be recruited by May 2003 and will establish themselves at the study sites prior to the arrival of MRAG and IIED staff arrival in June.

2. *Catch and Effort (CE) Monitoring Programme*

2.1 Objectives

- To provide information on the timing and direction of fish migrations by species at each sluice gate.
- To provide an estimate of the total number and biomass of fish attempting to, and succeeding, in migrating through each sluice gate.
- To determine which species and gears (and their operators) are most impacted by the sluice gates and therefore which would benefit most from improved management and operation.

2.2 Data to be generated

- Estimates of total catch taken each day within the vicinity of each sluice gate[1] subdivided by direction of migration (determined by gear position i.e. facing towards or away from the sluice gate), gear type and species.
- Estimates of total fishing effort within the vicinity of each sluice gate subdivided by direction of fish migration and gear type.

2.3 Theory / Planning Considerations

The survey design is intended to provide a complete census of fish catches (by species) taken by *interceptory* gears used within the vicinity of each sluice gate study site. These gears are deliberately positioned to take advantage of the seasonal migrations of fish towards or through the sluice gates. The orientation or placement of such gears will be used to determine the directional behaviour of the fish migrations. At the study site, these interceptory gears will include lift nets (*veshal* or *Khora jal*); bagnets (*suti jal*); and jump nets (*urani*). The directions in which fish are moving when caught can be determined by consideration of the positions of the gears (inside or outside the flood control embankment) and their orientation (facing towards or away from the sluice gate). This assumes that the orientation of the gear reflects the origin of the fish caught.

2.4 Methodology

2.4.1 Overall sampling strategy

At each sluice gate site, the required data (see above) will be generated from a combination of two activities. Firstly, all fishermen fishing within the vicinity of the sluice gate will be interviewed on a daily basis to provide data on their total catch weights and fishing efforts by gear type. In the case of gears operated by fishing teams such as bagnets, the head fishermen will be interviewed.

Secondly, the species composition of the catches will be estimated for each gear type by weighing the relative contributions of each species to the total catch sampled from *representative* gear types on a daily basis.

The details of these methodologies are given in the following sections. The final version of this manual will include the statistical formulae used to estimate the required data.

[1] Within the vicinity of the sluice gate hereafter refers to the area contained within a 100m radius of the gate both upstream and downstream when connectivity through the gate exists.

2.4.2. Interview of fishermen

Each day, the survey enumerators should travel to each sluice gate at a time when most gears (fishermen) are active but towards the time when most fishermen will be shortly completing their fishing activity for the day. This period of time may vary between sites and seasons and may only be identified after the data collection programme has begun.

For *every* interceptory gear operated on that day, the enumerator should interview the fishermen or head fishermen (in the case of gears operated by a team) for the required catch and effort statistics, as detailed in form CE 1 (see appendix). During the interview, the enumerator should attempt to establish for how many more hours (if any) the fishermen or fishing team intend (plan) to continue fishing for that day. The enumerator should also establish from the fishermen they interview, whether any other interceptory gears have been used in the vicinity of the gate during that day that were not in operation at the time of the visit, including the names and addresses of the fishermen operators. The enumerators should then search for these fishermen and interview them for the required statistics. It may necessary to return to the sluice gate later in the day to repeat the process.

Enumerators will eventually become familiar with the operators of each interceptory gear at the sluice gate. Each fisherman can then be visited either at the sluice gate or at his home at the end of every day ensuring that all catches have been recorded.

It may help to compile a register or checklist of the names and addresses of all the fishermen operating interceptory gears at each sluice gate to help keep track of which fishermen have been interviewed each day (see annex). Considerable effort may sometimes be required to find the last few fishermen each day. Such efforts, however, are essential to ensure that the results are not biased by the regular omission of those fishermen with unusual behaviour patterns.

2.4.2. Measurement of fishing effort

Different measures of fishing effort are used for different gear types. For fishing gears of a standard size eg cast nets, fishing effort must be measured in terms of the numbers of units of each gear used for defined lengths of time (eg *Number of cast-net-hours*). For jump, bag and lift nets, the length or effective fishing area of net used also needs to be defined: effort for these gears should thus be recorded as the numbers of jump net-*metre*-hours, bagnet-square-meter-hours and lift net-square-meter-hours. The appropriate effort measures for the gear types used in these fisheries are provided in Table 1.

Simple effort measures such as the overall numbers of fishermen or boats may provide rough comparisons of total fishing activity between sites. They are inadequate, however, for a detailed understanding of these artisanal fisheries because the seasonality patterns of individual gear types are so variable over the year. Only the detailed effort measures shown above will enable gear use patterns, and relative abundances, to be quantified and modelled over the cyclical flood season.

2.4.3. Recording the catch and effort data

The catch and effort data should be recorded ON form CE1. Separate forms should be used each day. Depending upon the numbers of fishermen operating at each sluice gate it may be possible to record the catch and effort data of all the fishermen onto a single form, otherwise records should be continued on a second form. Separate lines should be used for each gear type used by each fisherman respondent (see example in appendix).

The 'Hours Fishing' column should be used to record the number of hours actively spent fishing by the fishermen, on each different gear type. This information will be used to estimate the mean daily fishing hours of fishermen.

Several gears, such as bagnets and barrier traps, are fished by teams of fishermen. When the respondent is a member of such a team, the fishing effort and catch details should relate to the full equipment of the team, and the size of the team (number of men excluding the head fisherman) should be recorded.

For gillnets (FG) and traps (PT) that may remain fishing in situ for days or weeks at a time, the hours fished **between the last two hauls** and the catch taken **in the last haul** should be recorded in the "Hours Fishing" and "Catch (kg)" columns, respectively. The "soak hours" recorded should correspond to the number of hours the gear has remained in the water fishing since the beginning of the 24hr recording period (12midnight) until the last haul. If the fisherman plans to continue fishing with these gear types, during the remainder of the 24hr recording period, then these extra hours should be recorded in the "Extra Planned (Soak) Hours" column.

Table 1. Fishing Effort Units by Gear Type

Interceptory (Y/N)	Gear Type	Effort unit
Y	Bagnets (including Savar)	Net-m^2-hours[1]
Y	Lift Nets	Net-m^2 –hours[2]
Y	Jumping nets	Net-metre-hours[3]
Y	Gill Nets	Net-metre-hours
Y	Portable Traps	Trap-hours
Y	Active Filters / Seines	Net-metre-hours
N	Drag / Push Nets	Net-hours
N	Cast Nets	Net-hours
N	Katha FADs	Site[4]
N	Hooks (long lines, individual hooks etc)	Hook-hours
N	Spears	Spearing-hours

1 Corresponds to the area (m^2) of the bagnet mouth opening.
2 Corresponds to the area (m^2) of the liftnet.
3 Corresponds to the length (m) of the net
4 per *katha*. This effort measure takes no account of the different water areas fished.

2.4.4. Sampling of species composition data

Information on % species compositions by gear types will be used to apportion (divide) the total daily catches between different fish species.

Species composition data should be collected daily from at least one gear of each type in

operation both inside AND outside the sluice gate flood control scheme. Thus, if three different gears are in operation inside the sluice gate but only two different types are fished outside the gate, then a total of five samples would be required.

Species composition should only be determined from *unsorted* catches. Often, fish will be placed in baskets ready for transportation to market. In this case, baskets of fish for weighing should be *randomly* sampled from those available. Before taking records from a selected basket, the origin (inside or outside the sluice gate?), (gear type?) and integrity (whole, unsorted catch?) of the sample should be determined from the owner. If any origin information is not available, or the catch has been sorted, or mixed with catches from other gear types, *the basket should not be sampled*.

For selected samples meeting the above criteria, the % species composition of the catch should be recorded on data form CE2 (see appendix) after weighing the relative contributions of each species to the total sample weight with a spring balance. Percentages should indicate the weight (not the number) of each species in the catch. When species identities are uncertain, eg for mixed juvenile cyprinids, %s may be recorded for groups of species. Separate forms should be used for each day's sampling, and separate boxes (up to 3 on each form) should be used for the different gears sampled. Details of the position (inside and outside the flood control scheme) and orientation (facing towards [FT] or facing away [FA] from the sluice gate) of each gear sampled should also be recorded.

2.4.5. Data coding

For reliable interpretation, data should always be recorded in concise and consistent formats. Suitable codes have been chosen for each different fish species, gear type, sluice gate…etc as given in the examples below. NB Only these codes should be used on the forms. A full list of codes is provided in the Annex.

Fish Species		**Fishing Gears**	
Channa striatus	CS	Fixed Gill Net	FG
Notopterus notopterus	NN	Seine Net	SN
Anabas testudineus	AT	Brushpile (Katha)	KT
Puntius sophore	PS	Bagnet	BN

Sluice Gates	
Talimnagar	TG
Baulikola	BK

2.5 Proposed Data Analysis

2.5.1 Estimation of Catch by species by gear type, location and orientation

The estimated catch of species *s* on a given day, *d* for a particular portable trap (PT) or gillnet (FG) is given by:

$$C_{s,d,PT\,or\,FG} = \left(\frac{Catch_{d,PT\,or\,FG}}{Hours_{d,PT\,or\,FG}} . (SoakHours_{d,PT\,or\,FG} + ExtraHours_{d,PT\,or\,FG}) \right) . \frac{\left(\%\, Weight_{s,d,PT\,or\,FG}\right)}{100}$$

For all other gears (nets), the estimated catch for net type n is given by:

$$C_{s,d,n} = \left(\frac{Catch_{d,n}}{Hours_{d,n}} . (Hours_{d,n} + ExtraHours_{d,n}) \right) . \frac{(\%\, Weight_{s,d,n})}{100}$$

The estimated effort, E for a PT for a given day is given by:

$$E_{d,PT} = GearUnits_d . (SoakHours_d + ExtraHours_d)$$

The estimated effort for a FG:

$$E_{d,FG} = GearUnits_d . GearSize . (SoakHours_d + ExtraHours_d)$$

Estimated effort for a particularly net type is given by:

$$E_{d,n} = GearUnits_{d,n} . GearSize_n . (Hours_{d,n} + ExtraHours_{d,n})$$

The estimated catch per unit effort for species, *s* using gear type *g,on day d* is given by :

$$CPUE_{s,d,g} = \frac{C_{s,d,g}}{E_{d,g}}$$

The total catch of species s, on any given day, d is given by:

$$C_{s,d} = \sum_{gear\,1}^{g} C_{s,d,g}$$

Catch and effort estimates can also be subdivided by gear orientation and fishing location to determine the direction and magnitude of migrations of fish during different time periods in relation to the prevailing hydrological conditions.

With estimates of catchability, *q* of different gear types derived from the mark recapture programme, it may also be possible to estimate the total biomass and numbers of fish passing through the sluice gates.

For example, if all the interceptory gears together caught 3000 marked fish and 20,000 unmarked fish, then their combined catchability is 0.15 or 15%. This would suggest that the total numbers of fish passing through the gates is in the order of 20,000/0.15=135,000.

2.6 Summary of Fieldwork Activities

1. ***Catch and effort data collection***
   Catch and effort data should be collected for all *interceptory* gears within the vicinity of the sluice gates once a day by interviewing fishermen operators. Catch and effort data should be recorded on form CE1.

2. ***Species composition sampling***
   Species composition data should be collected daily from at least one gear of each type in operation both inside and outside the sluice gate. Species composition should only be determined only from whole *unsorted* catches and recorded on form CE2.

3. The Mark & Recapture Programme (MR)

3.1 Objectives

- To determine the passage success (% of fish passing through the sluice gate) and survival rates of different fish species in relation to different hydrological conditions, particularly velocity and turbulence and sluice gate aperture.
- Provide independent estimates of passage success for comparison with those estimated from the catch and effort (CE) monitoring programme (above)
- Provide data to generate empirical relationships between velocity or turbulence and gear catchability. As well as providing information directly for the development of guidelines, these can then be used to estimate (approximately) the total catch of fish taken in front of and behind the sluice gate using data from CE by calibrating the catchability coefficients of gears monitored under different hydrological conditions.

3.2. Data to be generated

- Percentage of fish passing through each sluice gate under different hydrological conditions including water velocity and turbulence (pressure) and sluice gate aperture.
- Mortality rates of fish passing through sluice gates under different hydrological conditions including water velocity and turbulence (pressure) and sluice gate aperture.
- Estimates of catchability of different gear types under different hydrological conditions measured as the number of recaptured fish as a proportion of the total number of released fish.

3.3 Theory / Planning Considerations

3.3.1 *The issue of* catchability

The efficiency or catchability (the proportion of fish caught with a unit of fish effort) of fishing gears, particularly interceptory types that typically 'filter' the water for (migrating) fish, will be influenced by the prevailing flow conditions. Monitoring programmes relying on such gears to provide information on the effects of different hydrological conditions generated by different sluice gate operating practices, on passage success, must therefore attempt to take account of these *gear catchability effects*.

An example
A lift net fishing behind a sluice gate caught 2kg of fish per hour operating in a current velocity of $0.5ms^{-1}$. When the sluice gate was opened further, the water velocity increased to $0.75ms^{-1}$ and the lift net began catching 3kg of fish per hour.

Does this increase in catch rates reflect greater fish passage success through the gate or simply greater gear efficiency, or both?

The methodology described below attempts to quantify how gear catchability varies according to the prevailing hydrological conditions, allowing the effects of these conditions on passage success and passage mortality to be quantified. Estimates of gear catchability will also provide the means to estimate, from the recorded catch data (section 2), the total numbers of fish attempting to and apparently succeeding in passing through the sluice gates under different hydrological conditions. This combined information will provide the basis for

developing guidlelines for sluice gate management and operating practices.

3.3.2. Overall design and precautions

The MR programme survey involves the capture, holding, marking and release of fish by project staff. The subsequent *recapture* stage involves the recovery of the animals and the detection and reporting of the mark, primarily, in this survey, by fishermen. The methodologies for the various stages are detailed in the following sections.

The success of this component of the project depends on the ability (and willingness) of fishermen to recognise marked fish and return them to the project. It will be necessary to determine the best method for the fishermen to report their recaptures. This will be discussed with the local collaborators at each site.

3.3.3. Publicity

To ensure reasonable return rates of marked fish, each MR survey needs to be widely publicised within the vicinity of the sluice gates. The best locations and media for such publicity will also be discussed with the local collaborators.

3.3.4. Labour, equipment and funding requirements

Marking and releasing fish for the MR programme should be undertaken by the project's field staff when they are not engaged on the CE and LF/ and RS surveys. It should be possible to develop a fieldwork itinerary to enable all programmes to be completed at the same time.

Equipment for the mark-recapture programme will be provided by MRAG and IIED. Appropriate marking methodologies have been identified. The major expenses involved will be the initial purchase of fish for marking and release, and the subsequent reward money paid for recaptured fish. It is hoped that fish in good condition can be purchased from the fishermen either at market value or an agreed percentage above this. Suitable amounts for rewards will be discussed with local collaborators prior to the surveys.

3.4 Methodology

3.4.1 General strategy

Passage success, passage mortality and gear catchability will be estimated using mark and recapture experiments, repeated regularly (every 3 weeks) throughout the flood season AND immediately after any changes to the sluice gate settings (gate openings).

Two equal-size batches of fish of mixed species and of different sizes (lengths) will be marked with colored dye in different locations to distinguish fish from the two batches. One batch will then be released just in front of (outside) the sluice gate, the other released just behind (inside) the gate.

The proportion of differently marked (live and dead) fish in the catch of gears operating in the vicinity of the gate will provide estimates of both passage success and passage mortality. The catchability of each gear type under the prevailing hydrological conditions will be estimated from the proportion of fish in the total catch of each gear bearing different marks depending on the orientation of the gear and the direction of fish migrations through the gate.

By repeating this procedure under a range of different hydrological conditions (velocity and turbulence, different sluice gate apertures etc) it should be possible to construct

relationships between passage success and gear catchability, and hydrological conditions.

3.4.2 Capture / supply of fish for marking and release

Live fish for marking and release will be purchased from fishermen at the market price (or a standard percentage above this) operating interceptory gears within the vicinity of the sluice gate. It may be possible establish arrangements with fishermen to regularly supply live fish for the programme. To minimise arguments over the correct prices for fish, field staff will be provided with weighing scales. Only freshly caught fish in good condition should be used for marking. Fish with missing scales or broken fins should not be used.

While waiting to be marked, fish should be kept in a *holding cage* perhaps constructed of mosquito mesh on a wooden frame and suspended in the river. Two similar *releasing cages* should also be constructed and lined with detachable nets to aid batch release of fish (see below).

As live fish are purchased from the fishermen they should be transferred immediately to the holding cage. When a large enough sample of fish has been gathered perhaps 800-1000 individuals, marking can begin. The minimum size (length) of fish for marking will be determined at the start of the programme after some experimentation.

3.4.3 Marking and releasing fish

The marking operation should be designed to be as quick and as stress-free to the fish as possible. Holding fish in cages and tanks for extended periods should be avoided. Fish should be handled gently and carefully, using knotless nets and suitable containers.

Fish should be randomly removed from the holding cage one-at-a-time using a knotless net and transferred to the marking area where fish will be marked and marking and release details recorded (see below). This random removal should ensure there is an equal chance of selecting fish of different species and size. The best method to achieve this will be explored with field staff at the start of the programme.

Each fish will be marked with a subcutaneous injection of Alcian Blue dye (paint) in the caudal peduncle region of the tail or other appropriate locations using a 'PanJet' needless injector system. This system has been used extensively to mark freshwater fish as small as 8cm in length.

Fish should be **alternately** marked on the left and right hand side of the tail with the PanJet so that half of the fish will have marks on their right hand side whilst the other half will have marks on their left side. Fish receiving marks to their RIGHT side should be transferred to the first *release cage* destined for release OUTSIDE the sluice gate. Fish receiving marks to their LEFT side should be transferred to the second *release cage* destined for release INSIDE the gate.

By following these procedures, the release cages should contain roughly similar numbers of fish of the same species and sizes (ie similar species and size compositions). This should be validated at the start of the programme using chi-square statistical tests.

When all the fish have been marked and transferred to their release cages, the fish should be released at **fixed** locations just in front of and behind the sluice gates. Because this mark-recapture programme relies on fishermen to return the release fish, marked fish should only be released when fishermen within the vicinity of the gates are most active (ie at peak fishing times).

NB To avoid confusion, the holding and release cages should be clearly marked eg

'HOLDING'

'RELEASE OUTSIDE (RIGHT MARK)'

'RELEASE INSIDE (LEFT MARK)'

In addition, the same marking and release system and procedure should be adopted throughout the flooding season, regardless of the direction of flow of water through the sluice gate.

3.4.4. Recording marking and release details

Providing that both batches of released fish contain species and size compositions that are NOT significantly ($P<0.05$) different, it will not be necessary to record the details of the species and size of individual (marked) fish. Instead only the number of fish released in the two (inside and outside) locations (which should be equal) and the release date is required. A form is attached for recording marking and release details (form MR1, appendix).

If batches of marked fish for release are likely to be dissimilar for any reason then it will be necessary to also include the release date, species, marking location (left or right side of tail), fork lengths (*cm*) and any comments for each fish released. This should be avoided given the additional work required.

3.4.5. Recapture of marked fish

Marked and released fish will be recaptured by fishermen within the vicinity of the sluice gate. It is anticipated that the majority of marked fish will be recaptured within a period of 1 week. Fishermen should be encouraged to report and return any marked fish they recapture to the project staff on a daily basis as part of the daily CE monitoring programme.

A small monetary reward of, say, TK10 will be given to the fishermen for each marked fish they return. To qualify for the reward, the fishermen must report how, where and when the fish was caught. In addition to the cash reward, the value of the fish (or a standard percentage above the market value) should be refunded to the fishermen by the project. Provision must be made for the fishermen to be paid for their recaptures immediately on presentation of marked fish. Procedures for this part of the survey will be discussed with local collaborators.

3.4.6. Recording of recapture details

Details of the recaptures of marked fish should be recorded on the second form provided (see appendix, form MR2). As for the released fish, the recapture date, species, marking location (left or right side of tail), location recaptured (inside or outside the gate), gear type used for recapture, gear orientation (facing away or towards the gate), fork length (*cm*), whether captured dead or alive, and any comments should all be recorded for every fish returned.

3.5 Proposed data analysis

The proportion of differently marked (live and dead) fish in the catch of gears operating in the vicinity of the gate will provide estimates of both passage success and passage mortality. The catchability of each gear type under the prevailing hydrological conditions will be estimated from the proportion of fish in the total catch of each gear bearing different

marks depending on the orientation of the gear and the direction of fish migrations through the gate.

By repeating this procedure under a range of different hydrological conditions (velocity and turbulence, different sluice gate apertures etc) it should be possible to construct relationships between passage success and gear catchability, and hydrological conditions.

3.6 Summary of fieldwork activities

1. For the mark and recapture survey, live, healthy fish will be bought direct from fishermen, marked with small, highly visible, blue dye mark on the either side of the tail. Batches of fish of similar species and size composition will be marked in this manner and released both inside and outside the sluice gates. Release details will be recorded on form MR1.

2. Marked fish recaptured by fishermen operating in the vicinity of the sluice gate will be returned to the project staff on a daily basis. Details of recaptures will be recorded on form MR2.

3. Suitable rewards will be given for each marked fish returned to the project staff to encourage reporting.

4. Hydrology and Sluice Gate Monitoring Programme

4.1. Objectives

- To improve understanding of existing sluice gate operations including timing and extent of openings.
- To provide estimates of water depth, velocity and turbulence, pressure…etc under these different modes of operation.
- To provide a hydrological basis to the interpretation of the seasonality of fish migration patterns.
- To provide information on water quality changes associated with flood seasonality which may act as stimuli for migratory activities.
- In conjunction with data generated under the programmes described above, to identify optimal hydrological conditions and sluice gate operations (timing and extent of openings) that maximises fish attraction and passage success through sluice gates, and that minimizes mortality rates.

4.2. Data to be generated

- At fixed points inside and outside each sluice gate, daily estimates of:
    - water height (measured at existing gauges)
    - current velocity
    - turbulence (both inside and outside)
    - pressure (through aperture – by calculation)
    - Water quality (turbidity, temperature, dissolved oxygen, conductivity, pH…etc).
- Daily records of:
    - Sluice gate aperture (number of panels open and their heights) AND hours open in the 24hr period (00:00 – 23:59).
    - Flow direction (into or out from flood control scheme including any leakage when gates are closed)
    - Reason for any change in sluice gate operation (ie opening or closing of gates, change in aperture etc.

4.3 Planning considerations and methodology

This important component of the sampling programme will simply involve *daily* readings of water heights, current velocity and pressure, turbulence measurement 4-6 times per month and *weekly* recordings of water quality parameters.

4.3.1. Water height recording

Daily water height should be measured once every day, if possible always at the same time and recorded in form HSG1. Records may be taken from any stable and secure gauges which are available, BOTH inside and outside each sluice gate.

4.3.2. Current velocity recording

Current velocities (river flows) should be measured daily on BOTH sides of the sluice gate, and always at the same mid-stream positions at convenient sites in the river using a calibrated

current meter. In the absence of a meter, flows may be adequately recorded by measuring the time taken for an immersed object to travel a given distance. This may be achieved in one of two ways: 1) by releasing a neutrally buoyant object (eg a piece of dense wood) attached to a string of known length, and timing how many seconds it takes for the string to become taught, or 2) by releasing a semi-buoyant object (eg an orange) and timing how many seconds it takes to travel a measured distance downstream. Two such measurements should be taken and the mean velocity recorded in $m.s^{-1}$ on form HSG1.

4.3.3. Turbulence

Turbulence should be measured 4-6 times per month considering operation of the gate and on both sides of the sluice gate, and always at the same locations with respect to the sluice gate apertures. Measurements should be recorded on form HSG2.

4.3.4 Pressure

Water pressure should be measured daily on BOTH sides of the sluice gate, and always at the same distance from the sluice gate apertures. Measurements should be recorded on form HSG2.

4.3.5 Water quality sampling and measurements

Various water quality indices, including dissolved oxygen, turbidity, conductivity, total dissolved solids, biological oxygen demand, pH and temperature could potentially be recorded at each site depending upon equipment availability.

4.4 Proposed data analysis

The hydrological variables and sluice gate settings will used to help interpret seasonal variation in fish abundance, timing of migrations and passage success through the sluice gates.

4.5 Summary of fieldwork activities

1. Water height, velocity to be recorded DAILY on form HSG1.
2. Pressure to be recorded daily on form HSG2 and turbulence 4-6 times per month on form HSG2.
3. Water quality parameters to be measured weekly on an appropriate form.

5. Length Frequency Data Collection (LF) Programme

5.1. Objectives

- To provide an age basis to the interpretation of fish migration patterns.
- To determine seasonal passage attempts and success through sluice gates by age (and length) groups of fish.
- To help determine the purpose of migrations through sluice gates.

5.2. Data to be generated

- Monthly estimates of the length frequency (LF) structure of catches of important species sampled from the interceptory gears both inside AND outside the sluice gates to estimate (i) the age structure of the migrating fish populations (identify age of migrating fish), and (ii) passage success as a function of fish size or age by comparing the LF distributions of fish sampled from the same gears fishing inside and outside the sluice gates.

5.3 Theory / Planning Considerations

5.3.1. Selection of key fish species

The primary objective of the LF survey is to estimate the age structure of fish attempting to migrate through the sluice gates during different times of the year. For this, the length structure of migrating fish populations must be sampled throughout the period of possible fish migrations (approx June- November depending upon location) from all interceptory gear types on both sides of the sluice gate. This is a data-intensive procedure which can only be done for a few of the different fish species caught at each sluice gate site. The first step is thus to select around 5 'key' fish species for LF sampling.

Key fish species should be selected to provide information on the migrations of a range of different species. These could perhaps include one large herbivore, one large carnivore, one small blackfish, one small whitefish and one shrimp species. Where possible, to enable comparative analyses, the same species should be selected at all sites. However, it is more important that the chosen species must be regularly caught in large enough numbers to provide large samples. The selection of key species will be determined after more detailed interviews with fishermen at the start of the data collection programmes.

5.3.2. Sampling locations and gear types

Samples should be taken monthly from each interceptory gear type fishing on both sides (inside and outside) of the sluice gate.

5.3.4. Labour, equipment and funding requirements

LF sampling should be undertaken by two field operators, one to handle and measure the fish and a second to remain clean and dry to record the measurements on the LF form. LF sampling can only be undertaken when fish are landed, often for a short, regular period each day. LF sampling will thus require only a few hours in each of the 10 days in the sampling window, every month. The sampling teams will require a LF measuring board, with a minimum 40cm length and appropriate data recording forms (see below).

Some fishermen may be more willing than others to cooperate with such a sampling scheme. Where possible, a relationship of goodwill should be developed, enabling fish to be borrowed temporarily from the fishermen, measured and returned in a short period of time. In some locations, it may be helpful to pay the fishermen a small amount for each sample measured, to compensate them for the inconvenience and delay caused. It should not be necessary to buy the fish for measuring alone.

5.4 Methodology

5.4.1. Sample sizes and frequencies

Sampling should be planned to give LF data for each of the key species within a 10-day period, or 'sampling window', every month. Time series of approximately six evenly-spaced samples should thus be collected for each species, location (inside and outside the sluice gate) and year of sampling, giving a total of approximately 60 samples per year for each sluice gate assuming five key species are regularly sampled.

Populations of small floodplain fish species will generally be comprised of less age classes than large ones, and hence require less LF data for estimating population parameters. For small fish, up to a maximum 20cm in length, a total sample size of 200 fish should be measured for each key species from each interceptory gear type. For larger fish species, with populations that may be comprised of several age classes, samples of 300 fish per key species per gear type should be measured in each time period.

Depending on the availability of fish, the total sample sizes of 200-300 fish may have to be made up from a number of separate sub-samples, perhaps taken from different fishermen or collected on different days. During periods when few fish are caught, it will sometimes be impossible to achieve the recommended sample sizes within the sampling window.

5.4.2. Selection of unbiased samples

To obtain representative and *unbiased* samples of the LF structures of the catches of interceptory gears, it is essential that either a whole catch from that gear is measured, or, if the catch is very large, a randomly selected part of it. Samplers must also make sure that only the catch of the intended gear is being measured. It must thus be explained to the fishermen that the *whole, unsorted catch* is required for sampling.

Where fish catches are landed in baskets, these containers may make useful sampling units from which a sample may be randomly selected. Care must always be taken, however, to ensure that large and small fish have not been sorted into different baskets. When this is the case, the best option is to measure all the fish in all the baskets being landed. When this would involve too much work, random samples should be taken from the different baskets in proportion to the relative numbers of fish of different sizes.

5.4.3. Recording of LF data

The source details of LF samples and the fish lengths should be recorded on the sampling form provided (form LF1). Separate sheets should be used for different sampling locations (inside and outside the sluice gate) and dates, but up to five sub-samples may be recorded on each form. For each sub-sample, the following source details should be recorded:

- species,
- gear type (and mesh size/ hook gape),
- location of capture (sluice gate name and either inside or outside the flood control

scheme.

For each (and every) fish in the sample, the *fork length* should be measured to the nearest cm *below* (or ½cm below for small fish) and entered as a tick on the LF data form (see example in appendix). The fork length is the distance from the tip of the snout to the fork in the tail. It is equivalent to the total length of round-tailed fish.

5.5 Proposed data analysis

Time series of length frequency distributions will be plotted for of each species and location. Modal Progression Analysis will be used to determine the age structure of populations attempting to pass through the sluice gates. Comparisons of the length structures will also be used to determine passage success according to age group.

5.6 Summary of fieldwork activities

1. LF samples should be taken for each of *approximately 5 key fish species* during a *10-day sampling window* in each month.

2. For each key species/time period, LF samples should be taken to produce *total sample sizes* of 200 fish (for small species) to 300 fish (for large species) from each interceptory gear type operating on both sides of the sluice gate.

3. To obtain *unbiased samples*, they should only be taken from the catches of fishermen. Care must always be taken to question the fishermen to ensure that their catch has not been *sorted* and contains only fish from a *single, known gear type*.

4. For each separate *sub-sample*, record the LF details on the sampling sheets provided (see appendix). Separate sheets should be used for different sampling locations (inside and outside the gate) and dates, but up to five sub-samples may be recorded on each form. For each sub-sample, record the *species, gear type* (and *mesh size/ hook gape*) and the *location where the fish were caught*.

5. For each fish, measure the *fork length* to the nearest cm *below* (or ½cm below for small fish) and enter the lengths as ticks on the form (see example in appendix).

6. Reproductive State (RS) Monitoring Programme

6.1. Objectives

- To help determine the purpose of fish migrations through sluice gates.
- To identify the spawning period of fish migrations through sluice gates.

6.2. Data to be generated

- Weekly estimates of the reproductive state of key species attempting to migrate through each sluice gate.
- Weekly estimates of mean Gonad Somatic Index GSI of key species to determine the spawning time of key species.

6.3 Theory / Planning Considerations

6.3.1. Overall sampling strategy

The *reproductive state* monitoring programme is designed to provide information on the purpose fish migrations through sluice gates, particularly with respect to reproductive behaviour. This information will be used to design appropriate mitigating measures and direct research effort during the second year of the study. For example, if it is found that the majority of fish attempting to penetrate the sluice gates have already spawned, it may be more appropriate to focus upon measures that improve the passage of fish larvae or juvenile fish rather than measures aimed at fewer numbers of recently spawned adult fish.

Catches of the key species taken with the same interceptory gears monitored under the CE, MR and LF programmes will be sub-sampled every month. Up to 6 samples will thus be taken per flood season (assuming a six month flood season) at monthly intervals to determine the seasonality of reproduction.

6.3.2. Selection of unbiased samples

Unlike the LF sampling programme, it is not essential that the actual length (age) structure of the population be represented in the sample. However, samples should contain, if possible equal numbers of fish of a range of different sizes. For this reason it is recommended that stratified sub-sampling be undertaken in conjunction with the length frequency (LF) programme (see above).

6.3.3. Labour and equipment requirements

Ideally, this programme should be undertaken by two field staff. The first should take the measurements from the fish while the second remains clean and dry to record the data on form RS1.

The following equipment requirements for the biological sampling programme will be provided by MRAG:

Dissection kit
Hand lens
50cm measuring board

Blotting paper
Electronic balance
Various size spring balances
Petri dishes

6.4 Methodology

6.4.1. Sample sizes and frequencies

As outlined in section 6.3.2, fish for reproductive examination will be sub-sampled from those fish sampled for the LF programme. Therefore, sampling and subsequent examination for this programme should occur within the same 10-day 'sampling window' as the LF data collection programme at regular monthly intervals throughout the flood season (approx June-November).

Six evenly-spaced samples should thus be collected each flood season. These samples should comprise 30 individuals of each species stratified according to size (small, medium and large) and sampling location (inside and outside the sluice gate) as indicated in Table 3 below.

Depending on availability, these sample sizes may be made up of a number of separate sub-samples, purchased from different fishermen or on different days. During each sampling window, a log should be kept of how many fish have so far been sampled in each species, location and size class category strata. Samples obtained from different sources should be kept separately so that the locations and times of capture can later be entered on to form RS1.

Table 3. Required monthly sample sizes for each key species stratified by fish size category and location (inside and outside sluice gate).

	Inside			Outside		
Species	**Small**	**Medium**	**Large**	**Small**	**Medium**	**Large**
1	5	5	5	5	5	5
2	5	5	5	5	5	5
3	5	5	5	5	5	5
4	5	5	5	5	5	5
5	5	5	5	5	5	5

6.4.2. Field Laboratory Methodology

After selection and purchase, the sub-sample of fish should be taken back to the field laboratory and work should begin as soon as possible before the fish desiccate.

As noted above, the date, time and location of capture should first be recorded for each fish. The following measurements and samples should then be taken systematically and recorded on data form RS1. It is important that the length and total weight of the fish be recorded first to before removing the gonads for weighing and inspection.

Length and Weight

For each fish in the sample, the fork length should be measured using a measuring board and recorded to the nearest mm. The fork length is the distance from the tip of the snout to the tip of the median rays (fork) of the tail. The fork length and total length are equivalent to each other for round-tailed fish. In addition, the weight in grammes (g) of the fish should be recorded to the

nearest gramme using the electronic scales, or, if the fish exceeds 100g, a spring balance.

Reproductive state examination

The gonad of the fish should be inspected and the sex determined and recorded. In mature females, eggs are present in the ovaries. In mature males, the testes are smooth, whitish and non-granular in appearance (care should be taken not to confuse testes with adipose (fat) tissue and bodies).

The gonad of each fish should then be dissected from the fish and placed on blotting paper to remove any excess water. Particular care should be given to ensuring that the entire gonad is removed from the fish *intact* and that the surrounding tissue is not damaged. The weight should then be measured using the electronic scales and recorded to the nearest 0.1 grams (g).

The gonad should then be inspected with a hand lens to determine the stage of sexual maturity. The stage of maturity should be classified as follows:

I	Immature-	Young individuals which have not yet engaged in reproduction. Gonads very small, with no eggs or sperm present or easily visible.
M	Mature-	Eggs and sperms are distinguishable with the naked eye; testes change from a transparent to a pale rose colour.
R	Ripe-	Gonads have achieved their maximum weight. Gonads contain obvious eggs or sperm.
S	Spent-	The sexual products have been discharged. Ovaries are often flaccid and bloodshot with the appearance of deflated sacs.

6.5 Proposed data analysis

Comparison of weekly reproductive states inside and outside will, together with the LF programme, be used to determine whether fish caught either side of the sluice gate belong to the same population.

Spawning period(s) in each location will be assessed through temporal changes in the gonadosomatic index defined as:

$$GSI = \frac{gonadweight}{Totalweight}.100$$

This will be supported by visual observations of the stage of maturity.

6.6 Summary of fieldwork activities

1. In conjunction with the LF sampling programme, a total of 150 fish should be sampled during a 10-day window in each month stratified according to Table 3.

2. For each individual sampled, its fork length, and total and gonad weight should be measured, and stage of maturity determined, and recorded on form RS1.

7. Ad Hoc Studies

7.1 Passage Survival of Juvenile Fish (LS)

Design proposals for a short research project to determine the surival of juvenile and larval fish under different hydrological conditions and sluice gate settings will be prepared in the second year of the project after preliminary analysis of the data generated under 5 programmes described above. It is anticipated that some form of experimental design similar to that described by de Graaf et al (2001) will be adopted. However, hatchlings caught by local savar fisheries will be used instead of hatchery produced individuals.

Funding and a source of MSc or PhD students to support this and related research programmes will be sought from the DFID-funded SUFER Programme in collaboration with BCAS. BAU may offer suitable candidate students for this research.

7.2 Depletion of fish prior to sluice gate passage (DPP)

The capture of migrating fish in rivers and canals connecting FCDI schemes to the main river channel may be more significant than the obstruction of migrations though sluice gates. A short research project will be undertaken to determine the extent of removals of fish in such channels prior to attempted passage through sluice gates.

The details will be finalised during year 2 of the project. It is envisaged that the research will involve monitoring declines in catch rates of interceptory gears positioned along channels connecting the main river to sluice gates (Figure 1). This will provide estimates of the magnitude of the depletion of populations attempting to reach the sluice gate. This can then be compared with estimates of passage success to determine their relative importance.

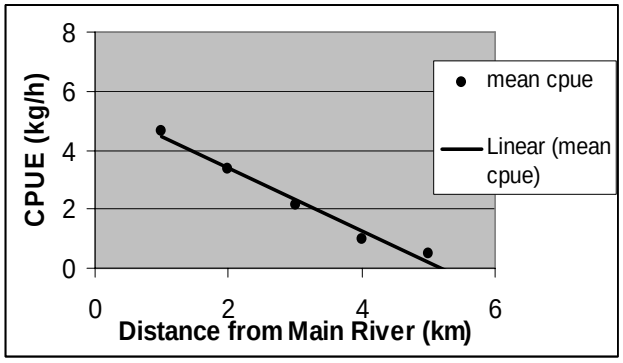

Figure 1 Depletion of migrant fish abundance from main channel to sluice gate.

7.3. Savar Fishery (SF) Monitoring Programme

Recommendations on sluice gate management and operation should also take account of the seasonal abundance of juvenile fish that may actively or passively migrate through open sluice gates. Due to their small size, the seasonal abundance of these individuals cannot be monitored under the routine monitoring programmes described above.

It is therefore proposed that a short monitoring programme of the savar fishery operating at the mouth of the Badai River in Pabna be undertaken during year 2. This should aim to provide information on seasonal abundance of juvenile fish in relation to hydrological conditions. This information can be used to inform operators on appropriate timing of sluice gate openings and aid the design simple ongoing monitoring programmes beyond the life of

the project for inclusion in sluice gate management guidelines or protocols.

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Data Recording Forms

- Register or checklist of fishermen for Recording CE
- Catch & Effort Data Recording Forms, CE1,
- Species Composition Recording Form CE2
- Mark & Recapture Data Recording Forms, MR1, MR2
- Hydrology and Sluice Gate Operation Recording Form, HSG1
- Hydrology and Sluice Gate Operation Recording Form, HSG2
- Length Frequency Data Recording Form, LF1
- Reproductive State Recording Forms, RS1

Examples

- Recording Catch/Effort Data on form CE2: An Example
- Recording Length Frequency Data on form LF1: An Example

Register or checklist of fishermen for routine monitoring of catch and effort data

Sluice Gate________________ Month________________ Year________________

X – Interviewed O – Interviewed BUT no fishing

		Calendar Day																														
Fishermen Name	Initials / Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Routine Catch and Effort Data Recording Form – CE1

Sluice Gate: _____ Day: _____ Month: _____ Year: _____ Sampler Initials:_____ . ***FG-Fixed Gill Net (previously GN)***

Fisherman Code	Hours Fishing (Since 12 midnight 00.00) For PT and FG number of hours between last two hauls.	Extra Planned Fishing Hours (or extra Soak Hours planned since last haul for PT and FG) (Until 12 midnight 23:59)	**Fishing Effort by Gear Type**								Catch (kg) (for last haul for PT and FG)	Comments
			Gear Type	Size (length, m or area m^2)	Mesh (mm)	Number of Gear Units	Soak Hours for PT and FG (Since 12 Midnight 00:00 to last haul)	Number of Men in Team	Gear Orientation: Facing Towards (FT) or Facing away (FA) from Sluice Gate	Inside (IN) or Outside (OUT) Flood Control Scheme		

Species Composition by Gear Type Data Form – CE2

Sluice Gate: _____ Day: _____ Month: _____ Year: _____

Sampler Initials:_____.

Gear Type	
IN or OUT	
FA or FT	
Sample Wt (kg)	
Species	% Wt

Gear Type	
IN or OUT	
FA or FT	
Sample Wt (kg)	
Species	% Wt

Gear Type	
IN or OUT	
FA or FT	
Sample Wt (kg)	
Species	% Wt

IN – Inside flood control scheme; OUT – Outside flood control scheme; FA- Gear facing away from sluice gate; FT – Gear facing towards sluice gate.

Mark-Recapture Programme Recording Form: Release Details (MR1)

Sluice Gate: ____________ **Sampler Initials:_______** **Date : ____________**

or other appropriate location

Species Code	Number of fish released		Comments
	Outside (right or bottom mark*)	Inside (Left or Top Mark*)	

Mark-Recapture Programme Recording Form: Recapture Details (MR2)

Sluice Gate: _____ **Sampler Initials:_____.**

Recapture Date			Species Code	Fork length (cm)	Release Location: IN or OUT*	Recapture Location: IN or OUT*	Gear Type	Gear Orientation (FA, FT)	Comments
DD	MM	YY							

**** see fish marking location key***

Hydrology and Sluice Gate Operation Recording Form (HSG1)

Sluice Gate_____ **Month**_____ **Year**_____

Day (DD)	Sluice gate panel heights (m) 0 m- panel closed, and hours open during 24hrs.												Flow direction (IN or OUT)	Leakage (Y, N or NA)	Water height (m)		Current Velocity (ms^{-1})		Secchi Depth (m)		Sluice gate Combination (Jugni Sluice only)	Reason for any operation of gate
	1		2		3		4		5		6				IN	OUT	IN	OUT	IN	OUT		
01																						
02																						
03																						
04																						
05																						
06																						
07																						
08																						
09																						
10																						
11																						
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21																						
22																						
23																						
24																						
25																						
26																						
27																						
28																						
29																						
30																						
31																						

Hydrology and Sluice Gate Operation Recording Form (HSG2)

Sluice Gate_____ **DD**_____**MM**_____ **YY**_____

		Panel-1 (Counting from right side)			Panel-2			Panel-3			Panel-4			Panel-5			Panel-6		
		H	V1	V2	H	V1	V2	H	V1	V2	H	V1	V2	H	V1	V2	H	V1	V2
Row-1 (U/S)	0.2H																		
	0.6H																		
	0.8H																		
Row-2 (U/S)	0.2H																		
	0.6H																		
	0.8H																		
Row-1 (D/S)	0.2H																		
	0.6H																		
	0.8H																		
Row-2 (D/S)	0.2H																		
	0.6H																		
	0.8H																		
Row-3 (D/S)	0.2H																		
	0.6H																		
	0.8H																		
Row-4 (D/S)	0.2H																		
	0.6H																		
	0.8H																		
Row-5 (D/S)	0.2H																		
	0.6H																		
	0.8H																		

Length Frequency Recording Form (LF1)

Sluice Gate: _____ Day: _____ Month: ____ Year: ____ Sampler Initials:_____.

Spp:	
Gear:	
IN/OUT:	
FA/FT:	

1		26	
1.5		27	
2		28	
2.5		29	
3		30	
3.5		31	
4		32	
4.5		33	
5		34	
5.5		35	
6		36	
6.5		37	
7		38	
7.5		39	
8		40	
8.5		41	
9		42	
9.5		43	
10		44	
10.5		45	
11		46	
11.5		47	
12		48	
12.5		49	
13		50	
13.5		51	
14		52	
14.5		53	
15		54	
15.5		55	
16		56	
16.5		57	
17		58	
17.5		59	
18		60	
18.5		61	
19		62	
19.5		63	
20		64	
20.5		65	
21		66	
21.5		67	
22		68	
22.5		69	
23		70	
23.5		71	
24		72	

Spp:	
Gear:	
IN/OUT:	
FA/FT:	

1		26	
1.5		27	
2		28	
2.5		29	
3		30	
3.5		31	
4		32	
4.5		33	
5		34	
5.5		35	
6		36	
6.5		37	
7		38	
7.5		39	
8		40	
8.5		41	
9		42	
9.5		43	
10		44	
10.5		45	
11		46	
11.5		47	
12		48	
12.5		49	
13		50	
13.5		51	
14		52	
14.5		53	
15		54	
15.5		55	
16		56	
16.5		57	
17		58	
17.5		59	
18		60	
18.5		61	
19		62	
19.5		63	
20		64	
20.5		65	
21		66	
21.5		67	
22		68	
22.5		69	
23		70	
23.5		71	
24		72	

Spp:	
Gear:	
IN/OUT:	
FA/FT:	

1		26	
1.5		27	
2		28	
2.5		29	
3		30	
3.5		31	
4		32	
4.5		33	
5		34	
5.5		35	
6		36	
6.5		37	
7		38	
7.5		39	
8		40	
8.5		41	
9		42	
9.5		43	
10		44	
10.5		45	
11		46	
11.5		47	
12		48	
12.5		49	
13		50	
13.5		51	
14		52	
14.5		53	
15		54	
15.5		55	
16		56	
16.5		57	
17		58	
17.5		59	
18		60	
18.5		61	
19		62	
19.5		63	
20		64	
20.5		65	
21		66	
21.5		67	
22		68	
22.5		69	
23		70	
23.5		71	
24		72	

Spp:	
Gear:	
IN/OUT:	
FA/FT:	

1		26	
1.5		27	
2		28	
2.5		29	
3		30	
3.5		31	
4		32	
4.5		33	
5		34	
5.5		35	
6		36	
6.5		37	
7		38	
7.5		39	
8		40	
8.5		41	
9		42	
9.5		43	
10		44	
10.5		45	
11		46	
11.5		47	
12		48	
12.5		49	
13		50	
13.5		51	
14		52	
14.5		53	
15		54	
15.5		55	
16		56	
16.5		57	
17		58	
17.5		59	
18		60	
18.5		61	
19		62	
19.5		63	
20		64	
20.5		65	
21		66	
21.5		67	
22		68	
22.5		69	
23		70	
23.5		71	
24		72	

24.5		73	
25		74	
25.5		75	

24.5		73	
25		74	
25.5		75	

24.5		73	
25		74	
25.5		75	

24.5		73	
25		74	
25.5		75	

Reproductive State Recording Form (RS1)

Sluice Gate: _____ Species: _____ Month: ____ Year: ____

a) INSIDE SLUICE GATE

Sample	Day (DD)	Gear Type	Gear Orientation (FA / FT)	Fork Length (cm)	Sex (?, M, F)	Maturity Stage (I,M,R,S)	Total Weight (g)	Gonad Weight (g)	Comments
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

b) OUTSIDE SLUICE GATE

Sample	Day (DD)	Gear Type	Gear Orientation (FA / FT)	Fork Length (cm)	Sex (?, M, F)	Maturity Stage (I,M,R,S)	Total Weight (g)	Gonad Weight (g)	Comments
1									
2									
3									
4									
5									
6									
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SPECIES CODES

SPPCODE	SPPNAME	SPPLATIN	SPPLOCAL	KEYSPP
AB	-0-	*Anguilla bengalensis*	Bamosh	No
ABO	-0-	*Apocrytes bato*	Chiring	No
AC	-0-	*Ailia coila*	Kajuli	No
AM	-0-	*Amblypharyngodon mola*	Mola	No
AMR	Aspidoparia morar	*Aspidoparia morar*	Piali	No
AP	-0-	*Aplocheilus panchax*	Kanpona	No
AT	Climbing perch	*Anabas testudineus*	Koi	No
BB	-0-	*Badis badis*	Napit koi	No
BBS	-0-	*Bagarius bagarius*	Baghair	No
BD	-0-	*Botia dario*	Rani	No
BN	-0-	*Brachygobius nunus*	Nanubaila	No
C	Carps	*-0-*	-0-	No
CA	-0-	*Crabs*	Kakra	No
CB	Air breathing catfish	*Clarias batrachus*	Magur	No
CBS	-0-	*Chanda baculis*	Chanda	No
CC	Catla	*Catla catla*	Catla	Yes
CCA	Square headed catfish	*Chaca chaca*	Kawa (chaca)	No
CCO	Common carp	*Cyrpinus carpio*	Carpo	No
CCS	-0-	*Chela cachius*	Chep chela	No
CF	Gouramy	*Colisa fasciatus*	Koia (Khalisha)	No
CG	-0-	*Clupisoma garua*	Ghaira	No
CGA	CHANNA GACHUA	*Channa gachua*	Tila taki	No
CGP	-0-	*Clarias Gariepinus*	-0-	No
CI	Grass Carp	*Ctenopharyngodon idella*	-0-	No
CL	-0-	*Chela laubuca*	Kash Khaira	No
CLA	Dwarf gouramy	*Colisa lalia*	Boisha	No
CLS	-0-	*Crossocheilus latius*	Kalabata	No
CM	Spot-tailed snakehead	*Channa marulius*	Gajar	No
CMA	Mrigal	*Cirrhina mrigala*	Mrigal	No
CN	Glass Perch	*Chanda nama*	Chanda	No
CP	Spotted snakehead	*Channa punctatus*	Taki	Yes
CR	Cirrhinus reba	*Cirrhinus reba*	Raik	No
CRA	-0-	*Chanda ranga*	Lal chanda	No
CS	Banded snakehead	*Channa striatus*	Shol	Yes
CSA	-0-	*Colisa sota*	Kholisha	No
CSN	-0-	*Corica soborna*	Kachki	No
DD	-0-	*Danio devario*	Chebli	No
DDA	-0-	*Danio dangalia*	Naptani	No
DR	-0-	*Danio rerio*	Anju	No
ED	-0-	*Esomus danricus*	Darkina	No
EV	-0-	*Eutropiichthys vacha*	Bacha	No
GC	? clupeid	*Gudusia chapra*	Chapila	No
GCA	-0-	*Gagata cenia*	Kauwa	No
GG	? goby	*Glossogobius giuris*	Bailla, Baliara	Yes
GN	-0-	*Gagata nangra*	Gang tengra	No
GV	-0-	*Gagata viridescens*	Gang tengra	No
GY	-0-	*Gagata yousoufi*	Kaiakata	No
HF	Stinging catfish	*Heteropneustes fossilis*	Shing	No
HI	Hilsa ilisha	*Hilsa ilisha*	Ilish	No

SPPCODE	SPPNAME	SPPLATIN	SPPLOCAL	KEYSPP
HM	Silver Carp	*Hypophthalmicthys molitrix*	Silver	No
HT	-0-	*Hilsa toli*	Chandana ilish	No
LB	-0-	*Labeo bata*	Bata	No
LC	? carp	*Labeo calbasu*	Kalbashu	No
LG	-0-	*Lepidocephalus guntea*	Gutum	No
LGS	-0-	*Labeo gonius*	Gonia	No
LN	-0-	*Labeo nandina*	Nandina	No
LR	Rohu	*Labeo rohita*	Rui	No
MA	Giant mystus	*Mystus aor*	Ayre	No
MAR	-0-	*Mastacembelus armatus*	Bara baim	No
MAS	-0-	*Macrognathus aculeatus*	Tara baim	No
MB	-0-	*Mystus bleekeri*	Gulsha tengra	No
MC	-0-	*Mystus cavasius*	Gulsha tengra	No
MCA	Mugil cascasia	*Mugil cascasia*	Dub khorsula	No
MP	Spiny eel	*Mastamcembelus pancalus*	Baim	No
MR	MACROBRACHIUM ROSENBERGII	*Macrobrachium rosenbergii*	Golda chingri	No
MS	-0-	*Mystus seenghala*	Guizza	No
MT	-0-	*Mystus tengra*	Bajari tengra	No
MV	Striped mystus	*Mystus vittatus*	Tingra / Tengra	No
NB	-0-	*Nemacheilus botia*	Balichata	No
NC	-0-	*Notopterus chitala*	Chital	No
NN	Grey featherback	*Notopterus notopterus*	Kalna (foli)	No
NNS	Mud perch	*Nandus nandus*	Bera, Meni	No
OB	Silurid (glass) catfish	*Ompok bimaculatus*	Pabda	No
OBR	-0-	*Ophichthyes boro*	Boro baim	No
OBS	OPESTERNON BENGALENSIS	*Opesternon bengalensis*	Bamus	No
OM	-0-	*Oreochromis mossambica*	Tilapia	No
ON	-0-	*Oreochromis nilotica*	Nilotica	No
OP	-0-	*Ompok pabo*	Madhu pabda	No
OT	Other species	*Other species*	Others	No
PA	-0-	*Pseudeutropius atherinoides*	Batasha	No
PC	-0-	*Puntius conchonius*	Canchon puti	No
PCA	-0-	*Puntius chola*	Chola puti	No
PG	-0-	*Puntius gelius*	Geli puti	No
PG0	-0-	*Puntius gonionotus*	-0-	No
PI	-0-	*Platycephalus indicus*	Mur baila	No
PL	-0-	*Pseudapocryptes lanceolatus*	Chewa	No
PP	Pangasius pangasius	*Pangasius pangasius*	Pangas	No
PPA	-0-	*Pama pama*	Poa	No
PPO	-0-	*Puntius phutunio*	Phutuni puti	No
PS	Spotfin swamp barb	*Puntius sorphore*	Jat puti	Yes
PSA	-0-	*Puntius sarana*	Sar puti	No
PT	-0-	*Puntius ticto*	Tit puti	No
PU	Asian barbs	*Puntius spp*	Puti	No
RC	-0-	*Rhinomugil corsula*	Khorsula	No
RCO	ROHTEE COTIO	*Rohtee cotio*	Dipali	No

SPPCODE	SPPNAME	SPPLATIN	SPPLOCAL	KEYSPP
RD	-0-	*Rasbora daniconius*	Darkina	No
RR	Rita rita	*Rita rita*	Rita	No
RRA	Rasbora	*Rasbora rasbora*	Darkina	No
SA	-0-	*Scatophagus argus*	Bishtara	No
SB	-0-	*Salmostoma bacaila*	Katari, Chela	No
SF	-0-	*Salmostoma phulo*	Fulchela	No
SG	-0-	*Securicula gora*	Gang chela, Chora chela	No
SGN	-0-	*Somileptes gongota*	Ghorpuiya	No
SH	Shrimps	*Shrimp/prawn spp*	Icha, Chingree	No
SP	-0-	*Setipinna phasa*	Phasa	No
SR	-0-	*Sisor rhabdophorus*	Sisor	No
SS	-0-	*Silonia silonia*	Shillong	No
TB	-0-	*Taenioides buchanani*	Raja chewa	No
TC	Puffer fish	*Tetraodon cutcutia*	Potka	No
TL	-0-	*Turtle / tortoise*	Kashim	No
WA	Giant silurid catfish	*Wallago attu*	Boal	Yes
XC	Round-tailed garfish	*Xenentodon cancila*	Kakila	No

GEAR CODES

GEAR CODE	GEAR NAME
AT	Active trap
BN	Bag Net
CL	Clap Net
CN	Cast Net
DG	Drift Gill Net
DN	Drag Net
DW	Dewatering (FP)
FG	Fixed Gill Net
HF	Hand Fishing
HK	Unattended Hook
HL	Attended Hook
JT	Jumping Trap
KT	Brushpile (Katha)
KU	Dewatering (Kua)
LL	Long Line
LN	Lift Net
PN	Push Net
PT	Passive Trap
SN	Seine Net
SP	Spear
SV	Savar Seine Net
UC	Ucha Bag Net

SLUICE GATE CODES

SLUICE GATE CODE	SLUICE GATE NAME	RIVER NAME	FLOOD CONTROL SCHEME	DISTRICT
BK	BAULIKHOLA	NATUABARI CANAL	PIRDP	PABNA
TG	TALIMNAGAR	BADAI RIVER	PIRDP	PABNA
JN	JUGNI	LOHAJANG	CPP	TANGAIL

PRELIMINARY FISH MARKING LOCATION KEY

SPPCODE	MARKING LOCATION	EQUIVALENT LEFT/RIGHT	RELEASE LOCATION
CR	THROAT (UNDERSIDE)	LEFT	INSIDE
CR	TAIL AT CAUDAL REGION (RIGHT SIDE)	RIGHT	OUTSIDE
MT	TAIL ABOVE ANAL FIN (LEFT SIDE)	LEFT	INSIDE
MT	TAIL ABOVE ANAL FIN (RIGHT SIDE)	RIGHT	OUTSIDE
PS	THROAT (UNDERSIDE)	LEFT	INSIDE
PS	TAIL AT CAUDAL REGION (RIGHT SIDE)	RIGHT	OUT
…etc			

Examples

Recording Catch/Effort Data on form CE1: An Example

The following CE1 data form is shown as an example of how CE data should be recorded. In this example, three fishermen have been interviewed about their catches at Talimnagar sluice gate during the day of the 5th of June 2003:

- Fisherman "A" fished a bag net (code BN) with two colleagues for four hours inside and facing towards the sluice gate. They caught 5.2kg of fish between them. Fisherman "A" then went on to recover his 8 passive traps which had been in the water in the same location and orientation for approximately 5 hours and caught 2.1kg of fish.

- On the same day, Fisherman "B" spent 2 hours fishing his $6m^2$ liftnet outside the sluice gate and facing away from it, and caught only 0.8kg of fish.

- Fisherman "C" had been fishing a 5m long jumping trap with a colleague for 3 hours at the time of the interview and had caught 8kg of fish. The gear was also set outside and facing away from the sluice gate. Fisherman "C" and his colleague planned to fish for another 2 hours after the interview.

Fishing gear types should be carefully defined in the Gear Type, Size and Mesh/Gape columns. Mesh sizes should be measured as the knot-to-knot distance of one diamond of mesh stretched taught. Sizes are particularly important for gill nets, where the length is part of the effort measure (Table 1).

The column for Hours Fishing is crucial to the effort measure for seines, lift nets, cast nets and spears, but should also be entered for other gears. The numbers of units of gear are the most essential effort measures individual traps (and non-interceptory gears such as hooks). All cells should, however, be filled in whenever possible.

Key points for completing the CE2 data recording form

- *Each fisherman or fishing team operating within the vicinity of the sluice gate should always be interviewed once per day* and ticked off on the *checklist* once they have been interviewed.

- Fisherman should be asked to recall their CEs for each gear they fished during the day.

- A separate row should be used for the CE data for each different fishing gear used by each fisherman or team of fishermen during the day.

- When the respondent fishes a gear as a *member of a team*, CE data should relate to the full equipment of the team, and the team size should be recorded.

- Suitable *codes* should be developed for the respondents, gear types and locations, and only these codes should be used on the forms.

Recording Length Frequency Data on Form LF1: An Example

The following LF data form is shown as an example of how LF data should be recorded.

In this example of a single day's LF sampling at Talimnagar sluice gate market, fish were measured from fisherman's catches from a liftnet and a bagnet. The lift net was fished outside and facing towards the sluice gate and the catch comprised fish of three different key species, *Puntius sophore*, *Glossogobius giurus*, and *Labeo rohita*. The bang net which was fished inside the and facing away from the sluice gate and catches contained only *Gudusia chapra*.

Key points for LF data recording forms

- Samples from different *days* and different *sluice gates* should be recorded on separate *forms*.

- Samples of different *fish species, gear types* and *capture locations or gear orientations* should be recorded in separate *columns*.

- Suitable *codes* should be developed for the gear types and locations, and only these codes should be used on the forms.

- The *fork length* of fish should be measured, ie from the snout to the fork of the tail. For round-tailed fish, this will be equivalent to the total length.

- Small fish (maximum lengths up to 25cm) should be measured to the *nearest ½cm below.* Large fish (maximum lengths over 25cm) should be measured to the *nearest 1cm below*, ie:

Small fish in ½cm classes	Larger fish in 1cm classes
1.0 - 1.49 = 1	26 - 26.99 = 26
1.5 - 1.99 = 1.5	27 - 27.99 = 27
2.0 - 2.49 = 2	28 - 28.99 = 28
etc	etc

- Measurements should be recorded in the appropriate boxes, by adding ticks in groups of five, thus 𝍸. This enables easy tallying during subsequent data entry.