Government of the Peoples Republic of Bangladesh
Flood Action Plan

FAP 17

Fisheries Studies
and
Pilot Project

FINAL REPORT

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Supporting Volume
No. 11

FISHERIES STUDY

MOVEMENTS OF FISH HATCHLINGS

ODA
Overseas Development Administration, U.K.

FAP 17

FINAL REPORT

SUPPORTING VOLUME NO. 11

** Draft **

FISHERIES STUDY

A-24

MOVEMENTS OF FISH HATCHLINGS

FAP 17
FISHERIES STUDIES
AND PILOT PROJECT

June, 1994

Funded by ODA in conjunction with the Government of Bangladesh

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ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of variance
cm	centimetre(s)
DoF	Department of Fisheries
FAP 17	Flood Action Plan Study No. 17 (Fisheries Studies and Pilot Project)
FAP 20	Flood Action Plan Study No. 20 (Compartmentalization Pilot Project)
FCD/I	Flood Control and Drainage with or without Irrigation
FPCO	Flood Plan Coordination Organization
GoB	Government of Bangladesh
H.Q.	Headquarters
HS	Highly significant
km	kilometre(s)
m/sec	metre per second
m	metre(s)
MIP	Manu Irrigation Project
MIS	Marginally insignificant
mm	millimetre(s)
NC	North Central
NE	North East
NS	Not Significant
NW	North West
ODA	Overseas Development Administration
PC	Percentages
PWD	Public Works Department Dutum
SHP	Shanghair *Haor* Project
SIG	Significant

ACKNOWLEDGMENTS

This report is based on the concerted efforts of a large number of people whose responsibilities covered: field data collection; administrative support; entry of data into computers; management of databases; analyses and interpretation of results, and report preparation.

Under the guidance of a senior fisheries supervisor, fisheries biologists, directly recruited by the project or provided through temporary employment by the Department of Fisheries, were responsible for the collection of fisheries, hydrological and limnological data. Field survey schedules required the team to monitor fishing activities from dawn to dusk, 12 hours each day, with additional surveys carried out before dawn to monitor night fishing. That the team accomplished its objectives despite arduous working conditions and long, unsocial hours of work, warrants the highest recognition and is a credit to both the team and the senior fisheries supervisors, Drs. Bhouyain, Islam and Wahab, who were responsible for maintaining not only discipline and high quality survey work but also team morale. The achievements of the FAP 17 fisheries survey teams demonstrated that it is possible in Bangladesh to obtain detailed quantitative fisheries appraisals based on the direct monitoring of fishermen's activities on water.

Administrative support staff and computer operators both in the field station and in Dhaka headquarters were responsible for the smooth running of the field programme and ensured that data were entered into the database promptly and accurately.

Mr. Asaf Hussain, senior computer programmer, was responsible for database management and programming and worked closely with Drs. James Scullion and Bernadette McCarton on data analyses. Fisheries resource assessment specialists, Professor John Beddington and Dr. Geoffrey Kirkwood of the Marine Resource Assessment Group, Imperial College, London, UK, advised on the statistical methods for the analysis of catch rates of gears which formed the basis of comparisons of fish catches inside and outside the flood control project.

Mr. Goutam Chandra Dhar, computer specialist, and a small team in Dhaka, were responsible for the preparation of the report.

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PREFACE

The Fisheries Studies and Pilot Project (FAP 17) was funded by the British Overseas Development Administration (ODA) in conjunction with the Government of Bangladesh. The national implementing agency for the Fisheries Studies was the Department of Fisheries of the Ministry of Fisheries and Livestock. FAP 17 also reported to the Flood Plan Coordination Organisation of the Ministry of Water Resources. The project was one of a number of supporting studies of a broader programme known as the Flood Action Plan (FAP) of Bangladesh. The FAP consisted of a series of major engineering and other studies.

FAP 17 was designed to address issues relating to fisheries and aimed to collect, analyse and interpret information with which to make predictions of the impacts of the planned flood control action upon the inland capture fisheries of Bangladesh. To do this, quantitative baseline fisheries and socioeconomic data were collected from inside and outside a range of flood control projects in four regions of the country.

A total of eight FCD/I projects was studied under FAP 17 and the results of each study were documented in a series of Supporting Volumes (Fisheries Studies) of the project Draft Final Report (see list of reports on page xiii). Two studies investigated the movements of a) adult and juvenile fish and b) fish hatchlings in regulated and unregulated rivers.

The present report is concerned with the study of b. Data on hatchling movements, water velocity and water level were collected for some rivers in three regions. Seasonal distribution of hatchling rates, the species composition of hatchling catches, distributional patterns of hatchling rates along horizontal and vertical cross-sections of rivers, the relationship between density difference and head difference and the impact of water regulators (sluice gates) on the flow of fish fries etc. are the topics of detailed investigations in this study.

Descriptions of the methods employed for field data collection, laboratory studies and analyses of data are provided in Appendix 3 of the Draft Final Report.

Two taxonomic guides were used for the identification of fish found during this study. The first was Rahman, A. K. A. 1989, Freshwater Fishes of Bangladesh, published by the Zoological Society of Bangladesh. The second was Talwar, P. K. and Jhingran, A. G. 1991, Inland Fishes of India and Adjacent Countries, Vols. 1 and 2, published by Oxford and IBM Publishing Co. Ltd. The more recent guide was used to provide a systematic listing of the scientific names of fish. However, the guide by Rahman was used more widely by fisheries biologists and all Bengali names of fish used in the present report were derived from this guide. The FAP 17 database also provides comprehensive lists of local names of fish collected in each region studied.

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The numbers of species recorded depended on the sampling effort deployed. No doubt more species would have been recorded had more sites or gear units been sampled more often using larger sub-samples of catches.

The source of all tables and figures presented in this report, unless otherwise stated, is from data collected by FAP 17 fisheries surveys.

SUMMARY OF THE FINDINGS

A. SEASONAL DISTRIBUTION OF HATCHLING RATES

Dhaleswari River in North Central Region

An extensive survey was undertaken for this site.

1. The pattern of hatchling density over survey dates is similar to that of hatchling number per hour with little variation in the two rates. This implies that there is little need to collect data on water velocity for computing hatchling density as well as hatchling number per hour.

2. The water level is more or less steady during the flood time but its velocity fluctuates frequently during the day. Hatchling density and hatchling number per hour, both having random fluctuations over time, are not found to be related to water velocity or water level.

3. There are two high flows of hatchlings; one in June and July at the beginning of the monsoon and the other in October and November after the monsoon. It is observed that the later hatching supply is usually much larger in size and duration. The later higher hatchling flow appears to have come from the offspring of the first generation of fish, which matured during the monsoon season.

4. *Kachki* species makes up more than 87% of the total density for 1993 on average for 2 nets. When *kachki* is excluded, 5 species out of 60 make up more than over 77% of the total density for net 1 (near the bank) and 6 species out of 66 account for more than 76% for net 2 in 1993. *Nama chanda* is the most dominant followed by *chingri/icha* and *bailla* for both nets. *Bata* and *kajuli* are the next most important for net 1 and *kajuli*, carp and *lal chanda* for net 2.

5. For 1992, *kachki* contributes 95.2% to the total hatchling rate.

   Only 8 species out of 105 make up 82% of the total hatchling rate excluding *kachki*. Dominant species have more or less similar patterns over the survey dates except carp.

6. Species composition varies widely between two years, 1992 and 1993, and also between months of the same year.

7. Fish hatchlings usually flow in larger numbers near the bank of the river than away from the bank except for November. Average densities differ significantly between 2 nets for August and October to December, 1993. Hatchlings drift along the river is in swarms.

8. The number of species is usually larger in June, July and September than other months. The number of species for net 2 is usually larger than those of net 1 (near the bank) for different months.

Padma River at Charghat in North West Region

An extensive survey was undertaken for this site on the major river.

9. As in the case of the Dhaleswari River, it is observed for the Padma River that the pattern of hatchling density is about the same as that of hatchling number per hour for 2 years; 1992 and 1993, with some exceptions, especially at the end of the monsoon when water velocity was high. The pattern of hatchling rates however varies widely between the two years. 1992 hatchling rates fluctuate more than those of 1993.

10. Hatchlings flow in waves or swarms and water velocity fluctuates randomly. There is hardly any relationship between hatchling rates and water velocity or more stable water levels for both years.

11. Peaks hatchling rates are observed in July, August and October, 1993. The hatchling flow from the breeding of first generation fish at the end of the monsoon is quite high. For 1992, higher density peaks occur in September and October. Those of July were missed due to the late start of hatchling survey.

12. Density patterns patterns of most dominant species are similar to those overall. For this major river, carp densities are high in late July and mid-August, and decreases sharply after September.

13. *Chingri/icha* is the most dominant species for this site, accounting for 35.6% and 29.1% of the total density in 1993 and 1992 respectively. *Kachki*, carp and *bata* are

also dominant, contributing much less in 1993, and *bata*, *bailla* and *nama chanda* for 1992. Species compositions vary widely between months over the 2 years.

14. 9 and 11 species, out of a total of 93 and 146 respectively, make up 73% of the total density for 1993 and 1992.

15. The average number of species does not vary much between months for 1993 but it varies considerably for 1992. The average number of species by month is much higher for 1992 than 1993.

Surma River in North East Region

The hatchling survey started in March and continued up to August, 1993 in 2 sites at Sylhet and Sunamganj. There are few records.

16. There is no apparent relationship between hatchling rates and water velocity or water level except for a large hatchling flow with the onrush of water at the beginning of the monsoon.

17. It is again observed here that the patterns of hatchling density and hatchling number per hour are similar for both sites, with a few exceptions.

18. Distributions of hatchling rates over dates varies somewhat between the two sites.

19. High hatchling flow occurs in mid April and early June for the Sylhet site and in May for the Sunamganj site. Hatchling flow dies down after 3rd week of June at both sites. It appears that hatchling drift starts early in the Surma River and there is no late season hatchling flow, as is the case with Dhaleswari and Padma rivers.

20. Average monthly hatchling densities are about the same for the two sites except for May when the average density at Sunamganj site is significantly higher than that at Sylhet. Average densities are low after May for both sites.

21. Species composition differs widely between the two sites. While unidentified *bele* has maximum PC of density for both sites, *bailla* is equally important for Sylhet, followed by *nama chanda*. For Sunamganj, *chingri/icha*, carp and *chanda* are the next dominant. Densities of dominant species are similar to the overall density over

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survey dates except for carp and *bailla*, for which hatching flow comes late in the 3rd week of May and stops after middle of July.

22. 5 species make up more than 63% of the total density for the Sunamganj site, which has 52 species in all. 8 species out of 34 account for 86% of the total density at the Sylhet site.

23. Species composition varies widely between months for both sites. Unidentified *bele* dominates in early months, *bailla* and *chanda* in later months.

24. The number of species per day is high in May and early June for the Sunamganj site and in April and May for the Sylhet site. The former site has much higher numbers with longer duration than latter site. The number of species fluctuates over dates for both sites.

Kushiyara River in North East Region

25. Hatchling data were collected for the Kushiyara River at 2 sites in the Sherpur and Fenchuganj areas. Data were collected for the Sherpur site from March to August and for Fenchuganj site for July and August only. The sample size was small for the latter site.

26. The pattern of hatchling density over the survey dates is similar to that of hatchling number per hour, as seen before. The patterns of dominant species are similar for the 2 sites.

27. It appears that there is some positive relationship between density and water velocity after March at Sherpur site. No relationship appears to be present between water level and hatchling rate.

28. There are significant differences of average densities between 2 sites for July and August. There is no after-monsoon influx of hatchlings for Kushiyara River also.

29. Species composition varies widely between 2 sites. *Bata* and unidentified *bele* are the most dominant at Sherpur site, followed by unidentified species (920) and *chanda*. *Nama chanda* is the most dominant species for Fenchuganj site, followed by *kachki*. *Fulchela* and *chingri/icha* are also important for this site.

30. Only 5 species contribute more than 87% of the total density for Sherpur, which has 70 species in total. 7 species out of 25 make up more than 77% of total density at the Fenchuganj site.

31. Species composition varies widely between months at Sherpur. *Bata* and *chanda* dominate in the first 3 months, *chanda* and *chingri/icha* in the last 3 months.

32. The average number of species per day is much higher for the Sherpur site than the Fenchuganj site. The number of species is higher in late April to late June than in other months for this site.

B. HATCHLING DISTRIBUTION ALONG CROSS-SECTIONS OF LOHAJANG RIVER IN THE NORTH CENTRAL REGION

There was an extensive survey of this site from June to early October, 1993.

1. Hatchlings flow in waves or swarms with peak flow occurring in June, July and September for both horizontal and vertical nets. In addition to early the high influx of hatchlings, there is a second generation of hatchling flow especially for surface nets in September and October, and this latter flow is quite high and prolonged.

2. Hatchling flow just below water surface (for surface nets) is much higher than that further down the water column for below-surface nets. This indicates that fish larvae mostly drift along the water surface. For bottom nets, hatchling flow is found to be quite high near the middle of river in September when these data were collected.

3. Average weekly hatchling density has a cyclical pattern every 3/4 weeks for both surface and below-surface nets.

4. Hatchling density varies significantly in both horizontal and vertical directions.

5. Monthly (temporal) variation of average density is highly significant for both horizontal and vertical nets.

6. Average density does not usually vary significantly between two nearby points within the same layer of the water column.

7. *Kachki* is the most dominant species for surface (horizontal) nets comprising about 91% of total density. *Chingri/icha* and *lal chanda* have only over 2% contributions each.

8. The percent composition of most dominant species, excluding *kachki*, produces *chingri/icha*, *lal chanda*, *nama chanda* and *bailla* as dominant. 5 species out of 71, excluding *kachki*, making up 81.8% of total density.

9. For below-surface nets, *kachki* is still the most dominant, althrough it accounts for only 32% of total density. *Bailla* and *chingri/icha* are the next most important species.

10. For these nets, percent compositions of the most dominant species excluding *kachki* show that *bailla*, *chingri/icha*, carp, and *kajuli* are dominant. 7 species out of 73, excluding *kachki*, make up 85.6% of total density.

11. For bottom nets, *chingri/icha* is the most dominant species contributing more than 69% of the total density. *Gang tengra* is the next most important species followed by *kachki*.

12. Dominant species varies widely among the months especially for below-surface nets.

13. Carp appears as a dominant species (14.4% excluding *kachki*) for below-surface nets only. This contrasts with the high flow of most of other fish larvae along the water surface.

Comparison of Densities between FAP 17 and FAP 20 Sites of Lohajang River

14. Average daily densities are usually somewhat larger for FAP 20 than FAP 17. The main reason for this appears to be that mesh size was smaller for FAP 20 nets than for FAP 17 nets so that more larvae were caught at the FAP 20 site.

15. Paired comparison by survey date shows that differences in mean densities of the two FAPs are not usually significant. For carp however, significant differences exist between the 2 FAPs between June to August.

Comparison of densities between Lohajang River and Dhaleswari River sites

16. The pattern and extent of daily average density are similar for the 2 rivers for horizontal nets during the common period of the hatchling survey. Comparison of the average densities of horizontal nets between 2 rivers gives a significant difference for September only when hatchling flow was at a minimum.

17. Carp densities are somewhat higher for the Dhaleswari River than for the Lohajang.

C. IMPACT OF WATER REGULATORS ON HATCHLING FLOW

Charghat regulator on Baral River in North West Region

An extensive hatchling survey was undertaken for this regulator.

1. Average monthly densities are mostly significantly higher outside (upstream of) the regulator than inside (downstream). The situation is similar for dominant species. This indicates that the regulator has an adverse effect on the free passage of fish fries through this regulator from the Padma River into the Baral River.

2. Patterns of density difference and head difference over survey dates are different and there is hardly any relationship between them for either year.

3. There is, however, a significant positive relationship between density difference and head difference for head difference > 1.0 metre in 1993. That is, the higher the head difference, the higher the density difference.

4. The overall percentages of dead fries were 13.2 and 2.2 inside and outside the regulator respectively, for the whole season in 1993. Similar differences in percentages of dead fries exist between the inside and outside for the majority of species for all months except July. This implies that the regulator destroys a considerable percentage of fish larvae in the course of their drift through the gates. *Bailla*, *nama chanda*, *gang tengra*, *chanda* and *bata* are the most affected species. Surprisingly, carp hatchlings do not appear to be affected.

5. Dominant species vary considerably between the 2 sides of the regulator and over the 2 years, 1992 and 1993. *Chingri/icha* is the most dominant species, contributing

between 18% and 35% to total densities for inside and outside for 2 years. *Bailla*, *bata*, *chanda* and *kachki* are also important species for 1992, and *bata*, carp and *kachki* for 1993.

6. 5 or 6 species account for more than 61% of total density for both sides having over 130 species in 1992. And 4 or 5 species contribute 45% and 62% to total density for inside and outside respectively having over 90 species, in 1993.

Bauitara regulator on Old Hurasagar River in North West Region

Number of records are much smaller for this site than Charghat.

7. The overall average densities are significantly higher outside the regulator than inside for September and October. Surprisingly, a significant difference is observed between the 2 sides in reverse order for June and July.

8. Dominant species are similar for both sides with *kachki* comprising more than 80% and 87% of total density inside and outside respectively. *Chingri/icha* and unidentified *bele* are the next most dominant species for both sides.

9. 4/5 species account for more than 64% of total density for both sides which have more than 40 species excluding *kachki*.

Talimnagar regulator on Badai River in North West Region

Sample sizes are small for this regulator.

10. Average overall densities are quite low for both sides of the regulator. A significant difference however exists between average densities outside and inside for August and all 4 months together.

11. Dominant species differ somewhat between the 2 sides of the regulator with *chingri/icha* having the highest contribution of over 27% to the total density for both sides. *Nama chanda*, carp, *chanda* and *nuna bailla* are also important species for the inside, and carp, unidentified *bele* and *lal chanda* for the outside.

12. 6 and 5 species make up more than 72% and 63% of total density for the inside, which has 37 species and for the outside, which has 31 species.

Regulator on Khorodari Khal in Sherpur area in North East Region

Sample sizes are small for this regulator.

13. Average monthly densities are similar for the two sides of the regulator and there is no significant difference between average densities except in March.

14. Dominant species are the same for the two sides but their percentage compositions of density differ widely. *Chingri/icha* and *lal chanda* are the most dominant species for the outside and inside respectively. *Lal chanda* and *chanda* are the next most important species for the outside and *chingri/icha*, followed by *chanda*, for the inside.

15. 4 species account for more than 87% of total density both inside and outside, which have 9 and 16 species respectively in total.

Regulator on Lumardai River in North East Region

Sample sizes are small for this regulator also.

16. Average monthly densities are similar on both 2 sides of the regulator and no significant difference exists between the 2 sides for either of the 2 months of the survey.

17. There are two highly dominant species for both sides but their importance differs widely. *Chingri/icha* and unidentified *bele* are the most dominant species for outside and inside respectively. These are also the second most important species for the two sides in reverse order.

18. 2 species out of 30 make up more than 95% of total density for both sides of this regulator.

IMPORTANT FINDINGS

1. Fish hatchlings flow in waves or swarms and the distribution of hatchling density fluctuates over the dates with frequent peaks and troughs.

2. The pattern of hatchling number per hour over the survey dates is found to differ little from that of hatchling density for all sites. This implies that there is little need to collect data on water velocity for computing hatchling density as well as another hatchling rate.

3. Hatchling rates with random fluctuations over dates are not related either to water velocity or water level.

4. In the North West and North Central regions there are two hatchling flows down the river; one in June and July at the beginning of the monsoon, and the other during September to November at the end of the monsoon. It is observed that the later hatchling drift is usually much larger and longer in duration than the earlier flow. The later hatchling flow appears to have come from the offspring of the first generation of fish, which matured during the monsoon time.

   For the North East Region however, hatchling flow usually starts early in March and ends in August. There are high peaks mostly in April and May and there is no late season high hatchling flow, unlike in the North West and North Central regions.

5. The number of species usually varies between 30 to 100 for different rivers. Only a few species (≤ 5) usually account for more than 70% of total density. *Kachki* alone contributes over 80% to total density for the Dhaleswari, Lohajang (surface nets) and Old Hurasagar rivers. The dominant species are usually small fishes and come from the following:

   kachki, *chingri/icha*, *chanda*, *bailla*, *kajuli*, *bata*, unidentified *bele*, *tengra* and *fulchela*.

6. Carp is not found to be a dominant species except at a few sites. For below-surface nets (0.3 m below water surface) set at Lohajang River, carp makes up 9.8% of total density. Its contributions are 8.4% and 6.6% for inside and outside the Charghat regulator on the Baral River. For Talimnagar regulator on Badai River, the percentage contributions of carp are 11.5 and 12.6 for inside and outside respectively. For other sites, carp density is not appreciable.

7. The Lohajang River study provides a more or less regular pattern of weekly average densities with an interval of three or four weeks, especially for surface (horizontal) nets.

8. Hatchling flow just below the water surface (surface nets) is much higher than that further down the water column for below-surface nets. This implies that fish larvae mostly drift along the water surface.

9. Hatchling density varies significantly in both horizontal and vertical directions.

10. Hatchling density usually varies significantly between months, having high values mostly in the early monsoon in all regions and at the end of the monsoon in the North West and North Central regions.

11. It appears from very limited data of one month (September) that the density at the bottom of the Lohajang River, is considerable. *Chingri/icha*, *gang tengra* and *kachki* are the dominant species here.

12. For the Charghat regulator on the Baral River, where sample size was considerable, densities outside the regulator are significantly higher than those inside for different months. For most other regulators, having much smaller sample sizes, densities outside are significantly higher than those inside for some months.

    Separate fish passes through the water, regulating dams over the rivers, are therefore desirable.

13. The Charghat study also shows that the water regulator (sluice gates) destroys a considerable percentage (11%) of fish fries in the course of their drift through the gates. This implies that regulators should be made fish-friendly. Overshot and retracted gates may be helpful to this end.

14. There is hardly any relationship between the patterns of density difference and head difference over dates for all regulators.

15. For the Charghat regulator, a significant positive relationship is observed between the two differences for head difference greater than 1.0 metre. This means that the higher the head difference, the higher the density difference.

1 INTRODUCTION

1.1 Background

Movement of fish fries from the main rivers on to the food-rich floodplain and *beel* through secondary rivers and *khal* is a regular phenomenon in this country during the monsoon season. In order to determine the nature, extent and amount of hatchling movement, a hatchling catch survey was undertaken for some rivers in three regions.

Tsai and Ali (1986) arranged a survey of spawning activities of major carps along the three main rivers: Jamuna, Brahmaputra and Padma. It was found that more than 93% of total carp fries had come from these three major rivers in 1984-85.

FAP 20 collected hatchling catch data at a site on the Lohajang River in Tangail district for one hour every day, from June, 1993 to August, 1995. It was observed that fish hatchlings move in waves or swarms and that there were high peaks in June, July and September.

Several other FAP projects considered mitigation measures against possible harmful effects of FCD/I projects on fish migration and production. Fish-friendly regulators, overshot and retracted gates and separate passageways (fish passes) were discussed in connection with the easy passage of fish larvae, especially during the early monsoon. A higher flow of water through the regulators induces more flow of hatchlings but this is contrary to the policy of increasing agricultural production by controlling water levels in the low-lying areas.

1.2 Present Hatchling Study

1.2.1 Need for the study

Investigations of downstream passive drift of fish hatchlings were carried out in all regions except the South West. The studies involved the collection of fish larvae in surface drift nets of known areas over measured time intervals and measured water velocities to provide quantitative estimates of supply rates and densities of different fish species under varying flow conditions.

Regulators and sluices play an important part in water control under FCD/I projects. Their role in allowing the passage of adult fish and hatchlings into canals and on to floodplains is very important in helping to ensure the replenishment of fish stocks. The effects of sluice operation on fish movement throughout the seasonal cycle of flooding has previously been little studied. Investigations were initiated on this subject because the successful migration of adult fish and hatchlings is key to the survival of the floodplain dependent species which form the major part of the catch from inland fisheries in Bangladesh.

The information is expected to be useful in assessing the impact of flood control embankments and regulators on fish movement at a critical stage of their life cycle prior to recruitment into subsistence and commercial fisheries. The results are also expected to help formulate mitigation measures by improvement in regulator design and operation to allow the passage of hatchlings on to their nursery grounds on the floodplains.

1.2.2 Sites for the hatchling catch surveys in the regions

North West Region

Investigation on hatchling movement started on the Baral River inside and outside the Charghat regulator in late August, 1992. The work was extended to other regulators at Bauitara on the Old Hurasagar River and Talimnagar on the Badai River in 1993. For the Charghat site, extensive data were collected for two years: 1992 and 1993. Nets were set up in pairs on either side (inside and outside) of the Charghat, Bauitara and Talimnagar regulators as shown in Figures 1.1, 1.2 and 1.3 (Appendix 1).

North Central Region

The hatchling catch experiments were carried out at sites on two rivers: the Dhaleswari and Lohajang. For the Dhaleswari site, data were collected for two years: 1992 and 1993. For the Lohajang River, hatchling catch data were gathered for 1993 only but investigation was extensive using several horizontal, vertical and bottom nets. Locations of sampling sites, net positions etc. are shown in Figures 1.4 and 1.5, of Appendix 1.

North East Region

There were 18 sites in all for hatchling catch surveys in this region. Several rivers/*khal* were involved, including the Surma, Manu, Kushiyara and Juri rivers. Data were collected for inside and outside of 2 rivers/*khal*. The hatchling experimental sites were mainly located in and around three large *haor* - Shanghair, Dekker and Hakaluki - and the Manu Irrigation

Project (MIP). Two sites were located on the Surma River near Sylhet and Sunamganj towns. For many sites, the amount of collected data and durations of the survey were scanty. Locations of the sampling sites and net positions are shown in Figures 1.6, 1.7, 1.8, 1.9, 1.10, and 1.11 of Appendix 1.

1.2.3 Year and duration of surveys

Usually, hatchling catch surveys were undertaken from the time water began to flow at the sites until it stopped or up to the time fries were not found in the net. However, for practical reasons, starting and ending times varied between sites and regions. Table 1.1. shows the years and durations of hatchling catch surveys for the sites which are included in the analysis here.

Table 1.1 Durations of hatchling catch experiments by region and site

Region	Regulator/River	Year	Duration of survey	
			From	To
North West	Charghat	1992	July	November
		1993	July	October
	Bauitara	1993	June	October
	Talimnagar	1993	July	October
North Central	Dhaleswari	1992	June	December
		1993	June	December
	Lohajang	1933	June	October
North East	Surma (Sunamganj)	1993	March	August
	Surma (Sylhet)	1993	March	August
	Kushiyara (Sherpur)	1993	March	August
	Kushiyara (Fenchuganj)	1993	July	August
	Khorodari (In)	1993	March	June
	Khorodari (Out)	1993	March	June
	Lumardai (In)	1993	March	April
	Lumardai (Out)	1993	March	April

2 OBJECTIVES

Since no large-scale survey on hatchling movement from rivers to floodland has been undertaken before, the FAP 17 hatchling catch survey may be regarded as a baseline survey in many respects. Its main objectives are as follows.

2.1 Baseline Features of Hatchling Movement and Seasonal Distribution

Hatchling drift data were collected for some rivers for some days in each month during the monsoon season. The collected data are expected to throw light on the number and extent of passage of fish fries through the rivers. Examination of seasonal variations and species compositions is likely to provide insight into temporal distribution of fries and clustering of species.

2.2 Baseline Data on Distribution of Fries over River Cross-Sections

Hatchling flow data were collected along horizontal, vertical and top-bottom directions for a site on the Lohajang River. The data will provide some basic comparisons of hatchling rates along these directions in addition to findings on seasonal variations and species compositions.

2.3 Impact of Water Regulators on Hatchling Movement

Some rivers with regulated water flow were selected to collect hatchling data on two sides of the regulators. In order to observe the impact of regulators, hatchling rates will be compared between the two sides of the regulators. The relationship between water level difference and differences in numbers of fries will also be examined.

For the Charghat regulator, data collected on the number of dead fries at both sides are to be used to examine the effect of the regulator on the mortality of fish larvae during their transit through the sluice gates.

3 METHODS

3.1 Data Collection

Methods of data collection on hatchling flow are stated below for the three regions.

3.1.1 North West Region

For this region, hatchling catch data were collected at the Charghat regulator on the Baral River, at Bauitara sluice gate on the Old Hurasagar River and at Talimnagar sluice gate on the Badai River mainly for comparison inside and outside the regulators.

Usually, two nets were put underwater (below the surface) at each side of the regulators. The period of survey is from mid-June to the 3rd week of October 1993, except for Charghat, for which the hatchling survey started in early July. The net was usually kept underwater for one hour at all sites. The survey was usually carried out 4 days per week at Charghat and 2 days at Bauitara and Talimnagar. The numbers of overall (all species) catches are 422, 200 and 99 for each side of the Charghat, Bauitara and Talimnagar regulators respectively in 1993.

For Charghat, hatchlings catches were made for 1992 also from late August to mid-November. The two nets at 2 sides of the regulator were kept underwater for mostly 24 hours on almost every day during this period of survey.

After each survey time, the fish fries were lifted from codend of the net and placed in bottles containing water mixed with 5-10% formalin. For Charghat, dead fish larvae were separated from live ones in 1993 and these were put in different bottles. The bottles were then sent to a laboratory in Tangail town. The number of fries was counted there by biologists using microscopes for each species of fish. The numbers were recorded by species, survey times and survey dates in prescribed forms which were then sent to Head Office in Dhaka for processing and analysis.

Water velocity data were collected by both float and meter methods for each survey date.

3.1.2 North Central Region

Hatchling catches were taken for two sites, one on the Dhaleswari River and the other on the Lohajang River near Tangail town in this region.

For Dhaleswari, two nets were placed near the left bank 2 metres (m) apart. Hatchling catches were taken from June to December 1993, and there were 62 survey dates during this period. The nets were kept under-water for 2 hours at each survey time and there were usually 4 survey times on each survey date. The number of records for overall (all species) catches was 386 for each net. Hatchling data were also collected in 1992 from June to December but water velocity data were lacking.

For Lohajang, a more comprehensive survey was undertaken. There were 6 horizontal nets placed under the water surface across the river at about equal distances except for the middle 2 nets between which the distance was greater. There were also 6 vertical nets divided into 2 groups each having 3 nets. The 3 nets in each group were placed one below the other. The uppermost net was placed below the water surface. Vertical nets were placed near the right bank of the river 4 metres (m) apart. In addition, two bottom nets were placed above the bottom of the river, one near the right bank and the other near the middle of the river. Data for bottom nets were collected for September only.

The nets were usually kept under-water for 2 hours for each of the 4 survey times on every survey date. There were 62 survey dates during the period of survey from the middle of June to early October, 1993. The number of records for overall (all species) catch was 1,331.

The method of collection of hatchling catch data from the nets and counting by species was the same as that described for the North West Region.

3.1.3 North East Region

No special hatchling catch survey was undertaken for the North East Region. There were 18 sites in all for hatchling catches and these sites were mostly scattered in and around 3 large *haor*: Shanghair, Dekker and Hakaluki, and Manu Irrigation Project (MIP). The duration of the experiment varied between 2 to 6 months during the period from March to August, 1993. The number of survey dates varied from 10 to 25 during this period. The number of survey days in a month lay mostly between 3 to 5. There were usually 3 survey times on a survey

date. A net was kept underwater for one hour for 461 of the catch records and half an hour for 295 records, out of the total records of 756.

Fourteen rivers or *khal* were involved in this hatchling study, the main ones being the Surma, Kushiyara, Juri and Manu. The hatchling data were collected for inside and outside 3 rivers or *khal*: the Lumardai, Khorodari and Old Surma River.

Usually 2 nets were used at each site. The collection of hatchling catch data from the nets was done in the same way as stated in the case of the North West Region.

3.2 Processing Techniques

3.2.1 Hatchling supply rate

For convenience of comparison and algebraic manipulation, the hatchling number caught by a net is divided by the period of time (in hours) for the catch. This gives hatchling number per hour, which is called here hatchling supply rate. Daily and monthly average hatchling rates are obtained from the hatchling supply rates of survey times.

3.2.2 Water velocity

Water velocity is likely to have some effect on hatchling supply. Water velocity is measured by two methods: (i) float method and (ii) current meter method.

(i) For the float method, an object is floated downstream. The distance (in metre) covered by the object, divided by the time (in second) taken, is the water velocity (metre per second).

(ii) For the meter method, the number of revolutions per second of the propeller attached to the water meter placed underwater is obtained at each survey time.

If the number of revolutions per second is less than 0.2 or between 0.32 and 11.28, then water velocity in metre per second, is given by

$$0.013 + 0.2512\ n$$

or

$$0.0008 + 0.2667\ n$$

where n is the number of revolutions per second.

3.2.3 Hatchling density

Water discharge (cubic metre/second) through a net for a hatchling catch, is the product of submerged area (square metre) of the net and water velocity (metre per second).

The hatchling density of a catch of the net is the number of hatchlings (per second) passing through the net, divided by water discharge (metre^3/second) through the net.

Density is thus the hatchling number per metre^3. Daily and monthly average densities are obtained from the individual densities of survey times.

Density is the standard hatchling catch rate in addition to the more crude hatchling supply rate of section 3.2.1.

3.3 Graphical Representation of Processed Data

Line graphs are mainly used to represent daily average hatchling rates usually along with water level and/or velocity data. Monthly average rates are also sometimes exhibited by line graphs. Pie charts are used to represent species compositions as percentages of total densities.

3.4 Comparisons of Hatchling Supply Rates or Densities by Non-parametric Tests

Non-parametric tests are used to compare distributions and the locations (central values) because the data of the above rates (variables) are not generally found to be normally distributed. The powers of the non-parametric tests are usually less than those of the corresponding parametric tests except for large samples.

3.4.1 Comparison between 2 independent samples (unpaired comparison)

The non-parametric Mann-Whitney U-test is used to compare distributions and locations of 2 independent samples. In this case, values of 2 samples, A and B, are ranked together. Then compute U_i as the number of B values that precede the ith A observation or vice versa, i =

1, 2, ..., n. The sum of these counts is the U-statistic. For a test of significance, computed values of U can be compared with tabulated values of U distribution prepared for the purpose. For sample sizes > 10, the normal test is used by standardizing U-values i.e,

$$z = \frac{U-\bar{U}}{\sqrt{Var(U)}}$$

is a standardised normal variable. The values of $\bar{U}$ and var (U) are obtained from the distribution of U.

Calculated values of z are compared with 5% or 1% values of normal table. A significance level (P-value) may also be obtained. This test is equivalent to unpaired parametric t-test for normal samples.

The sample values may be hatchling supply rates or densities on different dates inside and outside an FCD/I project.

3.4.2 Comparison between 2 dependent samples (paired comparison)

For dependent samples, paired values of 2 samples are considered. The non-parametric Wilcoxon sign test is used in this case. Let $D_i = x_i - y_i$ be the difference between 2 values of x and y of the same ith pair, i = 1, 2, .., n. The absolute values of D_i excluding 0, are ranked. Then calculate rank sums (T) for positive and negative values of D_i separately. The minimum of 2 rank sums is then compared with 5% and 1% values of T-table prepared for the purpose. For large n, z-test (normal test) is used in the same way as in (a).

The test is equivalent to a parametric paired t-test for normal samples.

3.4.3 Comparison between 3 or more independent samples

Non-parametric Kruskal-Wallis one-way analysis of variance (ANOVA) is used to compare $k \geq 3$ populations and their locations. In this case, all sample observations are ranked for all samples together from the smallest to the largest. Let R_i denote the sum of such ranks of all observations in the ith sample of size n_i, i = 1, 2, ..., k.

To test equality of distributions and locations, the Kruskal-Wallis statistic is

$$H = 12\{\Sigma R_i^2/n_i - 3(n+1)\}/n(n+1)$$

with $n = \Sigma n_i$.

The statistic H is approximately distributed as χ^2 with (k-1) degrees of freedom (df).

Computed values of H are compared with the values obtained from χ^2 -table for the same df.

This test is equivalent to the parametric one-way ANOVA test.

Correlation analysis is sometimes used to find the relationship between 2 sets of data.

4 SEASONAL DISTRIBUTION OF HATCHLING NUMBERS AND DENSITIES

In this section distributions of hatchling numbers per hour and densities are examined by survey date and month for four rivers: the Dhaleswari, Padma, Kushiyara and Surma. Species compositions of densities are obtained and dominant species selected. Patterns of densities of dominant species over survey dates and the distribution of number of species over time are investigated for each river.

4.1 Dhaleswari River at Elasin in North Central Region

The Dhaleswari River originates from the main river, Jamuna, in the Tangail district of the North Central Region. This river, along with its tributaries and *khal*, supplies floodwater to the floodplains and *beel* in the area.

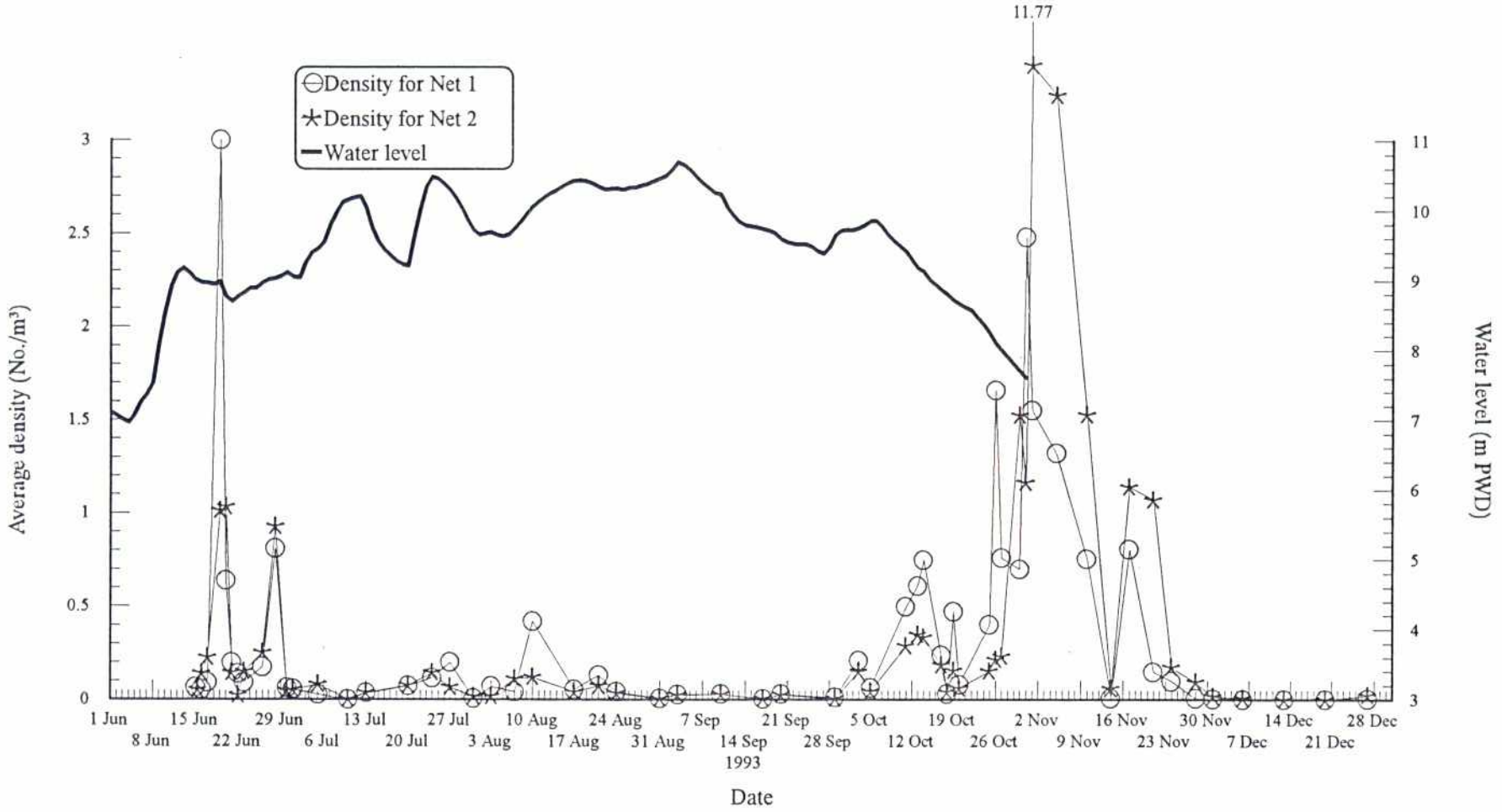
For the hatchling catch survey, two nets were placed below the water surface at positions near the left bank of the river at Elasin. One net was about 2 metres away from the bank and the other was at about the same distance from the first one across the river. The nets were kept under-water usually for 2 hours at each survey time. There were 62 survey dates during the period from June to December, 1993 and there were usually 4 survey times on a survey date. The number of records for overall (all species) densities for 2 nets, is 386 for the survey times and survey dates during the period of survey.

The hatchling survey also took place in 1992. Water velocity data were not collected properly, however, so that densities were calculated only for a short period. Most of the analysis after section 4.1.1 is made for 1993 data only.

4.1.1 Daily average densities and hatchling number per hour

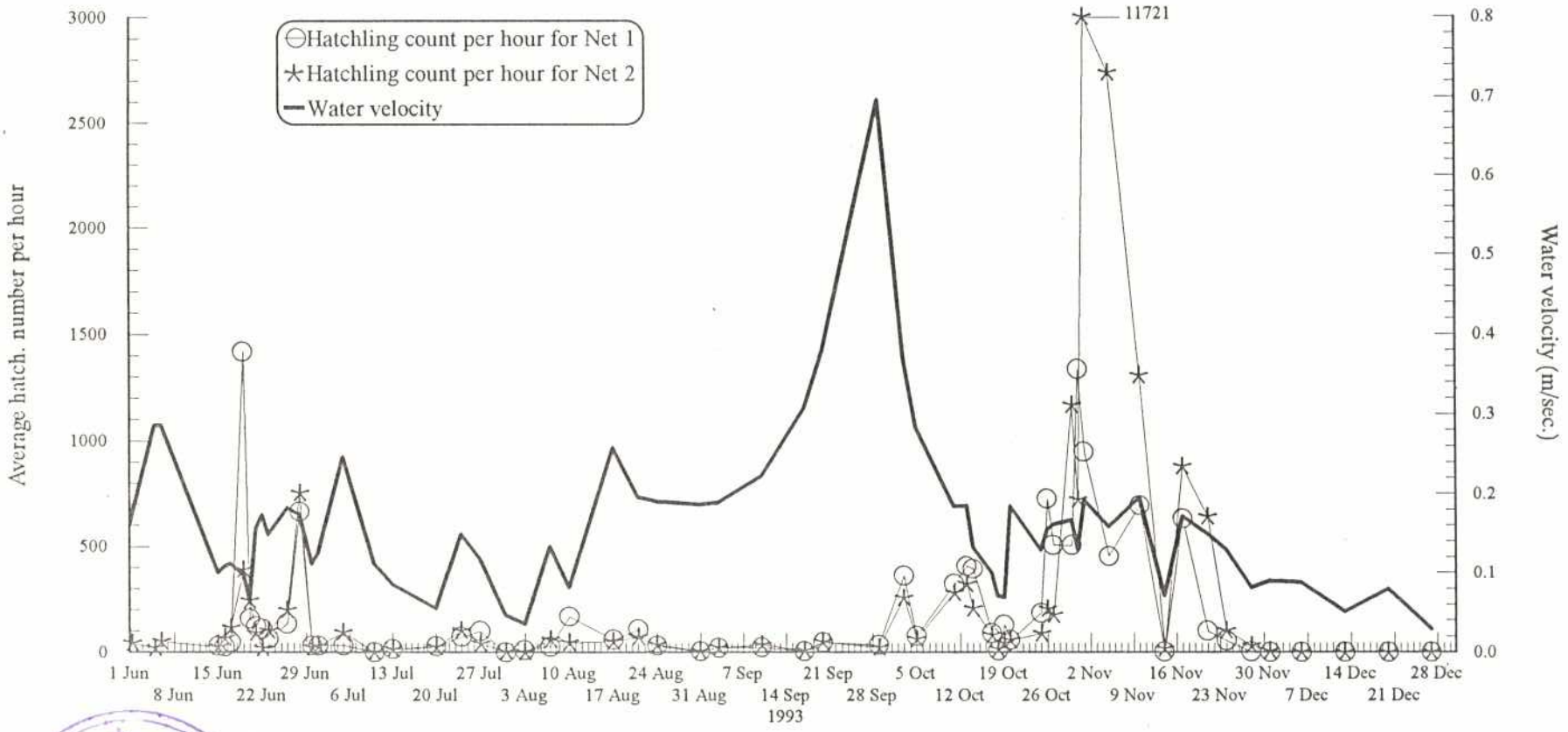
For each survey date, average density is computed over survey times for the two nets separately for 1993. These daily average densities are represented graphically in Figure 4.1 along with water levels. Average hatchling number per hour and water velocity are graphed in Figure 4.2. It is noticed from Figure 4.1 that, except for June and November, the densities are usually higher for net 1 situated near the bank than those of net 2 which is further away in the river. Higher peaks occur in June, July, October and November. Early November espacially experiences very high densities for net 2. The months of August and September with high flood have much lower densities. There is very little hatchling flow in December.

Figure 4.1 Graph of overall average density and water level by survey date for the two nets of the Dhaleswari River in 1993



Note: m PWD - metre (with reference to Public Works Department Datum)

Figure 4.2 Graph of overall average hatchling number per hour and water velocity by survey date for the two nets of the Dhaleswari River in 1993



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Figures 4.1 and 4.2 show that the pattern of hatchling number per hour over the survey dates is similar to that of density except in a few cases where the two rates differ.

It is also seen from Figure 4.1 that there is hardly any relationship between daily density and daily water level, with the exception that an early rise of the water level is followed by high density in June. During the high flood in August and September, when water level is high, densities are very low indicating no relationship during this period.

Similarly, Figure 4.2 shows that water velocity is random, having frequent, high fluctuations in early October. It appears that hatchling rates and water velocity are also not related. Hatchling rates for net 2 are much higher than those for net 1 in November.

For 1992, density could not be computed because of lack of velocity data. The hatchling number per hour is represented graphically in Figure 4.3 along with water level data. Figure 4.3 shows that there is not much hatchling flow in June and July at the beginning of the monsoon. Very high hatchling flow occurs in early November, when the water level goes down, and on one date in September. The hatchling number per hour fluctuates greatly for 3 months towards the end of the flood. It dies down after mid-November. There also appears to be no relationship between water level and hatchling rate for 1992. The pattern of hatchling rate over survey dates for 1992, when there was less flooding, is quite different from that of 1993.

Frequent fluctuations of hatchling rates over the survey dates show that hatchlings drift along the river in clusters or swarms.

4.1.2 Paired comparison of densities between 2 nets

The non-parametric Wilcoxon sign test is used to perform paired comparison of densities for times of survey on the same dates for 6 months separately and together for 1993. Results of this test along with sample sizes and mean densities are given in Table 4.1. It is observed from Table 4.1 that there are significant (mostly highly) differences of paired densities between the two nets for August and the last 3 months. The differences are not however significant for all 7 months together. The mean density is much higher for net 2 than net 1 for November. For most of the other months, mean densities are higher for net 1 than net 2, indicating greater hatchling flow near the river bank.

Figure 4.3 Graph of overall average hatchling number per hour and water level by survey date for the Dhaleswari River in 1992

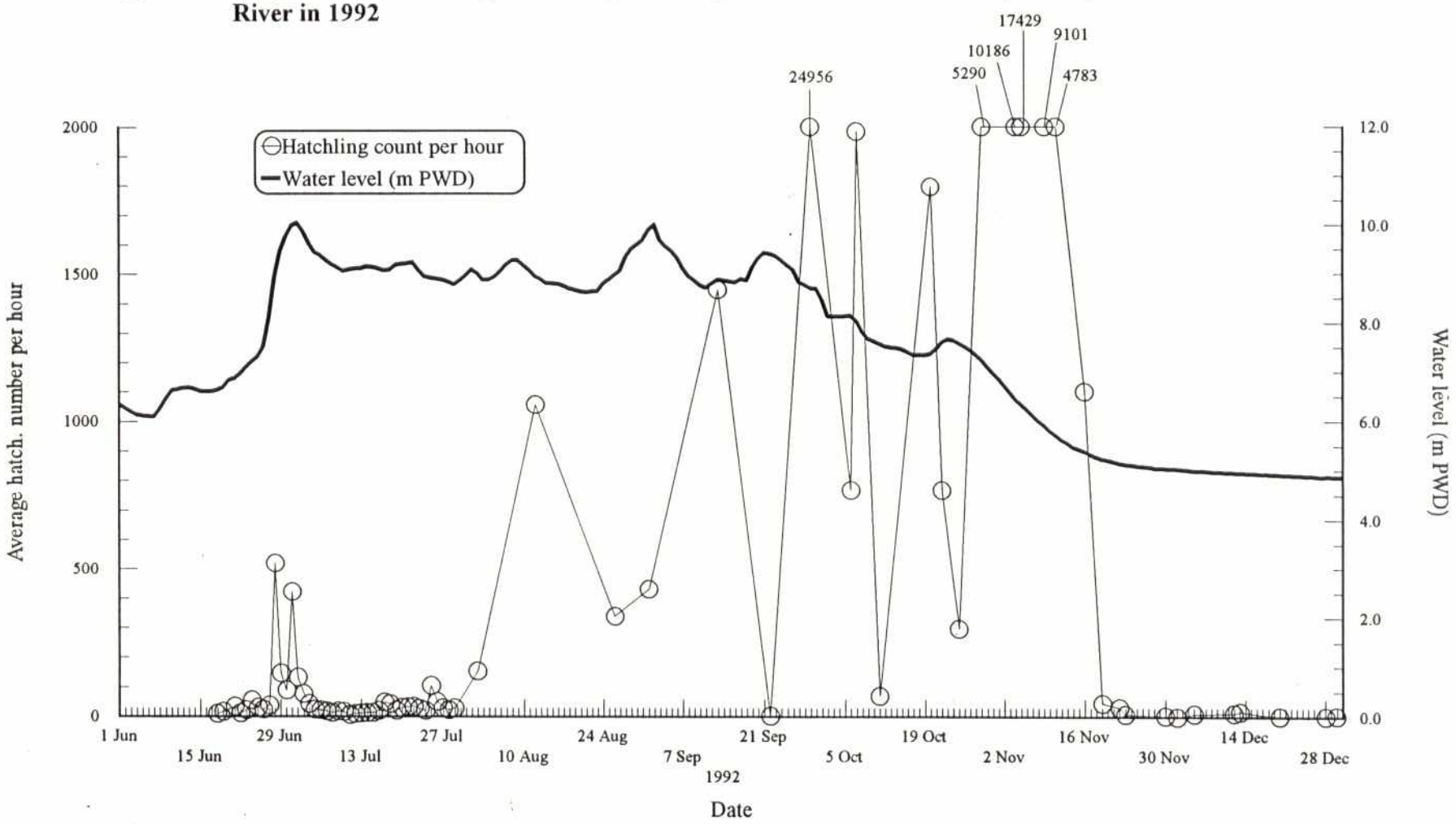


Table 4.1 Results of non-parametric test for paired comparison of densities between 2 nets for 1993

Month	Number of cases (pairs)	Mean densities		Non-Parametric Wilcoxon sign test		
		Net 1	Net 2	z-value	P-value	Comment
June	54	0.427	0.274	-0.19	0.846	NS
July	27	0.064	0.066	-0.46	0.648	NS
August	27	0.098	0.056	-2.69	0.007	HS
September	21	0.020	0.018	-0.57	0.566	NS
October	55	0.636	0.347	-4.61	0.000	HS
November	32	0.586	2.385	-4.00	0.000	HS
December	20	0.002	0.010	-1.99	0.045	SIG
All 7 months	236	0.346	0.492	-0.96	0.337	NS

4.1.3 Dominant species and species composition

There are 72 species for both nets together. The total number of records of densities by species is 2,962.

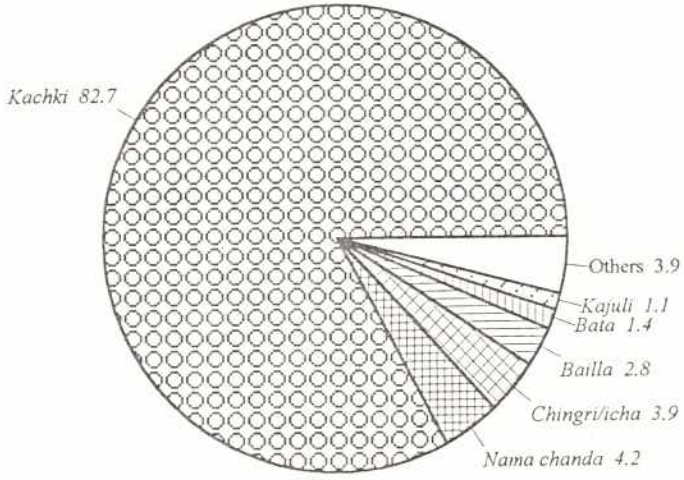
The basic densities are added by species over survey times and survey dates for different months separately and together. To obtain species compositions, percentages (PC) of these monthly and all month densities of individual species are taken with respect to the corresponding total densities of all species.

4.1.4 Overall species composition

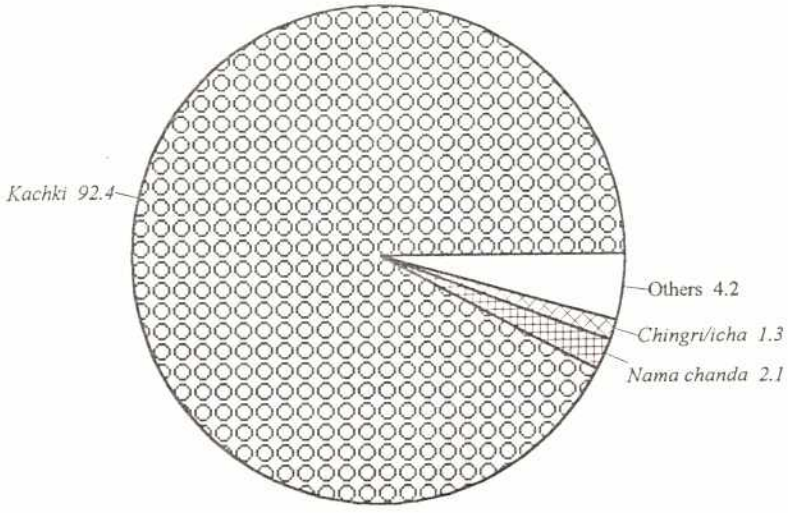
There are 61 and 67 species in all for net 1 and net 2 respectively for 1993. The overall (all month) species compositions with percentages (PC) of total densities for PC $>$ 1.0 are represented by the Pie chart in Figure 4.4. It is observed from Figure 4.4 that *kachki* accounts for more than 82% and 92% of total densities for net 1 (near the bank) and net 2 respectively. This species is thus overwhelmingly dominant. *Chanda* and *chingri* come next but with far lower PC compositions. The remaining species together contribute only about 4% to the total densities of the two nets.

Figure 4.4 Pie charts for species compositions of hatchling density for 2 nets in the Dhaleswari River in North Central Region in 1993 (PC > 1.0)

(a) Net 1



(b) Net 2



4.1.5 Overall species compositions excluding *kachki*

In order to obtain dominant species besides *kachki*, PC compositions are obtained excluding this species and presented as Pie charts in Figure 4.5a for PC > 5.0.

It is observed from Figure 4.5a that new species compositions differ somewhat between 2 nets. *Nama chanda* is the most dominant for both nets with over 24.0% contribution to total density. While *bailla* and *chingri/icha* are the next most important species for net 1, *chingri/icha* and *kajuli* are so for net 2. Carp has appeared as dominant for net 2 only. Only 5 or 6 species are dominant out of more than 60 species. These dominant species are mostly small fish.

For 1992, it is observed that *kachki* contributes 95.7% to total density.

Overall species compositions of density excluding the *kachki* are therefore represented for PC > 3.0 by the Pie chart for 1992 in Figure 4.5(b). It is seen from this figure that carp is the most dominant species, accounting for 48.8% of total density. *Chingri/icha*, *bailla* and *nama chanda* are the next most important species for this year.

Species composition therefore varies widely between 1992 and 1993.

4.1.6 Graphs of densities of dominant species

Graphs of average daily densities for the 2 nets together are presented in Figure 4.6 for 5 most dominant species and carp for 1993. It is observed from Figure 4.6 that average daily densities of *kachki* are much higher than those of other species, as is expected. For this species, there are 2 high peaks in late June and 2 in November when densities are much higher. The case is similar for other species (except carp) with early high peaks in June and July and late high peaks (but much higher) in October and November. Carp hatchling flow has a few peaks in June, then goes down and stops after the middle of August. Fluctuations of densities of the dominant species indicate that their hatchlings flow in waves or swarms.

Hatchling flow in August and September is low for the dominant species during the high flood.

Figure 4.5 Pie charts for species compositions of density for dominant species excluding *kachki* in the Dhaleswari River for 1993 with PC > 5.0 and for 1992 with PC > 3.0

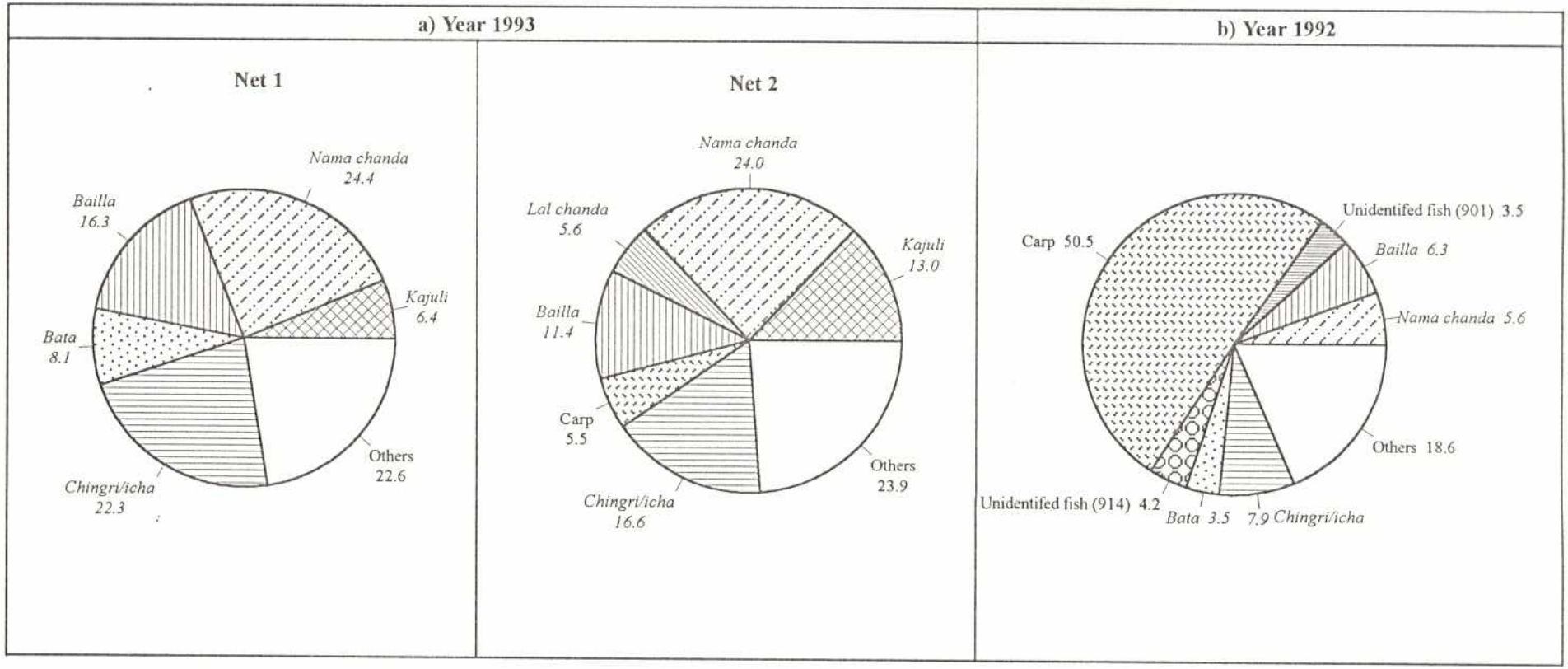


Figure 4.6 Seasonal variation of average density over survey date for dominant species in the Dhaleswari River in 1993

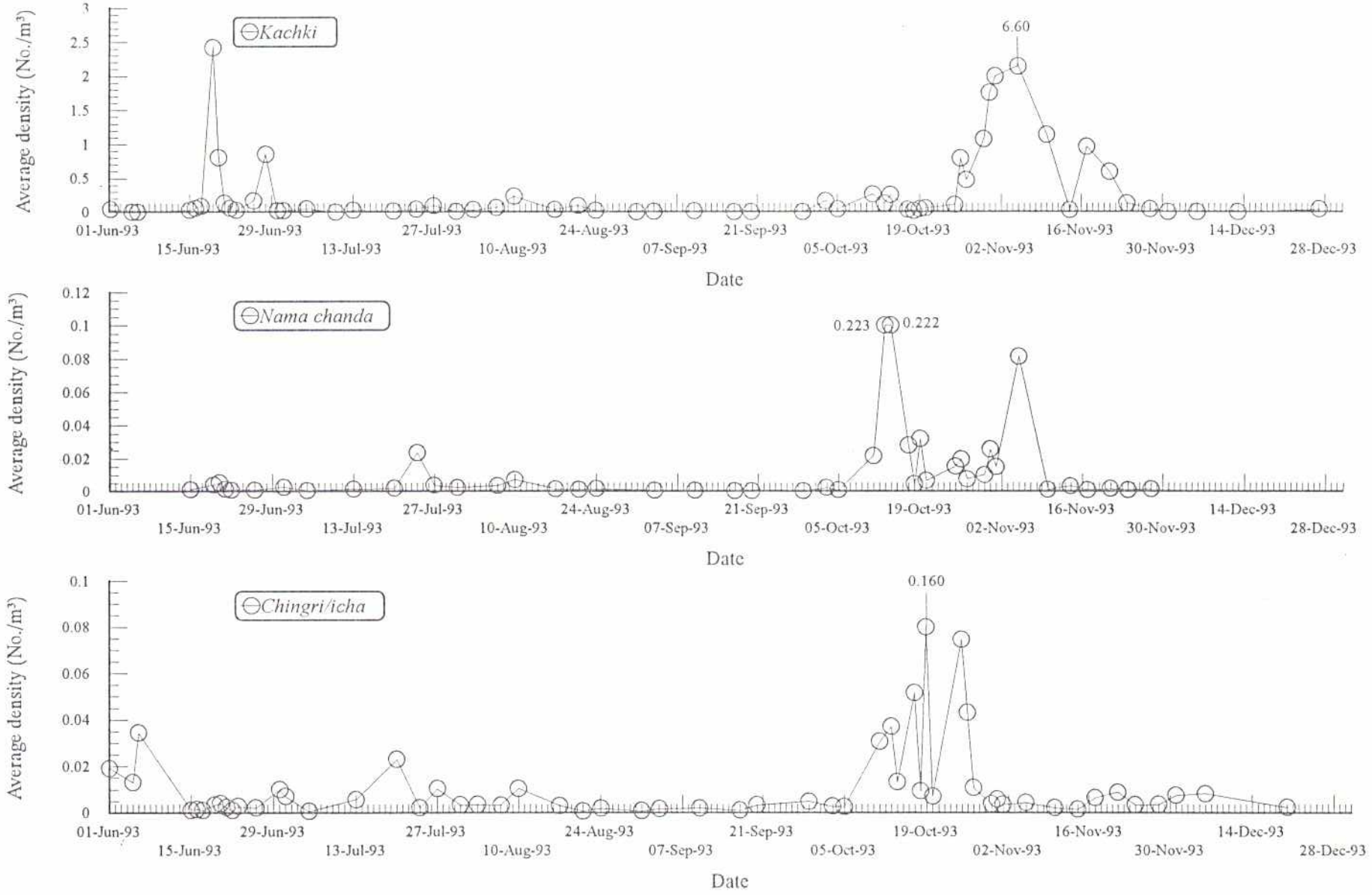
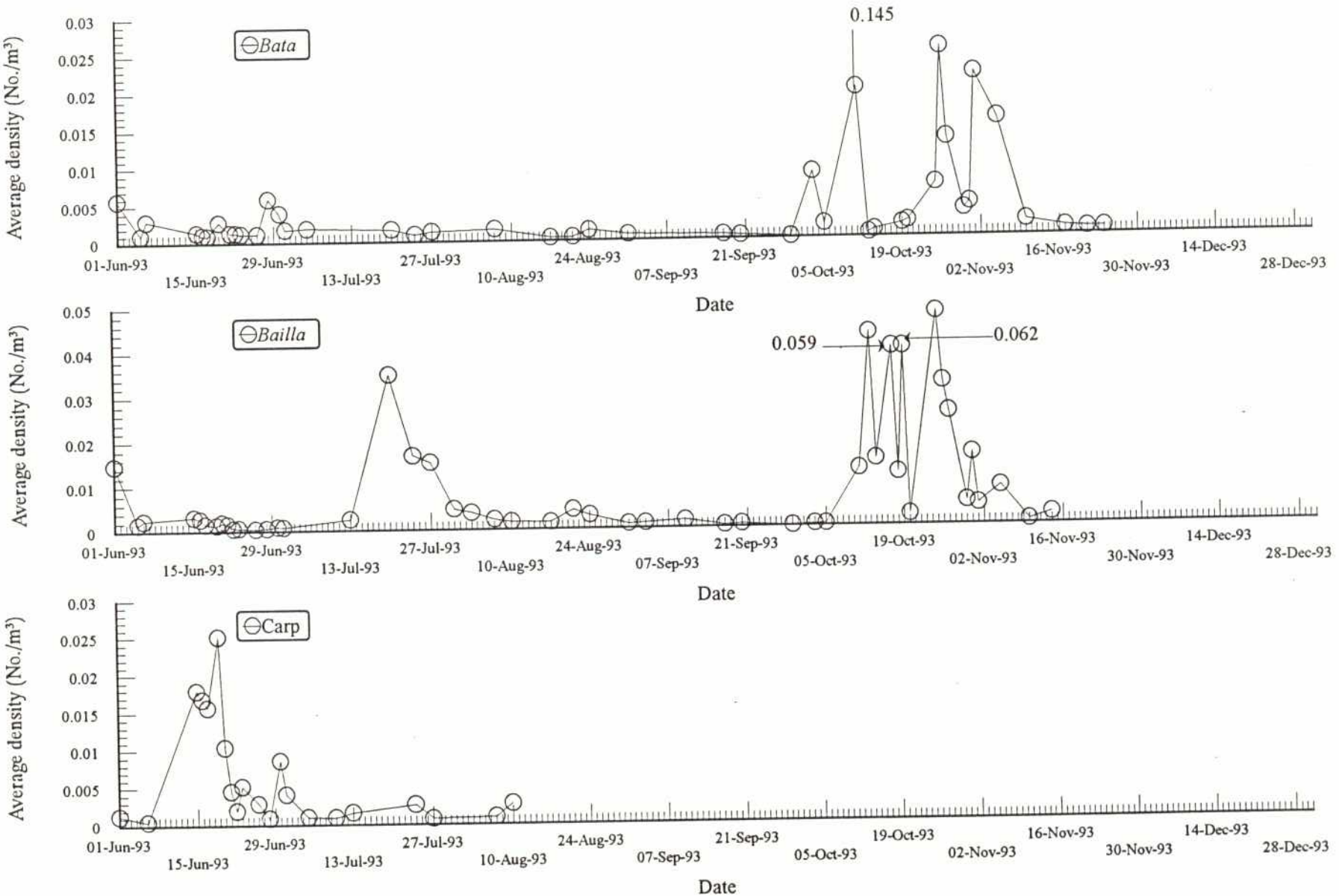


Figure 4.6 (Contd)



The patterns of densities of the dominant species is more or less similar to that of overall density, except for carp.

4.1.7 Number per hour of species observed by month and date

The numbers per hour of fish species observed by month and by survey date are obtained for hatchling catch survey on the Dhaleswari River at Elasin.

Number of species observed by month

The average number per hour of species observed by month for the 2 nets separately is given in Table 4.2 for 1993. It is seen from Table 4.2 that the number of species varies widely among the months. The highest number of species is observed in June followed by July, October and September. After October, the number of species decreases sharply and hatchling flow ceases in December. Net 2 has more species in 5 months but the differences are not great.

Table 4.2 Number of fish species observed per hour by month and net in the Dhaleswari River in 1993

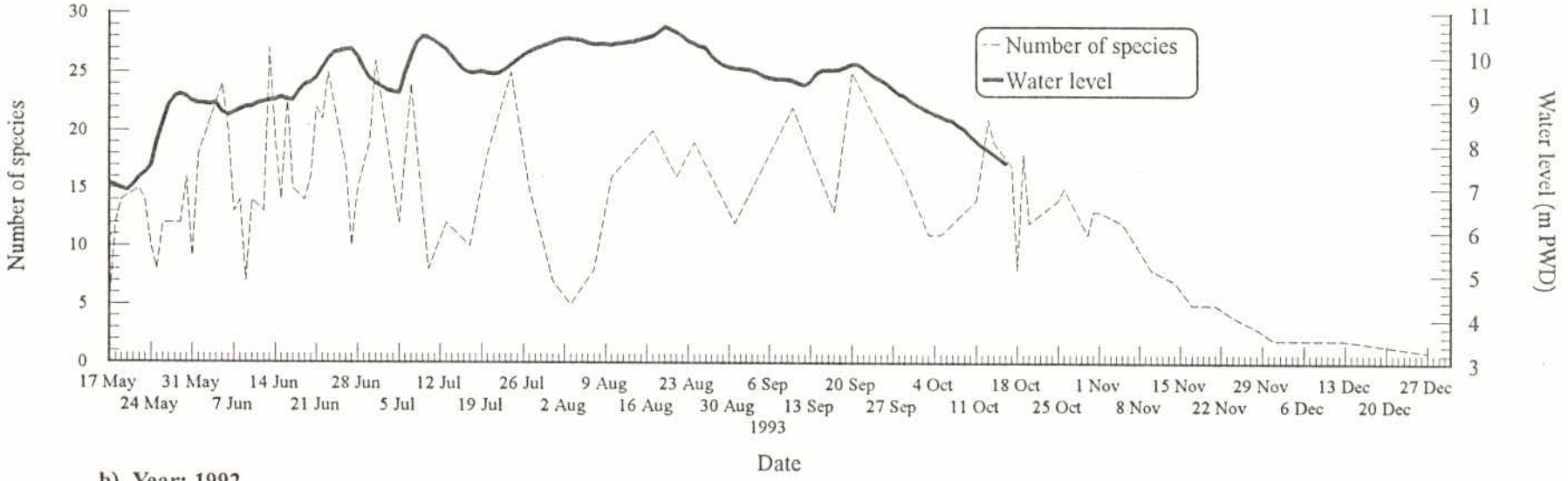
Month	Number of species observed for	
	Net 1	Net 2
June	43	48
July	36	39
August	29	27
September	28	34
October	31	30
November	13	15
December	3	3

Number of species observed by survey date

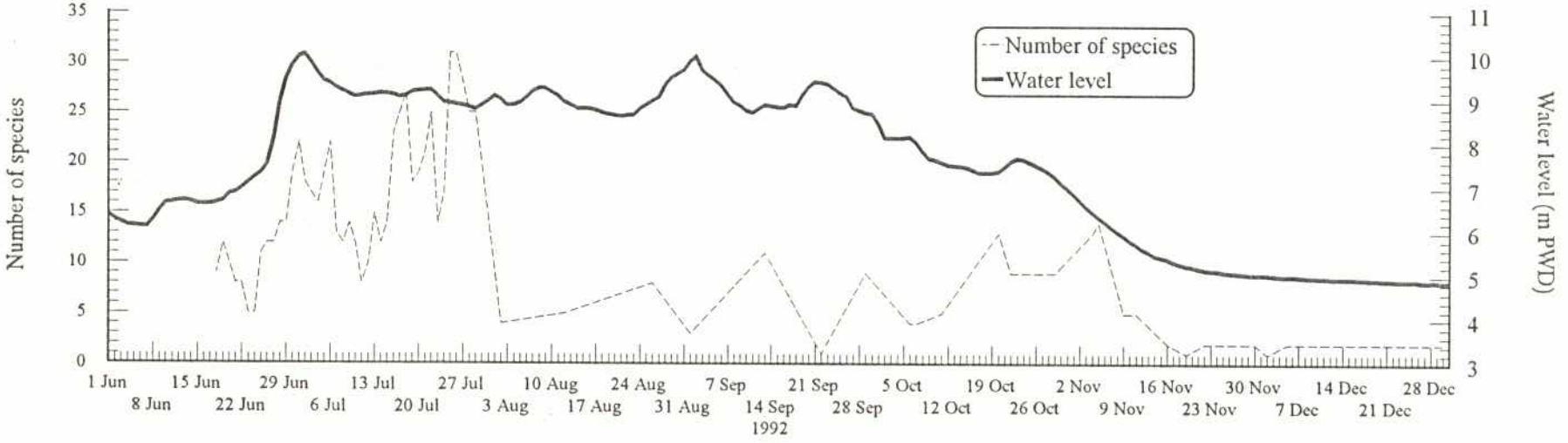
Since the variation of number of species (by month) between the 2 nets is small, the average number per hour of species observed by the survey date for 2 nets together, are represented graphically in Figure 4.7 along with water level data for 2 years. It is seen from Figure 4.7 that number of species varies widely among the days. Higher numbers of species usually occur in June and also in parts of July and September in 1993. For 1992, higher numbers occur mainly in July. There is up-and-down random movement of the number of species

Figure 4.7 Average number of species and water level by survey date for the Dhaleswari River for 2 years

a) Year: 1993



b) Year: 1992



over days with many peaks during the period June to October. This indicates that hatchlings flow in waves. The number goes down from October and then becomes negligible in December. August, having a higher water level, experiences fewer species on average. There is no relationship between number of species and water level for either year except that at the beginning and end of the monsoon both water level and the number of species go up and down.

4.1.8 Dominant species by month and species compositions

Monthly species compositions with percentages (PC) of total densities are given in Table 4.3 for PC > 5.0 for both nets together in 1993. Table 4.3 reveals that species composition varies widely among the months. For June, August and November, *kachki* alone contributes more than 82% to total density. July has the largest number of dominant species among which *kachki* makes up only 52.7% of the total density. In September *lal chanda* has the highest contribution of 39.9% and *kachki* has the second highest of 37.3%. In December, *kachki* has two thirds contribution and *chingri/icha* has a little over one fourth contribution. *Bailla* has some contribution in July.

Table 4.4 gives monthly species compositions for PC > 10.0 excluding *kachki* in 1993. It is observed from Table 4.4 that more species are dominant in June, August and November. *Kajuli*, carp and *bailla* dominate in June and July. *Chingri/icha*, *lal chanda* and *nama chanda* do so in later months.

Table 4.3 Monthly species compositions of density for dominant species having PC ≥ 5.0 in 1993

Month	Species name (Bengali)	Sample size	PC composition
June	*Kachki*	112	89.0
July	*Kajuli*	19	7.2
	Chanda nama	26	6.3
	Bailla	28	10.5
	Puti	15	5.2
	Kachki	48	52.7
	Chingri/icha	26	5.6
August	*Kachki*	52	82.9
September	*Lal chanda*	39	39.9
	Kachki	41	37.3
	Chingri/icha	35	11.4
October	*Chanda nama*	96	8.1
	Kachki	105	74.8
	Chingri/icha	106	6.5
November	*Kachki*	64	98.0
December	*Kachki*	18	67.8
	Chingri/icha	10	26.9
	Unidentified *bele*	5	5.3

Table 4.4 Species composition by month excluding *kachki* for PC > 10 in 1993

Month	Species name (Bengali)	Sample size	PC composition
June	*Kajuli*	95	38.58
	Carp	85	19.86
July	*Kajuli*	19	15.19
	Nama chanda	26	13.35
	Bailla	28	22.14
	Puti	15	10.97
	Chingri/icha	26	11.8
August	*Nama chanda*	37	14.93
	Lal chanda	35	10.86
	Bailla	40	15.37
	Chingri/icha	46	21.07
	Unidentified *bele*	18	13.47
September	*Lal chanda*	39	63.7
	Chingri/icha	35	18.17
October	*Nama chanda*	96	32.12
	Bailla	96	18.67
	Chingri/icha	106	25.87
November	*Nama chanda*	35	42.62
	Bata	25	16.76
	Chingri/icha	52	12.75
December	*Chingri/icha*	10	83.56
	Unidentified *bele*	5	16.44

4.2 Padma River at Charghat in North West Region

Charghat is situated at the conjunction of the Padma River and its tributary, the Baral River, about 15 kilometres east of Rajshahi town. There is a regulator (sluice gates) at Charghat on the Baral River. Outside (upstream of) the Charghat regulator, is the site of Padma River hatchling study. The hatchling survey took place in 1992 and 1993.

One net was fixed at the site for catching fish larvae. In 1992 the net was kept under-water for 24 hours on each survey date. The survey continued for 78 days between the last week of August and the middle of November.

In 1993, the net was kept underwater usually 6 times on a survey day for one hour each. There were 73 survey dates during the period from July to the middle of October.

Water velocity measured by the float method was used for obtaining densities for both the years.

Densities were computed for each survey date in 1992 and for each survey time on every survey date in 1993.

4.2.1 Graphical representation of density and hatchling number per hour

Average densities and hatchling number per hour were computed over survey times for each survey date in 1993. The average daily densities and hatchling number per hour are represented graphically along with water level and water velocity data respectively in Figures 4.8 and 4.9 for 1993. The same 2 hatchling rate data are also displayed with water level and water velocity data in Figures 4.10 and 4.11 for 1992.

For 1993, it is observed from Figures 4.8 and 4.9 that hatchling rates are very high in early June and fluctuate from day to day. There are some high peaks in July, August and October. Patterns of density and hatchling number per hour over dates are similar with some deviations of peak values. While water level remained more or less steady, around 15 metres, water velocity fluctuated very often with high peaks in early August and mid October. Figures 4.8 and 4.9 also show that there is no relationship between hatchling rates and water velocity or water level.

Figure 4.8 Graph of overall average density and water level by survey date for the Padma River at Charghat in 1993

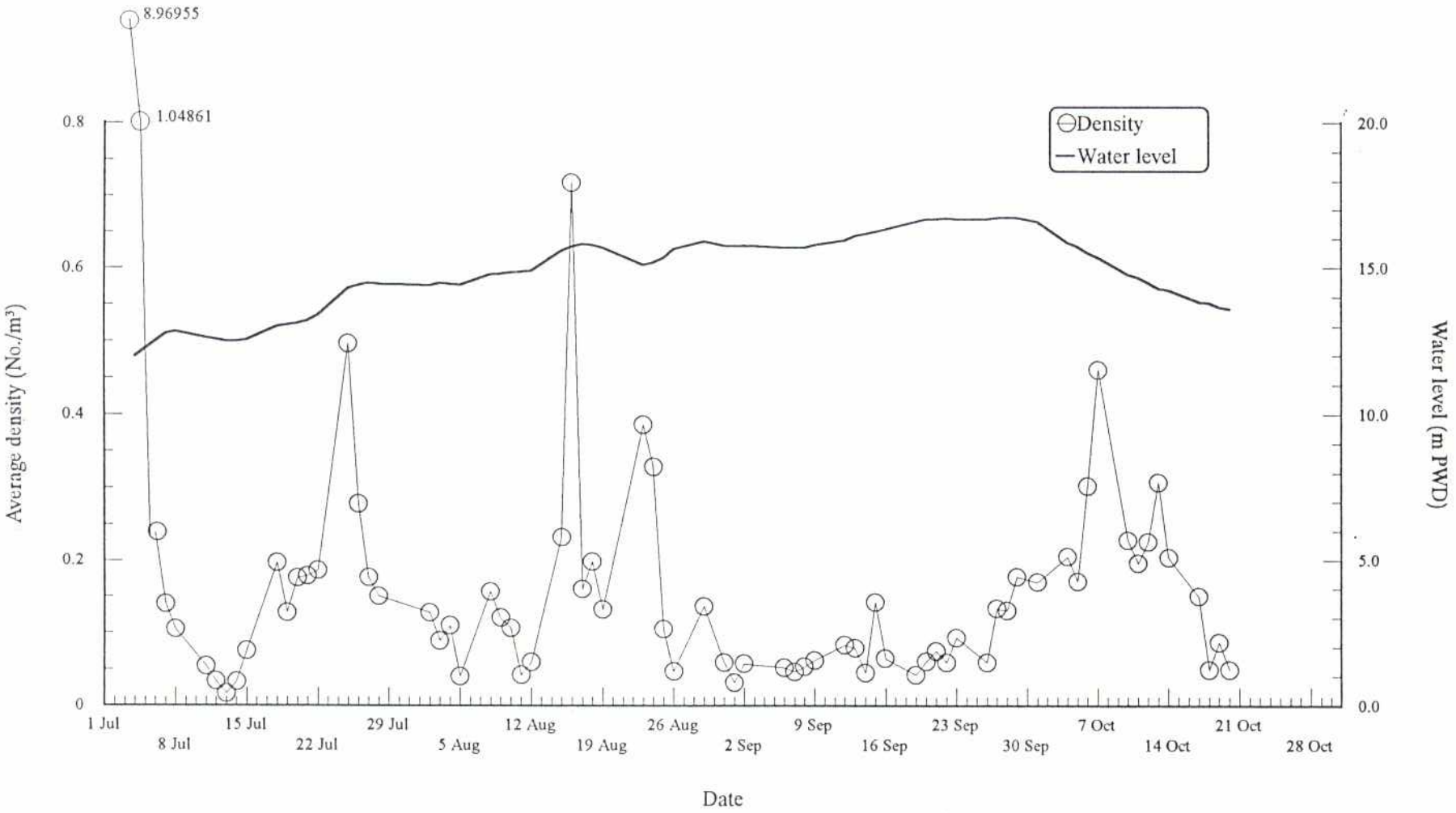


Figure 4.9 Graph of overall average hatchling number per hour and water velocity by survey date for the Padma River at Charghat in 1993

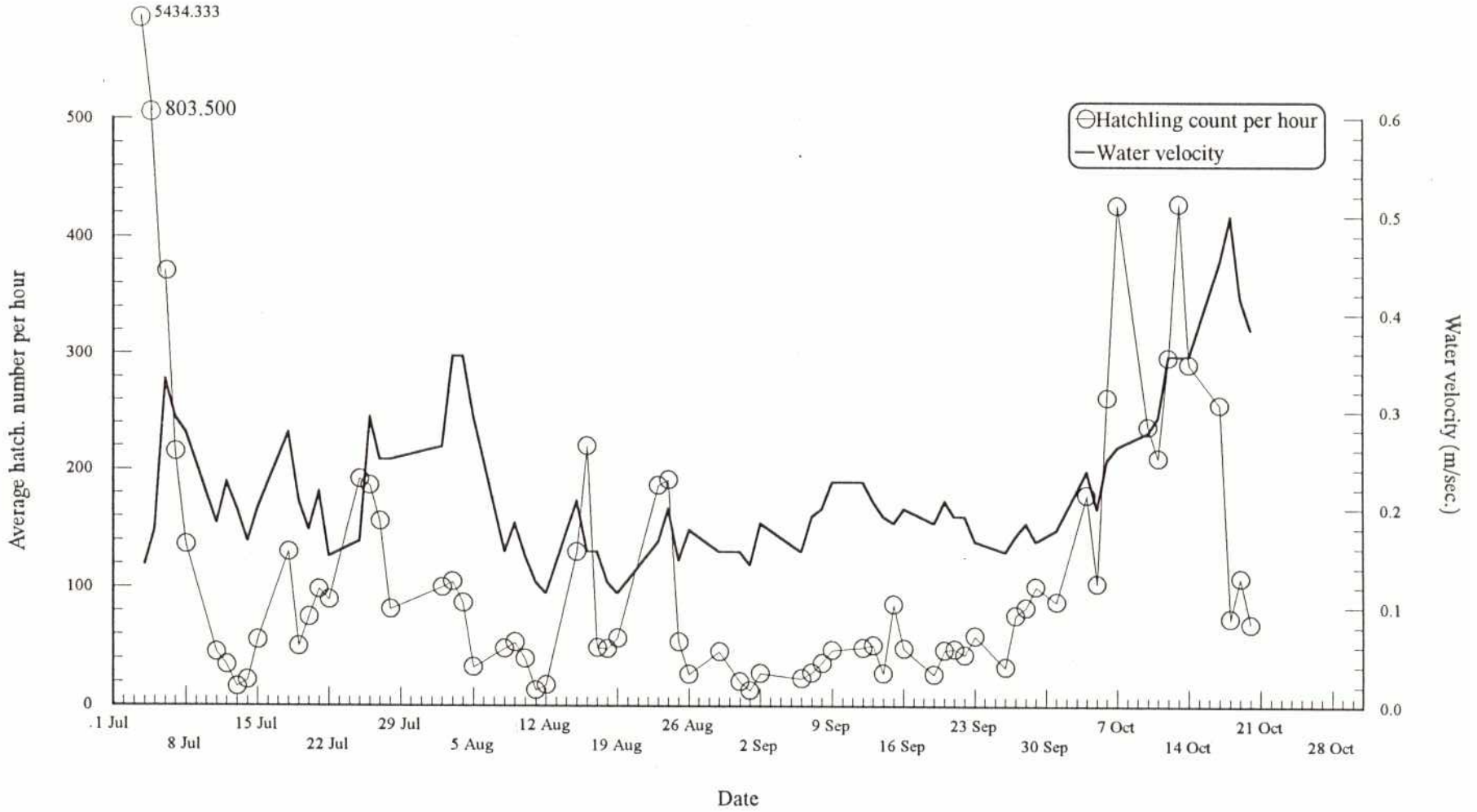


Figure 4.10 Graph of overall average density and water level by survey date for the Padma River at Charghat in 1992

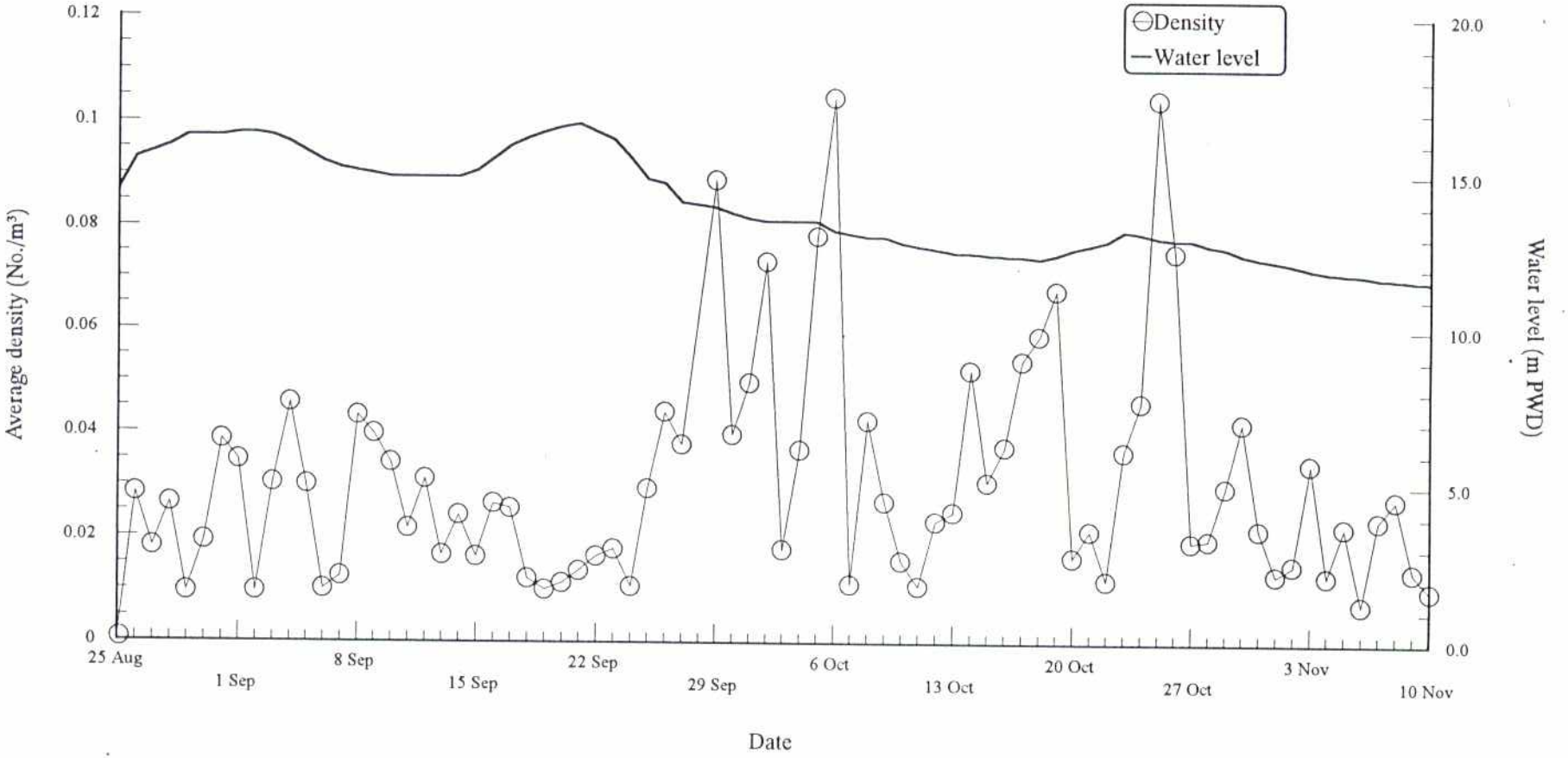
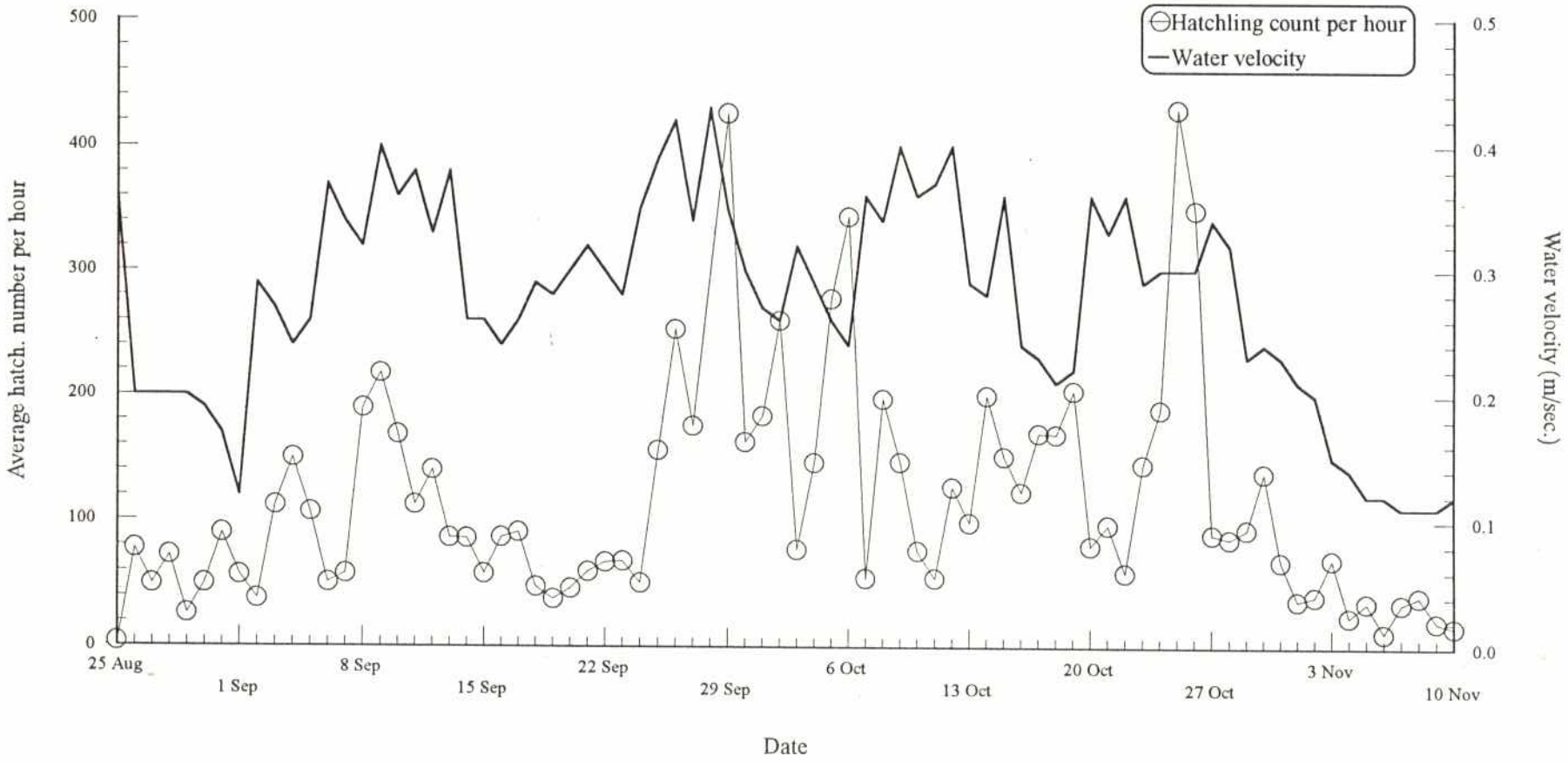


Figure 4.11 Graph of overall average hatchling number per hour and water velocity by survey date for the Padma River at Charghat in 1992



Frequent fluctuations of hatchling rates show that hatchlings flow in waves or swarms. For 1992, Figures 4.10 and 4.11 show that patterns of density and hatchling count per hour over dates are very similar with a few exceptions. But these rates fluctuate more frequently than those of 1993. The basic characteristics of steady water level and random fluctuations of water velocity are present and there is no relationship between these and hatchling rates in 1992 as is the case in 1993.

Hatchling rates are usually lower in 1992 than 1993 when flooding is greater.

Highly fluctuations of hatchling rate indicate that hatchlings drift in clusters.

4.2.2 Species composition and dominant species

There were 93 and 146 species observed in 1993 and 1992 respectively for this site at Charghat. The percentage (PC) of total density of each species with respect to total density of all species together, is computed for the whole period of survey.

These percentage densities are represented by a Pie chart for PC > 2.0 in Figure 4.12 for the two years separately.

It is observed from Figure 4.12 that the percentage composition of dominant species differs somewhat between the two years. 10/12 species make up more than 73% of total density in these 2 years. There are only a few highly dominant species. *Chingri/icha* dominates in both years, contributing 29.1% and 35.6% to total density in 1992 and 1993 respectively. Most of the other species are far less important. *Kachki* and *bata* are the next most important species for 1993 and 1992 respectively. Carp and *bata* are also dominant for 1993 and *bailla* and *nama chanda* for 1992. *Kachki* contributes only 5% to total density for this site.

4.2.3 Graphical representation of daily average densities for dominant species

Figure 4.13 presents graphs of average daily densities for 5 dominant species: *chingri/icha*, *kachki*, *bata*, *kachki* and carp for 1993. It is seen from these graphs that patterns of density over time (days) are similar for *chingri/icha*, *kachki*, *bata* and *kachki* with a high initial surge in July and after-monsoon revival of hatchling flow in October. For carp, a high peak occurs in late July and August but dies down after September.

Figure 4.12 Pie charts for species composition (in percentage) of hatchling densities at the Padma River in North West Region for 1992 and 1993

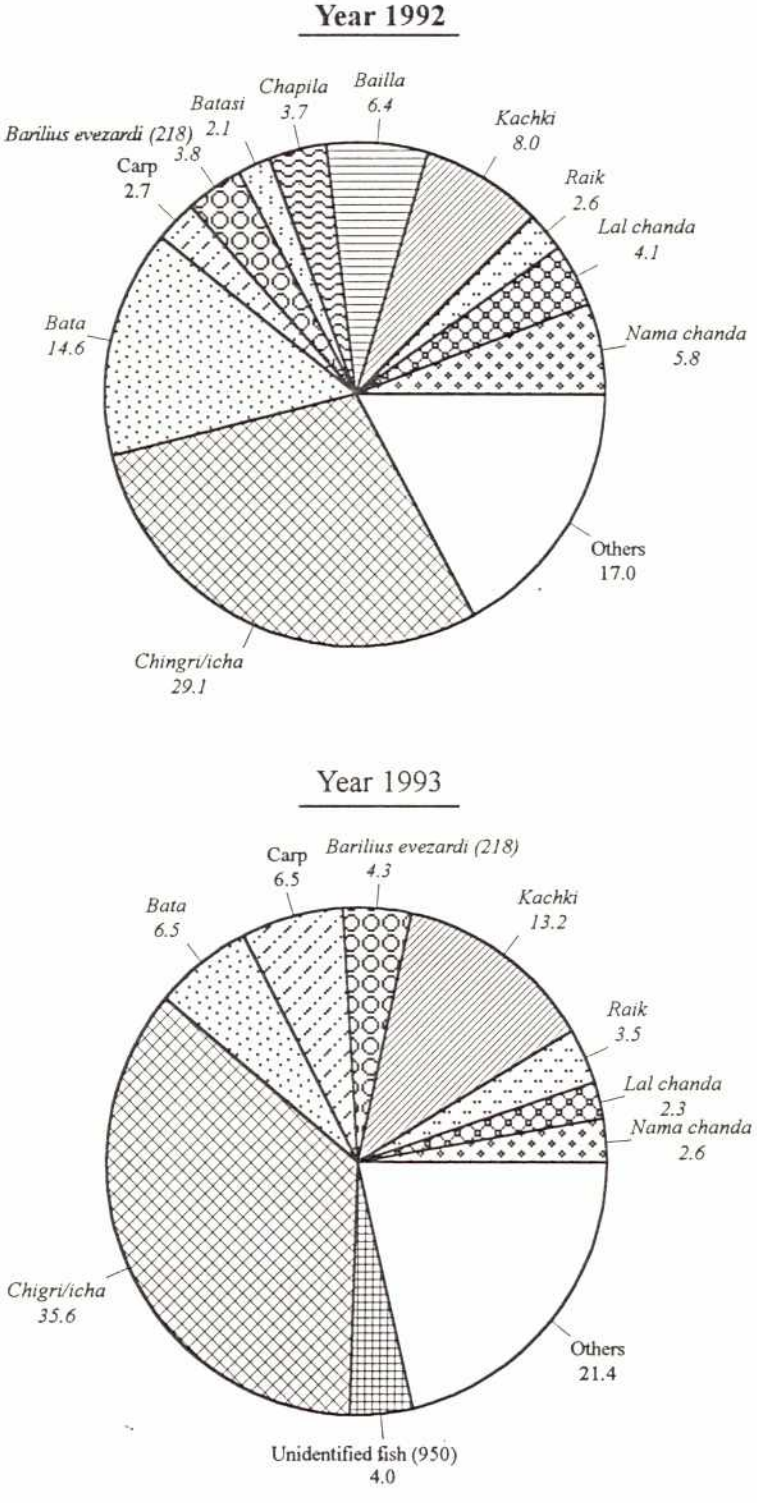
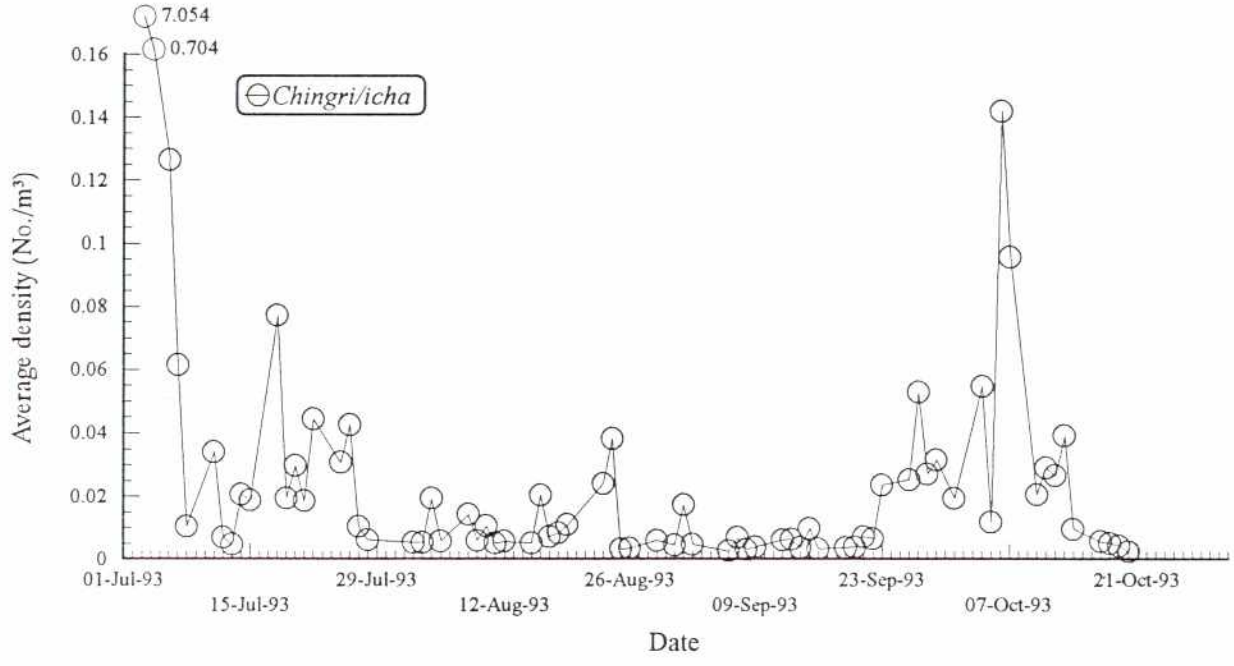


Figure 4.13 Seasonal variation of average density over survey dates for dominant species in the Padma River at Charghat in 1993



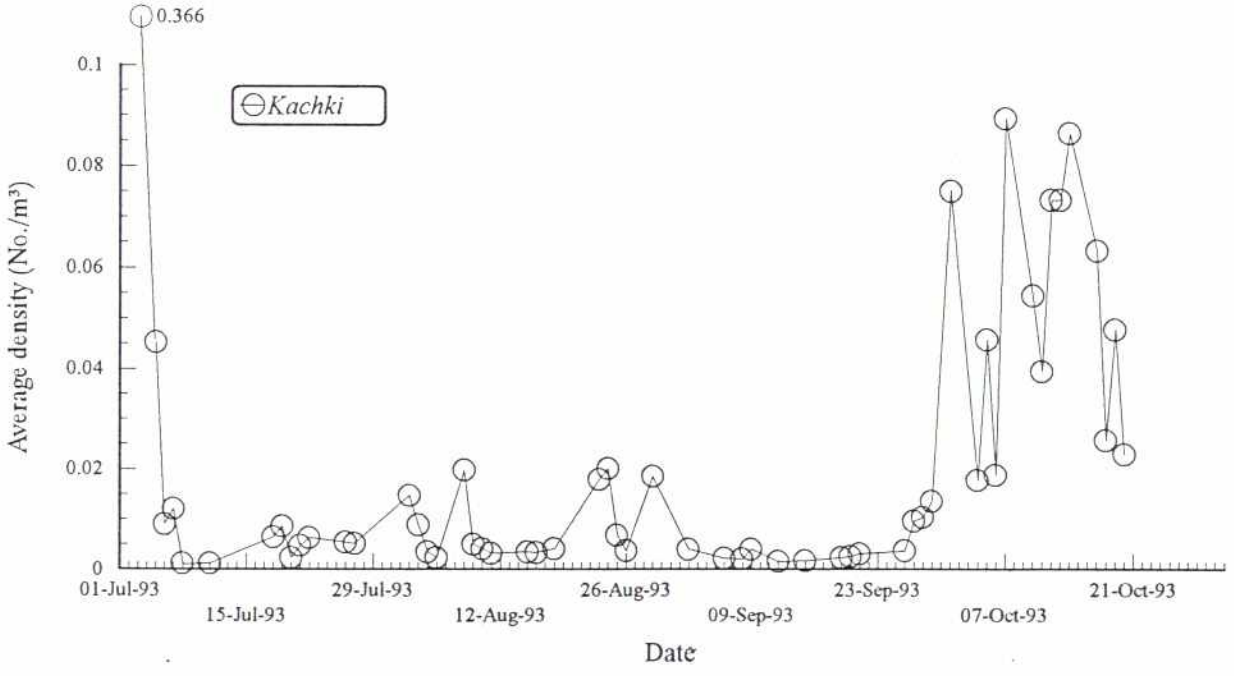
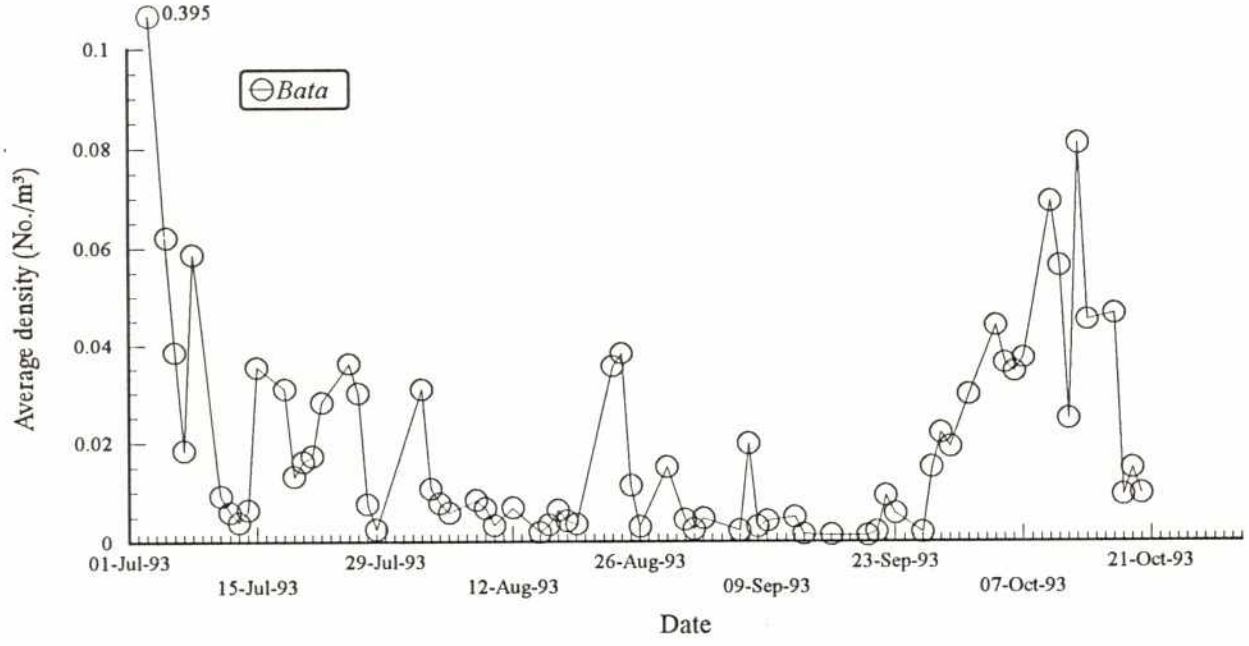
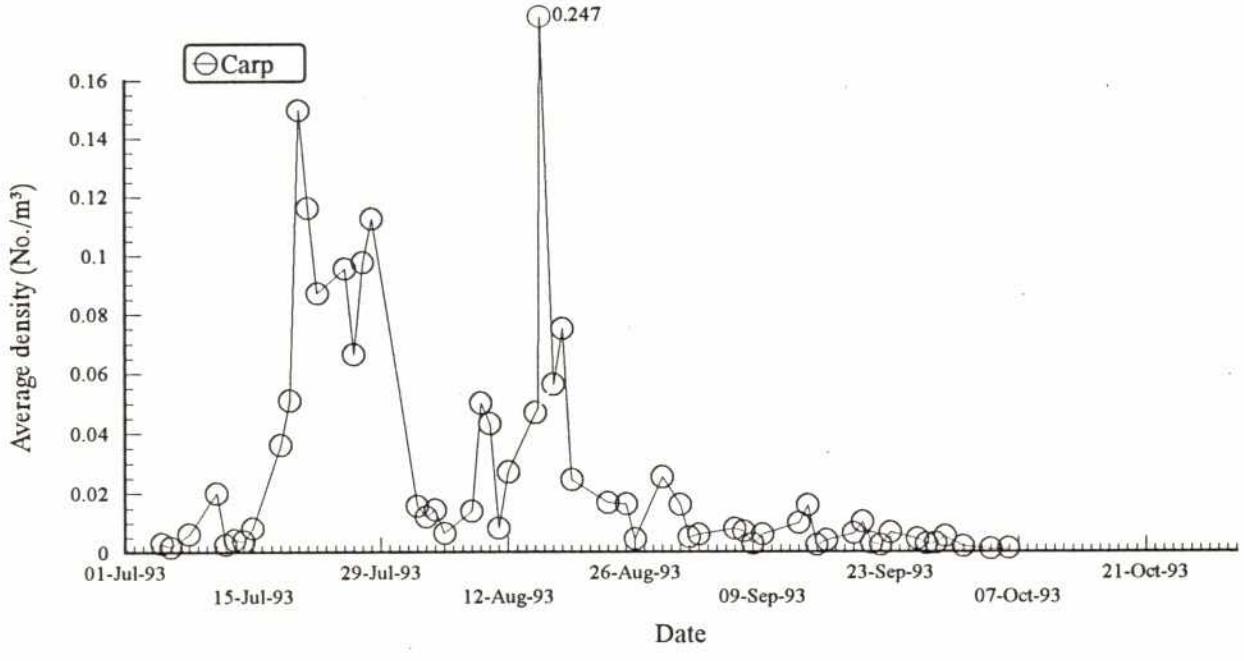


Figure 4.13 (contd.)





Graphs of the same species presented in Figure 4.14 give a similar but truncated picture for 1992. The hatchling survey started late towards the end of August and thus missed the early monsoon high hatchling flow. After the monsoon, a higher flow of hatchlings is prominent for all species in October except carp, for which a high peak occurs in August and early September. The average densities of the species are much lower in for 1992 than 1993 when there was greater flooding. Day to day variations in density differ between the two years for most of the species.

4.2.4 Number of species observed by month

The number of species observed by month and average number of species per day for each month are presented in Table 4.5 for 2 years.

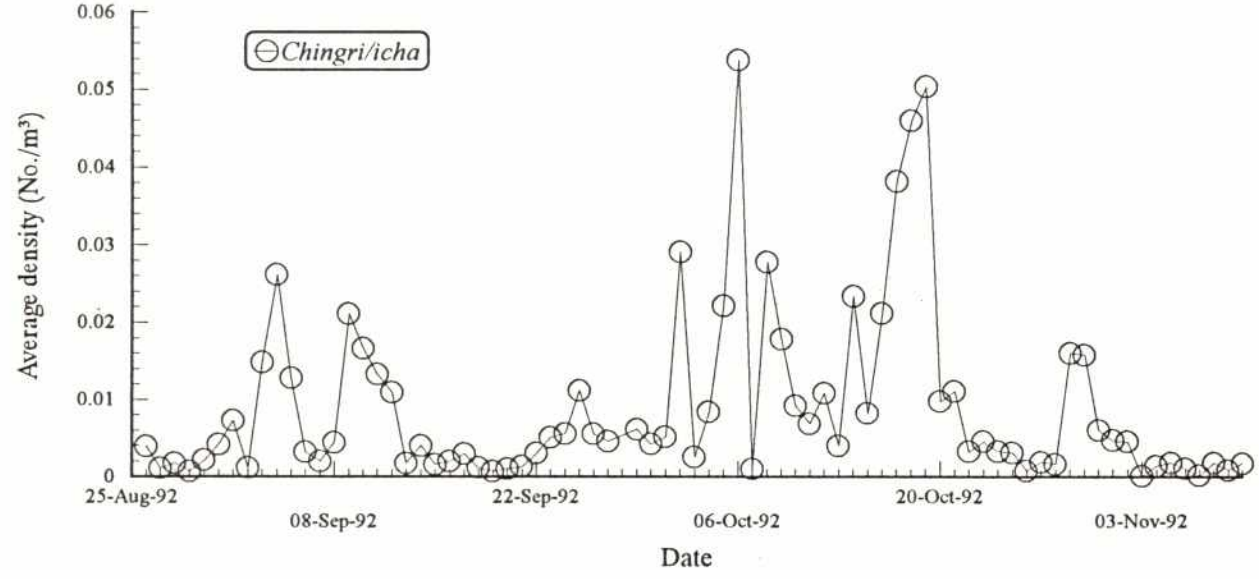
Table 4.5 Numbers of species observed by month for two years

Month	Number of species observed		Average number of species per day			
			Year: 1993		Year: 1992	
	Year: 1993	Year: 1992	Number of record	Number of species	Number of record	Number of species
July	60	-	19	22.0	-	-
August	71	76	20	25.4	7	37.3
September	70	115	20	29.0	29	49.2
October	60	98	14	28.5	31	38.1
November	-	62			10	28.6

Table 4.5 shows that there are wide variations in numbers of species between the two years in September and October. 1992, with less flooding, has much higher numbers in these 2 months since the net was underwater for 24 hours each day. Species numbers cannot be compared for July and November because of lack of data for one of the 2 years. September and October have higher numbers in 1992, August and September in 1993.

The average number of species observed per day also varies between months and years. The average numbers per day are much higher for 1992 than 1993. September has the highest average number of species for both years. The number decreases thereafter.

Figure 4.14 Seasonal variation of average density over survey dates for dominant species in the Padma River at Charghat in 1992



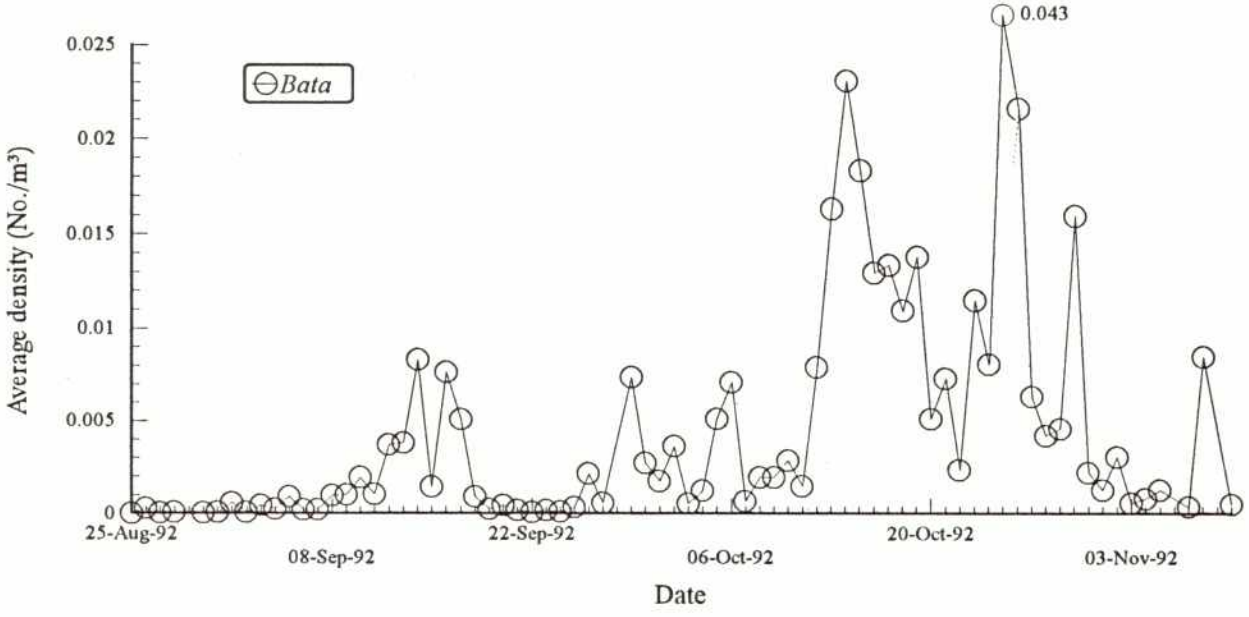
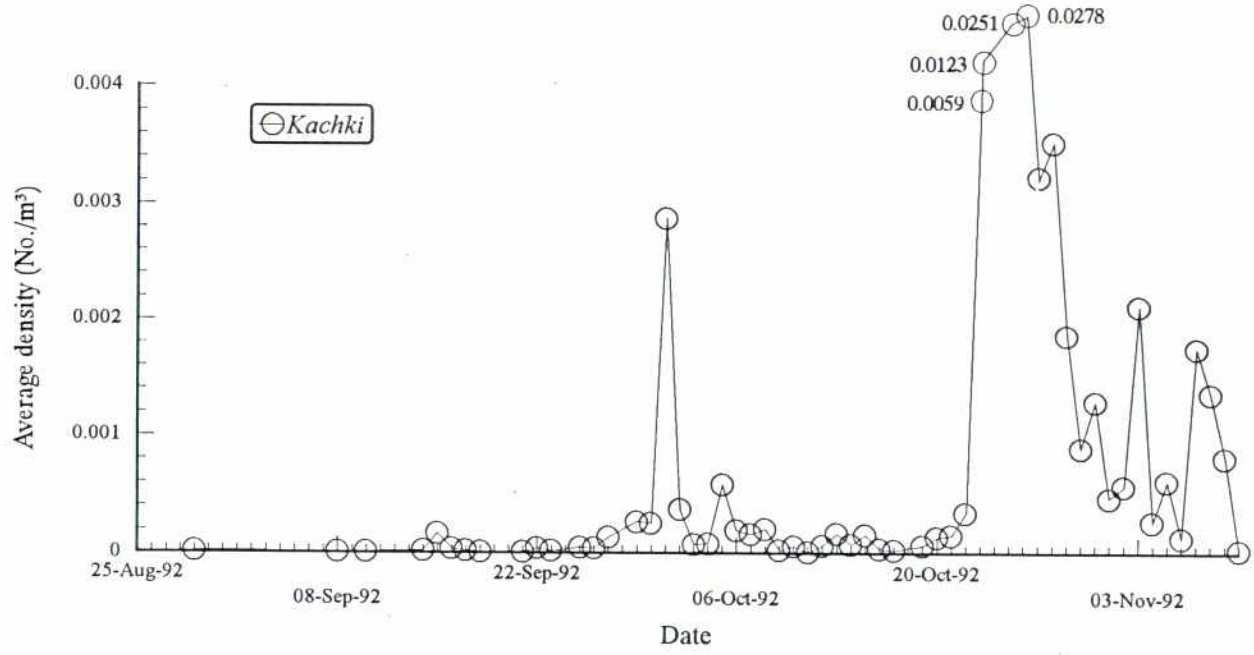
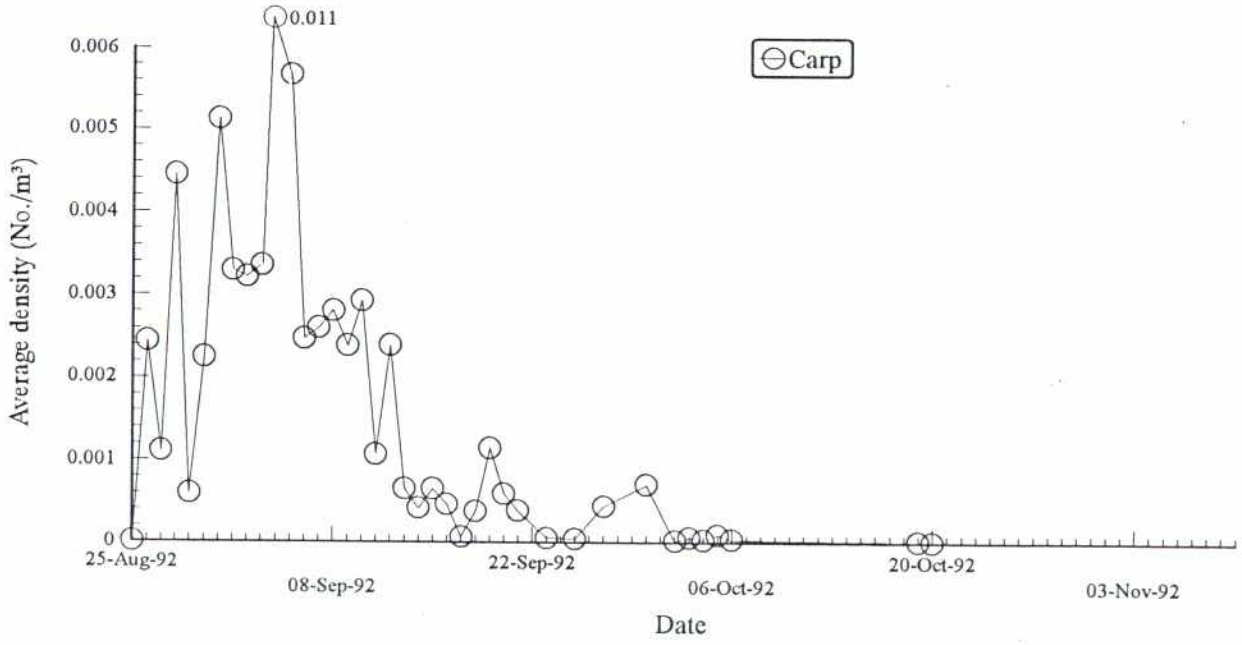


Figure 4.14 (continued)





4.2.5 Number of species observed by survey date

The numbers of species observed per day are presented graphically in Figure 4.15 for the 2 years. it is seen from Figure 4.15 that the number of species fluctuates frequently while water level remains more or less steady over the dates for the two years with different periods of survey. Numbers of species by date are usually larger for 1992 than 1993. There is no relationship between number of species and water level for either year.

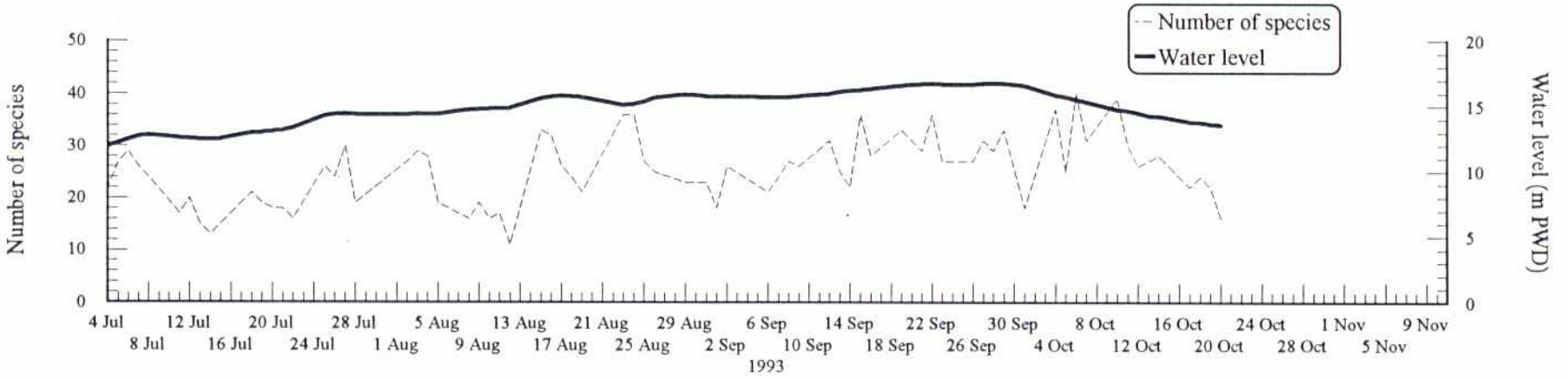
4.2.6 Species composition by month

Percentage densities for dominant species with PC > 5.0 are provided in Table 4.6 by month for 2 years.

It is seen from Table 4.6 that species composition varies widely among 5 months and between 2 years. For 1993, *chingri/icha* is the most dominant species for July and September, carp for August and *kachki* for October. *Kachki*, *chanda*, *bata* and *raik* are the next most important species in this year. For 1992, *chingri/icha* is the most dominant species for September and October, *raik* for August and *chapila* for November. *Chanda*, *bailla*, *bata*, carp and *barilius evezardi* (218) are the next most important species for 1992 in different months.

Figure 4.15 Number of species and water level by survey date for the Padma River at Charghat for 2 years

a) Year: 1993



b) Year: 1992

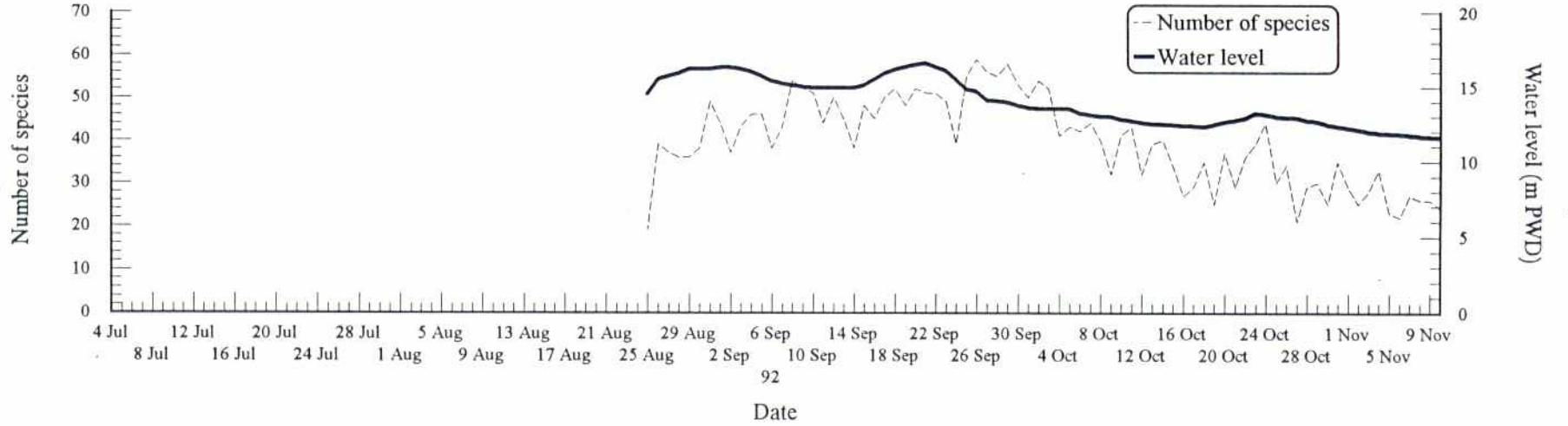


Table 4.6 Species composition by month for species having PC > 5.0 for 2 years

Month	Species name	Year: 1993	Year: 1992
		PC composition	PC composition
July	*Kachki*	12.73	
	Carp	5.96	
	Bata	5.64	
	Chingri/icha	57.52	
August	*Nama chanda*	5.53	10.06
	Raik	13.02	23.46
	Kalabata		5.07
	Barilius evezardi (218)	9.82	
	Carp	14.95	11.32
	Chingri/icha		9.77
	Unidentified fish (939)		5.99
	Unidentified fish (950)	9.22	
September	*Lal chanda*		7.14
	Raik	8.03	
	Gang tengra	7.57	
	Bailla		10.67
	Barilius evezardi		5.10
	Carp		6.22
	Bata		6.78
	Chingri/icha	9.67	24.96
	Unidentified fish (950)	8.75	
October	*Nama chanda*	6.60	7.93
	Lal chanda	8.70	
	Bailla	6.21	5.13
	Kachki	23.30	10.23
	Bata	17.06	21.83
	Chingri/icha	14.84	36.48
November	*Kachki*		6.50
	Chapila		25.03
	Barilius evezardi (218)		15.43
	Bata		9.10
	Chingri/icha		10.08
	Unidentified fish (998)		11.24

4.3 Surma River in North East Region

There were 2 sites on the Surma River: Site 1 near Sunamganj town, and Site 2 near Sylhet town. The distance between the two sites is more than 50 km. Site 1 is downstream of Site 2. Two nets were fixed on the water surface near the left bank of the river at both sites for catching the fish larvae. The hatchling survey was undertaken from March to August 1993 at both sites. Water velocity data were also collected on each survey date at the two sites.

Basic densities were computed for each survey time on every survey date by species and also for all species together. The average basic densities were calculated over survey times and dates for analysis. There are 165 records of overall (all species) densities. Out of this, 103 records belong to Site 1 and 62 records to site 2.

4.3.1 Graphical representations of hatchling density and number per hour

Average hatchling density and number per hour are plotted by date along with water velocity and water level data respectively in Figures 4.16 to 4.19 for the 2 sites. It is observed from Figures 4.16 and 4.17 that the patterns of distributions of density and hatchling number per hour over dates are similar with a few exceptions for the Sunamganj site. A high peak of hatchling rates occurs in the last week of May after a high rise in water level. Hatchling flow also falls with velocity in July. For Sylhet (Figures 4.18 and 4.19) patterns of the 2 rates are similar and a high peak occurs in late May after a high rise in water level. Hatchling rates fall sharply with the decrease in water velocity in late June.

Hatchling rates differ between the 2 sites in April. The water level is higher in Sylhet after April.

4.3.2 Comparison of densities between two sites

Basic overall (all species) densities of survey times are compared by month between the two sites by the non-parametric U-test (Mann-Whitney). Results of the test along with the number of records and mean densities are provided in Table 4.7.

It is observed from Table 4.7 that the monthly numbers of records and mean densities are usually higher for Site 1 near Sunamganj than Site 2 near Sylhet. The table also shows that the differences between average densities between the two sites are not significant except in

Figure 4.16 Graph of overall average density and water level by survey date for the Surma River at Sunamganj in 1993

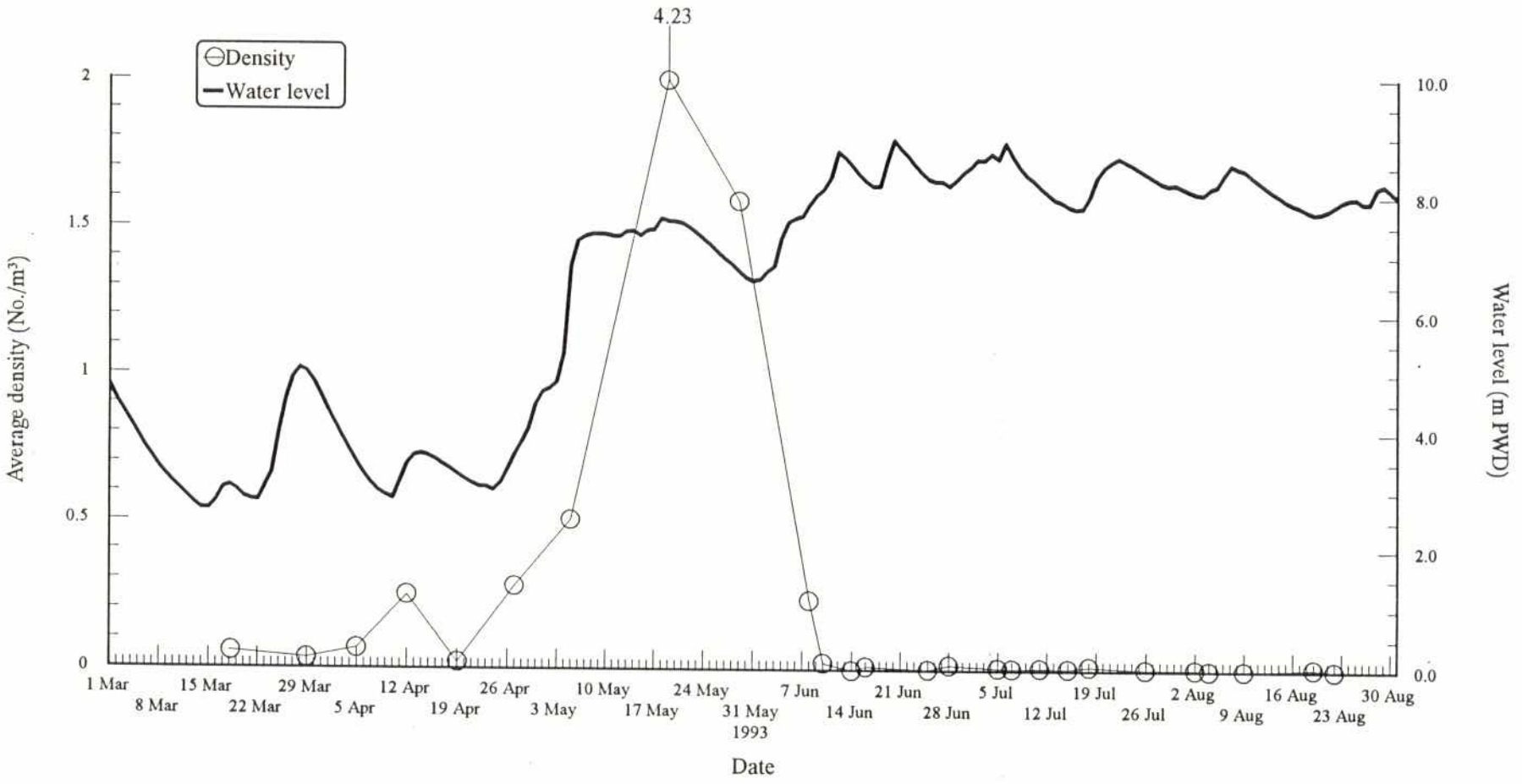


Figure 4.17 Graph of overall average hatchling number per hour and water velocity by survey date for the Surma River at Sunamganj in 1993

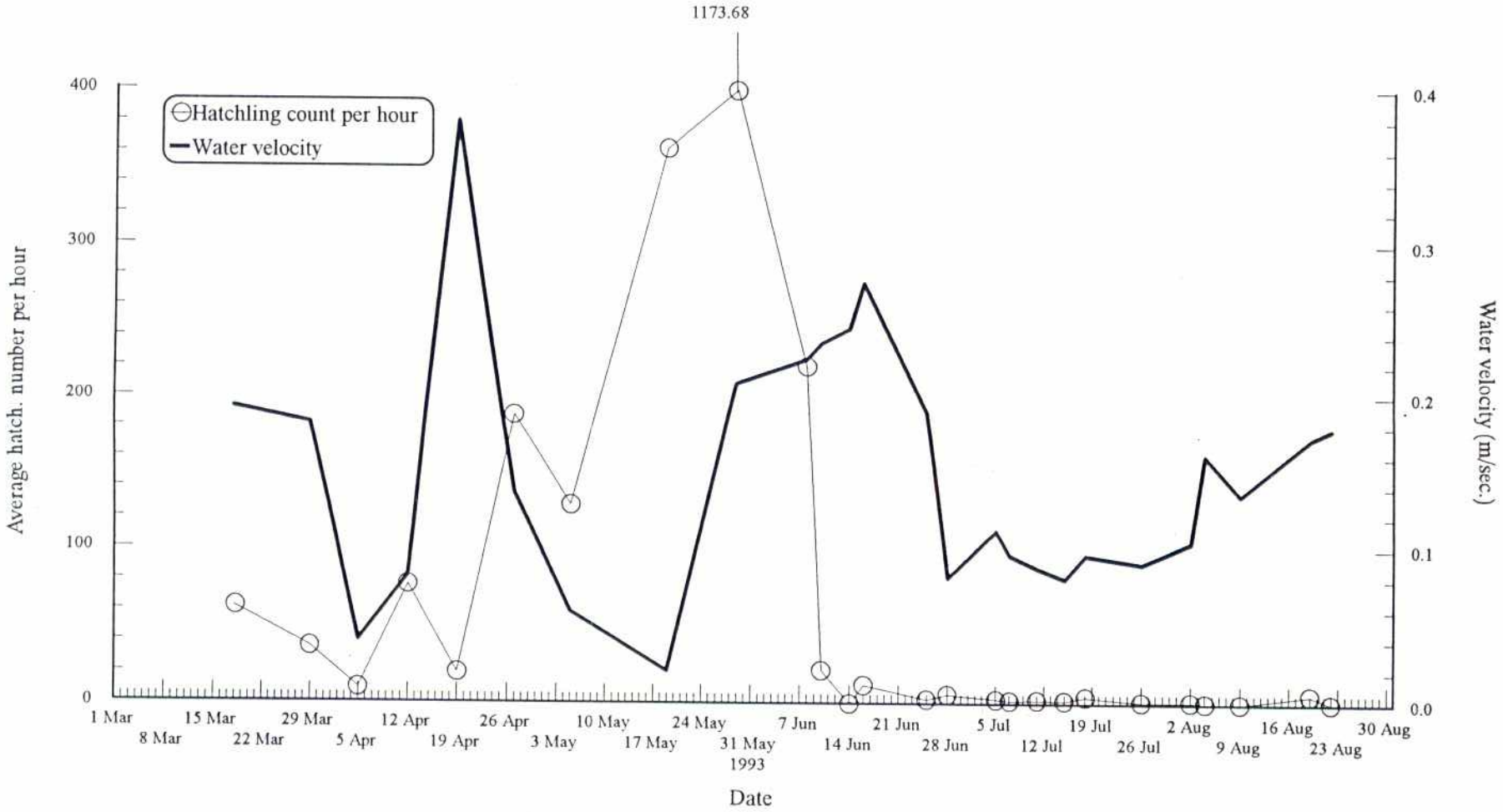


Figure 4.18 Graph of overall average density and water levels by survey date for the Surma River at Sylhet in 1993

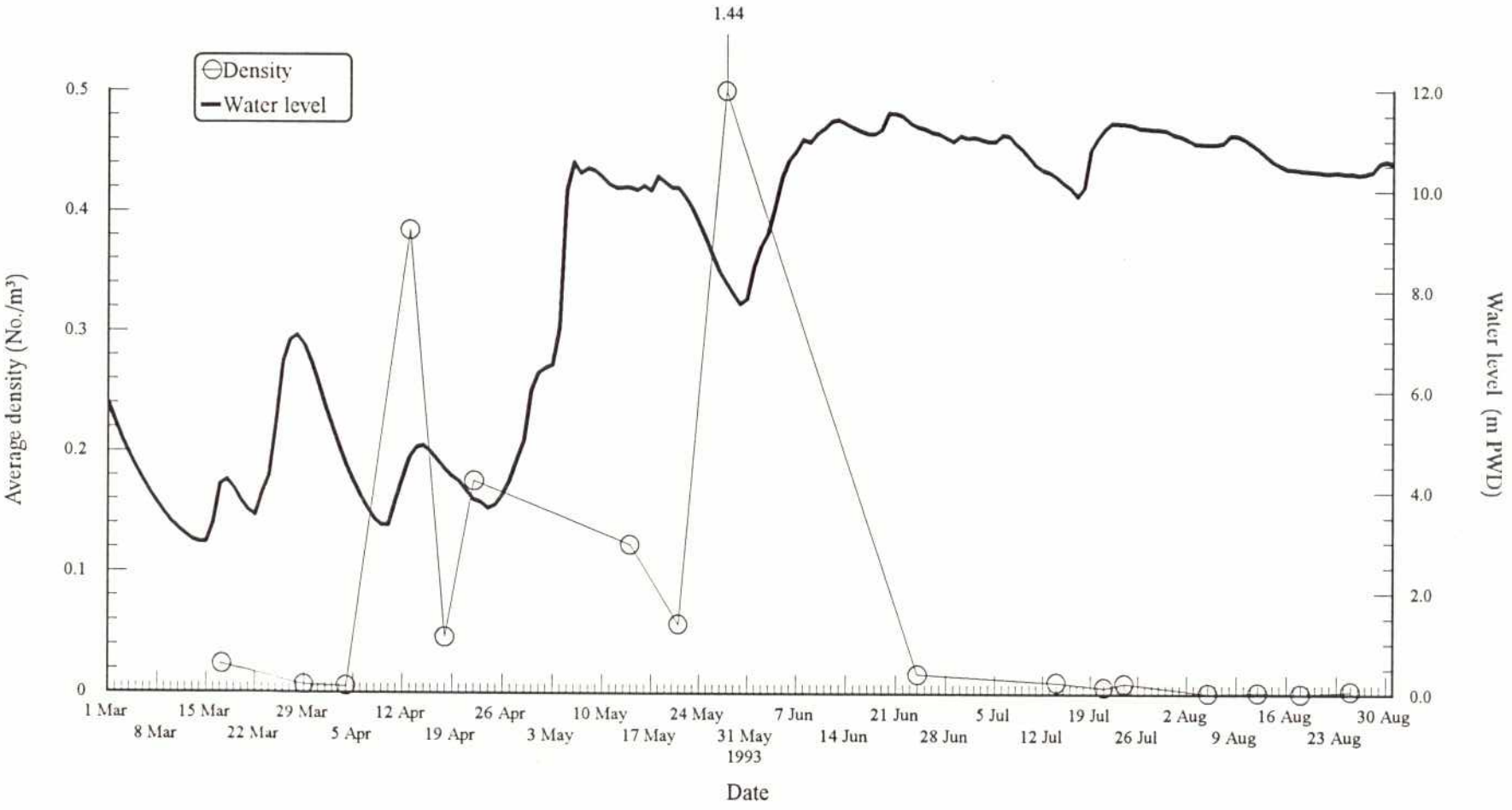
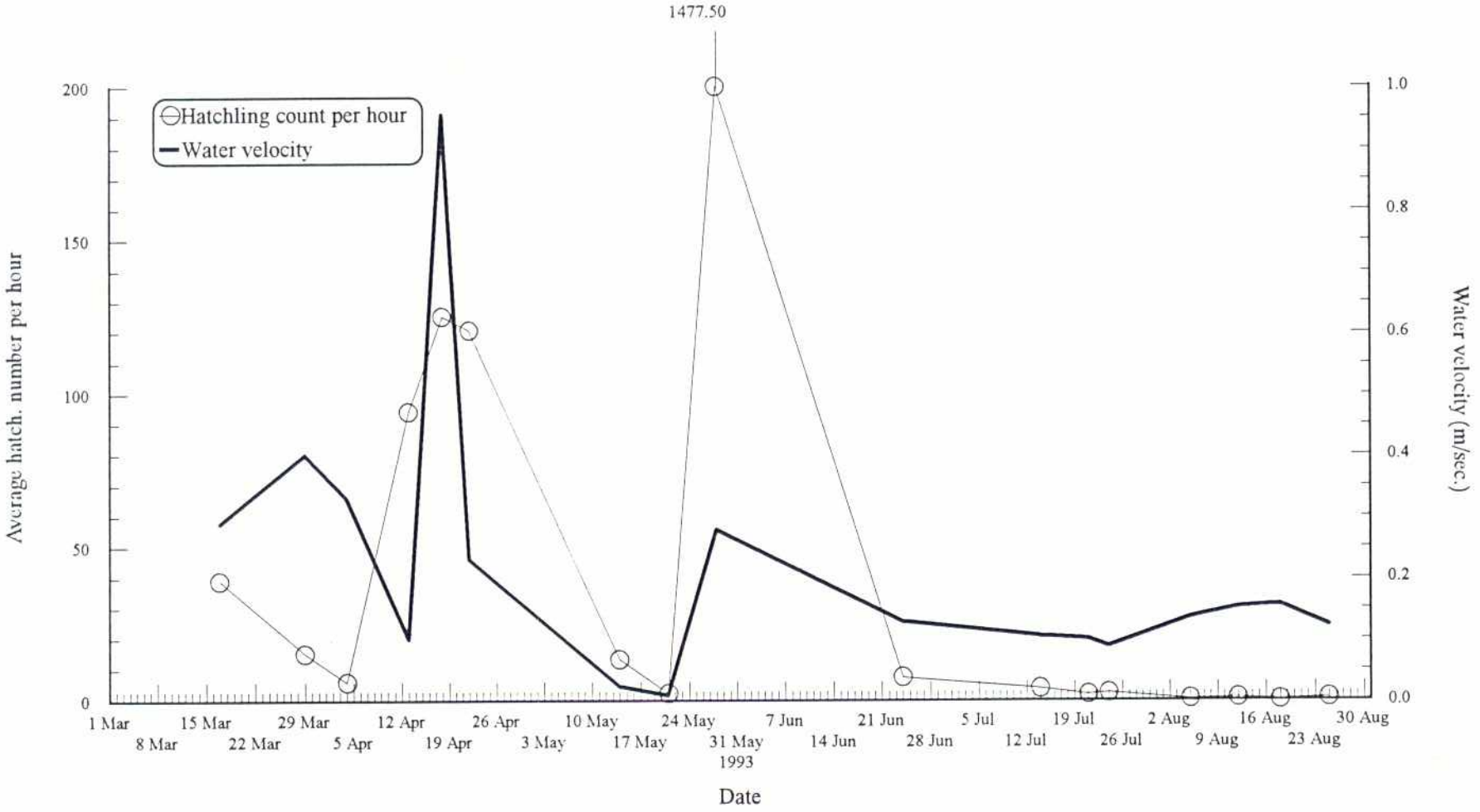


Figure 4.19 Graph of overall hatchling number per hour and water velocity by survey date for the Surma River at Sylhet in 1993



May, for which the average density at Site 1 is much higher than that at Site 2. Average densities are quite low except for April and May. It appears that hatchling flow is about the same down the Surma River at both the Sunamganj and Sylhet sites except during the peak month of May when the Sunamganj site has a much higher density.

Table 4.7 Results of comparison of densities between 2 sites on the Surma River

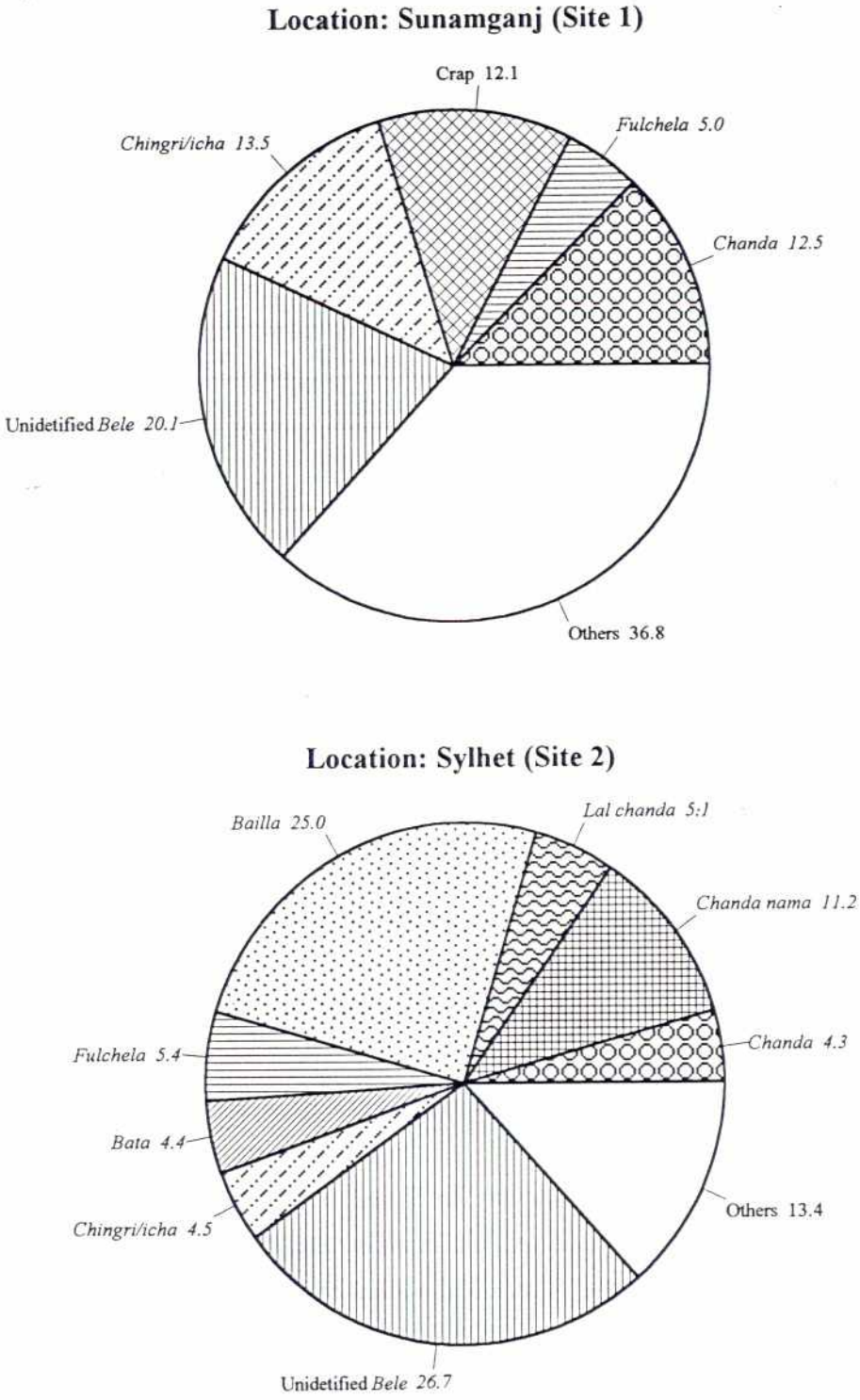
Month	Site 1 (Sunamganj)		Site 2 (Sylhet)		Non-parametric U-test		
	Number of record	Mean density	Number of record	Mean density	u/z value	P-value	Comment
March	8	0.045	8	0.015	16.0	0.105 (exact)	NS
April	16	0.153	15	0.163	-0.47	0.635	NS
May	13	2.474	10	0.630	-2.17	0.030	SIG
June	21	0.043	4	0.016	37.0	0.748 (exact)	NS
July	28	0.008	11	0.006	-0.27	0.790	NS
August	17	0.004	14	0.002	-0.19	0.847	NS
All months	103	0.351	62	0.146	-0.04	0.968	NS

4.3.3 Species composition and dominant species

The percentage (PC) of total density of each species with respect to total density of all species is computed by site for the whole period of survey. There 52 species for Site 1 and 34 for Site 2. Species compositions of density for dominant species with PC $\geq$ 5.0 are represented graphically by Pie charts in Figure 4.20 for 2 sites.

Figure 4.20 shows that species compositions are quite different for the two sites. There are only 5 dominant species contributing 63.1% to the total density for Site 1 and 8 species accounting for 86.8% of the total density for Site 2. While unidentified *bele* and *bailla* are the two most dominant species for Site 2, unidentified *bele* dominates at Site 1. *Nama chanda* is the next most important species for Site 2 while *chingri/icha*, *chanda* and carp form the second most important group of species for Site 1. Carp is not a dominant species for Site 2.

Figure 4.20 Pie charts for species compositions (in percentage) of hatchling densities for 2 sites on the Surma River in North East Region (PC > 5.0)



4.3.4 Graphical representation of daily average densities for dominant species

Daily average densities are plotted in Figures 4.21 and 4.22 for some dominant species for the 2 sites on the Surma River. It is seen from these Figures that most of the species have a few peaks in April and May. The numbers of data are usually small excepting *chingri/icha* for Sunamganj and *nama chanda* for Sylhet. The densities are usually small after May. Patterns of densities of most of the species over dates are similar except carp.

4.3.5 Number of species observed on survey dates

Numbers of species observed for different survey dates, are represented by graph in Figure 4.23 for 2 sites. It is observed from Figure 4.23 that number of species fluctuates somewhat over dates at both sites. For Site 1, the highest number of species occurs in May. For Site 2, the highest number occurs in April and May. After the middle of June, the number of species decreases gradually. The peak is higher at Site 1 than Site 2.

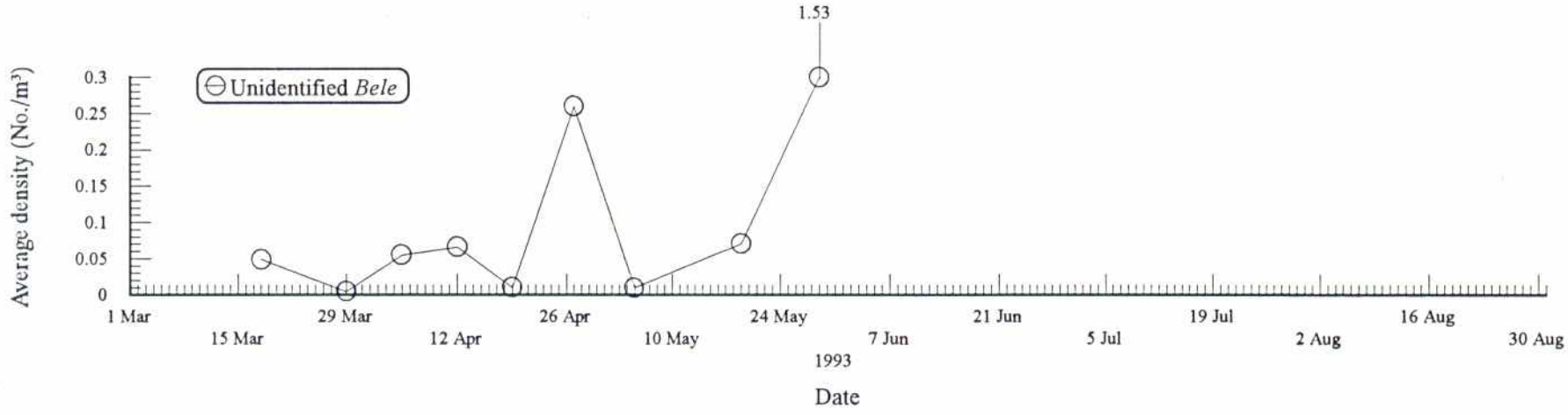
4.3.6 Species composition of dominant species by month

Percentage compositions of density are obtained by species and by month.

For dominant species having PC $\geq$ 15.0, percentage compositions are provided in Table 4.8 for the 2 sites. It is observed from Table 4.8 that species composition varies widely among the months for each site and between the two sites. For Site 1 at Sunamganj, unidentified *bele* is the most dominant in March to May, *bailla* in June and *nama chanda* in July and August. *Chingri/icha* is the next most important species in May and August. Carp has not appeared in the table but its PC composition is 14.1 for May at Site 1.

For Site 2 at Sylhet, unidentified *bele* dominates in April and May, *bailla* in May, *lal chanda* and *baral baim* in June, *nama chanda* in July and *chingri/icha* in August. The *Chanda* group of fish appears to be more common as the dominant species for this site. Carp is not an important species here.

Figure 4.21 Seasonal variation of average density over survey date for dominant species in the Surma River at Sunamganj in 1993



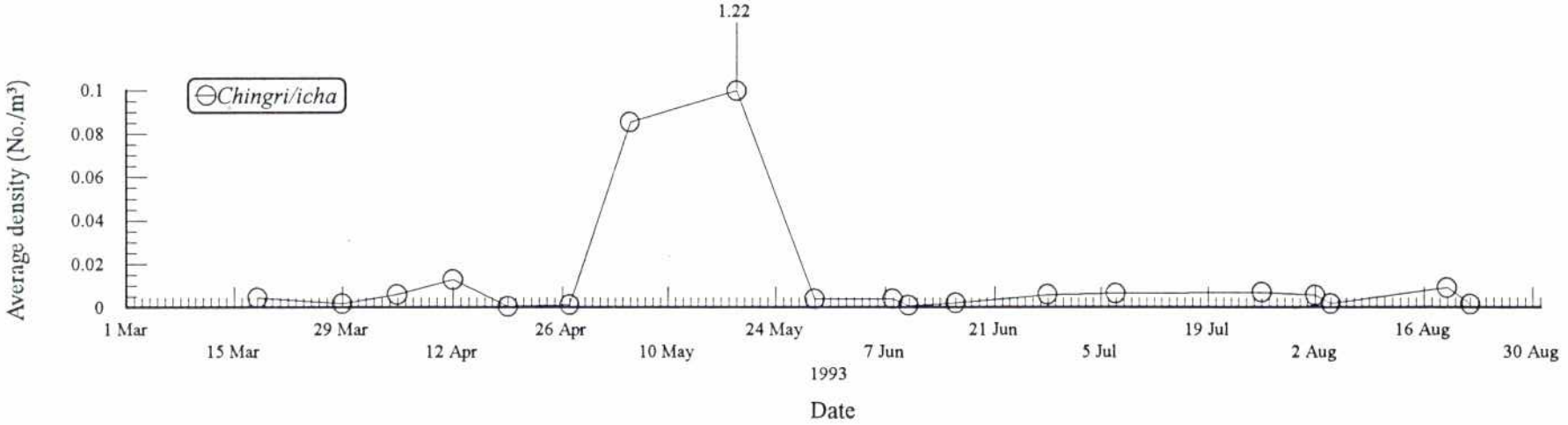
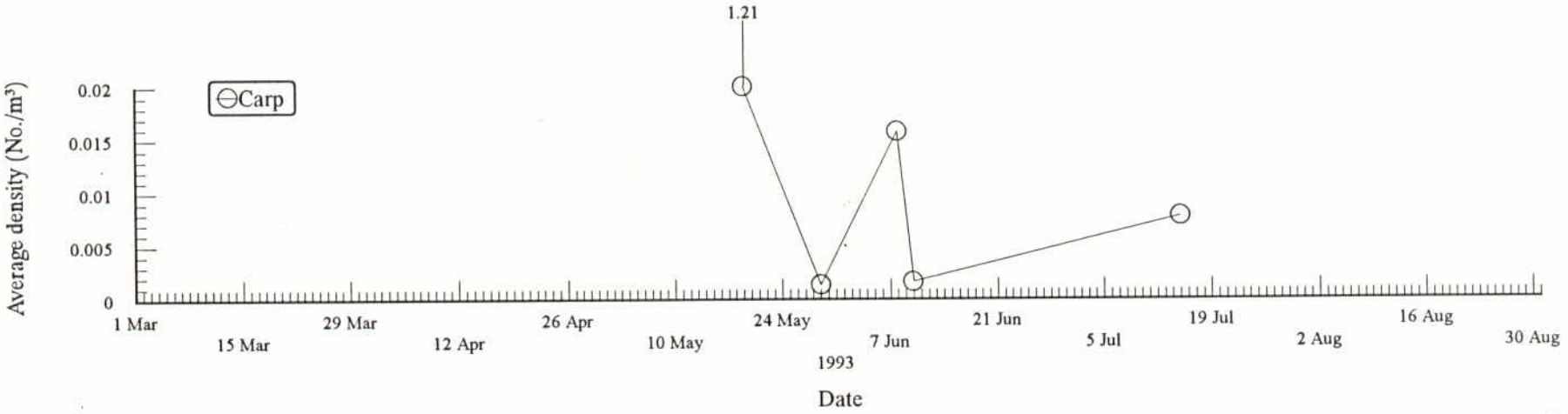


Figure 4.21 (Contd.)



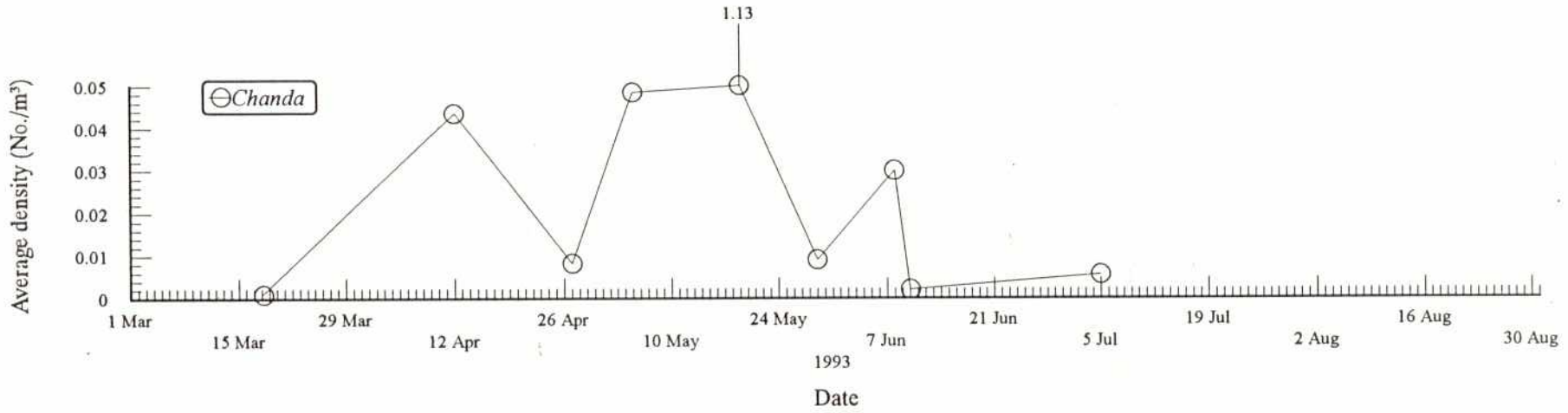


Figure 4.22 Seasonal variation of average density over survey date for dominant species in the Surma River at Sylhet in 1993

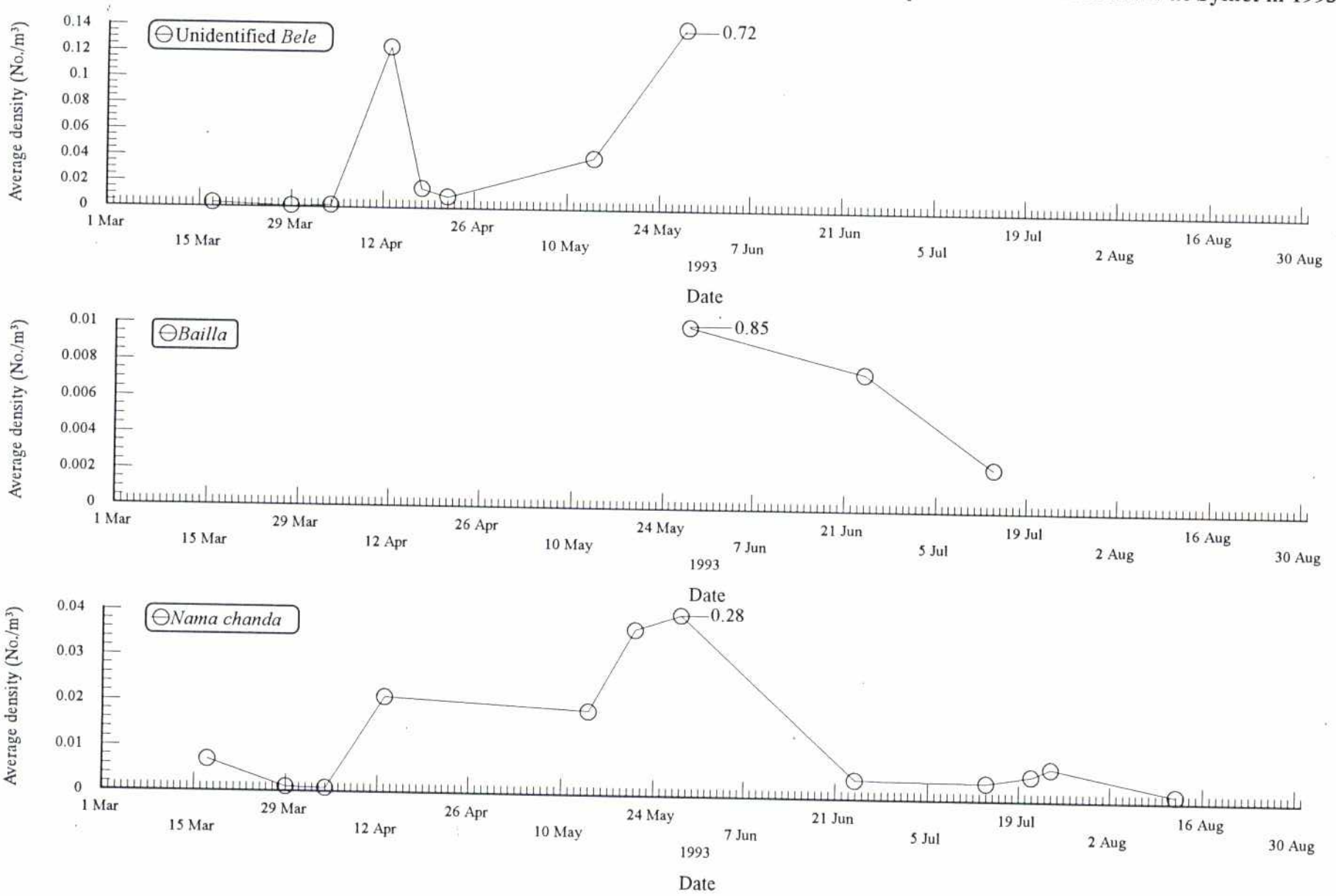


Figure 4.23 Number of species and water level by survey date for the Surma River in 1993

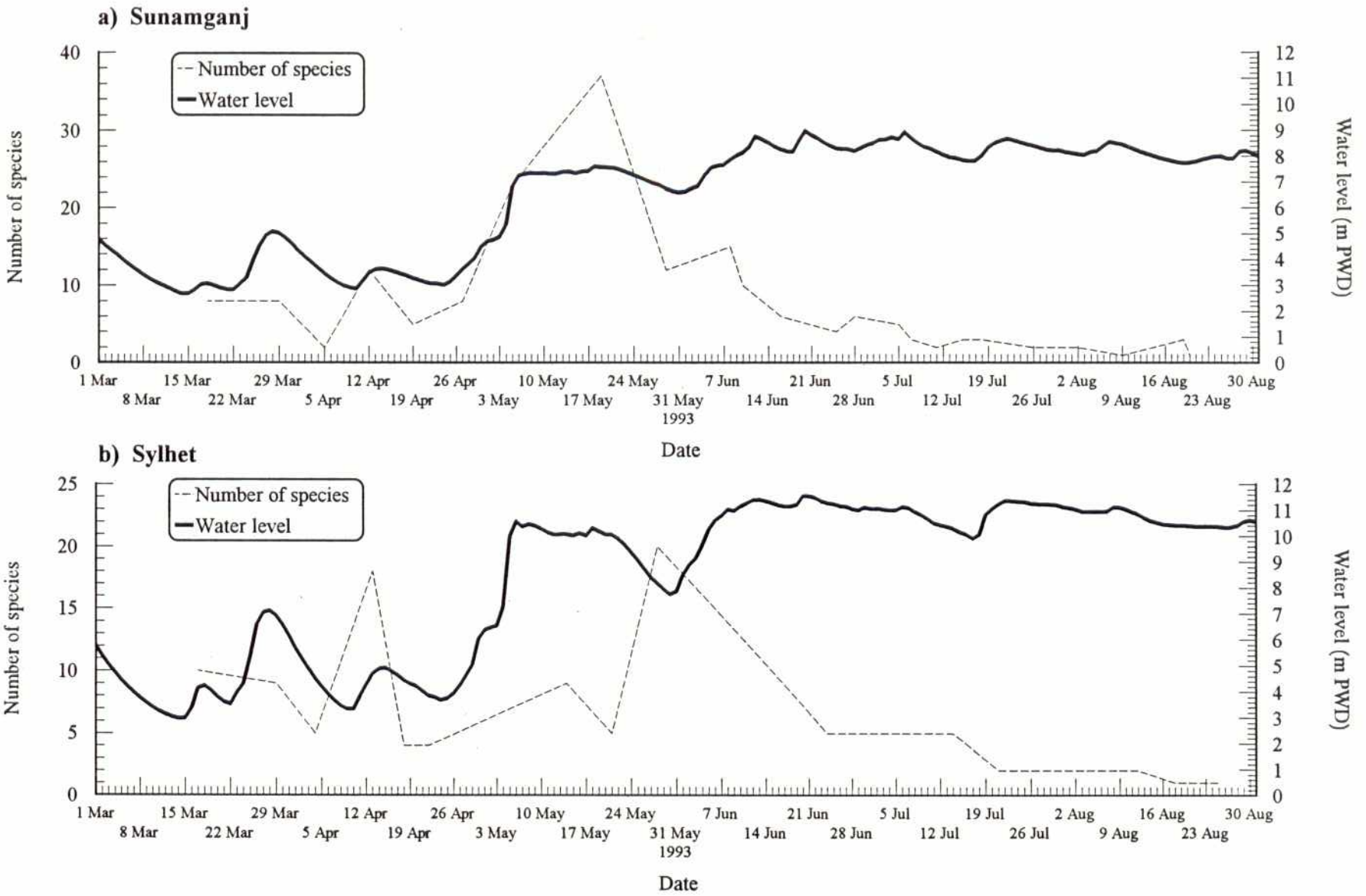


Table 4.8 PC compositions of dominant species by month for PC > 15.0 for 2 sites on the Surma River

	Month	Species name	Percentage composition
Site 1 (Sunamganj)	March	*Fulchela*	16.6
		Bata	16.4
		Unidentified *bele*	41.1
	April	Unidentified *bele*	42.3
	May	*Chingri/icha*	15.2
		Unidentified *bele*	18.7
	June	*Bailla*	48.2
	July	*Nama chanda*	19.9
		Lal chanda	19.8
	August	*Nama chanda*	42.2
		Chingri/icha	30.3
Site 2 (Sylhet)	March	*Nama chanda*	20.7
		Kachki	21.7
	April	*Bata*	21.2
		Unidentified *bele*	21.3
	May	*Bailla*	32.9
		Unidentified *bele*	29.6
	June	*Lal chanda*	22.9
		Bailla	20.0
		Baral baim	22.9
	July	*Nama chanda*	30.9
		Lal chanda	23.5
		Chingri/icha	27.9
	August	*Chanda*	25.6
		Chingri/icha	49.8

4.4 Kushiyara River in North East Region

There were two sites of hatchling catch survey for this river; Site 1 in the Sherpur area, and Site 2 in the Fenchuganj area. Site 1 is downstream of Site 2 (about 30 km). Two nets were fixed near the right and left banks for Site 1 and Site 2 respectively. The hatchling survey was undertaken from March to August at Site 1 and during July and August at Site 2. Hatchling densities and numbers per hour were computed for each survey time of every survey date by species and for all species together. Water velocity data were also collected for each survey date. The total numbers of records for all survey times and dates were 74 and 18 for Site 1 and Site 2 respectively. The number of survey dates was 23 and 6 for the 1st and 2nd sites respectively.

4.4.1 Graphical representation of hatchling density and number per hour

Average hatchling density and number per hour are plotted by date along with water velocity and water level data respectively in Figures 4.24 and 4.25 for the Sherpur site and in Figures 4.26 and 4.27 for the Fenchuganj site. It is clear from these Figures that patterns of density and hatchling numbers per hour are similar for both sites. Both hatchling rates and water velocity are randomly distributed over the dates at the Sherpur site with high densities in April and May. Hatchling rates become small after June. Densities of Site 2 are usually much smaller than those of Site 1 downstream in the last 2 months. There is hardly any relationship between density and water velocity for either site except that both hatchling rates and velocity decrease in July and August for Site 1. Figures 4.24 and 4.26 show that there is no relationship between density and water level for either site.

4.4.2 Monthly average densities and comparison between 2 sites

Monthly overall (all species) average densities are computed by taking the average of densities over survey times and survey dates in each month for the 2 sites separately. These average densities are given in Table 4.9 along with results of comparisons of densities between the 2 sites by Mann-Whitney U-test for the last 2 months, July and August, for which data at both sites are available.

It is observed from Table 4.9 that the mean density for Site 1 in Sherpur area (downstream) is highest in April followed by March. May has the 3rd highest average density. After May, hatchling flow falls sharply and stabilises for the last 3 months. For Site 2 in the Fenchuganj

Figure 4.24 Graph of overall average density and water level by survey date for the Kushiyara River at Sherpur in 1993

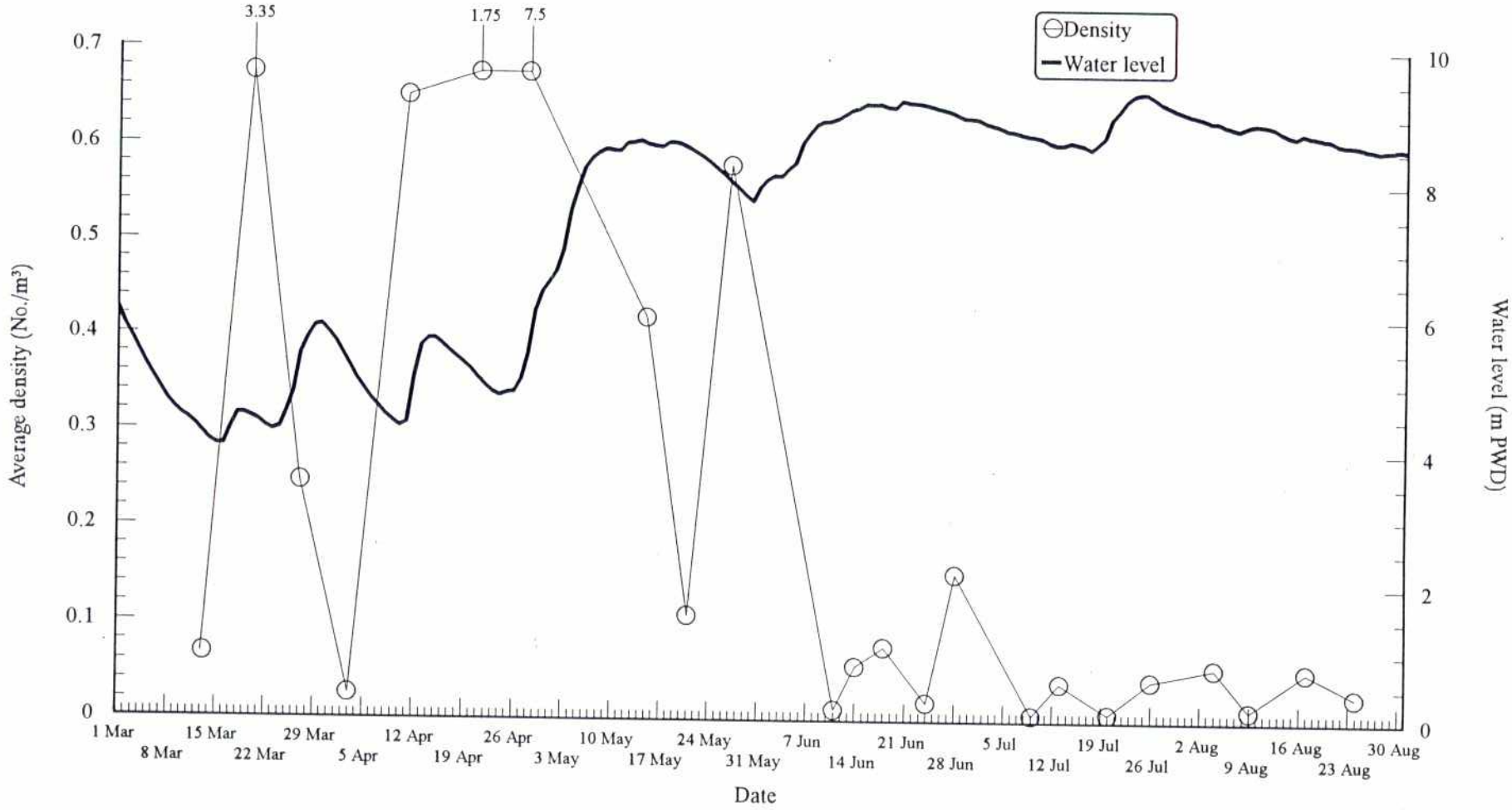


Figure 4.25 Graph of overall hatchling number per hour and water velocity by survey date for the Kushiyara River at Sherpur in 1993

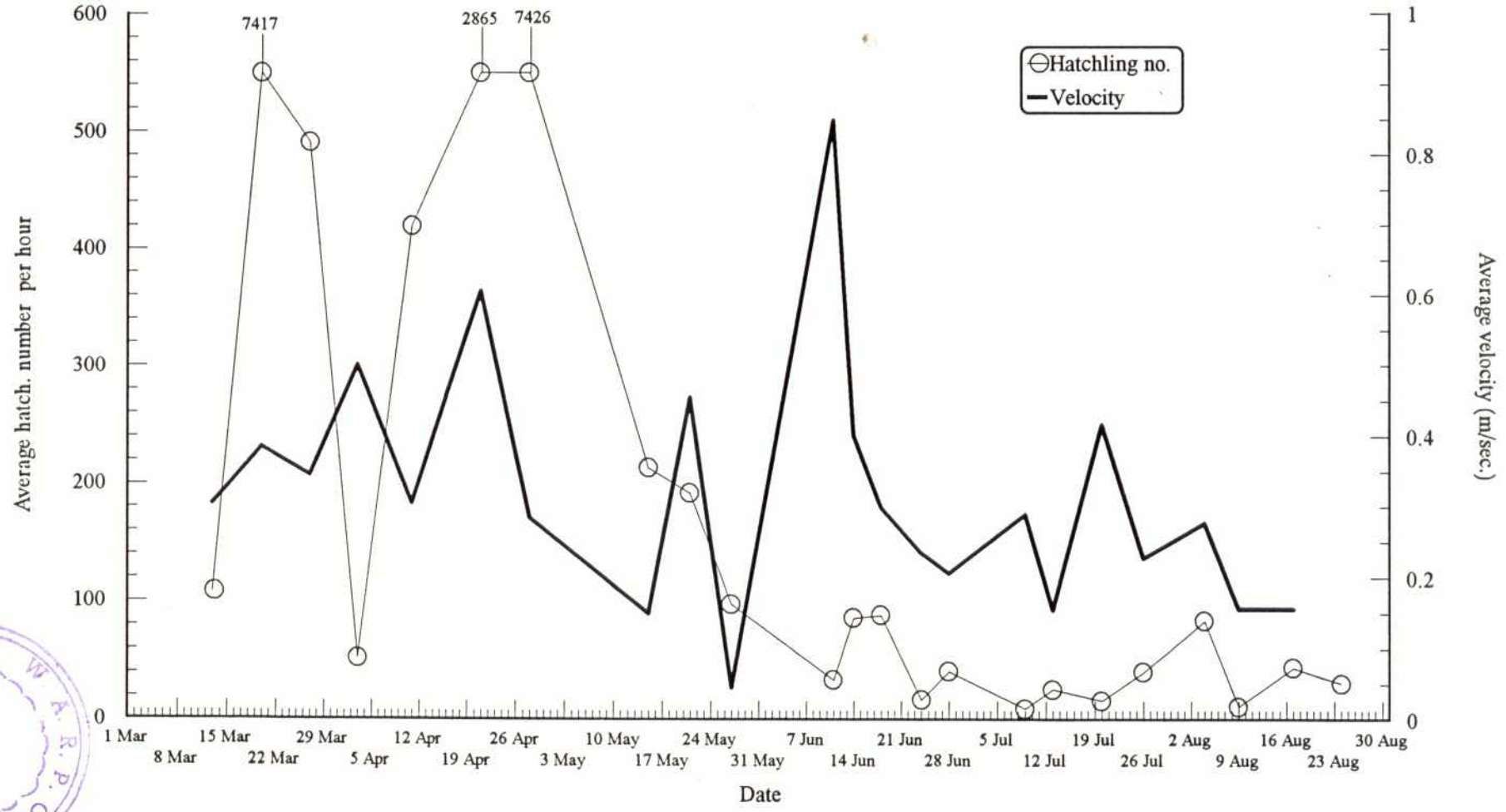


Figure 4.26 Graph of overall average density and water levels by survey date for the Kushiyara River at Fenchuganj in 1993

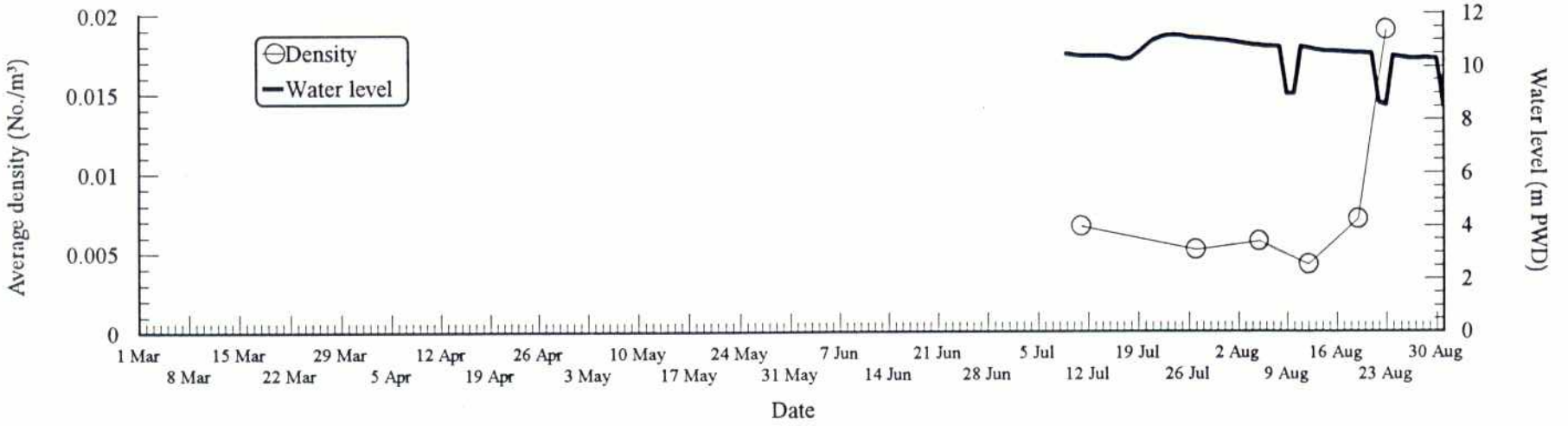


Figure 4.27 Graph of overall hatchling number per hour and water velocity by survey date for the Kushiyara River at Fenchuganj in 1993

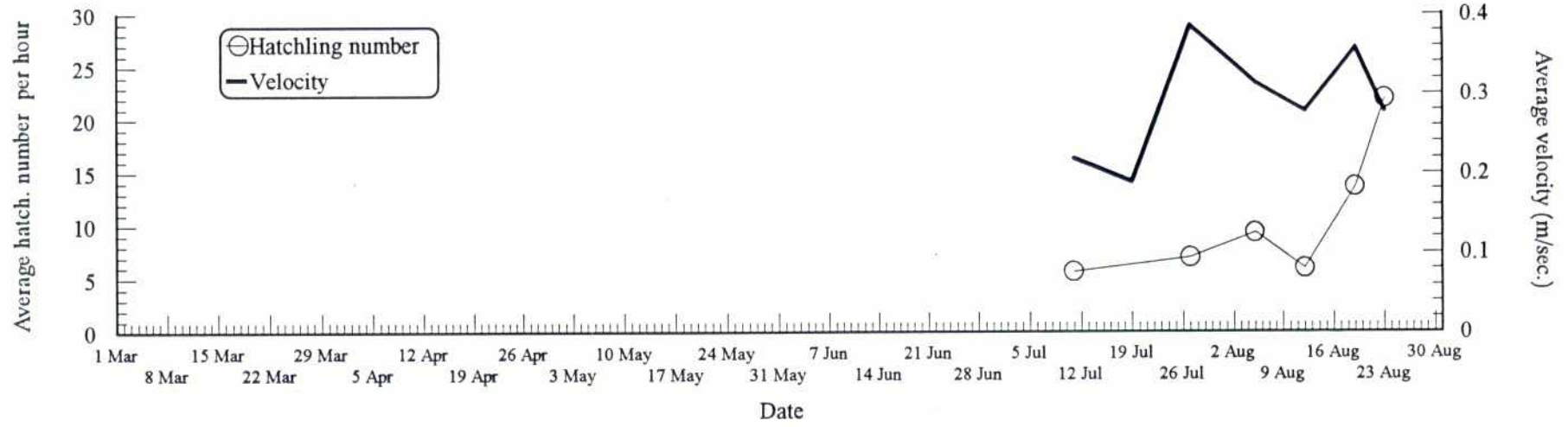


Table 4.9 Average monthly densities and comparison between 2 sites

Month	Site 1 (Sherpur)		Site 2 (Fenchuganj)		Non-parametric U-test		
	Number of record	Mean density	Number of record	Mean density	u/z value	P-value	Comment
March	11	1.326					
April	15	2.644					
May	9	0.369					
June	15	0.064					
July	12	0.025	6	0.006	10.0	0.013	SIG
August	12	0.037	12	0.009	-3.52	0.000	HS
All months	74	0.801	18	0.008	-4.02	0.000	HS*

Note: * test for last 2 months together

area (upstream) average overall densities are very low compared with Site 1. The difference of average densities between two sites is significant at the 2% level for July and is highly significant for August and both months together.

For the last 2 months, therefore, average density differs significantly between the 2 sites on this river.

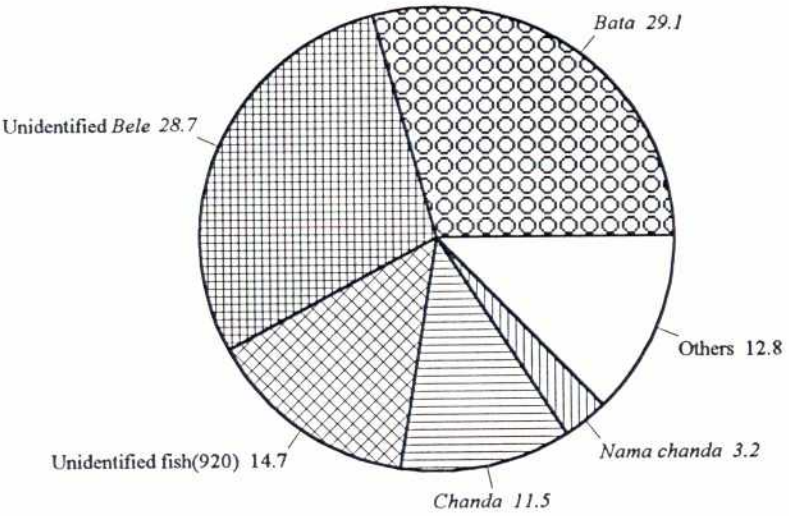
4.4.3 Dominant species and percentage composition

The percentage (PC) contributions from total density of each species to the total density of all species are computed by site for the whole period of survey. There were 70 species for Site 1 and 25 species for Site 2. The PC compositions of density of dominant species are represented by Pie charts in Figure 4.28 for 2 sites for PC $>$ 3.0.

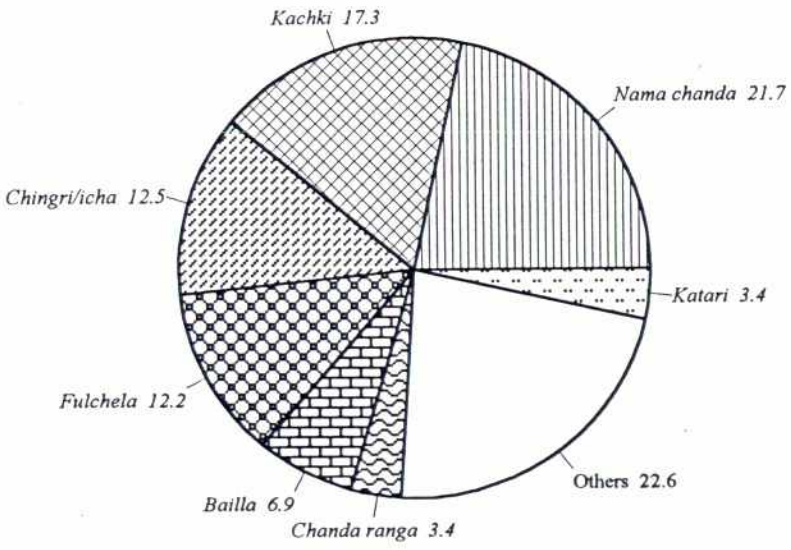
It is seen from Figure 4.28 that species compositions are quite different for the two sites. *Bata* and unidentified *bele* are the most dominant for Site 1 and *nama chanda* for Site 2. Unidentified species (920) and *kachki* are the next important species for Sites 1 and 2 respectively. *Chingri/icha* and *fulchela* have substantial contributions at Site 2 and *chanda* at Site 1. For Site 1, 5 species out of 70 make up 87.2% of total density and for Site 2, 7 species out of 25 contribute 77.4% to total density. Carp is conspicuous by its absence from both sites as a dominant species.

Figure 4.28 Pie charts for species compositions (in percentage) of hatchling densities for 2 sites on the Kushiyara River in North East Region (PC > 3.0)

Location: Sherpur (Site 1)



Location: Fenchuganj (Site 2)



4.4.4 Graphical representation of daily average densities for dominant species

Daily average densities of the dominant species are graphically represented in Figures 4.29 and 4.30 for Sites 1 and 2 respectively. Figures 4.29 for Site 1 shows that *bata* has 2 high peaks, one in March and one in April; unidentified *bele* has 2 peaks in April, and *chanda* has 2 peaks in April and May. Average densities of all these species are negligible after May.

For site 2, Figure 4.30 shows that there are few species on all dates in July and August and densities are very small with some variations. Densities of all species except *fulchela* increase after mid-August. Peak densities in the early months are missing at this site because of lack of data.

Patterns of densities over dates are roughly similar for dominant species at Site 1 and Site 2.

4.4.5 Number of species by survey date

Numbers of species of hatchling catches for different survey dates are presented graphically in Figure 4.31 for two sites. This figure shows that highest numbers of species occur in late April and early May for Site 1. The number of species varies considerably over the survey dates.

For Site 2, species vary more in number over dates than at Site 1 in July and August. Water level and the number of species per day are not related.

4.4.6 Dominant species and species composition by month

Percentage compositions (PC) of density are obtained for species by month and these are presented in Table 4.10 for dominant species with PC compositions > 10.0.

It is observed from Table 4.10 that species composition varies widely between months for Site 1. *Bata*, unidentified *bele* and *nama chanda* make up 93.5%, 40.0% and 55.5% of total density for March, April and August respectively for Site 1. *Chanda* and *chingri/icha* are also important. For Site 2, *fulchela* and *nama chanda* appear to be more important. PC composition varies widely between the two sites.

Figure 4.29 Seasonal variation in average density over survey dates for dominant species in the Kushiyara River at Sherpur in 1993

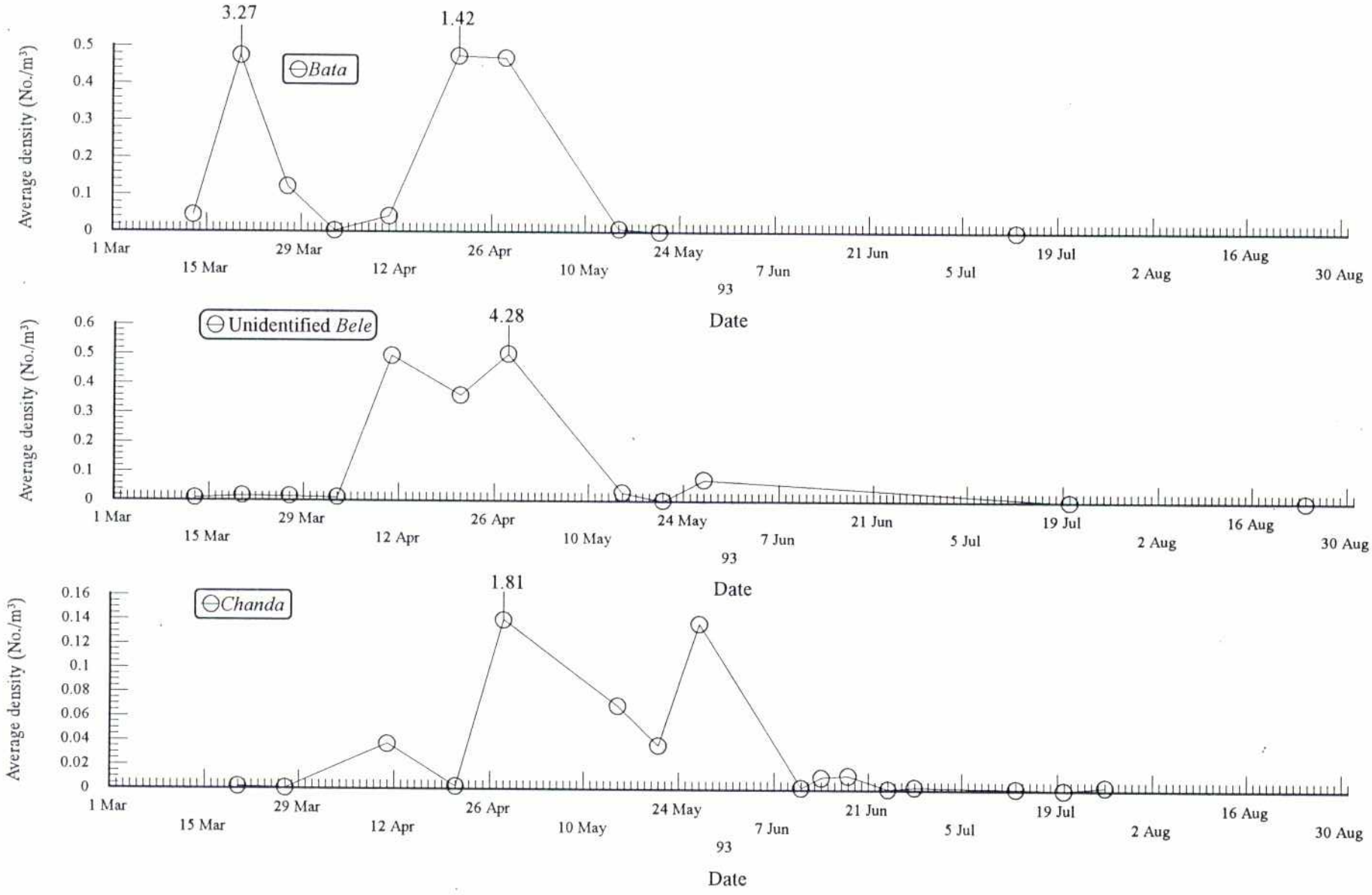


Figure 4.30 Seasonal variation in average density over survey dates for dominant species in the Kushiyara River at Fenchuganj in 1993

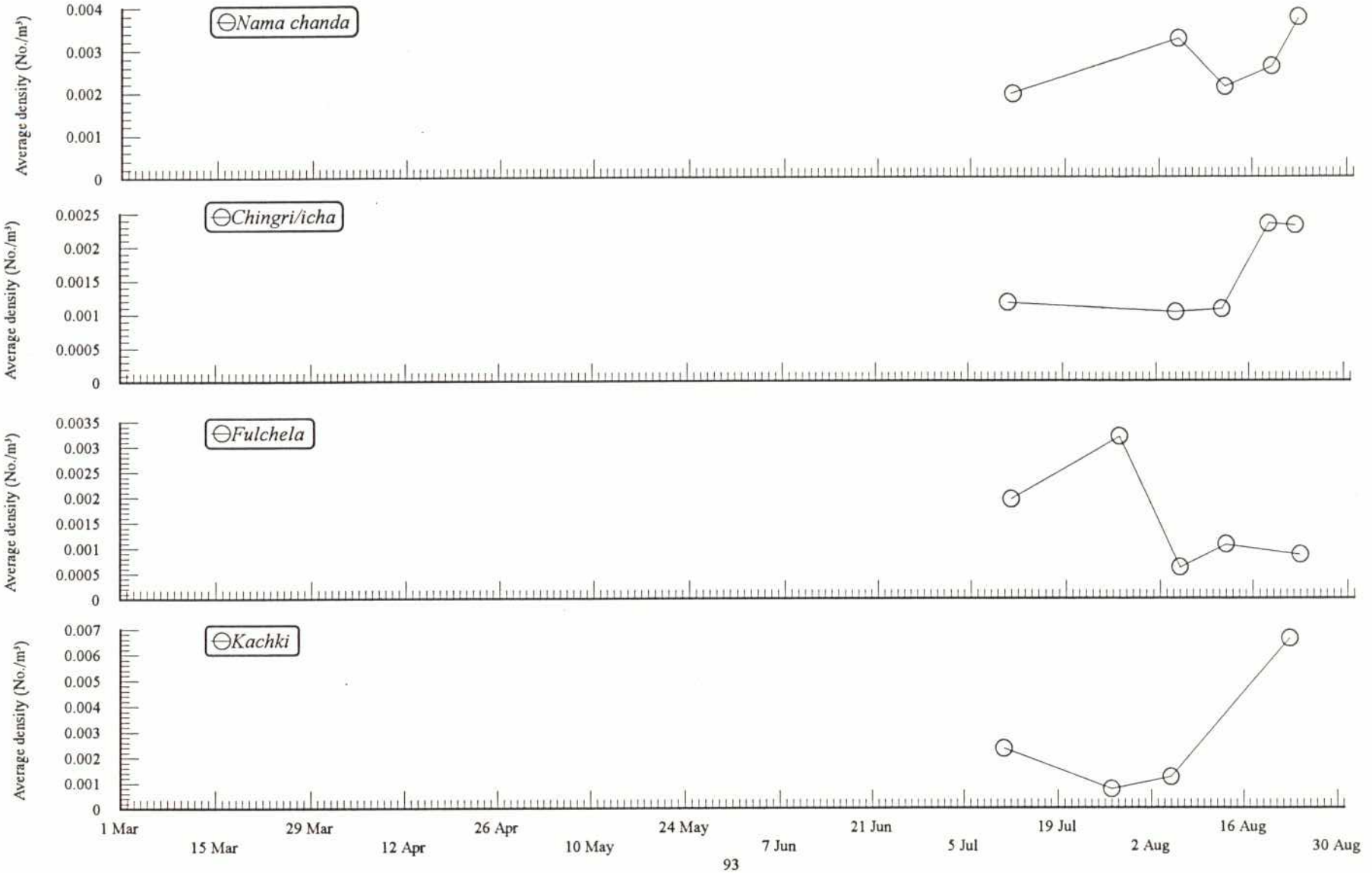


Figure 4.31 Graphs of number of species and water level by survey date for 2 sites on the Kushiyara River in 1993

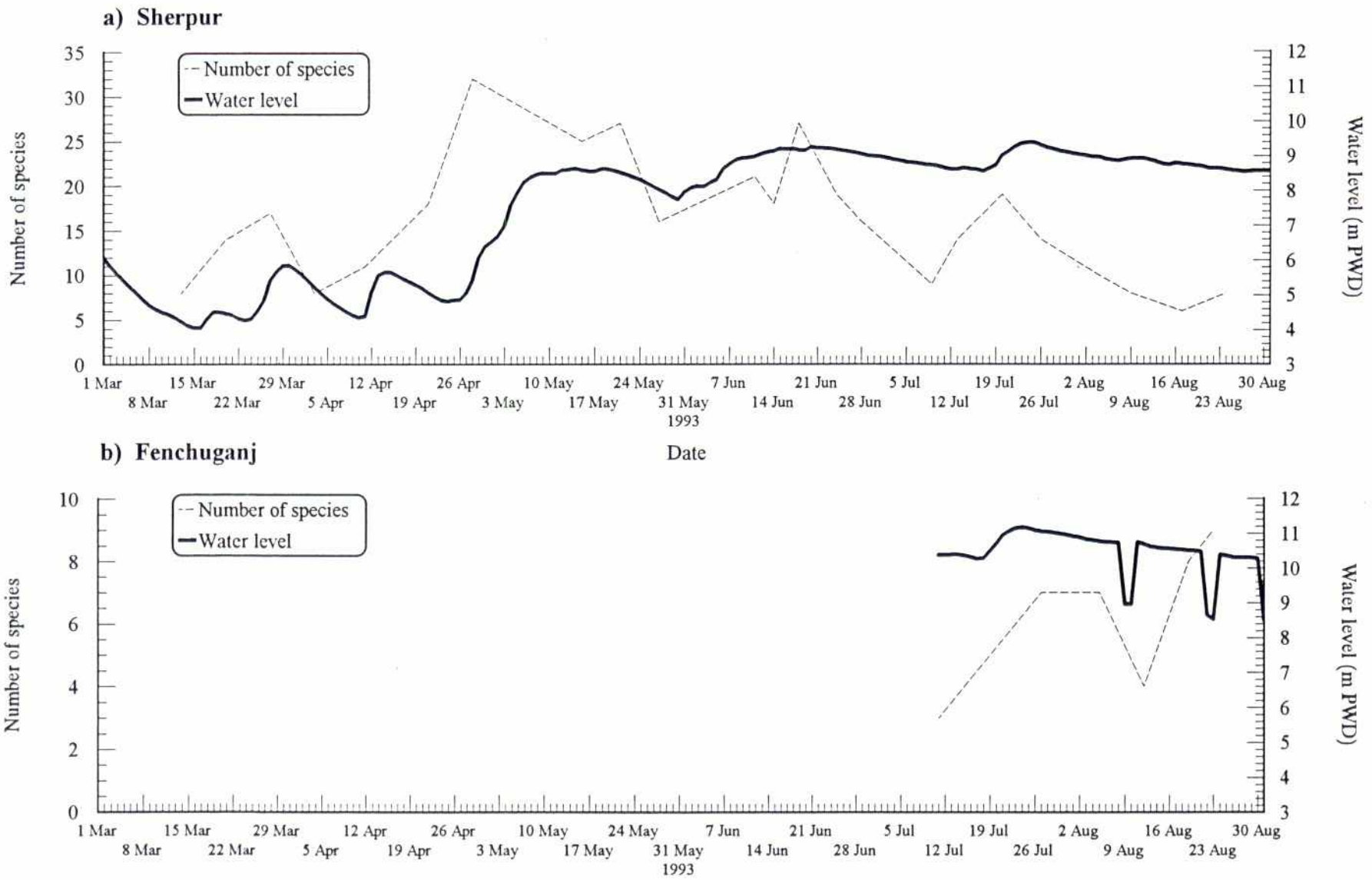


Table 4.10 **Percent compositions of dominant species by month for PC > 10.0 for the 2 sites**

	Month	Species name (code)	PC composition
Site 1 (Sherpur)	March	*Bata*	93.49
	April	*Chanda*	14.36
		Unidentified fish (920)	21.15
		Bata	15.02
		Unidentified *bele*	40.00
	May	*Chanda*	19.81
		Nama chanda	14.96
		Chingri/icha	20.51
	June	*Lal chanda*	22.54
		Fulchela	12.42
	July	*Nama chanda*	12.52
		Kachki	13.12
		Chingri/icha	10.02
	August	*Nama chanda*	55.48
Site 2 (Fenchuganj)	July	*Nama chanda*	12.41
		Fulchela	32.67
		Chingri/icha	19.54
	August	*Nama chanda*	24.78
		Kachki	16.59
		Chingri/icha	14.21

5 DISTRIBUTION OF HATCHLINGS ALONG CROSS-SECTIONS OF LOHAJANG RIVER IN NORTH CENTRAL REGION

The Lohajang is a tertiary river originating from the secondary river, the Dhaleswari, which is a branch of the main Jamuna River. The Lohajang passes through Tangail district and links floodplains and *beel* with the Dhaleswari. During the monsoon, fish fries travel from the Jamuna to the floodplains and *beel* via the Dhaleswari and Lohajang rivers.

5.1 Experimental Site and Materials

A site near Tangail town was selected on the Lohajang River for catching fish hatchlings in horizontal and vertical directions. For horizontal catches, 6 nets were placed just below the water surface across the river. The horizontal nets are here named as H1, H2, H3, H4, H5 and H6. Three nets, H1, H2 and H3, were placed at 2 metres (m), 6 m and 10 m respectivelyfrom the right bank of the river. Similarly, the other 3 nets, H6, H5 and H4, were placed at 2 m, 6 m and 10 m respectively from the left bank. The open midstream space between H3 and H4 is about 10 m wide and was used for the passage of boats.

For vertical net placements, the 6 nets were divided into two groups of 3. V1, V2 and V3 comprised one group and V4, V5 and V6 the other. The uppermost group 1 net, V1, was placed just below the water surface, V2 was placed below V1 and V3 below V2. The other 3 nets, V4, V5 and V6 were similarly placed elsewhere. The first group of vertical nets lay 6 m from the right bank, and the second group, 10 m from the same bank. The two groups were thus at the same distances as H2 and H3 respectively from the right bank of the river, but somewhat upstream. Vertical nets, V1 and V4, were used as surface nets like the horizontal nets. Two horizontal nets H3 and H6 were used as bottom nets in September and October.

The two bottom nets B1 and B2, were situated 30 centimetres (cm) above the river bed, at a distance of 2 m and 10 m respectively from the right bank along the line of horizontal nets. Horizontal and vertical nets were immersed in the water on different survey dates in the 4 survey months. Bottom nets were used along with the horizontal nets on the same date. Horizontal nets H1 and H3 were thus the top nets of B1 and B2 respectively. The nets were fixed into position with bamboo poles. There were thus 3 divisions of net: horizontal, vertical and bottom. The mesh size (diameter) of the nets was 1.5 millimetre (mm). The horizontal and vertical lengths of the rectangular net opening (made of iron bar) were 1 m and 0.3 m

respectively. The net was cone-shaped and 2.7 m long. It had a codend of length 0.46 m, where fish fries gathered during the catch time.

5.2 Data Collection

The nets were usually kept under water for two hours at several survey times (usually 4) on each survey date, after which fish fries were collected in boats from codends using plastic bowls. Plastic vials were then used to preserve the larvae in 10% formalin in the field. The samples were taken to the FAP 17 laboratory at Sabalia in Tangail town. The fish fries for each catch were then counted by species, a microscope being used to identify small fries.

The water velocity in the river was measured by both float and speed meter methods. In the float method, an object is floated down the river. The distance covered by the object, divided by the time taken, is the water speed in m/sec. In the meter method, a speed meter is used underwater and speed measured with the help of revolutions/sec of a propeller attached to the meter. The meter can be used at any river depth whereas the float method is used for surface water only.

There was an encroachment of the left bank of the river into the river before the net site, which reduced the river width at the site. There is also a canal on the right bank a little downstream of the net site. As a result, water speed appeared to the higher near the right bank than near the left at the experimental site.

The duration of the hatchling catch experiment at the Lohajang River was about 4 months, from 13th June 1993 to 4th October 1993, with 62 survey dates during the period. There are 5,763 records in all of hatchling count by species for this experiment. The number of records for overall (all species) hatchling counts in 1,331.

5.3 Hatchling Density Data and their Characteristics

Density is hatchling number (per sec) of a catch divided by water discharge (water velocity x net area under water in m^3/sec). Density is thus hatchling number/m^3.

Density is computed using both types of velocity. Since the water meter is used to measure water velocity for both surface nets and below-surface nets, there are many more density

density from the meter method than from the float method. For this reason, density data from the meter method are analysed here.

For each survey time on a survey date, the overall (all species) density is computed by net type considering the total catch of all species. There are 1331 records of such overall densities for different nets and different times of surveys dates. The average overall densities are obtained by net for each survey date. There are 348 such average daily density records by net for the Lohajang River.

Density data for bottom nets are available for September only. The water meter was out of order in October although hatchling counts were taken in this month. Density could not, therefore, be calculated for October.

5.3.1 Pattern of daily average densities by net type

Daily average densities are represented graphically for horizontal, vertical and bottom nets in Figures 5.1, 5.2 and 5.3 respectively.

It is observed from figure 5.1 that average densities of horizontal net H5 and H6 are usually less than those of other horizontal nets. There are several peaks of average densities for all horizontal nets. This shows that hatchlings flow down the river in waves or large batches. The high peak occurs mostly in June, July and late September.

Figure 5.2 shows that 2 vertical nets, V1 and V4, usually have much higher densities than the other 4 vertical nets. Since V1 and V4 are surface nets, this reveals that hatchling density is much lower below the first layer of water. The pattern of peak densities for vertical nets is similar to that for horizontal nets except that September peaks are fewer and lower for vertical nets.

Figure 5.3 shows that average densities for the second bottom net are usually higher than those for the first bottom net. This indicates that many hatchlings flow away from the river bank at the bottom in the month of September. The average density is quite high in the 3rd and last weeks of September so that the flow of hatchlings is appreciable at the bottom of the river at this time.

Figure 5.1 Graph of overall average densities by date for horizontal (surface) nets in the Lohajang River in 1993

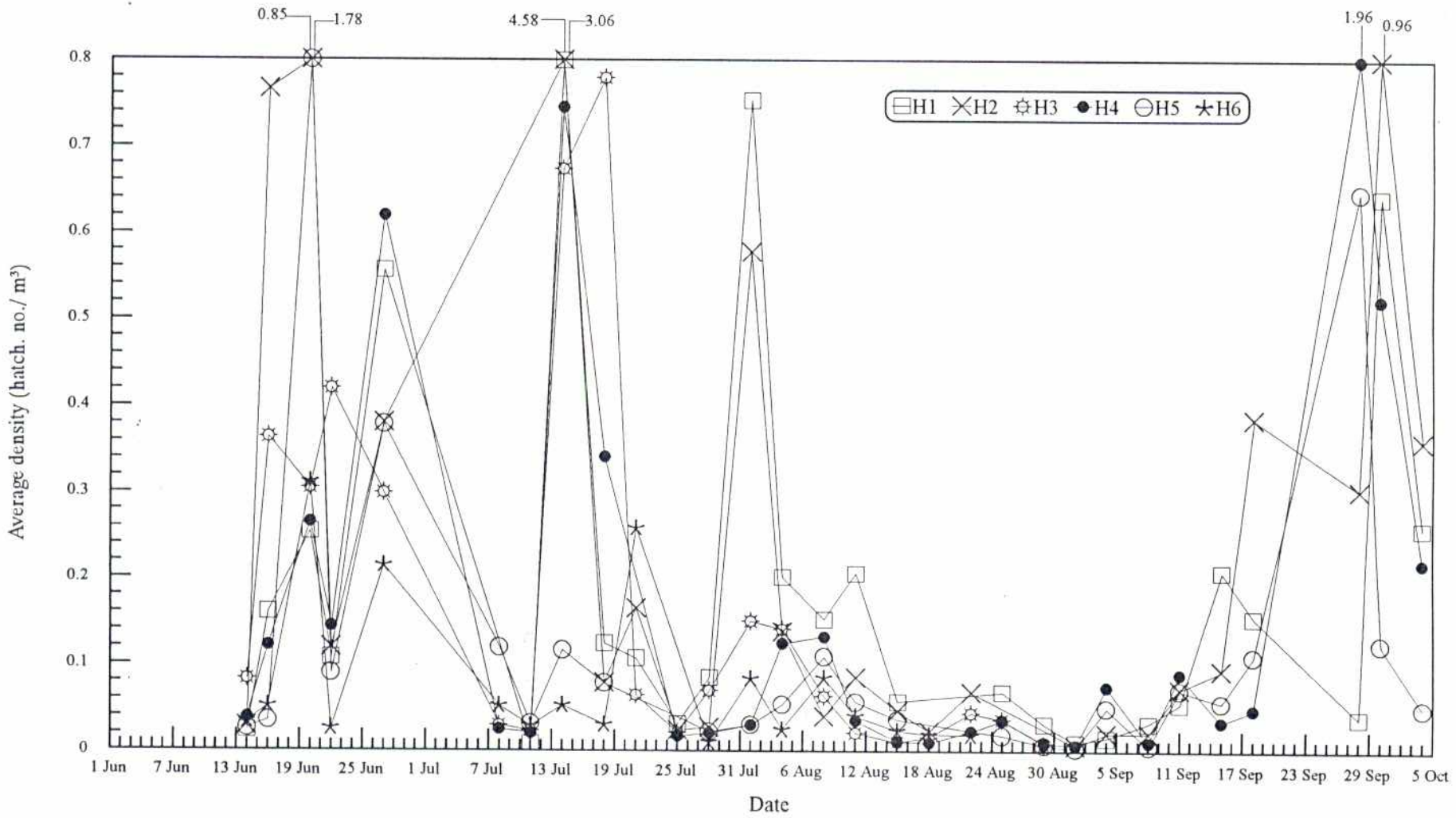


Figure 5.2 Graph of overall average densities by date for vertical nets in the Lohajang River in 1993

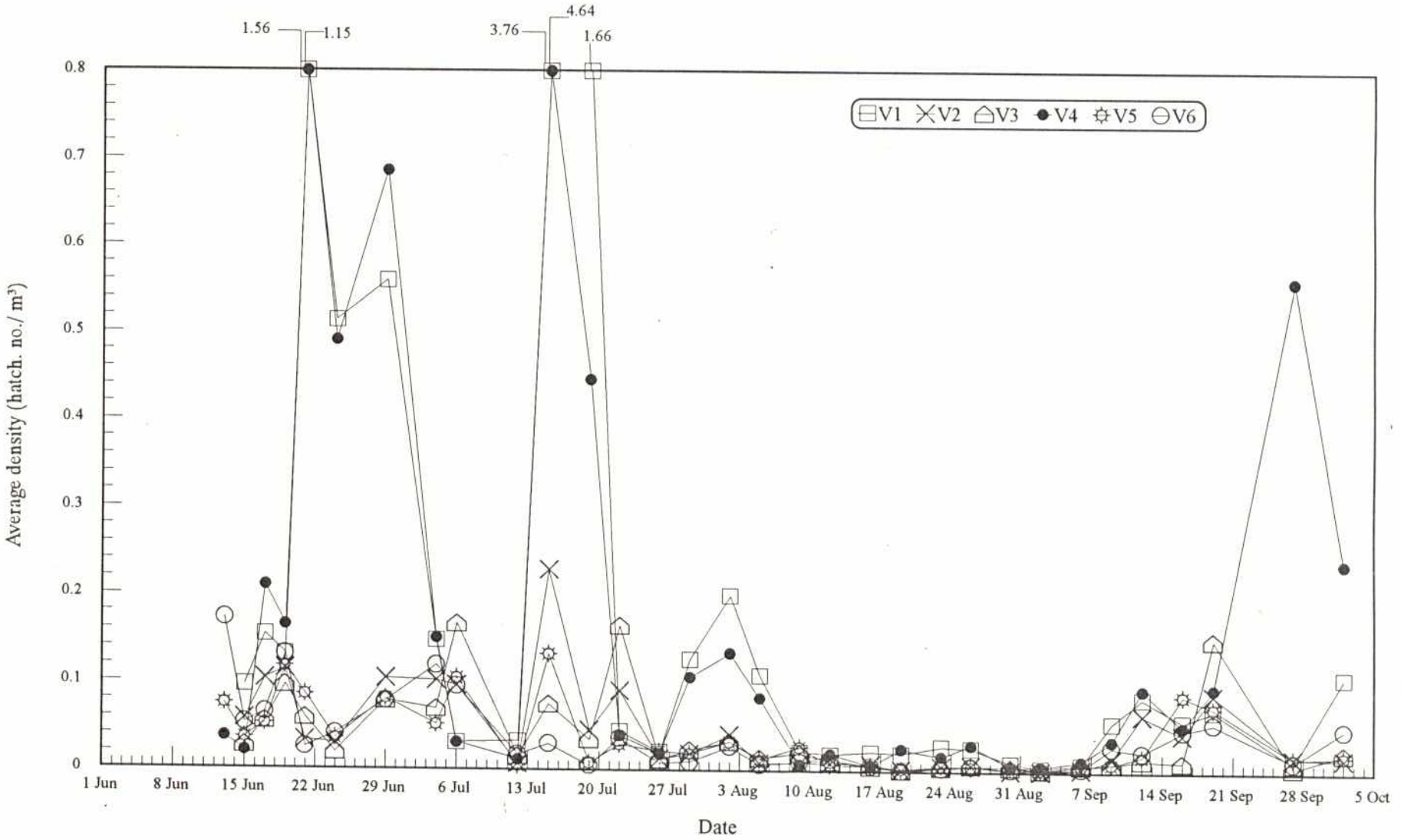
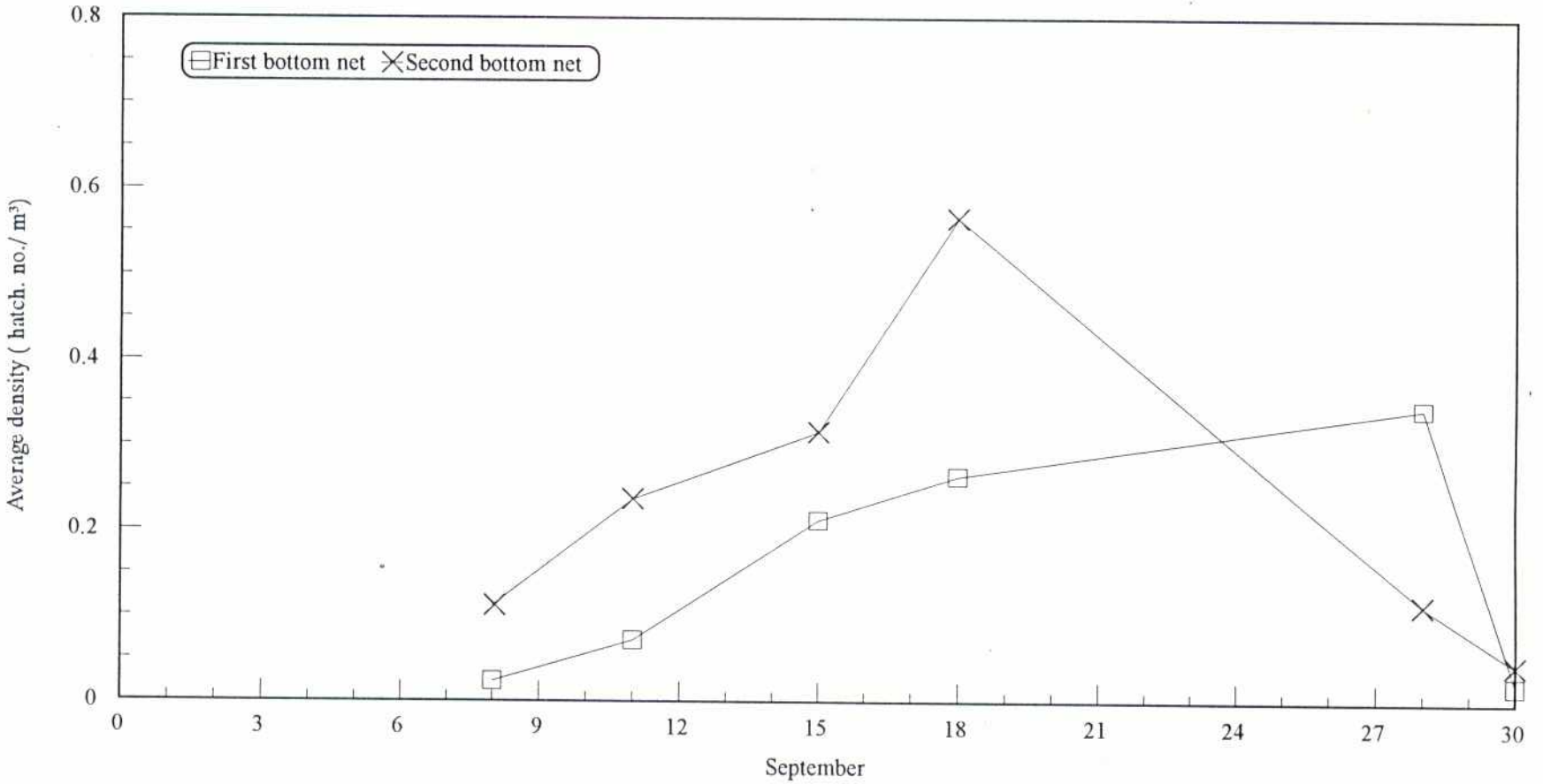


Figure 5.3 Daily average densities for bottom nets for September in 1993



5.3.2 Monthly average densities by net type

Densities computed at survey times on survey dates are averaged for each net in each month in order to get monthly average densities by net. The monthly average densities by net are presented in Table 5.1. These are also represented by Figures 5.4 and 5.5 for horizontal and vertical nets respectively. There is only one average monthly density for each of the bottom nets, B1 and B2, in September. These two average densities are substantial and the average density of B2 is higher than that of B1.

Table 5.1 Overall (all species) average densities by net for the Lohajang River for 5 months in 1993

Month	Net type														
	Horizontal						Vertical						Bottom		All Net type
	H1	H2	H3	H4	H5	H6	V1	V2	V3	V4	V5	V6	B1	B2	
June	.220	.615	.332	.246	.281	.127	.503	.074	.056	.408	.069	.077	-	-	.244
July	.978	.651	.260	.187	.076	.046	.710	.073	.070	.703	.047	.040	-	-	.305
August	.210	.147	.057	.048	.045	.044	.051	.010	.012	.037	.012	.009	-	-	.052
September	.140	.226	-	.335	.130	-	.042	.035	.030	.109	.032	.025	.156	.231	.126
October	.258	.360	-	.217	.049	-	.108	.016	.022	.238	.019	.049	-	-	.124

It is seen from Table 5.1 and Figure 5.4 that average densities for 2 horizontal nets, H1 and H2, are usually higher than those of other 4 horizontal nets. Net H6 has the lowest average densities among the horizonal nets and H5 has the second lowest. This indicates that there is much lower hatchling flow near the left bank where the water flows more slowly. Figure 5.5 shows that average monthly densities of the vertical surface nets, V1 and V4, are usually much higher than those of other vertical nets placed well below the water surface. This means that most fish larvae flow just below the water surface. The average densities are highest in July. June shows the next highest densities followed by October and September. Average densities are lowest in August during river bank flooding. There are no density data for H3 and H6 in September and October since these were used as bottom nets during those months.

Figure 5.4 Monthly average densities for horizontal nets at the Lohajang River for the year 1993

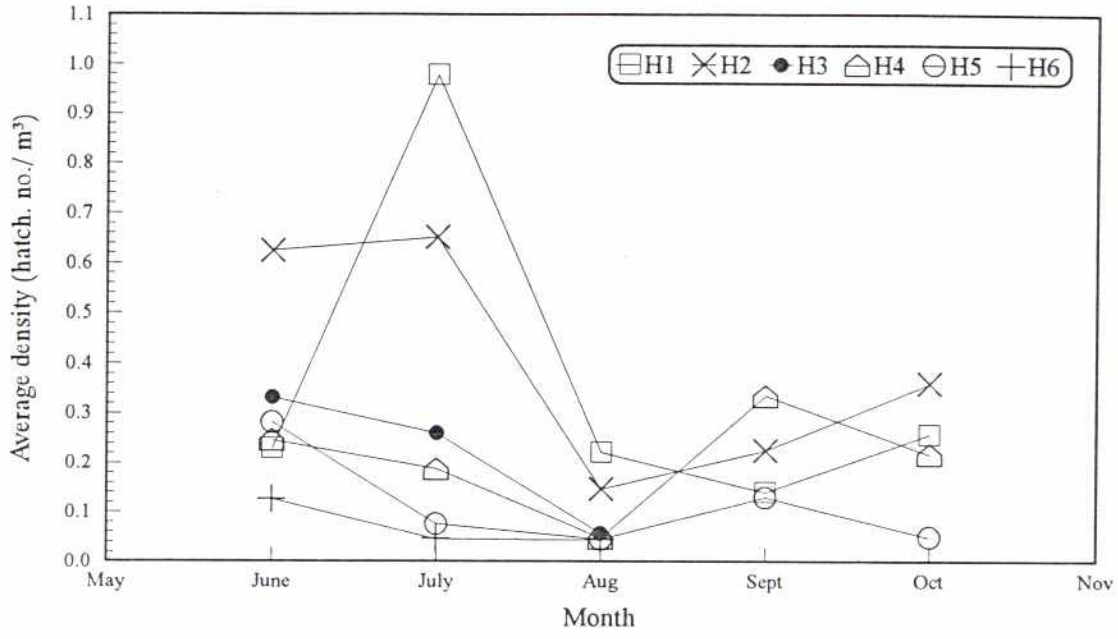
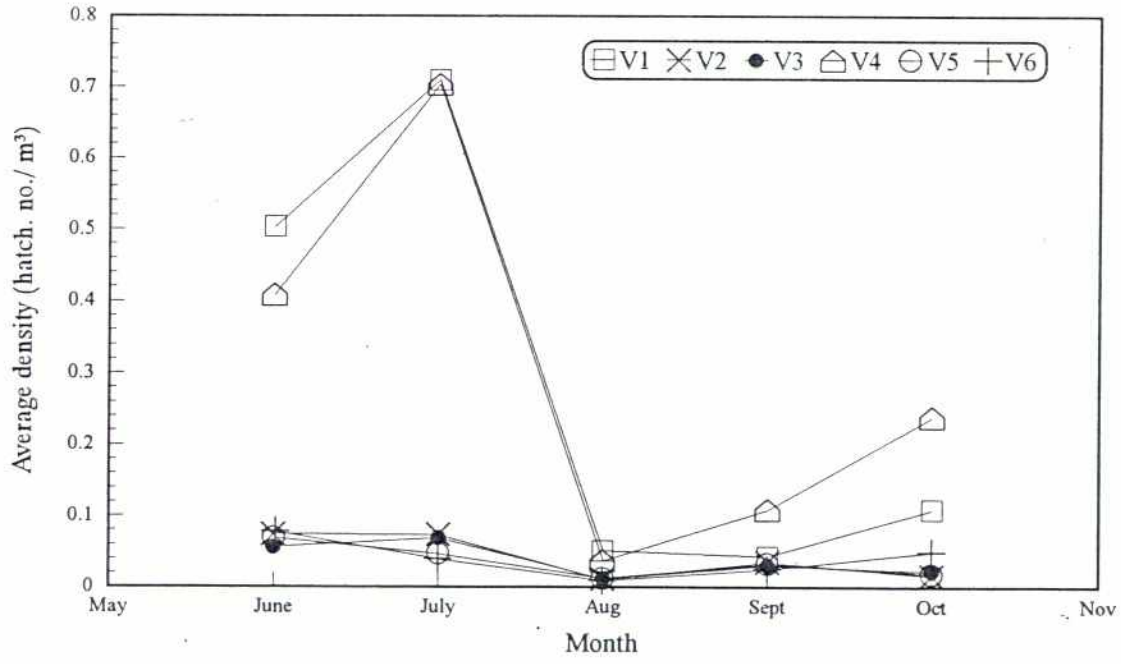


Figure 5.5 Monthly average densities for vertical nets at the Lohajang River for the year 1993



5.3.3 Average densities of nets for different months

Average densities of horizontal and vertical nets are represented graphically in Figure 5.6(a) and 5.6(b) respectively for different months. The two graphs are quite different. Figure 5.6(a) shows that average densities of horizontal nets usually decrease from H2 to H6 for all months with initial upward movement from H1 to H2. Figure 5.6(b) reveals that average densities of 2 vertical (surface) nets, V1 and V2, are highest in July followed by June, October and September. These are also lowest for August. All other vertical nets, V2, V3, V5 and V6, have far lower average densities, the highest occurring in June.

5.3.4 Grouping of nets according to average densities

The nets are divided into 4 groups on the basis of overall (all month) average densities for the whole survey period, as stated below. The overall (all month) average densities are given in Table 5.2 by net. It is seen from Table 5.2 that hatchling flow is much lower (about 1/10th on the average) below 0.3 m of the first layer of water for vertical nets V2, V3, V5 and V6, but quite high for bottom nets B1 and B2.

Table 5.2 Average overall densities by net

Net	Horizontal						Vertical						Bottom		All net
	H1	H2	H3	H4	H5	H6	V1	V2	V3	V4	V5	V6	B1	B2	
# Rec	102	102	79	114	102	67	123	123	123	124	124	124	12	12	1331
Average density	0.346	0.371	0.188	0.198	0.125	0.069	0.316	0.045	0.040	0.306	0.037	0.036	0.156	0.231	0.172

Table 5.2 also shows that average hatchling flow near the surface is high near the left bank (H1, H2, V1, V4) and low near the right bank (H6) and medium near midstream (H3, H4, H5). Water speed is also high near the left bank, low near the right bank and medium in the middle. Considering the average overall (all month) densities of Table 5.2, the nets are divided into four net groups shown in Table 5.3.

There are thus 4 net groups in addition to 3 net types: horizontal, vertical and bottom. This division of nets into 4 groups appears to be more analytically scientific. High average densities for bottom nets should be considered with caution because of small samples and the presence of one month's data only.

Figure 5.6a Average densities of horizontal nets for different months in the Lohajang River in 1993

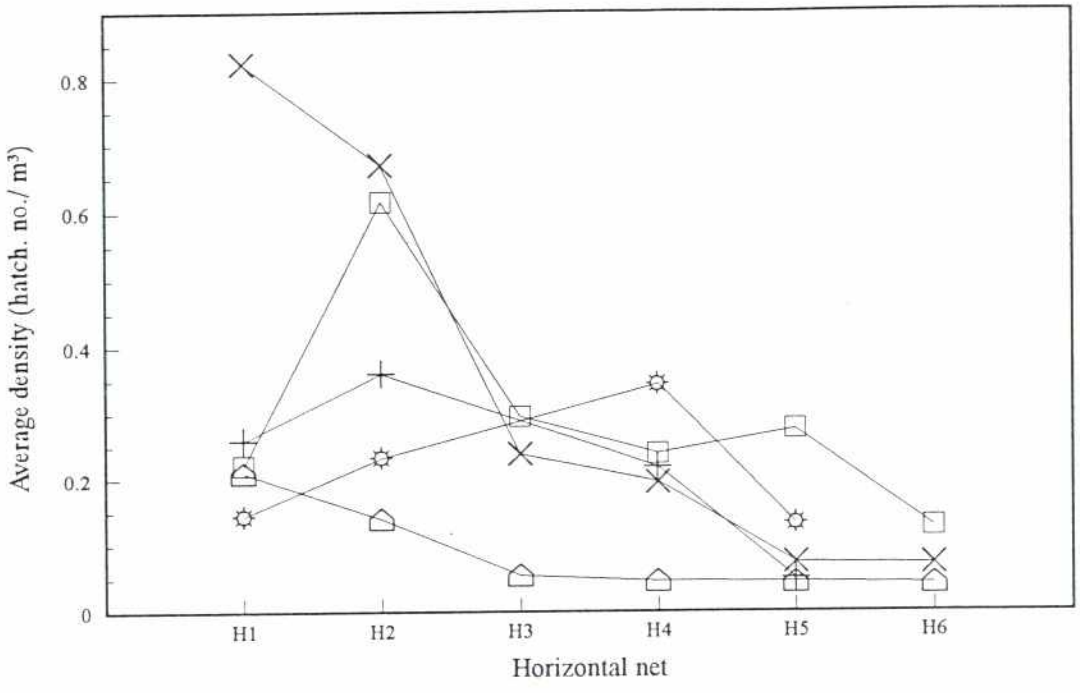


Figure 5.6b Average densities of vertical nets for different months in the Lohajang River in 1993

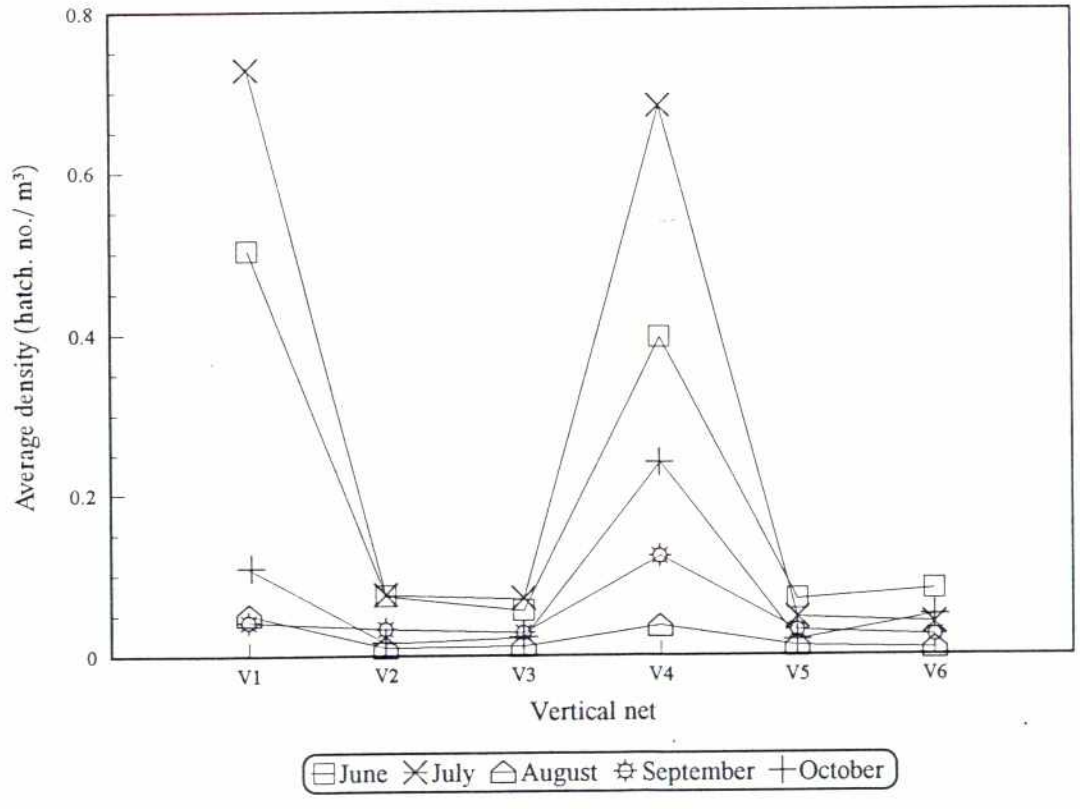


Table 5.3 Four groups of net according to average densities

Net group	Name of net group	Nets in the group	Net position	Average density (all nets)	Number of record	Range of average density
1	Horizontal net 1	H1, H2, V1 and V4	Surface	0.333	451	0.306 to 0.371
2	Horizontal net 2	H3, H4 and H5	Surface	0.170	295	0.125 to 0.198
3	Vertical net	H6, V2, V3, V5 and V6	Below surface (<0.3 m) except H6	0.043	561	0.036 to 0.069
4	Bottom net	B1 and B2	Near river bed	0.194	24	0.156 to 0.231

5.3.5 Monthly and weekly average densities by net group

Monthly average densities by net group are given in Table 5.4. These average densities are computed from basic density data of survey-times on survey dates in each month.

The average monthly densities are also represented graphically by net group in Figure 5.7(a). It is observed from Table 5.4 and Figure 5.7(a) that average monthly densities are usually highest for net group 1 (Horizontal net 1) and lowest for group 3 (Vertical nets). Net group 2 usually has medium average monthly densities. Net group 4 (bottom nets) has the monthly average density for September only, which is quite high. For September, therefore bottom hatchling flow is nearly as high as for some of the surface nets. Net group 1 has the highest average density in July followed by June. On the other hand, net groups 2 and 3 have the highest average density in June followed by September/July. Average density is lowest in August for all net groups.

Weekly average densities are computed from 3 weeks in June, 4 weeks in of July, August and September and one week in October, i.e. 16 weeks in all. Weekly average densities are represented graphically in Figure 5.7(b) which shows a clear peak and trough every 3/4 weeks for all 4 groups of net. Average weekly densities are high in June, July and September but quite low in August and early September. July experiences the highest peak of average density for net group 1. Weekly average densities for horizontal net group 1 are usually higher than those of the second horizontal group of nets. Vertical net group densities are the lowest, as before. In September, 4 average densities for bottom nets are quite high, especially for the third week.

Figure 5.7a Average hatchling density by month for different net groups in the Lohajang River for 1993

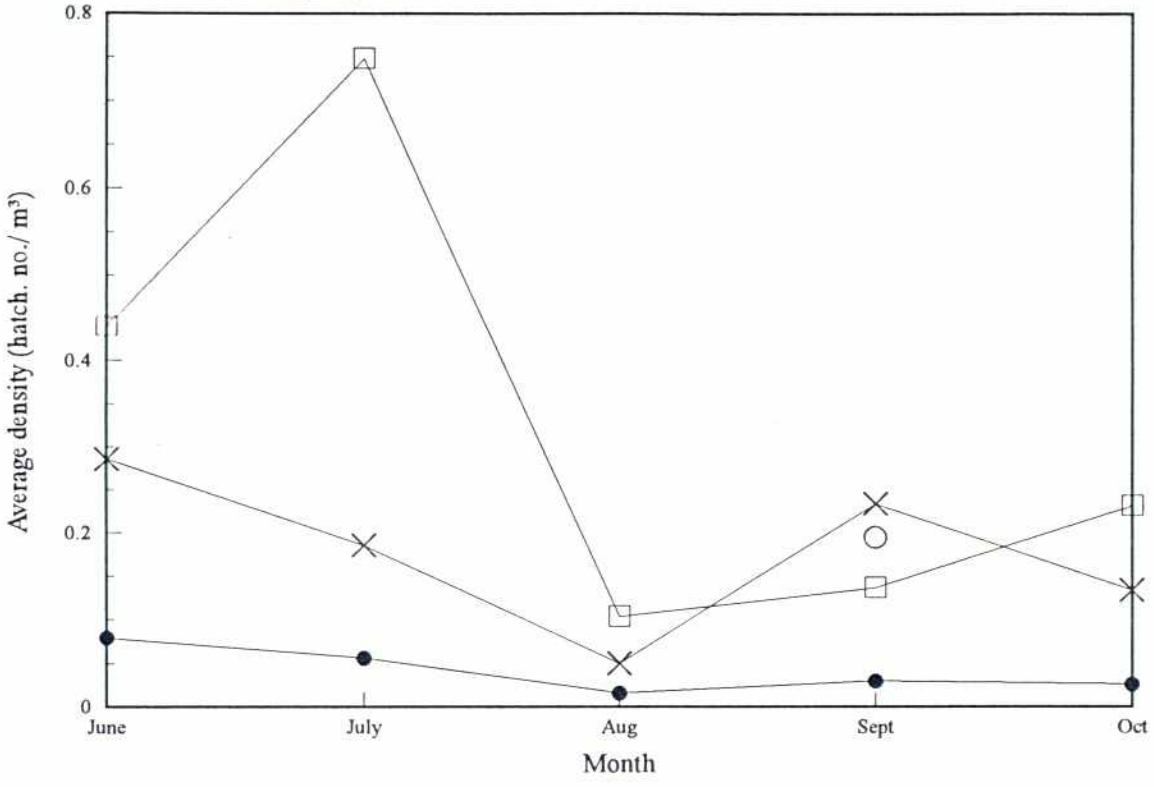


Figure 5.7b Average hatchling density by week for different net groups in the Lohajang River for 1993

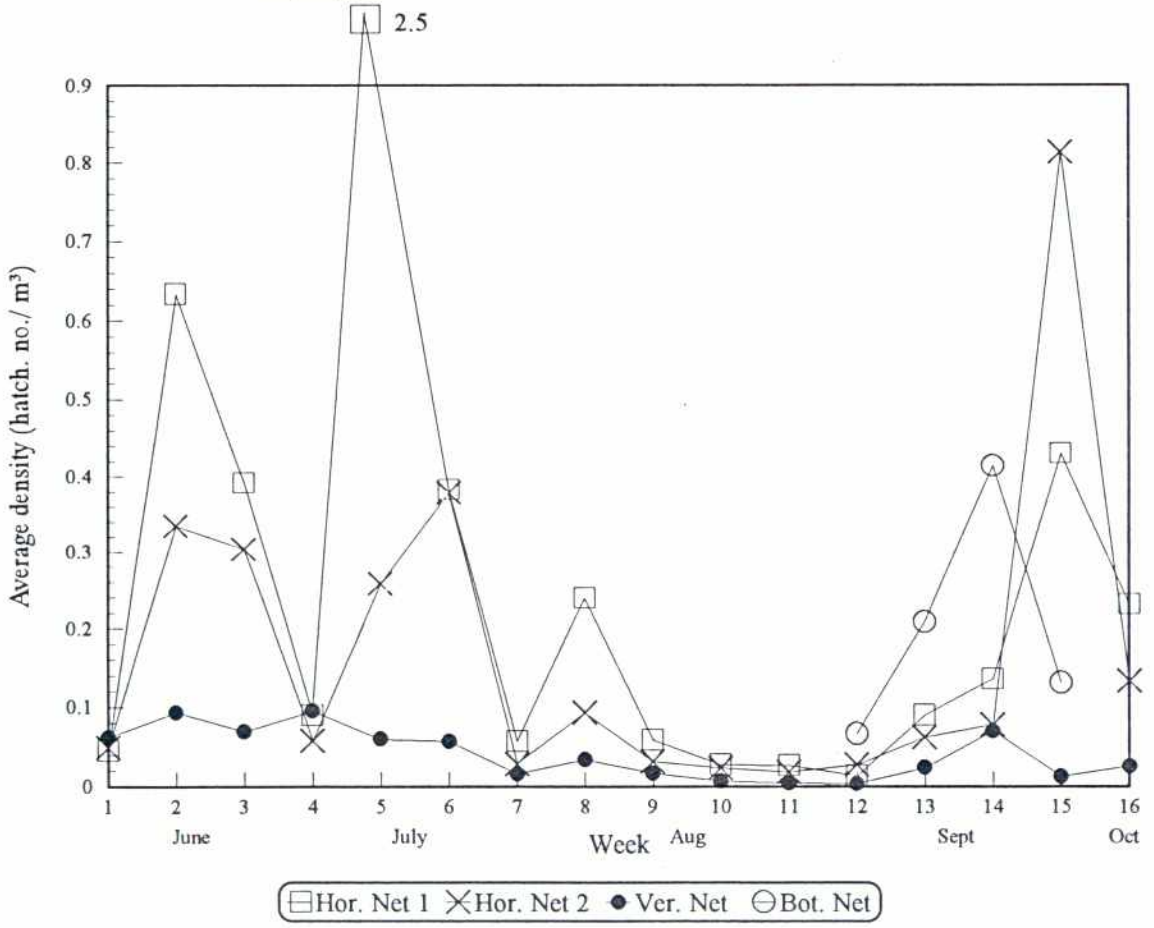


Table 5.4 Monthly average densities by net group

Group	Net group	Month	Number of record	Average density
1	Horizontal net 1	June	91	0.441
		July	104	0.748
		August	124	0.103
		September	118	0.135
		October	14	0.231
		All months	451	0.333
2	Horizontal net 2	June	54	0.286
		July	75	0.184
		August	94	0.050
		September	66	0.233
		October	6	0.133
		All months	295	0.170
3	Vertical net	June	122	0.079
		July	149	0.056
		August	170	0.016
		September	104	0.030
		October	16	0.026
		All months	561	0.043
4	Bottom net	September	24	0.194
	All groups	All months	1331	0.172

5.4 Analysis of Density Data

Some statistical tests are used here to compare average densities along space (horizontal and vertical) and time (month) and for paired comparison. Tests are performed separately for 3 types of net - horizontal, vertical and bottom - and also for 3 groups of net: horizontal net 1, horizontal net 2 and vertical nets.

D2C

5.4.1 Tests for net types and net groups

Test results are presented here separately for spatial, temporal and paired comparisons of densities for 3 types of net - horizontal, vertical and bottom - and also for 4 groups of net.

Spatial comparisons of densities of nets within each net type by month

It is found from the normality test {K-S (Lilliefors) test} that average hatchling densities are not usually normal. Hence, the non-parametric one-way ANOVA (Kruskal-Wallis test) is performed on density data. Results of these tests by month are provided in Table 5.5 for 3 types of net. Basic density data of survey-times on survey dates are considered for this analysis.

Table 5.5 Results of comparison of densities among nets of same type

Month	Number of record	Non-parametric ANOVA on density for								
		Horizontal nets			Vertical nets			Bottom nets		
		χ^2 - value	P-value	Comment	χ^2 - value	P-value	Comment	χ^2 - value	P-value	Comment
June	114	11.02	0.051	MIS	32.64	0.000	HS			
July	136	6.95	0.224	NS	19.93	0.000	HS			
August	172	33.03	0.000	HS	50.48	0.000	HS			
September	132	0.51	0.916	NS	10.73	0.057	MIS	0.96	0.326	NS
October	12	4.44	0.218	NS	4.28	0.510	NS			
All months	566	20.8	0.000	HS	65.78	0.000	HS			

Note: HS - Highly significant (at 1% level), SIG - Significant at 5% level, MIS- Marginally insignificant, NS- Not significant

It is observed from Table 5.5 that differences of average densities among horizontal nets are highly significant in August and all months together. For vertical nets, differences are highly significant for the first 3 months and all months together. For September, differences of densities are marginally insignificant. For October, no significant differences are found among vertical nets possibly because of small samples. For bottom nets, differences between 2 means are not significant. A significant density differential thus exits along horizontal

directions for August and the whole period. Vertically, however, a significant density differential is present most of the months and for whole the period.

Spatial comparison of densities of nets within each net type by month

It was observed before that significant differences of densities do not exist among the nets within each of the 4 net groups. Here, comparisons are therefore made between 3 groups of net: Horizontal net 1, Horizontal net 2 and vertical net. Basic densities of these 3 groups of net, are compared by the above non-parametric test for each month and all months together, where a comparison of 4 groups is made, including bottom nets. The results are given in Table 5.6.

Table 5.6 Results of comparison of densities the among net groups by month

Month	Number of record	Non-parametric ANOVA on density		
		χ^2 -value	P-value	Comment
June	267	46.89	0.000	HS
July	328	20.15	0.000	HS
August	388	105.64	0.000	HS
September	312	51.59	0.000	HS
October	36	8.52	0.014	SIG
All months	1331	162.17	0.000	HS

It is clear from Table 5.6 that differences in average densities among the 3 groups of net are almost always highly significant for all months separately and together.

Similar results are obtained when the nets are divided into two groups:- (1) Surface nets including all horizontal nets and 2 Vertical nets V1 and V4, and (2) Below-surface nets consisting of the remaining 4 vertical nets and bottom nets. These results show that most fish larvae flow just below the water surface rather than further down the water column. Of course, September data show that there is a considerable flow of hatchlings at the bed.

5.4.2 Temporal comparison of densities for net types and groups

In order to observe the effect of time (month), average densities are compared between 5 months for each net type and group. The basic densities of survey times on survey dates are also considered here for the analysis by the same non-parametric ANOVA test on density. The results of the tests are given in Table 5.7.

Table 5.7 Results of comparison of densities among months

Type/Group	Net type or group	Number of record	Non-parametric ANOVA on density		
			χ^2 -value	P-value	Comment
Net type	Horizontal net 1 (H1 to H6)	566	42.00	0.000	HS
	Vertical net 1 (V1 to V3)	369	99.42	0.000	HS
	Vertical net 2 (V4 to V6)	372	87.12	0.000	HS
	All Vertical net (V1 to V6)	741	180.57	0.000	HS
	All 3 net types	1331	167.78	0.000	HS
Net group	Horizontal net 1	451	48.63	0.000	HS
	Horizontal net 2	295	43.88	0.000	HS
	Vertical net	561	136.00	0.000	HS
	All net groups	1331	167.78	0.000	HS

It is evident from Table 5.7 that temporal comparison of basic densities produces highly significant differences among 5 months for all types and all groups of net. Month to month variations of average densities are thus very high in all cases. The overall (all net) monthly average densities are:

Month	June	July	August	September	October
Number of record	267	328	388	312	36
Average densities	0.244	0.305	0.052	0.126	0.124

July has the highest average density and August the least, as before. Differences among these average densities are highly significant.

5.5 Paired Comparisons of Average Daily Densities Between Comparable Nets

In order to obtain paired comparisons of average densities by date, the non-parametric Wilcoxon sign test is performed. This is equivalent to the parametric t-test. Average daily densities are considered here for paired comparisons.

5.5.1 Paired comparisons between vertical nets of the same layer

Vertical nets V1 and V4 are surface nets. Vertical nets V2 and V5 belong to the second layer of water and nets V3 and V6 to the 3rd layer. Each layer has a width of 0.3 m. Paired comparisons of densities are therefore made between 2 vertical nets belonging to the same layer of water. The results of the comparison are presented in Table 5.8 for 3 pairs separately by month.

Table 5.8 Results of paired comparisons of densities between 2 vertical nets of the same layer

Pair of vertical nets	Months	Number of record (pairs)	Mean density for		Non-par. Wilcoxon test on density		
			1st set	2nd set	z-value	P-value	Comment
V1 and V4 (1st layer)	June	24	0.503	0.454	-0.09	0.932	NS
	July	31	0.751	0.703	-0.74	0.456	NS
	August	36	0.051	0.037	-1.66	0.096	NS
	September	26	0.042	0.109	-0.90	0.367	NS
	October	4	0.108	0.238	-1.46	0.144	NS
	All months	121	0.320	0.312	-0.50	0.617	NS
V2 and V5 (2nd layer)	June	24	0.074	0.068	-0.77	0.441	NS
	July	31	0.071	0.047	-2.84	0.004	HS
	August	36	0.010	0.012	-1.39	0.164	NS
	September	26	0.035	0.032	-0.85	0.395	NS
	October	4	0.016	0.019	-0.36	0.710	NS
	All months	121	0.044	0.036	-2.04	0.041	SIG
V3 and V6 (3rd layer)	June	24	0.056	0.066	-0.54	0.587	NS
	July	31	0.061	0.039	-2.51	0.012	SIG
	August	36	0.012	0.009	-1.69	0.092	NS
	September	26	0.030	0.025	-0.27	0.790	NS
	October	4	0.022	0.049	-1.09	0.273	NS
	All months	121	0.037	0.033	-1.62	0.105	NS

It is seen from Table 5.8 that the paired differences of densities are not significant except in 3 cases out of a total of 18. Significant differences in peak flow are observed in July between V2 and V5 of the 2nd layer of water, and between V3 and V6 of the 3rd layer, and also for all months together between the former pair of nets. A horizontal spatial difference of densities thus rarely exists between the 2 positions of vertical nets in each of the 3 layers of water.

5.5.2 Paired comparisons between vertical nets of different layers

Surface nets V1 and V4 have much higher average densities than those below surface nets. Paired comparisons are therefore made between vertical nets of the 2nd and 3rd layers at the same position by the same test. The results for comparison between V2 and V3, are given in Table 5.9 by month. It is clear from the table that no significant differences exist between average densities of V2 and V3 of the 2nd and 3rd layers respectively in any of the months and all months together. Results are similar for V5 and V6 between the 2nd and 3rd layers. It may therefore be concluded that vertical spatial differences in density between the 2nd and 3rd layers of water are negligible.

Table 5.9 Results of paired comparisons between V2 and V3

Month	Number of record (pairs)	Mean density		Non-parametric Wilcoxon test on density		
		V2	V3	z-value	P-value	Comment
June	24	0.074	0.056	-1.29	0.198	NS
July	33	0.073	0.069	-0.08	0.936	NS
August	36	0.010	0.012	-0.86	0.387	NS
September	26	0.035	0.030	-0.70	0.485	NS
October	4	0.016	0.022	-0.73	0.465	NS
All months	123	0.045	0.040	-0.70	0.485	NS

5.5.3 Paired comparisons between horizontal nets

It is observed from Table 5.2 that the overall average density is highest (0.371) for horizontal net H2 and lowest (0.069) for H6. Paired comparisons (by date) by the same non-parametric Wilcoxon test are therefore made by month first between these 2 nets. No hatchling data were collected for H6 in September and October when it was used as a bottom net. Comparisons were consequently made between June and August. The results are given in

Table 5.10. Results of paired comparison of average densities by date between H5 and H6 (having the two lowest average densities) and H2 and H5 (having highest and second lowest average densities respectively, Table 5.2) are also ginen Table 5.10.

Table 5.10 Results of paired comparisons between some pairs of horizontal nets

Pair of horizontal nets	Month	Number of record (pairs)	Mean density		Non-parametric Wilcoxon test on density		
			H2	H6	z-value	P-value	Comment
H2 and H6	June	20	0.624	0.126	-2.20	0.028	SIG
	July	13	0.651	0.045	-2.55	0.011	SIG
	August	18	0.147	0.044	-2.11	0.035	SIG
	All 3 months	51	0.449	0.069	-3.91	0.000	HS
			H5	H6			
H5 and H6	June	20	0.282	0.126	-0.60	0.550	NS
	July	20	0.076	0.035	-2.91	0.004	HS
	August	18	0.060	0.055	-0.94	0.349	NS
	All 3 months	58	0.141	0.072	-2.36	0.018	SIG
			H2	H5			
H2 and H5	June	20	0.625	0.282	-1.23	0.218	NS
	July	14	0.910	0.070	-1.60	0.109	NS
	August	26	0.147	0.045	-2.65	0.008	HS
	September	33	0.226	0.1301	-1.62	0.106	NS
	October	3	0.360	0.049	-1.60	0.109	NS
	All 5 months	96	0.392	0.127	-3.73	.000	HS

It is seen from Table 5.10 that paired comparison of average densities between H2 (with the highest mean) and H6 (with the lowest mean) gives significant differences for all 3 months separately and together. Comparison between H5 and H6, having the 2 lowest average densities, produces significant differences for July and all 3 months together. On the other hand, comparison between H2 and H5, having the highest and second lowest mean densities respectively, gives highly significant differences for August and all 5 months together. For other pairs of horizontal nets, paired differences of densities are mostly insignificant except in a few cases.

Paired comparison thus indicates that significant density differentials exist horizontally in all the months and for the whole period of study between H2 and H6. For other pairs, some significant differences also exist.

5.5.4 Paired comparisons between top and bottom nets

Bottom net data are scanty and there are only 6 average densities for 6 dates in September. Horizontal nets, H1 and H3 are the top nets above 2 bottom nets, B1 and B2 are respectively in the same water columns. There is no data for H3 in September, however, as this was used as a bottom net. Hence, the nearest horizontal net H2 is taken as top net for bottom net B2 on the same water column. Paired comparisons of average daily densities (same dates) are made between B1 and H1 and between B2 and H2 by the Wilcoxon test. The results are given in Table 5.11.

Table 5.11 Results of paired comparisons of densities between top and bottom nets

Pair of nets	Month	Number of record (pairs)	Mean density		Non-parametric Wilcoxon test on density		
			H1/H2	B1/B2	z-value	P-value	Comment
H1 and B1	September	6	0.188	0.156	-0.52	0.600	NS
H2 and B2	September	6	0.305	0.231	-0.10	0.916	NS

Table 5.11 reveals that paired differences of average densities between top and bottom nets are not significant for either pair in September. Hatchling flows at the top and bottom of the river are thus about the same in September. Since sample size is small, these results must be considered with caution.

5.6 Dominant Species and Species Composition

For obtaining dominant species, hatchling nets are divided into three groups :

Surface nets: This group consists of all 6 horizontal nets and two vertical nets V1 and V4 which were placed just below the water surface like horizontal nets.

Below-surface nets: This group comprises the remaining four vertical nets, V2, V3, V5 and

V6, which were placed below the first layer of water.

Bottom nets: The two bottom nets are included in this group.

5.6.1 Species composition of overall densities

There are 71, 73 and 24 species for the surface net, below-surface net and bottom net groups, respectively.

The Total density of each species is obtained by adding density over survey times and survey dates during the whole period by net group. Percentage (PC) total densities of individual species are computed with respect to the corresponding total density of all species for each net group.

The PC compositions of density are represented by Pie charts for each net group for PC > 1.0. It is evident from Figure 5.8 that species compositions differ widely over three groups of net. *Kachki* is overwhelmingly dominant for surface nets. It also has the highest contribution to total density for vertical nets but has much less PC composition. *Chingri/icha* and *bailla* are the next most dominant species for below-surface nets. For bottom nets *chingri/icha* is the most dominant, followed by *gang tengra*. Dominant species therefore vary vertically the same water column in the river.

5.6.2 Species compositions excluding *kachki*

Since *kachki* contributes 91.0% and 32.1% to total density for surface and below-surface nets respectively, percentage compositions of dominant species excluding this one are represented graphically by Pie charts for PC > 3.0 in Figure 5.9. It is seen from Figure 5.9 that several species appeared dominant for surface nets. *Chingri/icha* dominates most for these nets, followed by *lal chanda*. *Nama chanda* and *bailla* are the next most important species. For below-surface nets, *bailla* and *chingri/icha* are most dominant, followed by carp and *kajuli*. Carp contributes substantially to total density for below-surface nets only.

Figure 5.8 Pie charts for percentage compositions of density of dominant species having PC > 1.0 for 3 groups of net in the Lohajang River in 1993

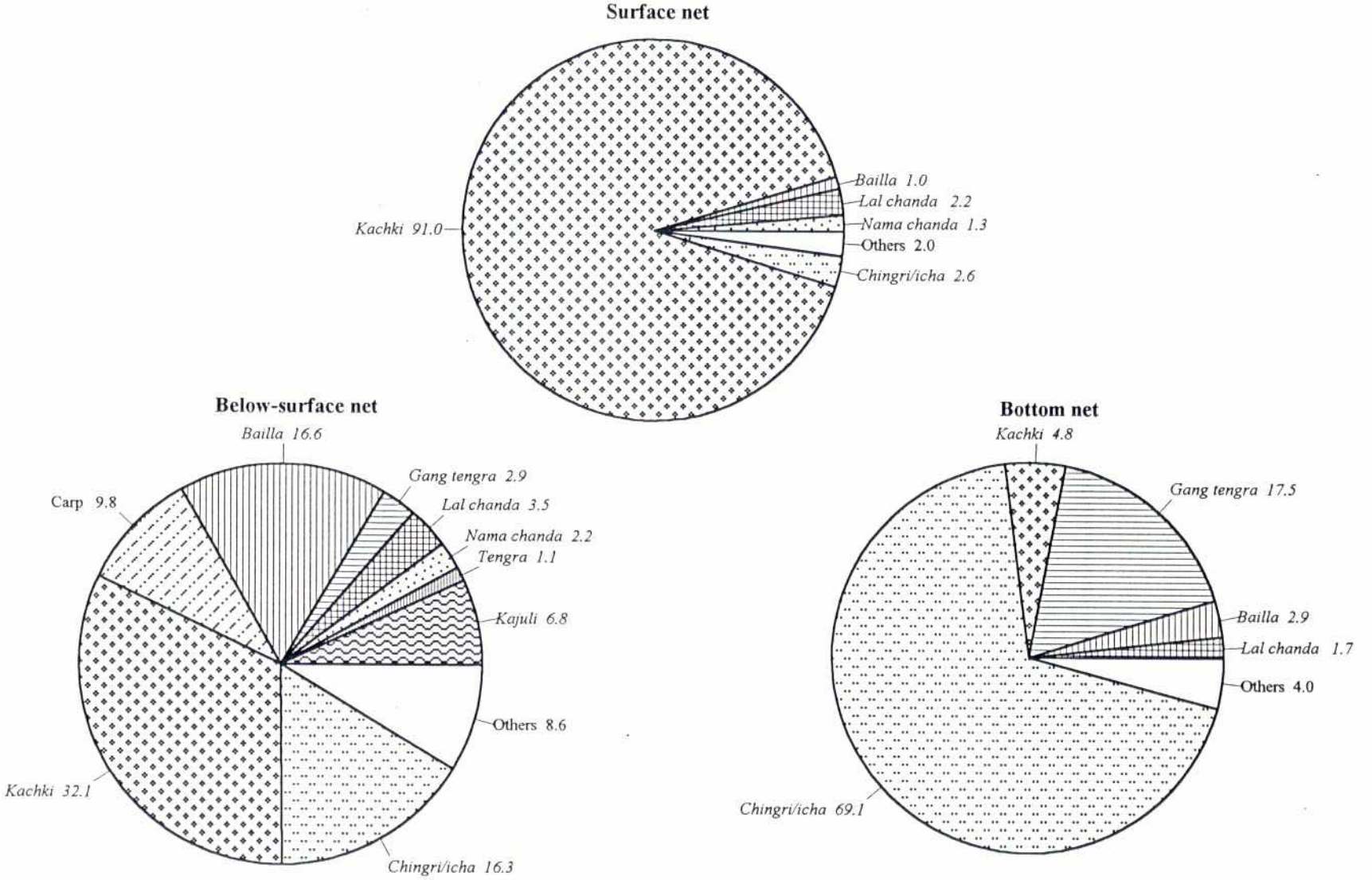
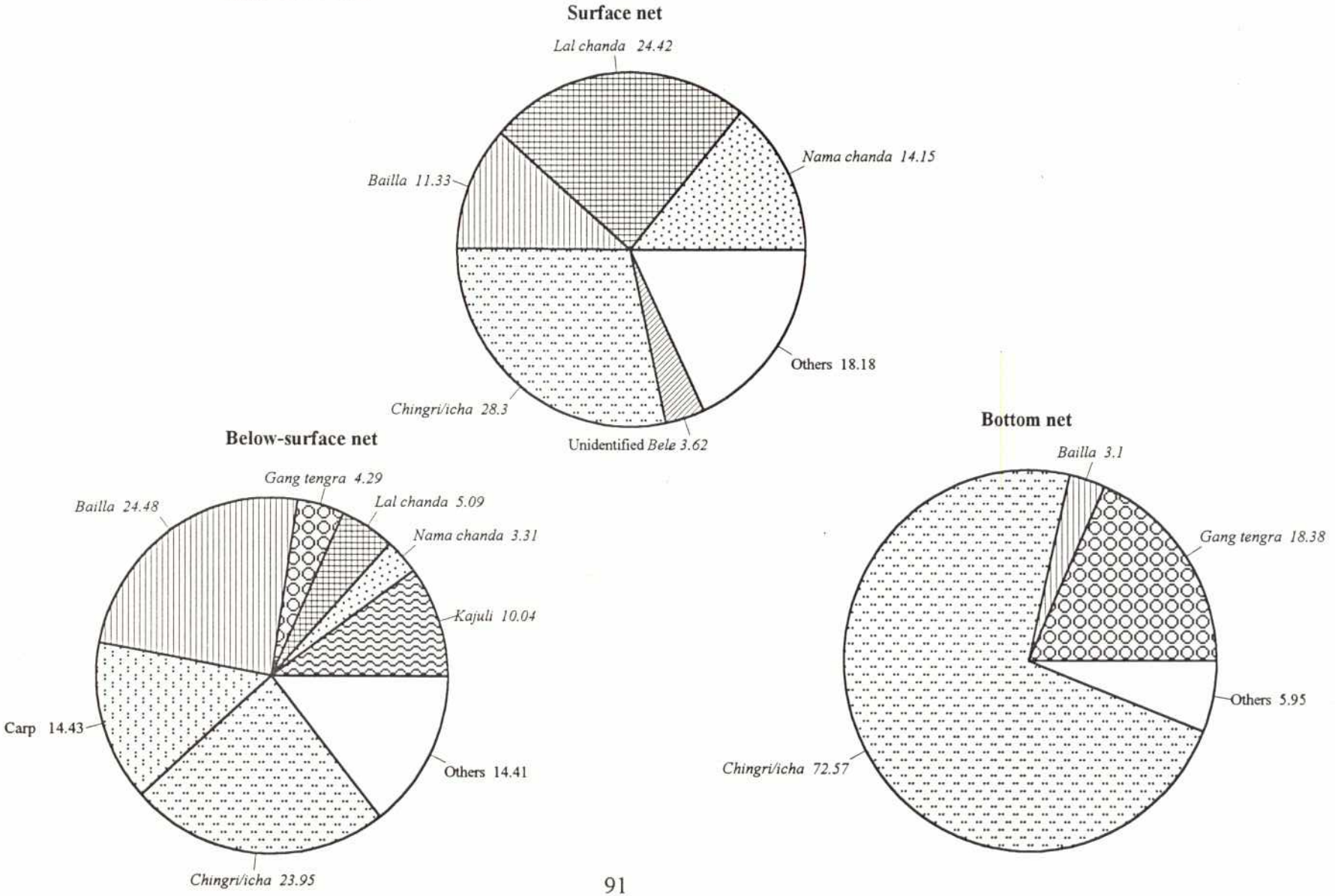


Figure 5.9 Pie charts for percentage compositions of density for dominant species excluding *kachki*, with PC > 3.0



5.6.3 Species composition by month

Total monthly densities of species are computed using the sum of densities over times of survey and survey dates in each month for each group of nets. The percentages (PC) of these total densities of individual species with respect to total density of all species are obtained for each month. The percentage compositions for dominant species having PC > 5.0 are presented in Table 5.12 by net group and month.

It is seen from Table 5.12 that, for surface nets, *kachki* makes up more than 90% of densities in June, July and October, and more than 80% in August and September. The next most important species are *lal chanda* and *chingri/icha* in August and September, although they are far less dense. For below-surface nets, *kachki* is still dominant, except in June and September, but its PC density is much lower. Species, *bailla* and *chingri/icha* are most dominant in June and September respectively. *Chingri/icha*, carp and *kajuli* also dominate for below-surface nets. For bottom nets, *chingri/icha* is the most dominant species followed by *gang tengra*. There are more dominant species with PC > 5.0, for below-surface nets, especially during the high monsoon flood of July and August. Carp has appeared in June and July for below-surface nets only.

Percentage species compositions thus vary widely among the net groups and also among the months. The last column of Table 5.12 gives the subtotal of the percentage densities for dominant species in each month. The subtotal exceeds 80%, except in June, for below-surface nets.

5.6.4 Species composition by month excluding *kachki*

The percentage composition of density for dominant species, except *kachki*, are provided in Table 5.13 for PC > 10. This table shows that for surface nets *chingri/icha* has appeared as the most dominant species in some months and *chanda* and *bailla* in other months. For below-surface nets carp is the most dominant in July and 2nd most important in June. Carp is absent from the other 2 net groups.

Table 5.12 Percentage species composition of densities with PC > 5.0 by net group for the Lohajang River

Month	Species name (Bengali)	No of record	PC composition of densities	Monthly subtotal of PCs
(1) Surface nets (all 6 horizontal nets and vertical nets)				
June	*Kachki*	140	90.58	90.58
July	*Kachki*	188	96.43	96.43
August	*Lal chanda*	150	5.08	94.64
	Kachki	234	82.19	
	Chingri/icha	142	7.37	
September	*Lal chanda*	168	8.86	96.09
	Kachki	155	80.48	
	Chingri/icha	136	6.75	
October	*Kachki*	19	94.24	94.24
(2) Below-surface nets (4 vertical nets)				
June	*Bailla*	63	36.53	78.21
	Carp	33	7.89	
	Kachki	63	33.79	
July	*Kajuli*	61	11.71	82.07
	Gang tengra	32	6.36	
	Bailla	62	5.95	
	Carp	63	18.35	
	Kachki	84	39.70	
August	*Kajuli*	60	13.12	84.13
	Lal chanda	52	5.03	
	Bailla	36	5.47	
	Kachki	75	29.03	
	Chingri/icha	94	26.43	
	Unidentified *Bele*	31	5.05	
September	*Lal chanda*	75	13.56	87.97
	Kachki	44	8.91	
	Chingri/icha	60	65.50	
October	*Kachki*	13	57.59	89.78
	Chingri/icha	13	32.19	
(3) Bottom nets (2 nets)				
September	*Gang tengra*	23	17.49	86.56
	Chingri/icha	19	69.07	

Table 5.13 **Percentage composition by month of density of dominant species excluding *kachki***

Month	Species name (Bengali)	No of record	PC composition of densities	Monthly subtotal of PCs
(1) Surface nets (all 6 horizontal nets and vertical nets)				
June	*Nama chanda*	45	27.24	71.38
	Bailla	50	22.56	
	Chingri/icha	44	21.58	
July	*Nama chanda*	67	18.59	61.59
	Lal chanda	116	16.24	
	Bailla	76	13.81	
	Chingri/icha	72	12.95	
August	*Lal chanda*	150	28.53	69.91
	Chingri/icha	142	41.38	
September	*Lal chanda*	168	45.41	80.01
	Chingri/icha	136	34.60	
October	*Lal chanda*	16	34.48	86.93
	Chingri/icha	17	52.45	
(2) Below-surface nets (4 vertical nets)				
June	*Bailla*	63	55.18	67.10
	Carp	33	11.92	
July	*Kajuli*	61	19.58	60.90
	Gang tengra	32	10.64	
	Carp	63	30.68	
August	*Kajuli*	60	18.49	55.74
	Chingri/icha	94	37.25	
September	*Lal chanda*	75	14.88	86.79
	Chingri/icha	60	71.91	
October	*Lal chanda*	7	10.20	86.12
	Chingri/icha	13	75.92	
(3) Bottom nets (2 nets)				
September	*Gang tengra*	23	18.38	91.95
	Chingri/icha	19	72.57	

5.6.5 Daily average densities for Carp

Daily average densities for carp (909) are presented graphically in Figure 5.10 and 5.11 for horizontal and vertical nets respectively in the Lohajang river. No carp hatchling data are available for the second horizontal net, H2. Figure 5.10 shows that average daily densities for carp are small and scarce for horizontal nets. Average densities are usually higher in the 3rd week of June, then decrease. There are some peaks around mid July, after which carp flow virtually stops.

Figure 5.11 gives a different picture for vertical nets. Average carp densities for 2 vertical nets, V1 and V4 which are actually surface nets, are usually much lower than those of the other vertical nets in the second and third layers of water. There are a few peaks in the third week of June, one in the first week of July and one around the middle of July. By far the highest peak occurs in the first week of July for all vertical nets. Carp hatchling flow virtually stops after July.

Numbers and amounts of carp densities are usually much higher for vertical than horizontal nets.

For bottom nets, no hatchling catch data for carp is available in September.

While some sort of pattern is visible for vertical nets, it is absent from horizontal nets for there are few records.

5.7 Comparisons of Average Densities with Dhaleswari River

The Lohajang River starts from the Dhaleswari which usually contains water throughout the year. Hatchling density is compared between the two rivers graphically and by test for horizontal nets because the nets used in the Dhaleswari River were also surface nets.

5.7.1 Comparison of densities by graph

The average daily densities of the 2 Dhaleswari nets are represented graphically in Figure 5.12 along with water level data. It is seen from Figure 5.12 that peak densities are high in June, October and most of November. Peaks and troughs in the graph show that hatchlings flow in waves, as in the Lohajang River. There is no relationship between density and water level for this site.

Figure 5.10 Average carp density by survey date for 6 horizontal nets in the Lohajang River

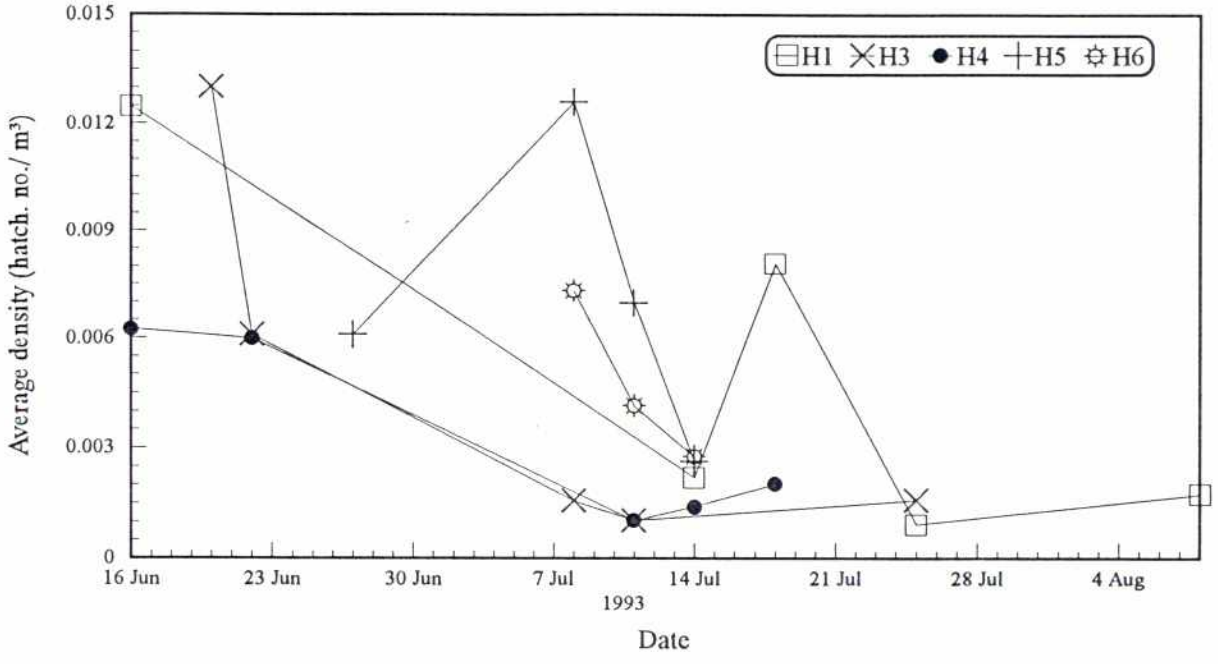


Figure 5.11 Average carp density by survey date for 6 vertical nets in the Lohajang River

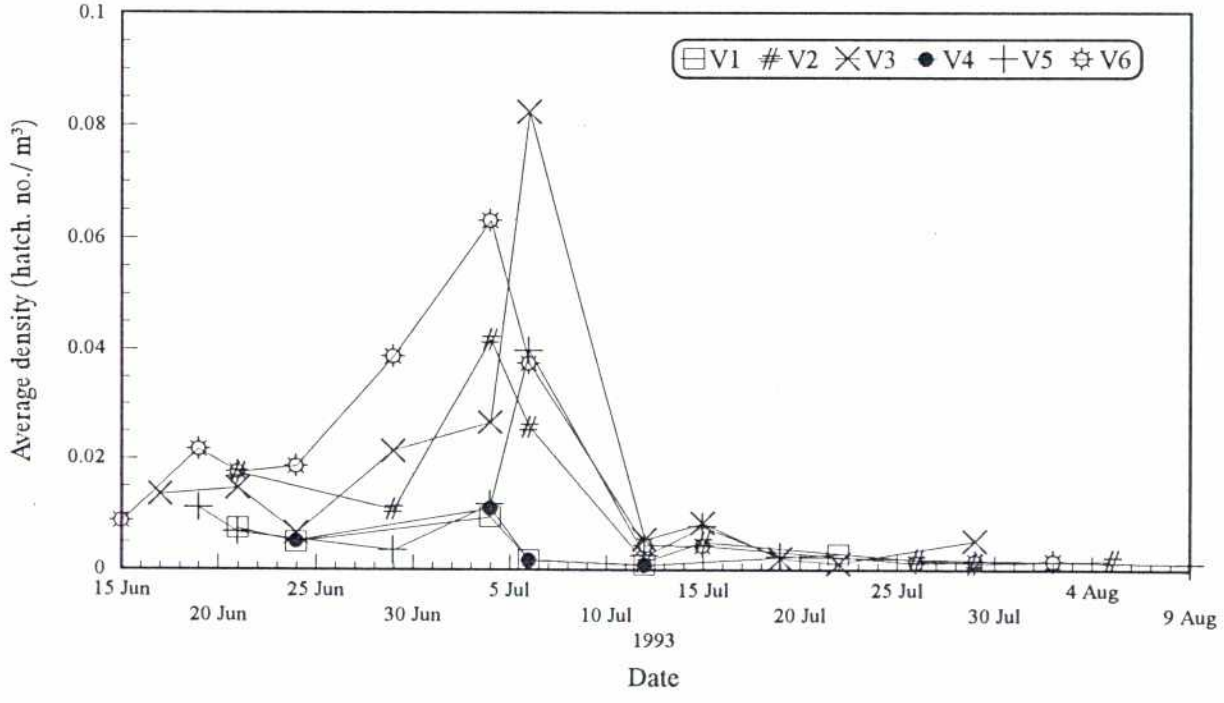
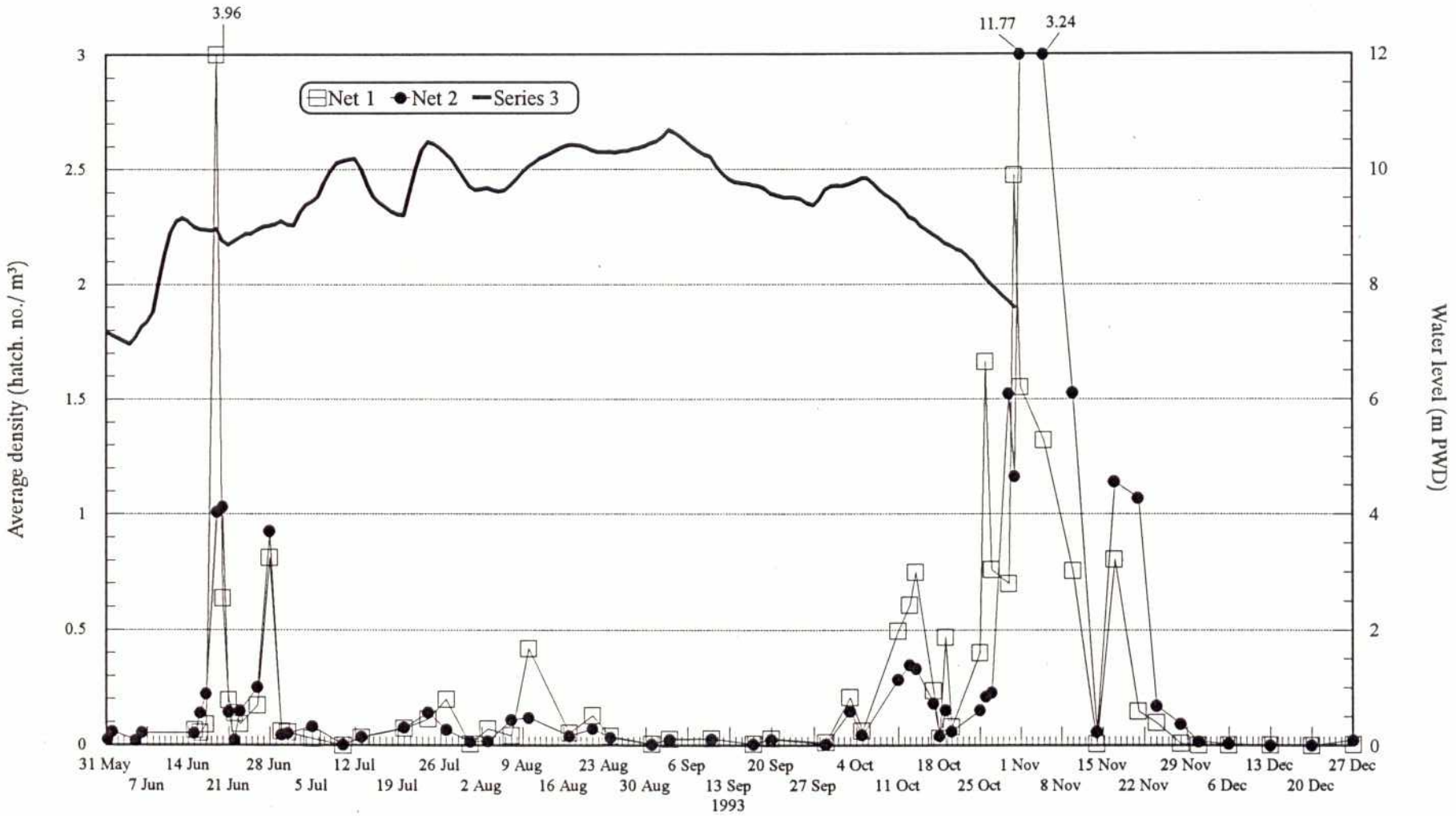


Figure 5.12 Average hatchling density and water level by survey date for 2 nets in the Dhaleswari River in 1993



Comparison of Figures 5.1 and 5.12, shows that hatchling densities are usually much higher in July and September for the Lohajang River than the Dhaleswari; the reverse is true for October. It is also seen that very high densities occur in November in the Dhaleswari compared to nothing in the Lohajang because of lack of water. The pattern of hatchling flow thus varies widely between the two rivers.

5.7.2 Comparison of overall densities by test

The non-parametric U-test (Mann-Whitney) on density is performed to compare densities of horizontal nets (6 for the Lohajang and 2 for the Dhaleswari) between the two rivers by month. The results of the test along with sample sizes and mean densities are provided in Table 5.14.

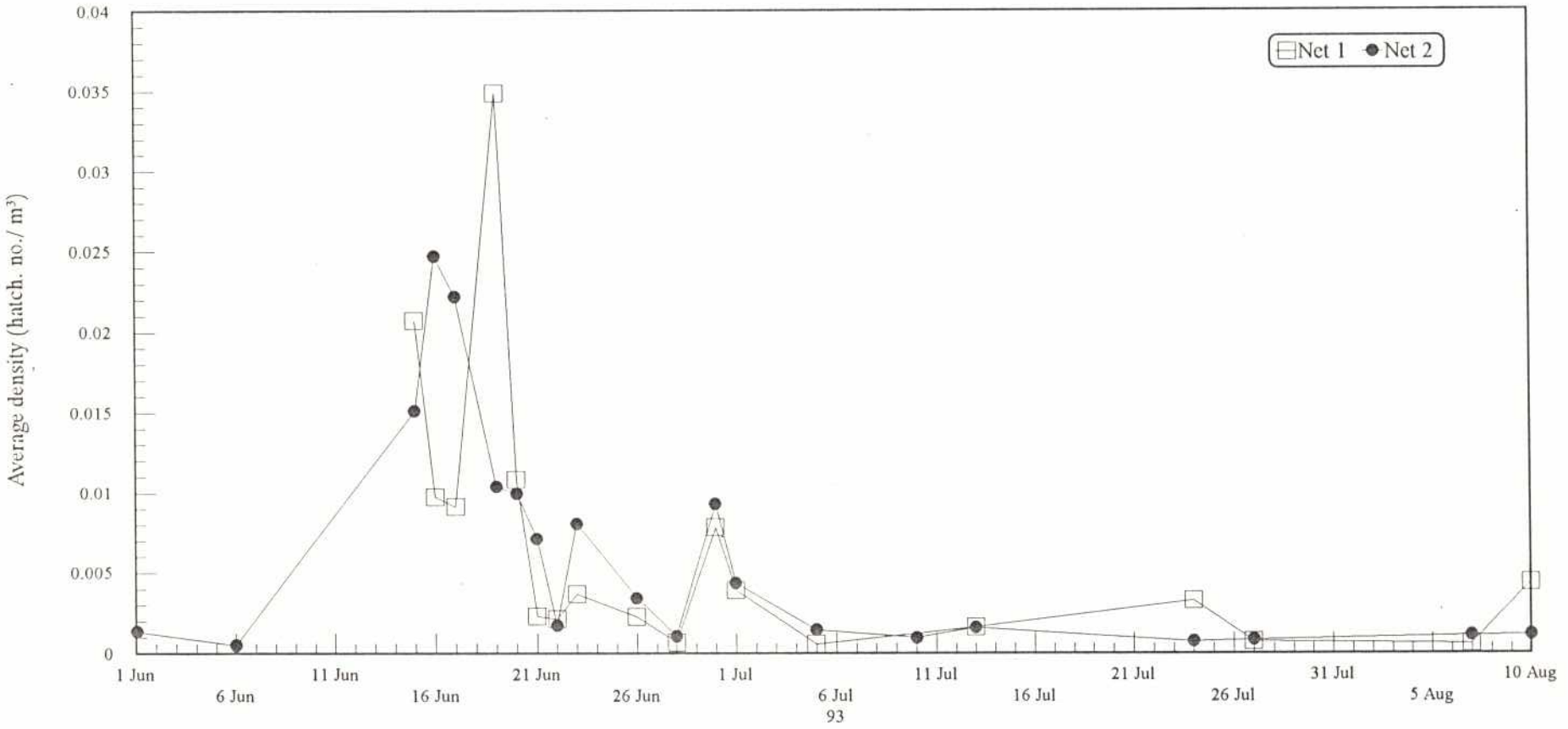
It is observed from Table 5.14 that mean density is much higher in July and September for the Lohajang River, as is expected from the graphs. While the difference between the 2 mean densities is highly significant for September, that for July is marginally insignificant (parametric t-test on the log of density, however, shows a highly significant difference). For June and August, mean densities are similar for the two rivers and the differences are not significant. For October mean density is much higher for the Dhaleswari but the difference is not significant because of the small Lohajang sample. For all months, the mean Dhaleswari density is significantly higher than that of the Lohajang River.

Some significant differences in average densities thus exist between the 2 rivers.

Table 5.14 Results of unpaired comparison of densities between the two rivers

Month	Lohajang River		Dhaleswari River		Non-parametric U-test on density		
	No of record	Mean density	No of record	Mean density	z-value	P-value	Comment
June	114	0.308	117	0.345	-0.740	0.460	NS
July	136	0.349	56	0.065	-1.660	0.097	MIS
August	172	0.090	54	0.075	-0.590	0.556	NS
September	132	0.208	42	0.019	-4.860	0.000	HS
October	12	0.221	110	0.491	-0.550	0.582	NS
All months	566	0.226	379	0.272	-2.470	0.014	SIG

Figure 5.13 Average daily carp hatchling density for 2 nets at a site on the Dhaleswari River in 1993



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5.7.3 Comparison of densities of carp between two rivers

Average daily densities of carp are represented graphically in Figure 5.13 for the Dhaleswari River for two nets separately. Figure 5.13 shows that densities are much higher in the 3rd week of June. The undulating curve indicates that carp hatchlings move in waves after intervals of some days.

Comparison of Figures 5.10 and 5.13 reveals that the flow of carp larvae is scanty and irregular for the Lohajang River for surface (horizontal) nets but is more abundant and prolonged, showing some pattern, for the Dhaleswari. For both rivers, a higher carp flow occurs in June and there appears to be a time lag of few days for the high peak in the Lohajang River in comparison with the Dhaleswari. Average daily densities are usually higher for the Dhaleswari in June. The distribution of carp densities over dates varies considerably between the two rivers for horizontal nets. Comparison of Figures 5.11 and 5.13 gives a different picture for below-surface nets. Carp densities are usually higher for below-surface (vertical) nets of the Lohajang River than those of the Dhaleswari in late June and early July. Density patterns over dates are similar for the 2 rivers with high but late peaks in July for Lohajang.

Comparison of carp densities by test between two rivers

Non-parametric U-tests on density are performed to compare carp densities of horizontal nets between the two rivers by month. The results are given in Table 5.15 along with mean densities and sample sizes.

Table 5.15 Results of unpaired comparison of carp densities between two rivers

Month	Lohajang River		Dhaleswari River		Non-parametric U-test on density		
	No of record	Mean carp density	No of record	Mean carp density	z-value	P-value	Comment
June	07	0.008	85	0.010	-0.180	0.854	NS
July	30	0.004	22	0.002	-2.150	0.031	SIG
August	01	0.002	05	0.002	-0.870	0.380	NS
All months	38	0.005	112	0.008	-1.060	0.290	NS

It is observed from Table 5.15 that mean carp density is higher in July for the Lohajang River than for the Dhaleswari and the difference between them is significant. The differences between mean carp densities are not significant for other two months and all months together. For August there is only one record for the Lohajang River. The overall (all month) mean carp density is higher for the Dhaleswari.

5.8 Comparison of Densities of FAP 17 with those of FAP 20

For the hatchling catch experiment, the FAP 17 site was about 20 feet upstream (north) from a bridge on the Lohajang River to the south west of Tangail Town. The FAP 20 site on the Lohajang River was about 2 km upstream near the Dhaleswari.

At stated earlier, six horizontal (surface) nets - H1, H2, H3, H4, H5 and H6 - were fixed across the Lohajang River from west to east bank at about equal distances, except for the middle two nets; H3 and H4. More space was kept between these for the passage of boats. The first two vertical nets of each group, V1 and V4 were also surface nets. They were used in place of H2 and H3 respectively on different dates. In order to increase the sample size, densities of H2 and V1 at the west bank are combined. Since data on H3 are not complete because this net was used as a bottom net after August, data on the vertical net V4 and nearest horizontal net H4, are combined to increase the sample size in the middle of the river for the FAP 17 site.

At the FAP 20 site, there were 3 surface (top) nets of which 2 were placed near the 2 banks of the river and the other in the middle of the river. For the two nets on the east bank and in the middle of the river, hatchling data were collected regularly on each day during the monsoon time. Hatchling data on these 2 nets are compared with similar of FAP 17 nets.

For FAP 20 nets, hatchling data were collected for one hour (daytime) on almost every date of the monsoon period. For FAP 17 nets, however, the hatchling catch was usually taken for one hour at 4 different survey times on each date. Average densities are therefore taken over survey times on each survey date to get daily average densities for FAP 17 nets.

For comparison purposes, daily densities of mid-river nets at the FAP 20 site and daily average densities of 2 combined mid-river nets (H4 and V4) of FAP 17 are considered by matched survey dates. Similarly daily densities of the east bank net at the FAP 20 site and average daily densities of 2 combined west bank nets (H2 and V1) at the FAP 17 site are

considered by matched survey dates. The reason for this latter comparison is that the water flows fastest at the east and west banks of the FAP 20 and FAP 17 sites respectively. Comparisons of densities for 2 pairs of nets at the two sites, are made graphically and by the paired non-parametric (Wilcoxon sign) test.

5.8.1 Graphical comparisons of densities

Line charts for overall densities of the east bank net at the FAP 20 site, and average overall densities of the west bank net of at the FAP 17 site (H2 and V1 combined) are presented in Figure 5.14 by date for the period from June to October, 1993. It is observed from Figure 5.14 that FAP 20 densities are usually larger than FAP 17 densities except in some cases towards the end. In some instances there are time lags in peak densities between the 2 sites. One reason for higher densities at the FAP 20 site may be that the mesh size for this site is much smaller resulting in higher catch rates. Densities at both sites are low during the high monsoon flood in August and September, which overflows the river banks and thus diffuses the hatchling flow.

Daily densities at mid-river nets at the two sites are represented graphically for the same period in Figure 5.15 which shows that mid-river densities are more or less similar except in some cases where FAP 20 densities are higher and some where FAP 17 densities are higher.

Carp densities are represented graphically for the period from June to August, 1993, in Figures 5.16 and 5.17 for river bank sites and mid-river sites respectively. It is clear from these figures that carp densities of FAP 20 nets are usually much higher than those of FAP 17 nets for both mid-river and bank sites. The reason for this is not clear. If carp larvae are smaller than other species, more would be expected to be caught in FAP 20 nets than FAP 17 nets, the meshes of which are larger.

5.8.2 Paired comparison of densities by non-parametric test

Graphical representations have shown some differences between the 2 sets of densities, especially for carp. The non-parametric Wilcoxon sign test is applied here to compare daily densities by month and net between the two sites. Test results along with sample sizes and mean densities are given in Table 5.16.

Figure 5.14 Daily overall densities of corresponding river bank nets of FAP 20 and FAP 17 sites in 1993

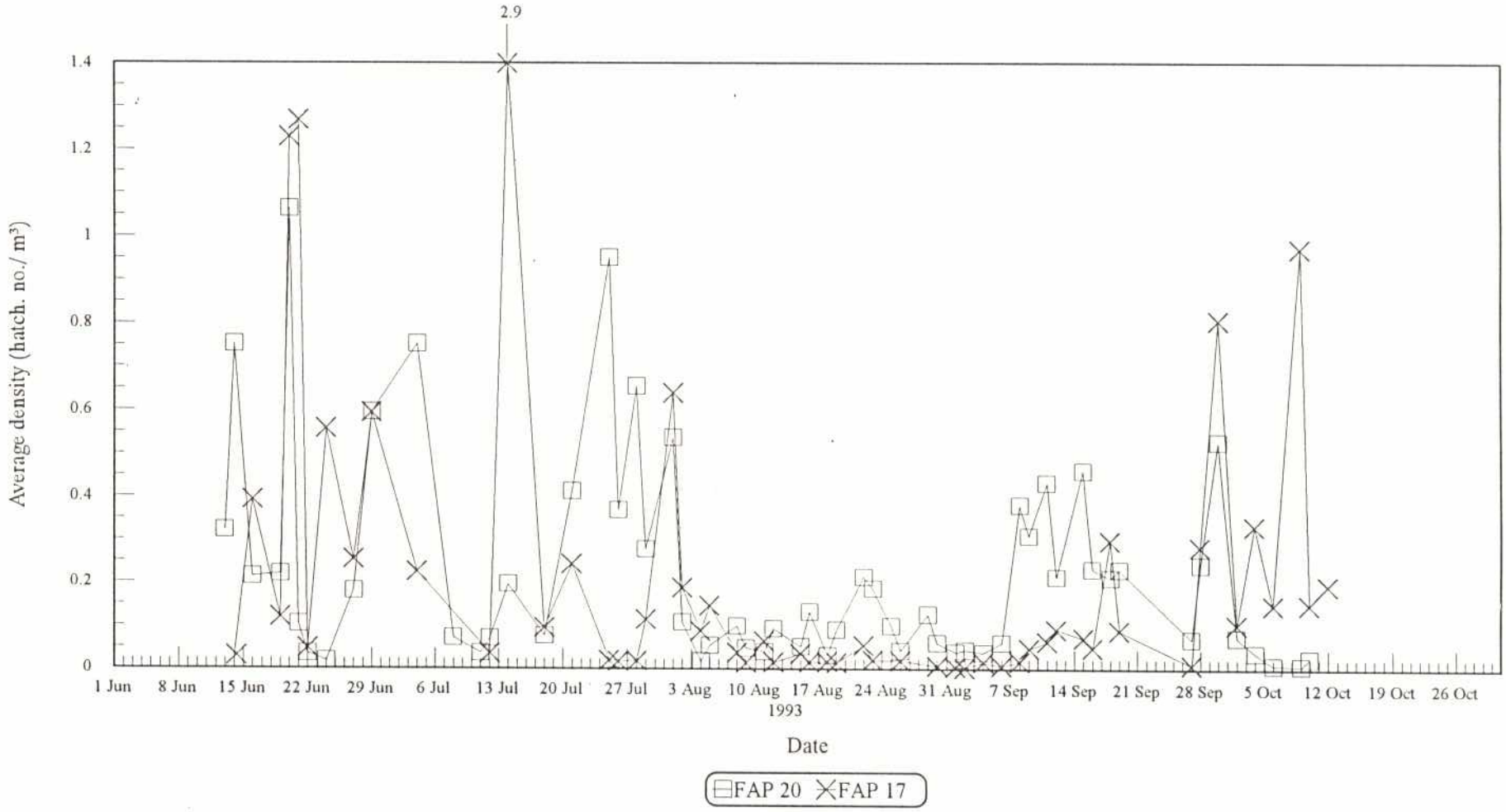


Figure 5.15 Daily overall densities for FAP 20 and FAP 17 nets at/near the middle of the Lohajang River in 1993

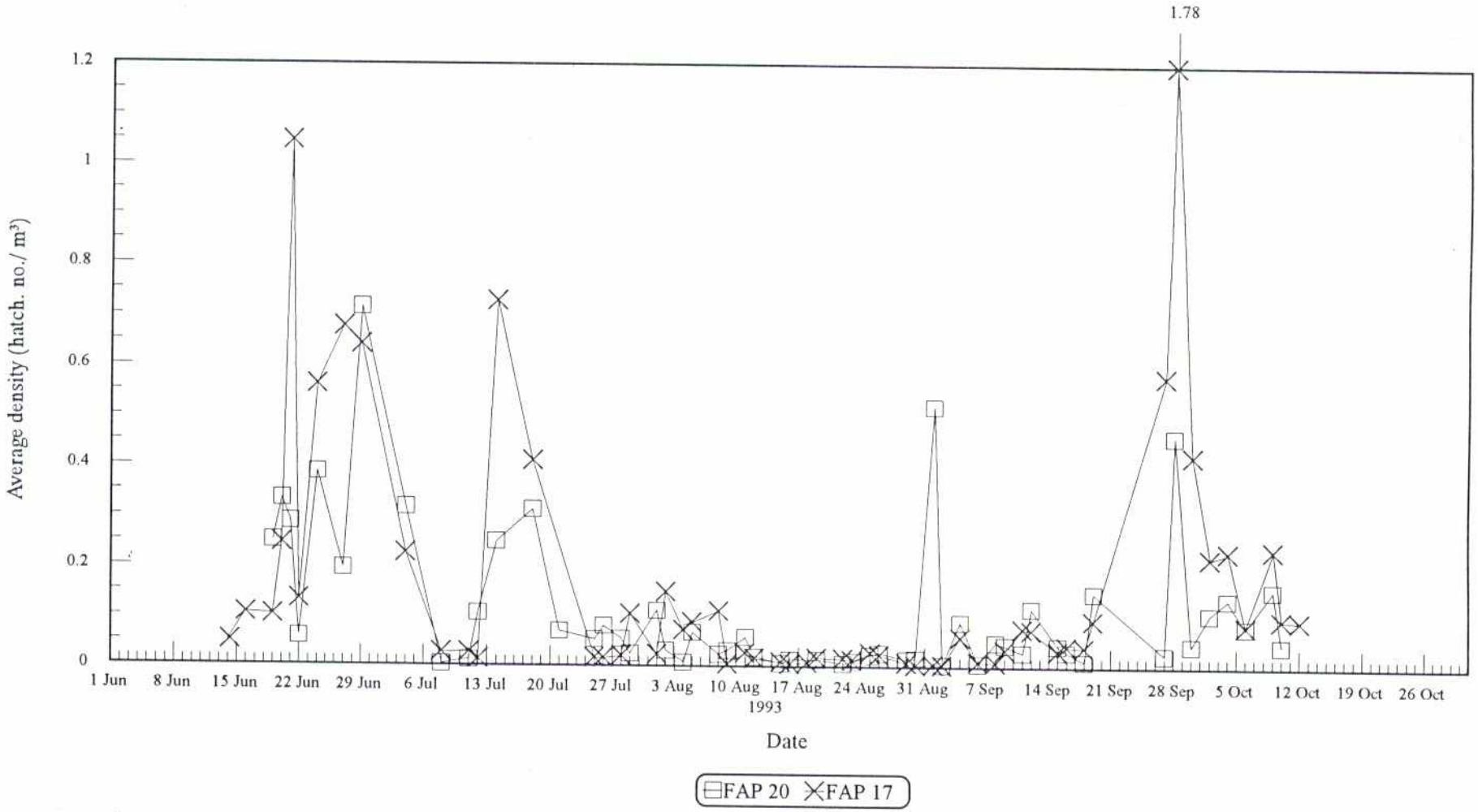


Figure 5.16 Daily densities for carp of corresponding river bank nets at FAP 20 and FAP 17 sites in 1993

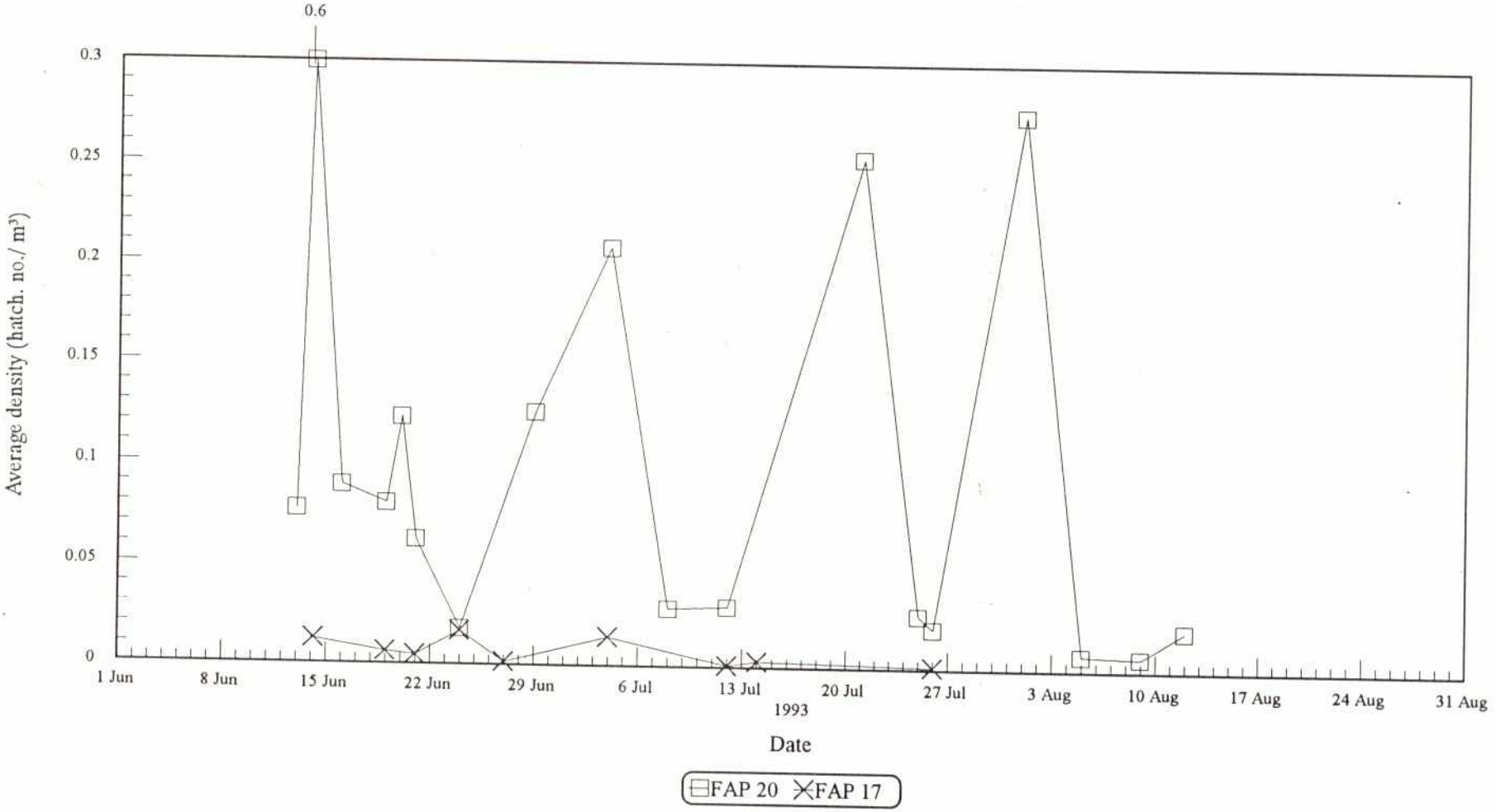


Figure 5.17 Daily densities for carp of FAP 20 and FAP 17 nets at/near the middle of the Lohajang River in 1993

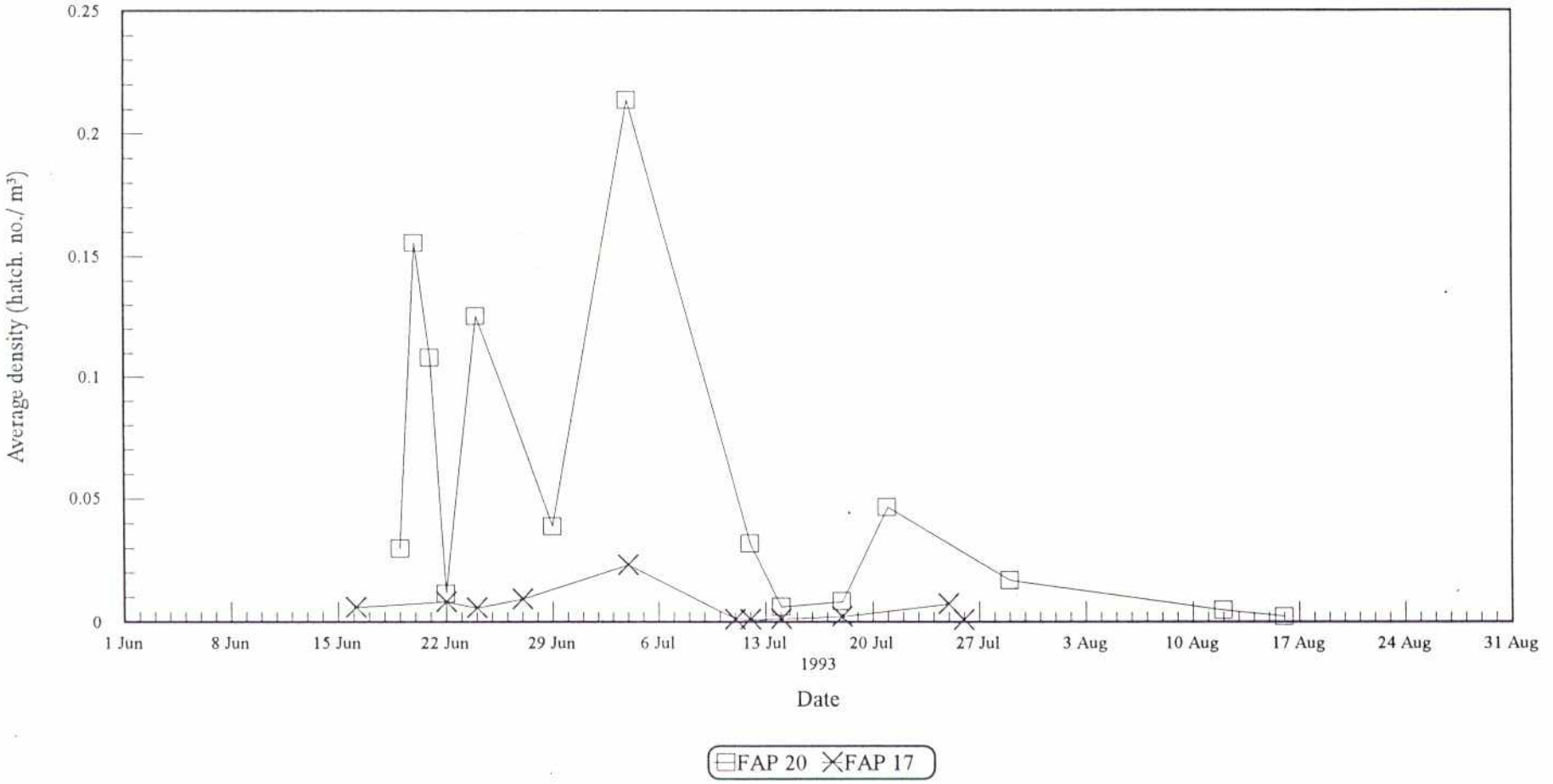


Table 5.16 Paired comparison of densities between FAP 17 and FAP 20

Month	Number of record (pairs)	Mean density		Non-parametric Wilcoxon sign test on density		
		FAP 17	FAP 20	z-value	P-value	Comment
Overall density (all species) - Bank-side nets						
June	9	0.499	0.353	-1.13	0.260	NS
July	9	0.408	0.418	-1.48	0.139	NS
August	16	0.087	0.113	-1.03	0.301	NS
September	15	0.124	0.232	-2.10	0.036	SIG
October	5	0.341	0.031	-2.02	0.043	SIG
All months	54	0.243	0.230	-1.22	0.223	NS
Overall density (all species) - Mid-river nets						
June	7	0.487	0.318	-1.01	0.310	NS
July	10	0.159	0.122	-0.05	0.959	NS
August	17	0.036	0.029	-0.02	0.981	NS
September	15	0.217	0.109	-0.17	0.864	NS
October	5	0.173	0.105	-2.02	0.043	SIG
All months	54	0.180	0.113	-1.23	0.218	NS
Carp density - Bank-side nets						
First 2/3 months	7	0.008	0.145	-2.37	0.018	SIG
Carp density - Mid-river nets						
First 2/3 months	6	0.007	0.066	-2.20	0.028	SIG

It is observed from Table 5.16 that mean densities of FAP 17 nets are significantly larger than those of FAP 20 nets in October for both bank-side nets and mid-river nets. For September, the average density of FAP 20 is significantly larger than that of FAP 17 for bank-side nets. For other months and all months together, the differences in mean overall densities are not significant for either net site. These few cases aside, the daily mean densities are about the same for the 2 FAPs.

For carp density, sample size (number of pairs) is rather small and the FAP 20 site has higher means for both pairs of net. The differences of the mean carp densities between the 2 FAPs are significant at the 5% level for both types of net. This is also indicated by the graph.

6 IMPACT OF REGULATORS ON MOVEMENT OF HATCHLINGS

In order to control flood water passing through secondary rivers into low-lying floodplains and *beel*, regulators (sluice gates) were constructed on some of the rivers. To examine the impact of such regulators on hatchling movement, hatchling catch surveys were carried out both inside and outside some of the regulators. These are at Charghat on the Baral River, Bauitara on the Old Hurasagar River and Talimnagar on the Badai River in the North West Region. For the North East Region, the regulators for hatchling surveys were undertaken for two *khal* or rivers; Khorodari and Lumardai.

Hatchling densities are computed for both inside (downstream of) and outside (upstream of) these regulators. These densities are compared here graphically by day and month and by statistical tests.

6.1 Charghat Regulator on Baral River

For this regulator, a more comprehensive study was carried out for two years, 1992 and 1993. For 1993, dead fries were counted along with live ones on both sides on the regulator.

6.1.1 Graphical comparison between density difference and head difference

For each survey date, (average) density outside the regulator minus (average) density inside is the density difference for that date. Similarly, average water level outside minus average water level inside is the head difference for each date. In order to examine the relationship between the two differences graphically, density difference and head difference data are plotted by date in Figures 6.1 and 6.2 for 1993 and 1992 respectively. It is observed from Figure 6.1 that for 1993 some relationship exists between them for a short period in August when water level is rising and in October when water level is falling. For September, density difference remained low whereas head differences were high. While there are few peaks for head difference, the density difference is marked by frequent and random fluctuations. In general, there is hardly any relationship between head difference and density difference in 1993.

For 1992, Figure 6.2 shows a similar random pattern in density difference data. Head difference has two peaks one in early September and the other in late September, after which the head difference decreases very quickly. There is no apparent relationship between the density difference and head difference in 1992.

Figure 6.1 Graph of density difference and head difference by survey date for the Charghat regulator in 1993

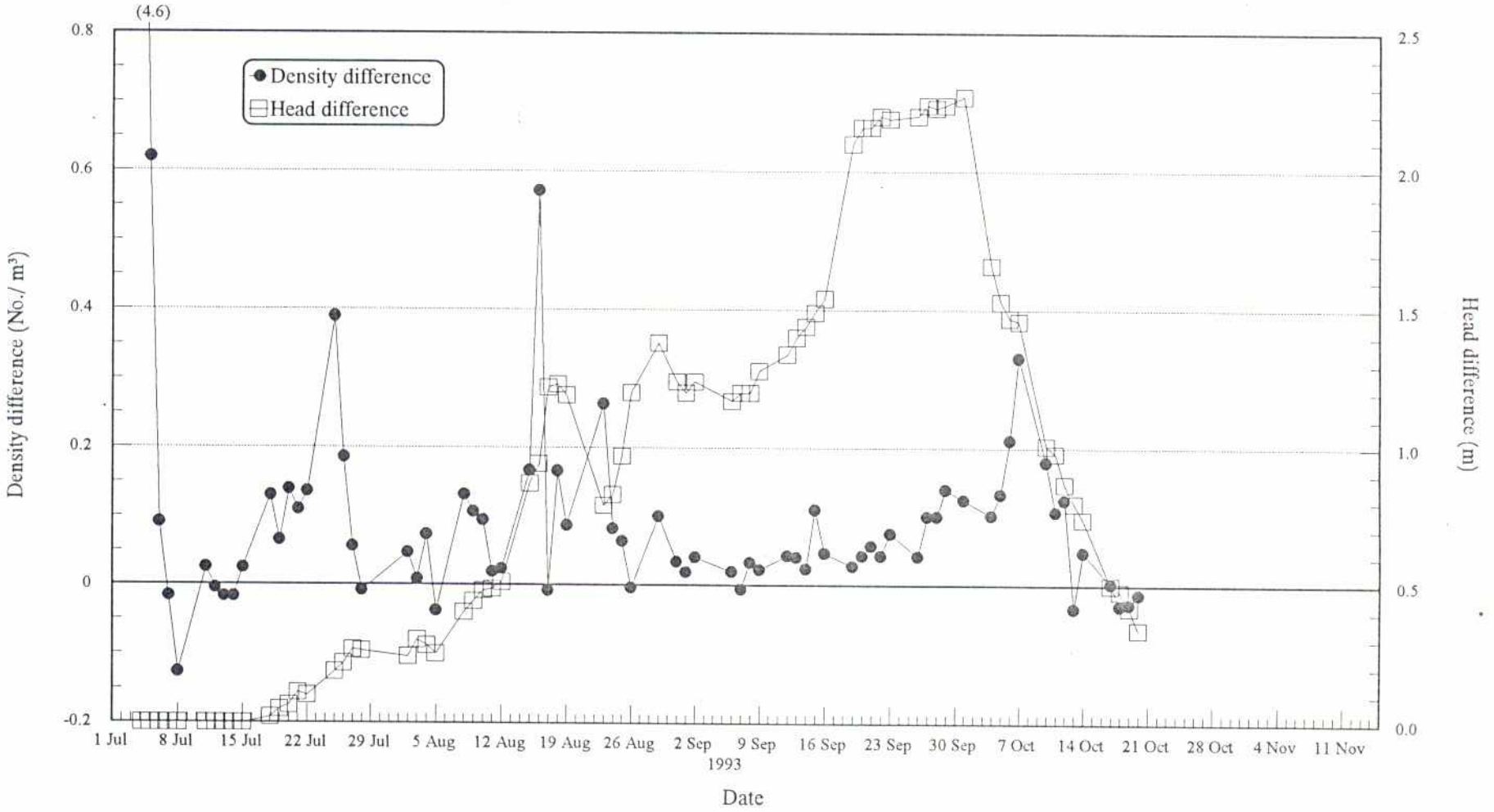
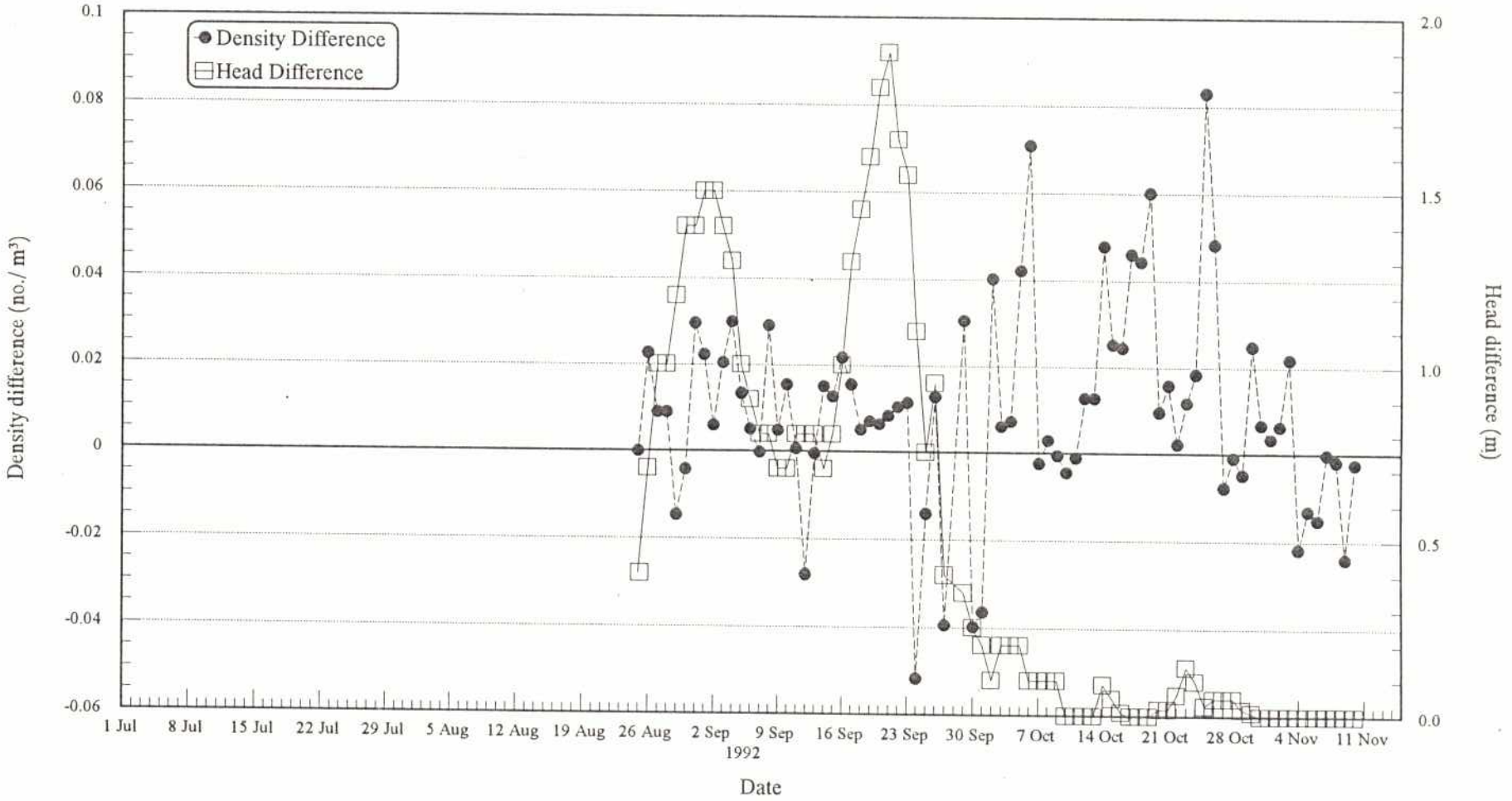


Figure 6.2 Graph of density difference and head difference by date for the Charghat regulator in 1992



Thus, while the patterns of density difference are random and similar for the two years, the patterns of head differences differ markedly in the two years, in which different flood patterns occured. Density differences are higher on average in 1993, when greater flooding occured than in 1992.

6.1.2 Relationship between density difference and head difference

For higher head differences, density differences are expected to be higher. In order to find the relationship between the two differences, head differences are divided into class intervals differently for each of the 2 years, so that the record number is larger. For each class interval, the non-parametric Spearman's rank correlation is computed between density difference and head difference, since density data are not normally distributed. The results of tests of significance of this rank correlation for different strata in each year are presented in Table 6.1.

It is observed from Table 6.1 that rank correlations for different strata of head difference are not significant for 1992 when river flooding was quite low.

For 1993, however, results show that rank correlation is highly significant for 2 head difference class intervals: 1.2 to 1.7 metre (m) and $\geq$ 1.7 m i.e. when density difference $>$ 1.2 m. It is also found that the rank correlation is significant when head difference $\geq$ 1.0 m but is not so for head difference $<$ 1.0 m. It can thus be said that a positive and significant relationship exists between the two differences when the head difference is greater than 1 metre but not when head difference is less than 1 metre.

6.1.3 Paired comparison of average overall densities between 2 sides

Since hatchling flow inside the gate on a day is expected to depend on hatchling flow outside, a paired comparison of average densities by date is made by the non-parametric Wilcoxon sign test on density data. The results of the test are shown by month in Table 6.2 for two years separately.

It is observed from Table 6.2 that inside mean densities are all lower than the corresponding outside average densities except for one case in 1992. Mean densities of 1992 are also much lower than those of 1993. The test results show that the average densities outside the regulator are significantly higher than those inside for all months separately and together in 1993.

Table 6.1 Relationship between density difference and head difference by stratum of head difference at Charghat for 2 Years

Year: 1992

Stratum No	Class interval of head differences (metre)	Number of record/cases	Rank correlation	t-value	Significance
1	0.2 to 0.9	15	0.062	0.23	NS
2	0.9 to 1.4	10	0.264	1.13	NS
3	> 1.4	11	-0.075	-0.23	NS
4	0.2 to 1.0	17	0.110	0.43	NS
5	> 1.0	19	-0.118	0.49	NS

Year:1993

1	0.2 to 0.7	16	-0.107	-0.40	NS
2	0.7 to 1.2	12	0.054	0.14	NS
3	1.2 to 1.7	19	0.707	4.12**	HS
4	> 1.7	10	0.791	3.66**	HS
6	0.2 to < 1.0	32	0.397	2.37*	SIG
5	> 1.0	25	0.348	1.77	NS

Note: NS - Not significant, SIG - Significant at 5% level (*) and HS - Significant at 1% level (**)

Table 6.2 Paired comparison of average density data by date between 2 sides

Month	Number of cases	Mean		Non-parametric Wilcoxon test		
		Inside	Outside	z-value	P-value	Comment
Year: 1992						
August	7	.013	.020	-1.01	.310	NS
September	29	.022	.027	-1.98	.048	SIG
October	31	.021	.041	-3.68	.000	HS
November	11	.021	.016	-1.07	.284	NS
All months	78	.021	.030	-3.82	.000	HS
Year: 1993						
July	19	.165	.667	-2.70	.006	HS
August	20	.068	.167	-3.50	.000	HS
September	20	.026	.077	-3.90	.000	HS
October	14	.110	.200	-2.40	.016	SIG
All months	73	.090	.279	-6.30	.000	HS

Note: NS - Not significant, SIG - Significant at 5% level and HS - Significant at 1% level

For 1992, differences in average densities are significant for September, October and all 4 months together. The other two months of 1992 have fewer data. The differences are mostly highly significant. These results indicate that the regulator is a real barrier for free movement of fish larvae.

6.1.4 Paired comparison of densities between 2 sides for some dominant species

Paired comparisons of densities by date between 2 sides are made by the same non-parametric Wilcoxon test for 4 dominant species: *chingri*, *bata*, *kachki* and carp for 1993 (section 6.1.5). The results are provided in Table 6.3.

Table 6.3 Paired comparison of densities by date between 2 sides for some dominant species in 1993

Species name (Bengali)	Month	No of records (pairs)	Mean density		Non-parametric Wilcoxon Test		
			Inside	Outside	z-value	P-value	Comment
Carp	July	17	0.020	0.051	-1.91	0.056	MIS
	Aug	20	0.015	0.036	-2.11	0.035	SIG
	Sept	20	0.003	0.006	-3.16	0.002	HS
	Oct	3	0.001	0.001	-1.99	0.046	SIG
	All months	60	0.012	0.028	-3.08	0.002	HS
Kachki	July	19	0.015	0.025	-0.86	0.388	NS
	Aug	17	0.004	0.008	-2.81	0.005	HS
	Sept	16	0.001	0.004	-2.28	0.022	SIG
	Oct	14	0.026	0.052	-2.62	0.001	HS
	All months	66	0.011	0.021	-2.24	0.025	SIG
Bata	July	19	0.014	0.043	-1.62	0.105	NS
	Aug	20	0.008	0.010	-1.97	0.048	SIG
	Sept	20	0.002	0.006	-1.87	0.062	MIS
	Oct	14	0.027	0.038	-1.65	0.098	NS
	All months	73	0.012	0.023	-2.44	0.015	SIG
Chingri/icha	July	19	0.075	0.438	-0.63	0.53	NS
	Aug	20	0.005	0.010	-3.35	0.001	HS
	Sept	20	0.004	0.013	-3.49	0.000	HS
	Oct	14	0.013	0.033	-1.33	0.183	NS
	All months	73	0.025	0.127	-3.40	0.001	HS

Note: MIS - Marginally insignificant

Table 6.3 shows that the differences between average catch rates inside and outside are usually significant for dominant species except for July and October for 2 species. Most of the differences are highly significant. Mean densities are higher outside than inside. These results are similar to those of Table 6.2, supporting the finding that the regulator has an adverse effect on hatchling flow.

6.1.5 Species composition of density

There are 132 and 146 species inside and outside respectively in 1992. The corresponding numbers of species for 1993 are 90 and 93. There are therefore many fewer species in 1993 than 1992. The main reason for this appears to be that the net was kept underwater for 24 hours every day in 1992 and more species were therefore caught then.

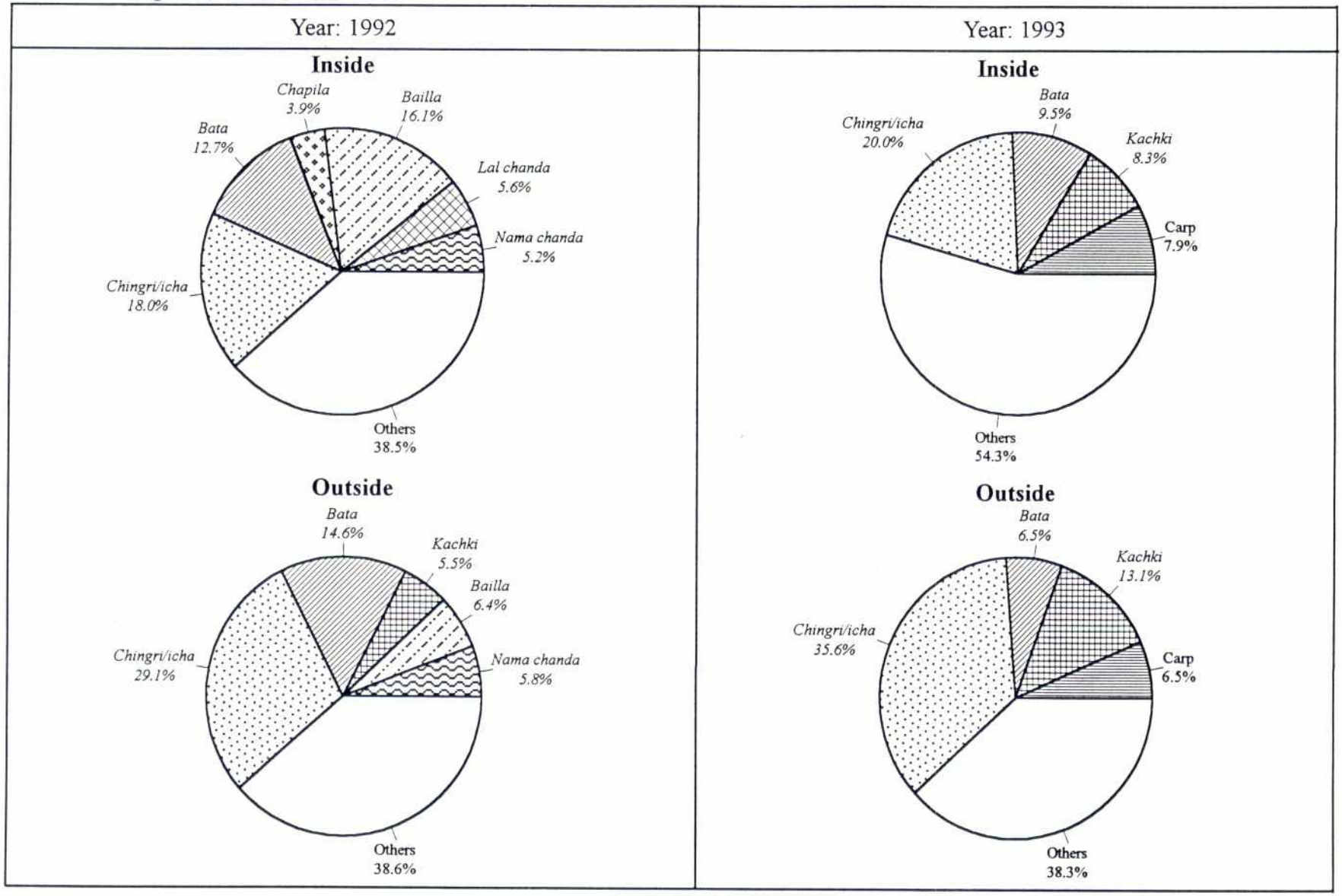
The average daily densities are added over dates by species for the whole period of survey. In order to obtain species compositions of density, the percentages (PC) of these total densities of individual species with respect to corresponding total densities of all species, are computed.

The overall (all month) percentage compositions of densities for the dominant species having PC $\geq$ 5.0 are presented as Pie charts in Figure 6.3 for 2 sides. It is seen from Figure 6.3 that the number of species with overall PC $\geq$ 5.0 is quite small in the two years. Only 3 dominant species are common in both years. The species *chingri/ icha* is the most dominant for both sides over both years. For 1992, the next most important species is *bailla* followed by *bata* on the inside. These 2 species are also the next most important on the outside, in reverse order. For 1993, *kachki* followed by *bata* and carp are the next most important on the outside. For the inside, *bata* then *kachki* are the next most important. Carp is a dominant species in 1993 but not in 1992. Thus, species composition varies considerably between the two sides during each year and widely between the 2 years.

6.1.6 Fish fry mortality in 1993

For 1993, the number of dead hatchlings was counted by species along with the total number of fries for every catch on both sides of the Charghat regulator. For each survey date, total counts by species were obtained over survey times for live and dead species. There were 34 dates (26 inside and 8 outside) for which dead fries were found. 486 records by species contained dead fries in these 34 days. Of these, 377 records are for the inside and 109 for

Figure 6.3 Pie charts for overall (all months) species compositions of dominant species having PC > 5 for 2 sides of the Charghat regulator in 1992 and 1993



the outside. The percentages of dead fries (mortality) with respect to all fries (live and dead together) were computed for each survey date by species and all species together.

(a) Graph of daily overall (all species) mortality and head difference

Figure 6.4 presents the graph by date of overall (all species) percentages of dead fries for the inside and outside, and also the head difference. It is observed from Figure 6.4 that mortality inside has some positive relationship with head difference in early September and October. Inside mortality fluctuates more or less randomly while head differences rises gradually and then falls sharply. On the outside, there are only 6 mortality dates in the whole season. Death of fries thus occurs rarely outside the regulator and is much more common inside.

(b) Monthly number and PC of dead fries

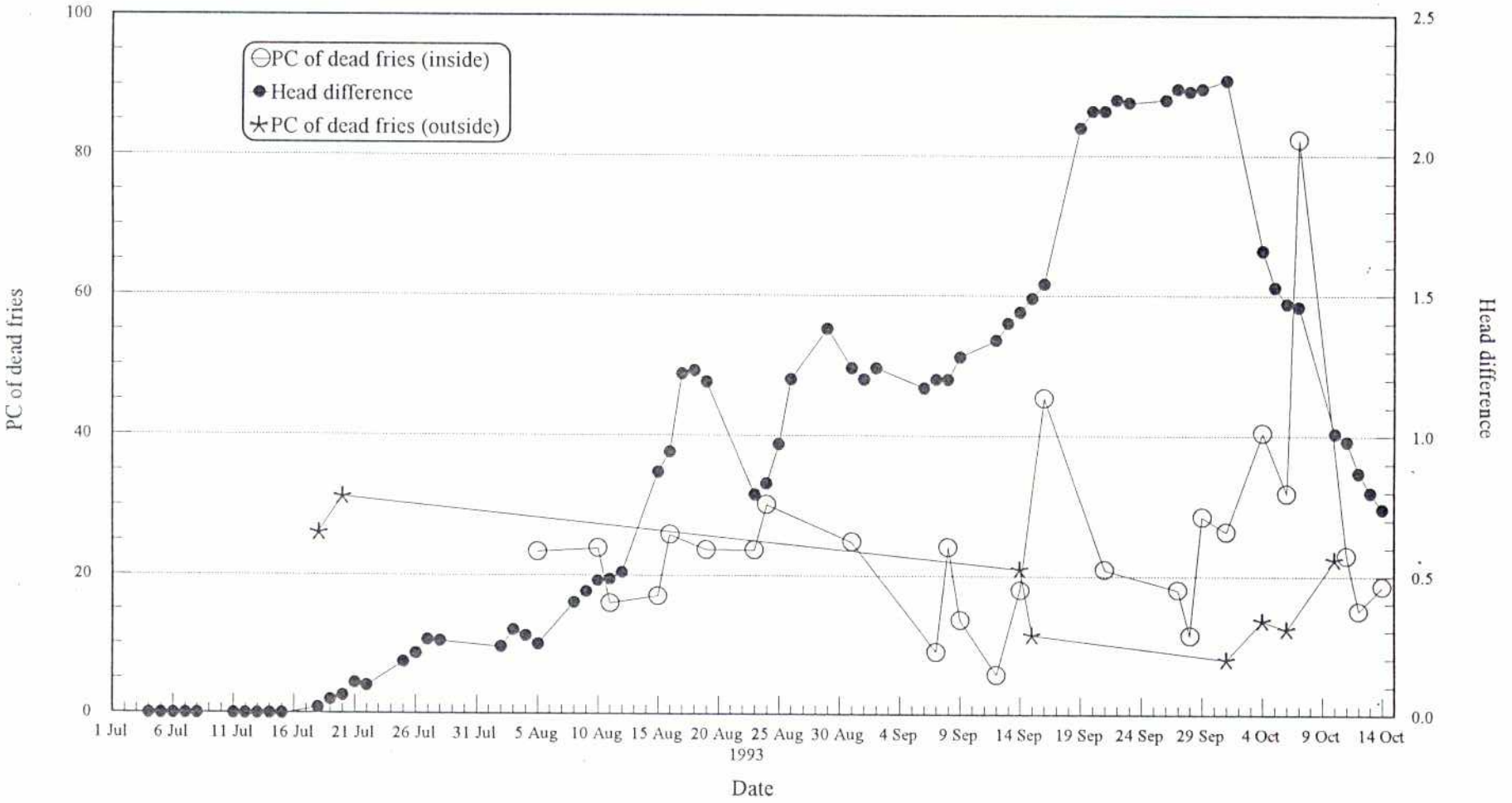
Total number of fries and number of dead fries and mortality (PC) of dead fries (all species) are provided in Table 6.4 by side and by month month.

Table 6.4 Number and PC of dead fries by month in 1993

Month	Total no. of survey date	Inside				Outside			
		No. of Sdate* having dead fries	No. of Dead fries	Total no. of fries	PC of dead fries	No. of Sdate* having dead fries	No. of Dead fries	Total no. of fries	PC of dead fries
July	19			7685	0	2	703	41859	1.7
August	20	9	1166	6895	16.9			8901	0
September	20	10	442	3635	12.2	2	110	5647	2.0
October	14	7	2830	15315	18.5	4	840	17925	4.7
All months	73	26	4438	33530	13.2	8	1653	74332	2.2

* Note: Sdate denotes survey date

Figure 6.4 Graph of head difference and PC of dead fries for inside and outside the Charghat regulator in 1993



It is observed from Table 6.4 that, for the inside, there are fewer hatchlings in total for all months, but the numbers of dead fries are much higher (except for July) than on the outside. Except for the first month, therefore, the percentages of dead fries are much higher (several times) inside than outside the Charghat regulator. Also, the number of survey dates having dead fries is much larger inside than out.

The overall PC (all month) of dead fries is 13.2 for inside and only 2.2 for outside. The PC of dead fries varies significantly between months for both sides. The pattern (or distribution) of dead fries also varies significantly between the two sides. These statistics indicate that the Charghat regulator has an adverse effect on the tiny fries, destroying a considerable percentage of fish larvae in the course of their flow through the gate.

(c) Percentages of dead fries by species

The dead fries involves 60 species on the inside and 41 species on the outside.

Average percentages (PC) of dead fries are computed by species over all the survey dates for the 2 sides separately. Table 6.5 gives the species with average PC of dead fries for record numbers > 40 and PC > 13 for the inside along with carp. The species given in Table 6.5 are more susceptible to death.

Table 6.5 Species with high average PC of dead fries in 1993

Species name	Inside		Outside	
	Number of record	Average PC of dead fries	Number of record	Average PC of dead fries
Kachki	57	13.3	56	2.4
Raik	54	14.8	60	0.3
Carp	54	6.4	58	8.0
Bata	71	18.6	69	4.0
Nama chanda	72	22.5	70	2.3
Gang tengra	47	22.1	54	3.3
Bailla	45	27.0	55	2.7
Unidentified fish (950)	63	13.1	68	1.2
Chanda	64	19.5	63	7.2
All species	1779	13.7	1915	2.2

It is seen from Table 6.5 that the numbers and mortalities of species are quite different on the two sides. For the inside, the number of species and average mortality are all larger than those outside, except carp. *Bailla* has the highest average percentage of dead fries followed by *nama chanda*, *gang tengra* and *chanda* for the inside. The corresponding PCs of dead fries on the outside are much smaller. Surprisingly, carp has a higher PC of dead fries outside than inside.

Mortality data of Table 6.5 is represented by a bar diagram in Figure 6.5 for the 5 most affected species and carp, and all species together, for visual comparison. It is evident from Figure 6.5 that mortality is much higher inside than outside.

The Charghat regulator thus has highly adverse effects on the larvae of these species, destroying a substantial number of fries.

6.2 Bauitara Regulator on the Old Hurasagar River in North West Region

In order to examine the impact of the regulator on hatchling flow, densities inside and outside of Bauitara regulator are compared using the Mann-Whitney U-test by month. The comparison is unpaired, as samples are too small for paired comparison to be effective. Species compositions are also given.

6.2.1 Unpaired comparison of densities by month

Unpaired comparison of densities on the 2 sides are made by the non-parametric U-test. The basic densities of survey times on survey dates are considered by month. The results are given in Table 6.6.

It is seen from Table 6.6 that the differences between average densities are significant for all months separately except August, when both mean densities are about the same. For all months together, however, the difference is not significant, although the two mean densities differ greatly. A parametric t-test on log of densities, however, shows a highly significant difference in this case for all months together with P-value= 0.001. Average densities are higher for outside than inside except for the first 2 months.

Figure 6.5 Bar diagram of mortality (PC) of some susceptible species and all species together for 2 sides of the Charghat regulator in 1993

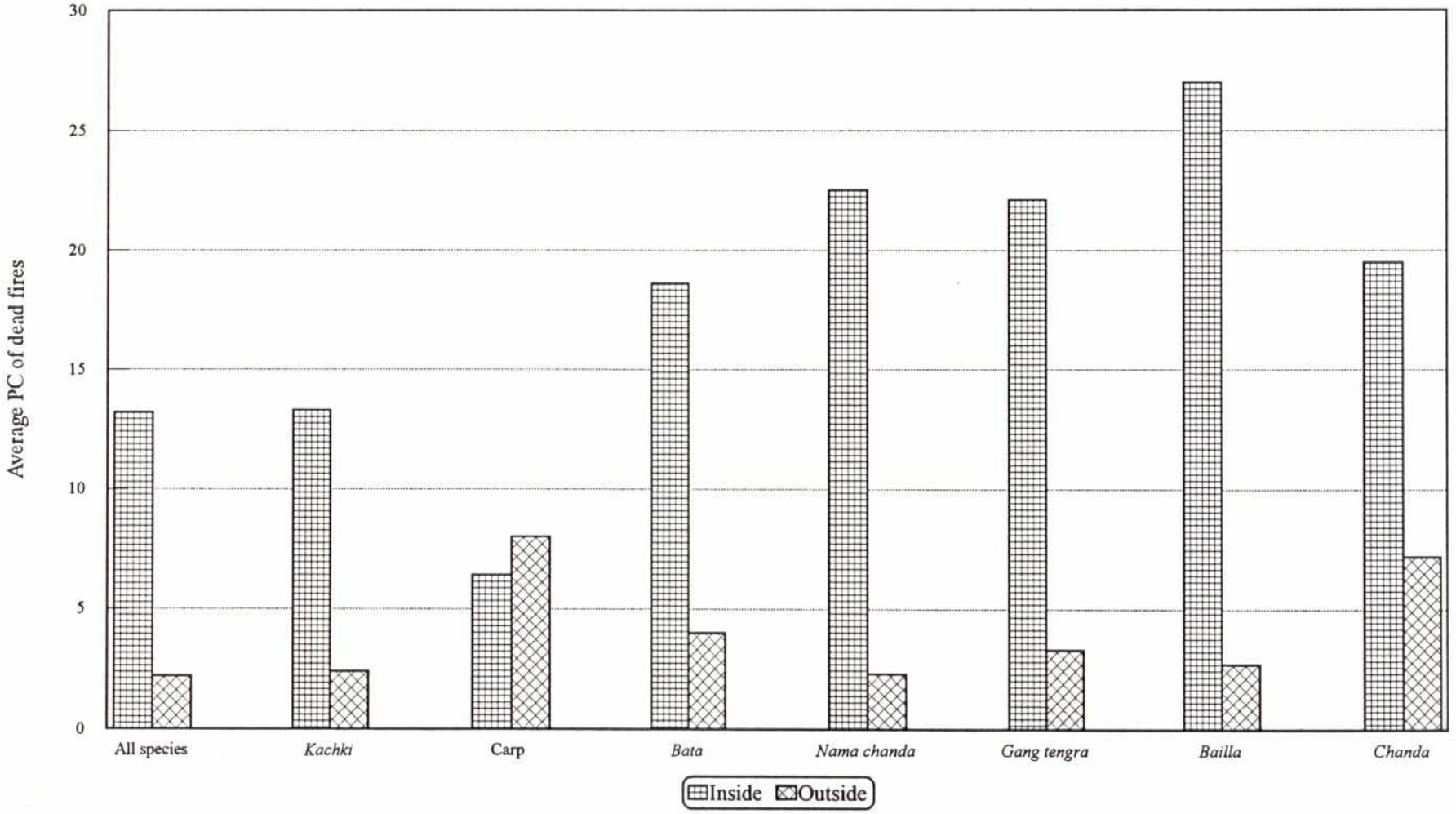


Table 6.6 Results of unpaired comparisons of densities by month

Month	Inside		Outside		Non-par U-test		
	Number of Record	Mean	Number of Record	Mean	z-value	P-value	Comment
June	33	0.369	33	0.166	-2.02	0.043	SIG
July	30	0.045	30	0.012	-2.32	0.020	SIG
Aug	49	0.008	49	0.008	-1.26	0.208	NS
Sept	50	0.585	46	3.079	-3.83	0.000	HS
Oct	38	0.200	34	1.370	-2.48	0.013	SIG
All months	200	0.254	192	1.013	-0.915	0.360	NS

6.2.2 Species composition of density

There are 49 and 40 species inside and outside respectively. Percentage (PC) compositions of density are obtained and represented by Pie charts in Figure 6.6 for dominant species having PC > 3.0.

It is observed from Figure 6.6 that *kachki* has a very high percentage (over 84%) of total density both inside and outside the regulator. Only 3 species account for more than 88% and 2 species make up more than 94% of densities inside and outside the regulator. *Kachki* is a very highly dominant species for the Bauitara regulator.

6.2.3 Species composition of density excluding *kachki*

In order to find other dominant species, species composition of density is calculated excluding this *kachki*. PC compositions of density excluding this species are represented by Pie charts in Figure 6.7 for PC > 8.0. It is observed from this figure that unidentified *bele* and *chingri/icha* are the most dominant, having 21.0% and 32.2% contributions to total density inside and outside respectively. *Chingri/icha* followed by *bailla* is the next most important species inside, and unidentified *bele* followed by *nama chanda* outside. Carp is dominant for the inside only.

Only 5 species make up 66.8% of total density inside, with 48 species in all, and 3 species account for 64.6% outside, out of a total of 39 species.

Figure 6.6 Pie charts for percentage compositions of dominant species having PC > 3.0 for the two sides of the Bauitara regulator

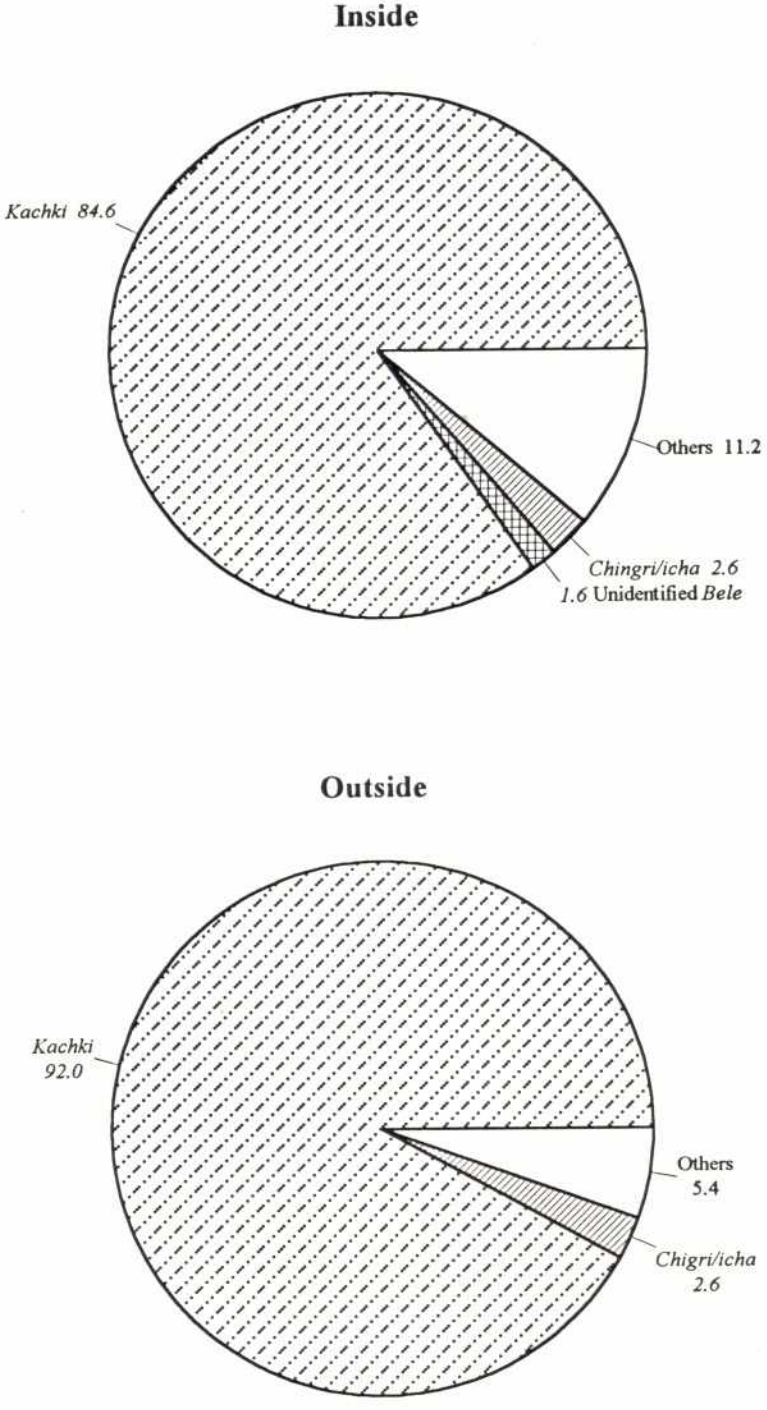
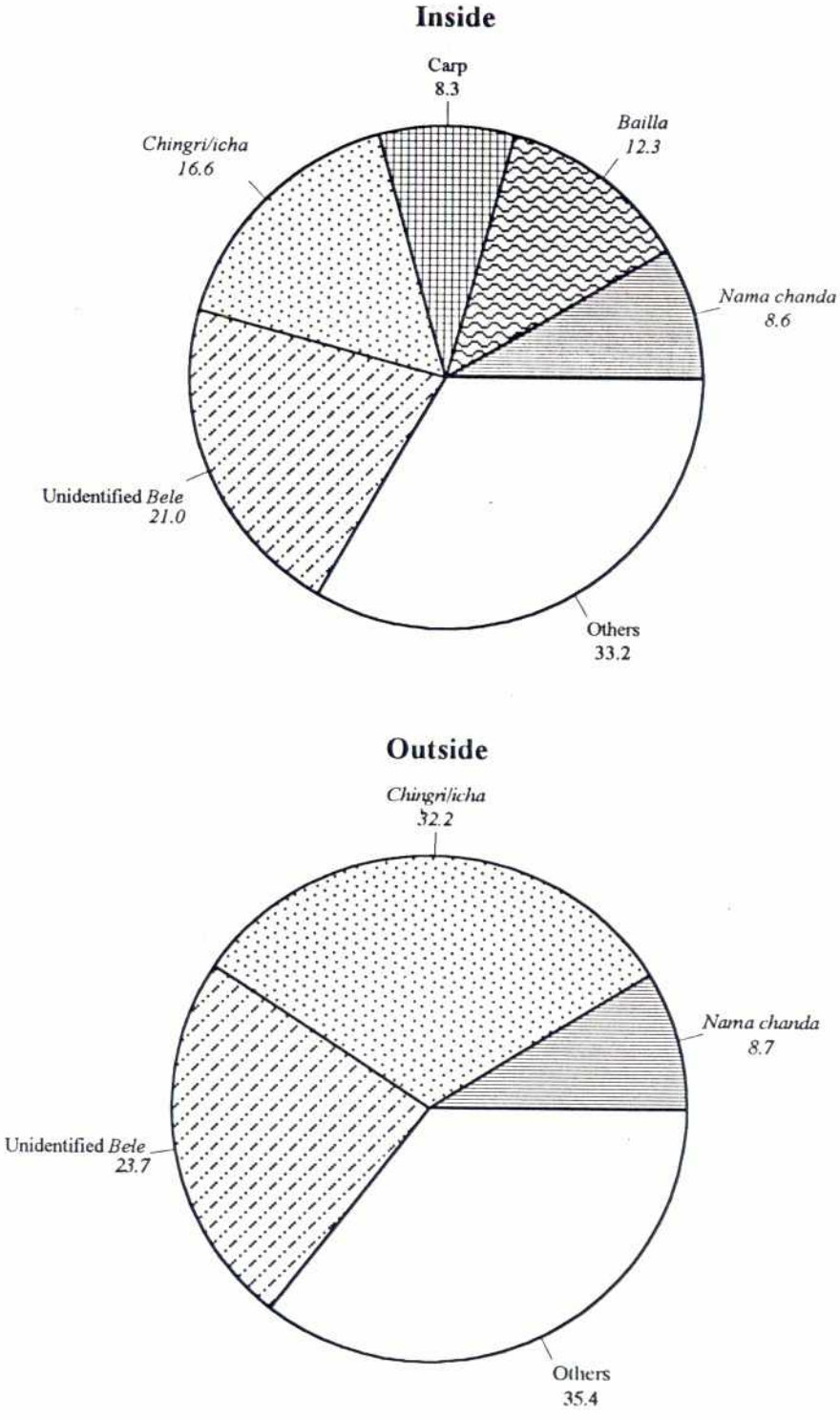


Figure 6.7 Pie charts showing percentage compositions of density of dominant species excluding *kachki*, with PC > 8.0 for the Bauitara regulator



6.3 Talimnagar Regulator on the Badai River in North West Region

Paired comparisons of densities are made by the Wilcoxon test inside and outside the regulator. Species compositions are also provided.

6.3.1 Paired comparison (by date) of average densities between 2 sides by month

There is little difference in sample sizes between paired and unpaired comparisons of densities. Paired comparison is therefore made by date between the 2 sides with the help of the non-parametric Wilcoxon sign test on density. The results are given in Table 6.7 for different months.

Table 6.7 Results of paired comparisons (by date) of densities between 2 sides

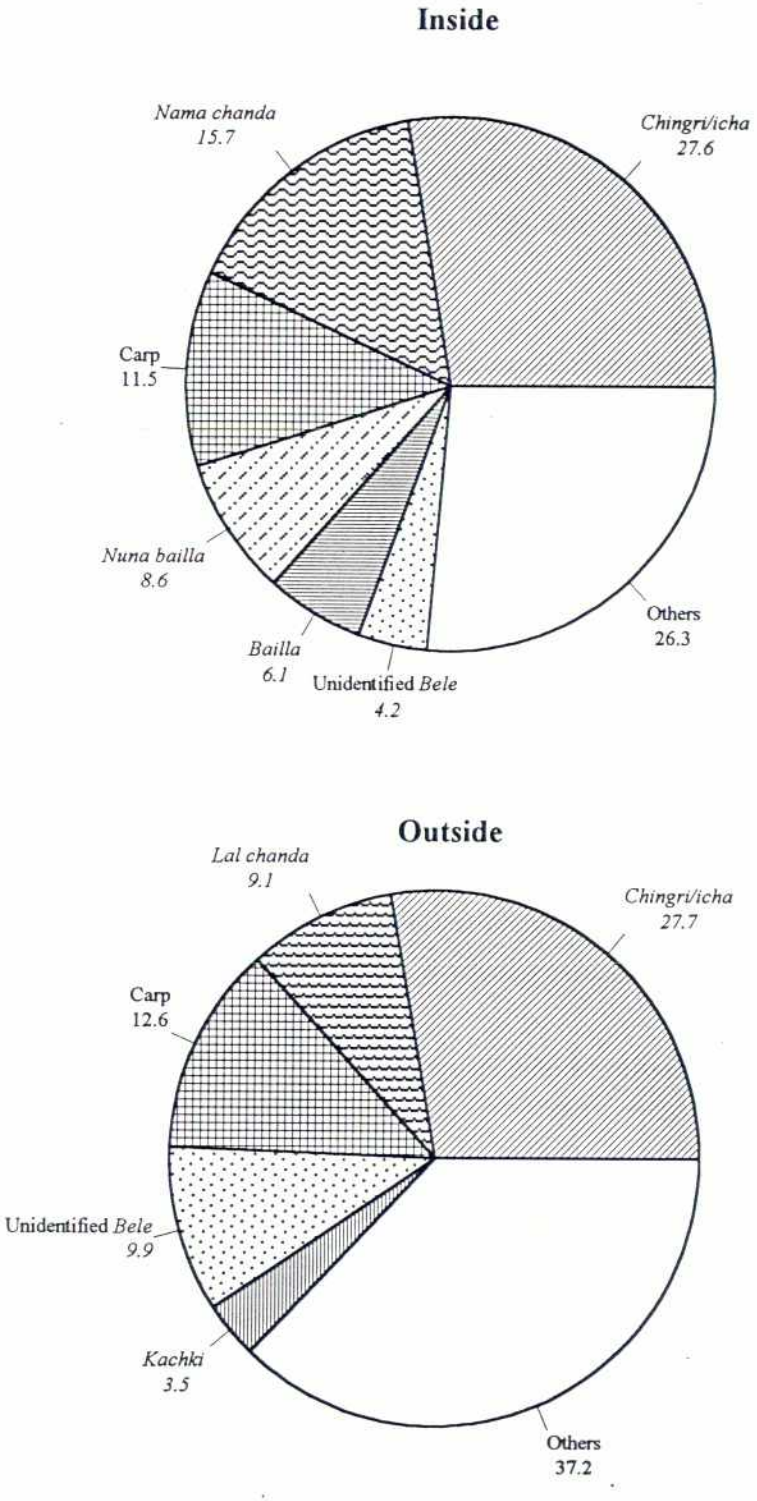
Month	Number of record (Pairs)	Mean density		Non par. Wilcoxon test on density		
		Inside	Outside	z-value	P-value	Comment
July	9	0.053	0.053	-0.70	0.484	NS
August	15	0.070	0.012	-3.07	0.002	HS
September	26	0.006	0.003	-1.73	0.083	MIS
October	22	0.006	0.011	-0.44	0.661	NS
All months	72	0.025	0.013	-2.91	0.004	HS

Table 6.7 shows that mean densities inside are usually higher than those outside although differences are small. The non-parametric test gives highly significant differences between average densities of two the sides for August and all months together. For September, the difference between the 2 average densities is significant at the 9% level.

6.3.2 Species composition of density

There are 37 and 31 species in total inside and outside respectively. Percentage (PC) compositions of density are computed for the 2 sides and represented by Pie charts in Figure 6.8 for dominant species having PC > 3.0. It is seen from Figure 6.8 that *chingri/icha* has the highest percentage compositions for both sides. Carp followed by *lal chanda* and unidentified *bele* has next highest PC of density outside, and *nama chanda* followed by carp and *nuna bailla* inside. Species composition differs widely between the 2 sides with half the species being common to both. More than 73% of total density is made up from 6 species out of 37 for the inside, and 62% is formed from by 5 species out of 31 on the outside.

Figure 6.8 Pie charts showing percentage compositions (PC) of density for dominant species having PC > 3.0 for 2 sides of the Talimnagar regulator



6.4 Khorodari Regulator in Manu Irrigation Project (MIP)

Hatchling data were collected both inside and outside of a regulator on Khorodari *Khal* in the North East Region for 3 months from March to June 1993. Sample sizes are rather small.

6.4.1 Comparison of densities between two sides of Khorodari regulator

Because of small samples, unpaired comparisons of densities are made by the non-parametric U-test by month. The results of the tests are given in Table 6.8.

Table 6.8 reveals that unpaired comparison produces insignificant differences between average densities, except for March, when mean densities are widely and significantly different. For April, the mean density inside is raised by one very high density. The sample size for June is small. Mean densities outside are usually higher.

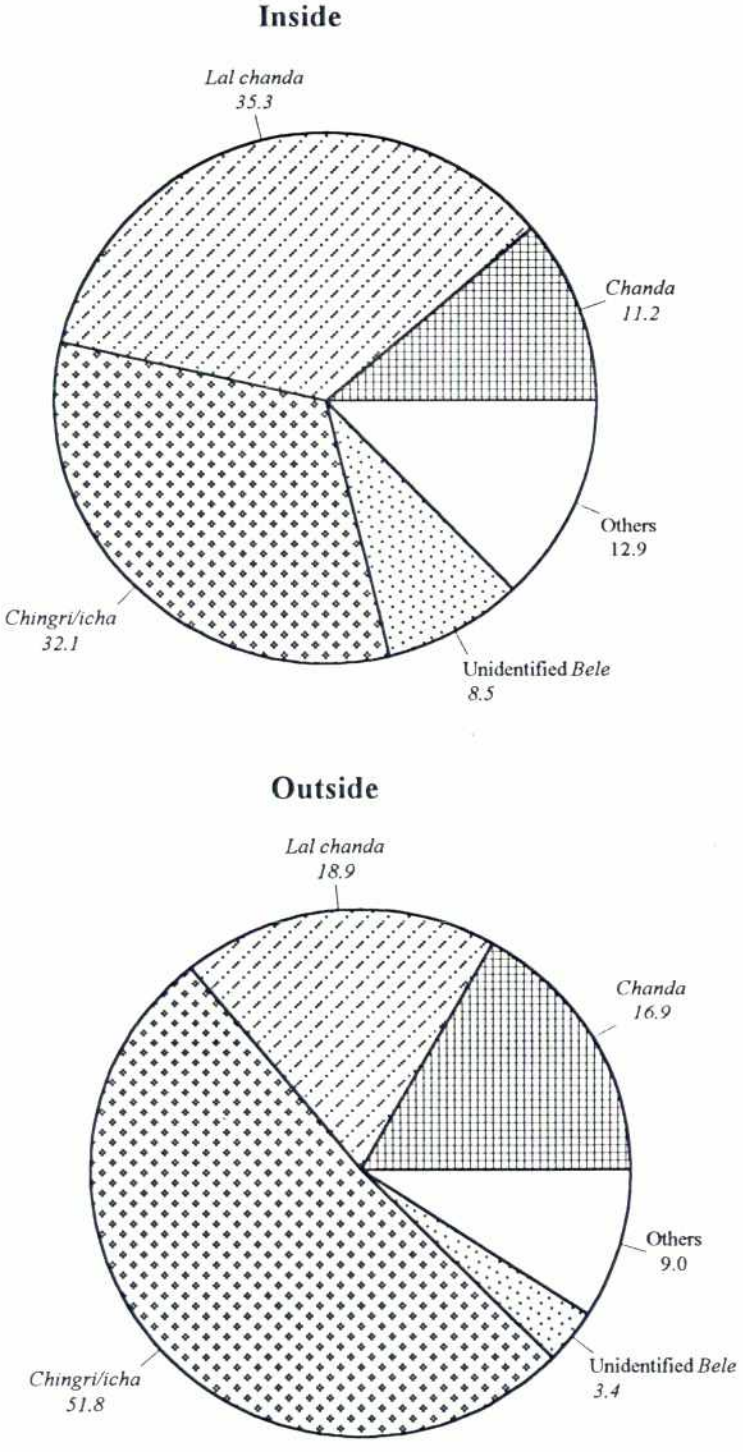
Table 6.8 Results of unpaired comparison of densities between inside and outside of the regulator on the Khorodari *Khal*

Month	Inside		Outside		U-test		
	Number of record	Mean density	Number of record	Mean density	u/z-value	P-value	Comment
March	9	0.018	6	0.059	-2.36	0.018	SIG
April	12	0.537	9	0.070	-1.14	0.255	NS
May	9	1.533	9	1.603	-1.02	0.309	NS
June	3	0.015	3	0.098	-	0.100 (Exact)	NS
All months	33	0.620	27	0.582	-0.08	0.935	NS

6.4.2 Species composition of density

There are only 9 and 16 species at the inside and outside locations respectively. Species compositions as percentages (PC) of total densities are obtained for the whole period (4 months) and these are presented as Pie charts in Figure 6.9 for PC > 3.0.

Figure 6.9 Pie charts for PC compositions of density for PC > 3.0 for two sides of the Khorodari regulator



It is evident from Figure 6.9 that dominant species are the same both inside and outside but their relative importance varies between the 2 sides. While *lal chanda* and *chingri/icha* are about equally important inside the regulator, *chingri/icha* is much more important outside. *Lal chanda* and *chanda* are the next most dominant species on both sides. Four species contribute more than 87% of the total density.

6.5 Lumardai Regulator in Shanghair *Haor* Project

Hatchling catch data were collected for both inside and outside locations of Asumura sluice gate on the Lumardai River for 2 months only, March and April, and the sample size is small for March.

6.5.1 Comparison of densities between two sides of the Lumardai regulator

Because of the small sample size, unpaired comparisons of densities are made between the two sides of the gate by the Non-parametric U-test for two months. The results are provided in Table 6.9.

Table 6.9 Results of unpaired comparison of densities between inside and outside of Asumura gate on the Lumardai River

Month	Inside		Outside		U-test		
	Number of record	Mean density	Number of record	Mean density	z-value	P-value	Comment
March	3	0.502	3	1.115	-	0.200 (Exact)	NS
April	12	0.417	9	0.251	-1.92	0.055	MIS
Both months	15	0.434	12	0.467	-1.61	0.107	NS

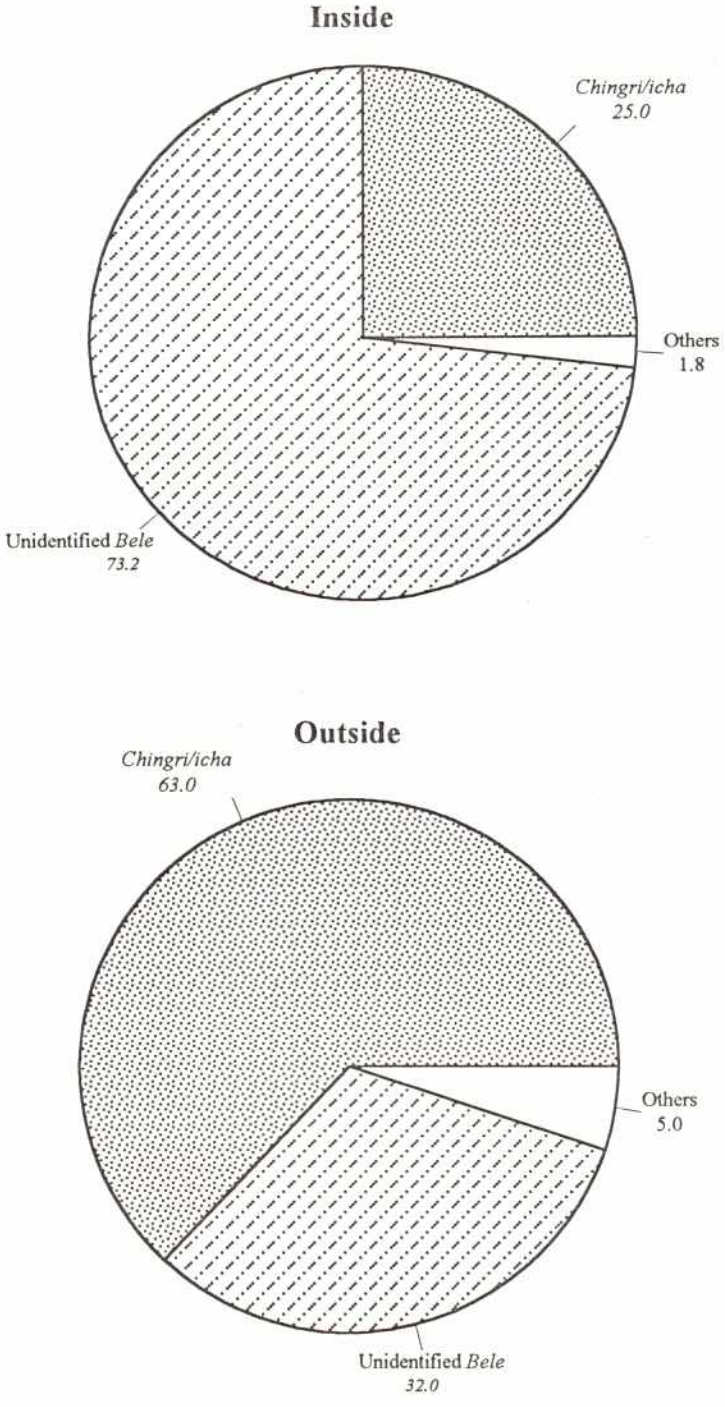
It is evident from Table 6.9 that differences in average densities inside and outside are not significant for March and both months together. For April, the difference is marginally insignificant. The sample size for March is quite small, so that a wide difference between the two means is not significant for this month. Larger samples are needed for more reliable and accurate results.

6.5.2 Species composition of density

There are 30 and 31 species in total inside and outside respectively. Species compositions as percentages of total densities are obtained for the whole period (2 months). For dominant species with PC > 3.0, PC compositions are presented in Figure 6.10 as Pie charts.

It is observed from Figure 6.10 that two species, *chingri/icha* and unidentified *bele*, are very highly dominant outside and inside respectively. These are the next most dominant in reverse order for the 2 sides. These two species, out of 30 altogether make up 95% or more of total densities for both sides. Their relative importance varies between the two sides, however.

Figure 6.10 Pie charts for PC compositions of densities for PC > 3.0 at two sides of the Lumardai regulator



APPENDIX 1

Figure 1.1 Location and net position of fry sampling site for the Charghat regulator in North West Region

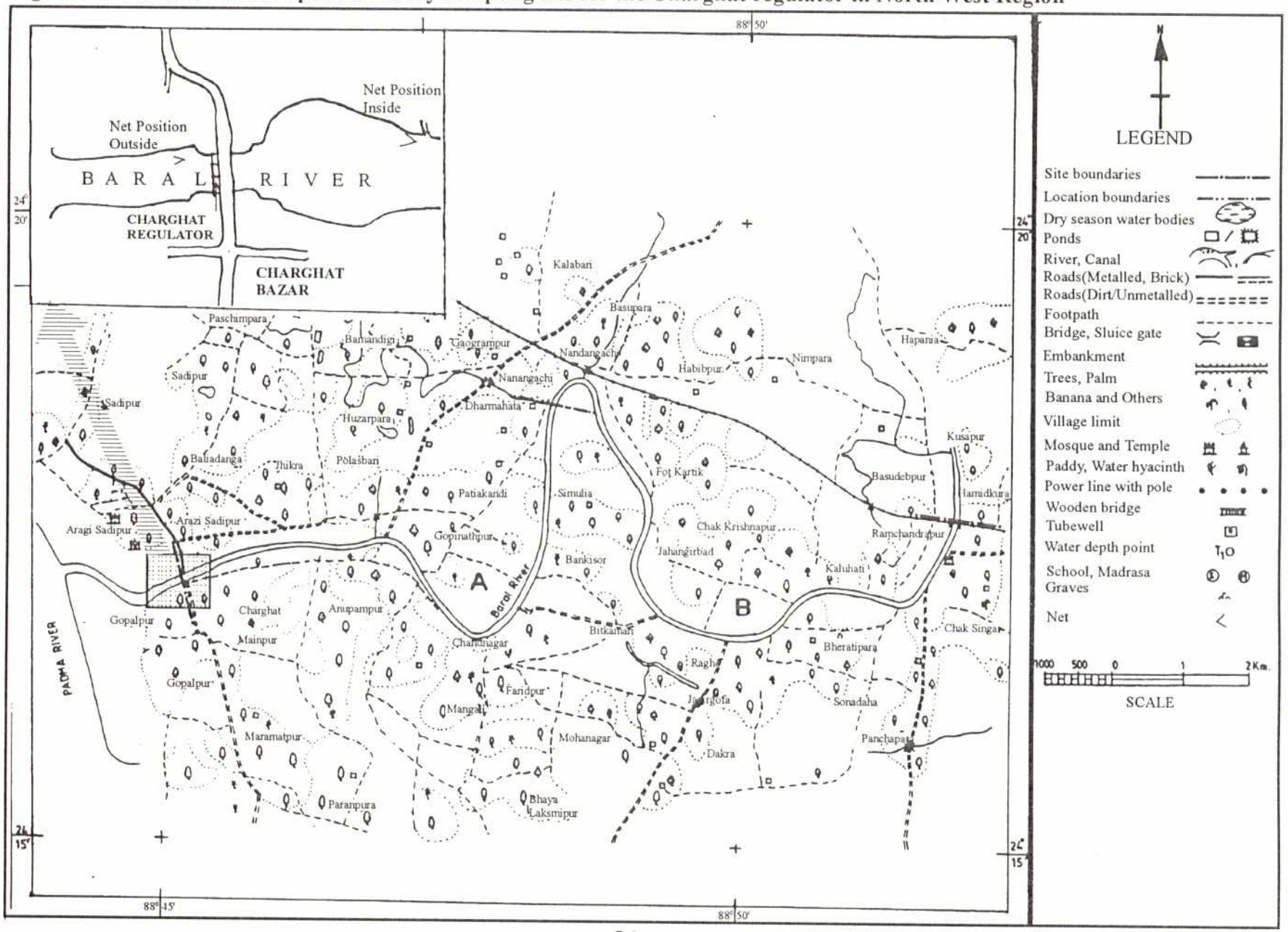


Figure 1.2 Location and net position of fry sampling site for the Bauitara regulator in North West Region

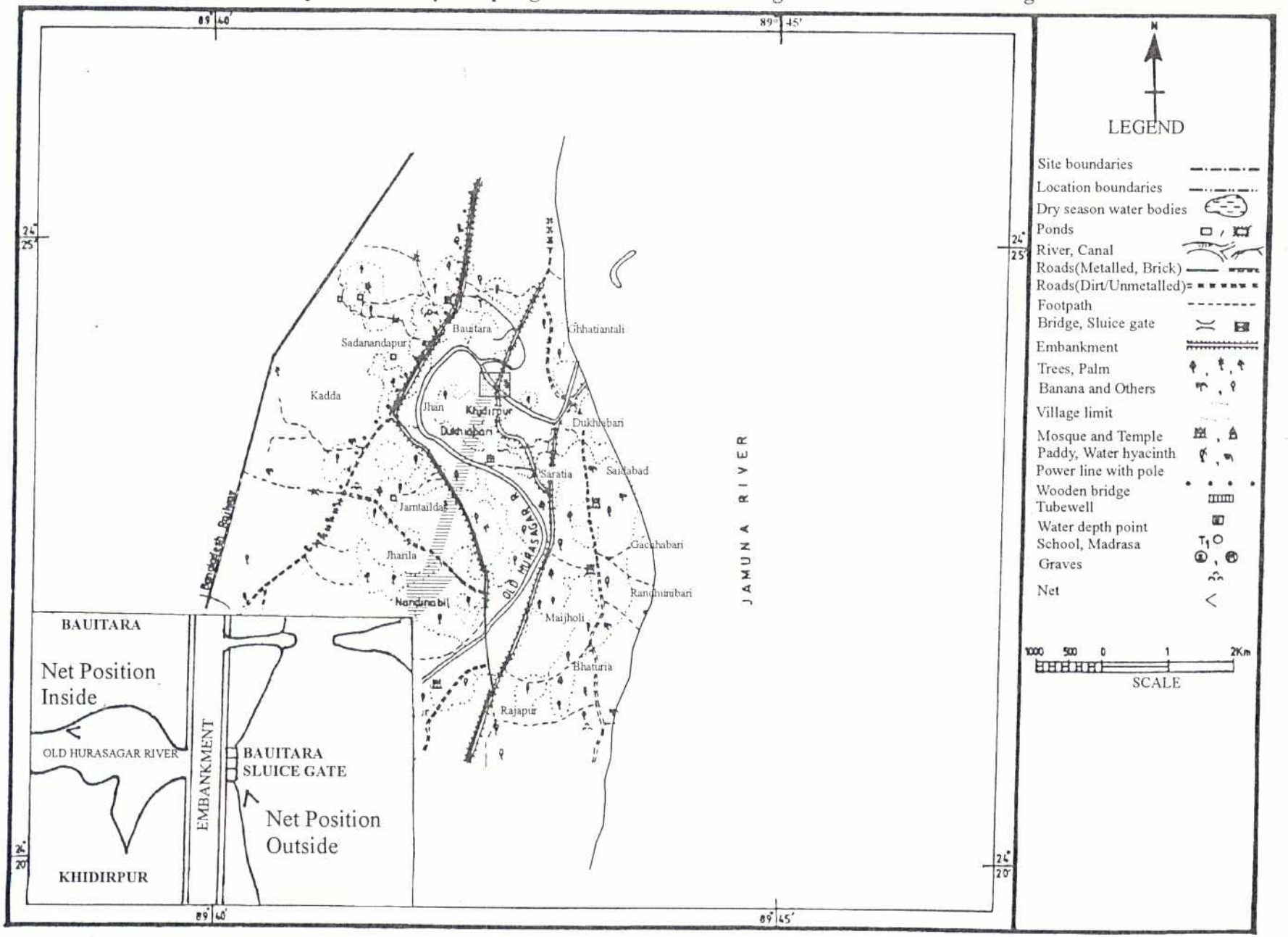


Figure 1.3 Location and net position of fry sampling site for the Talimnagar regulator in North West Region

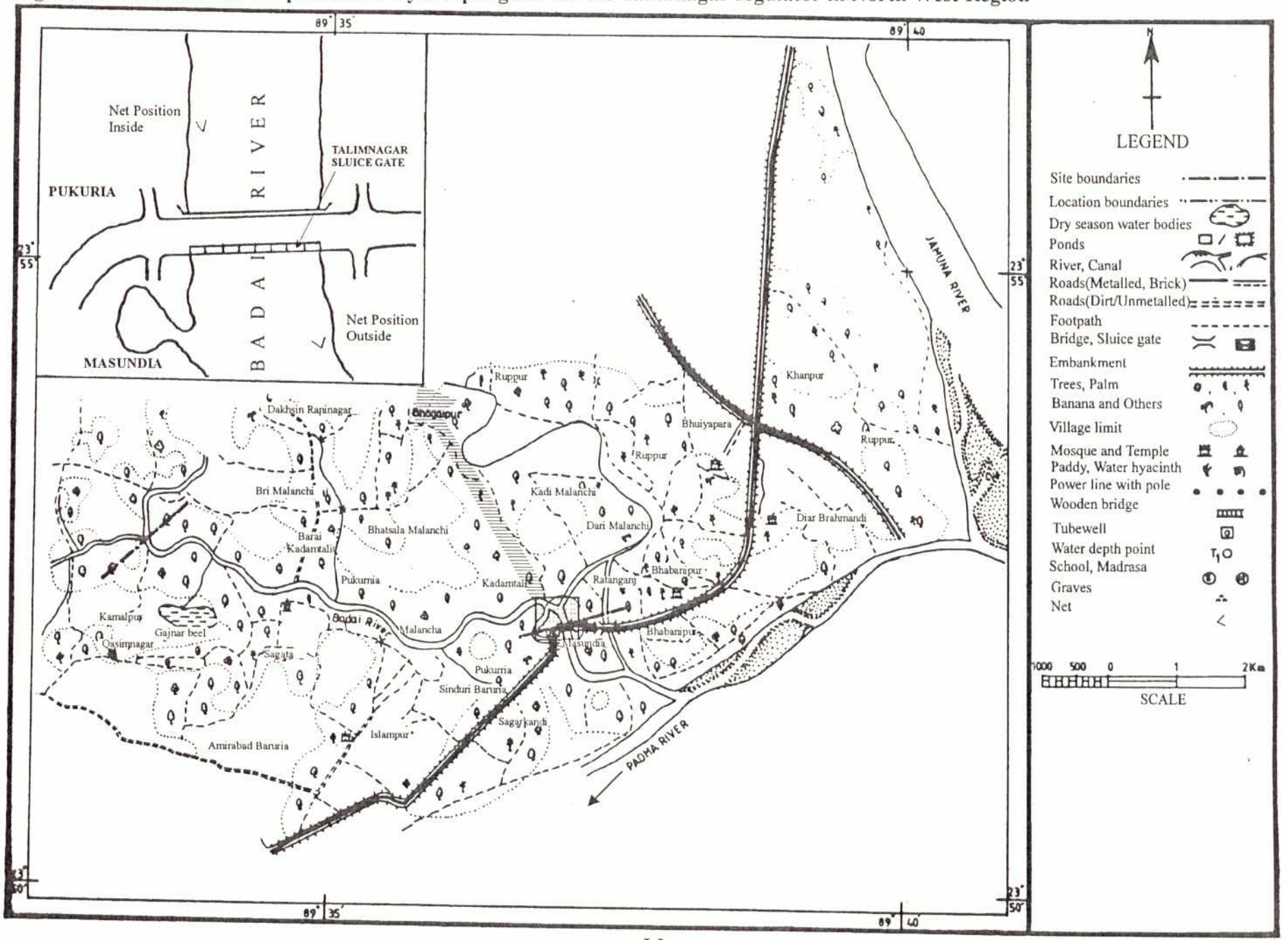


Figure 1.4 Location and net position of fry sampling site on the Dhaleswari River in North Central Region

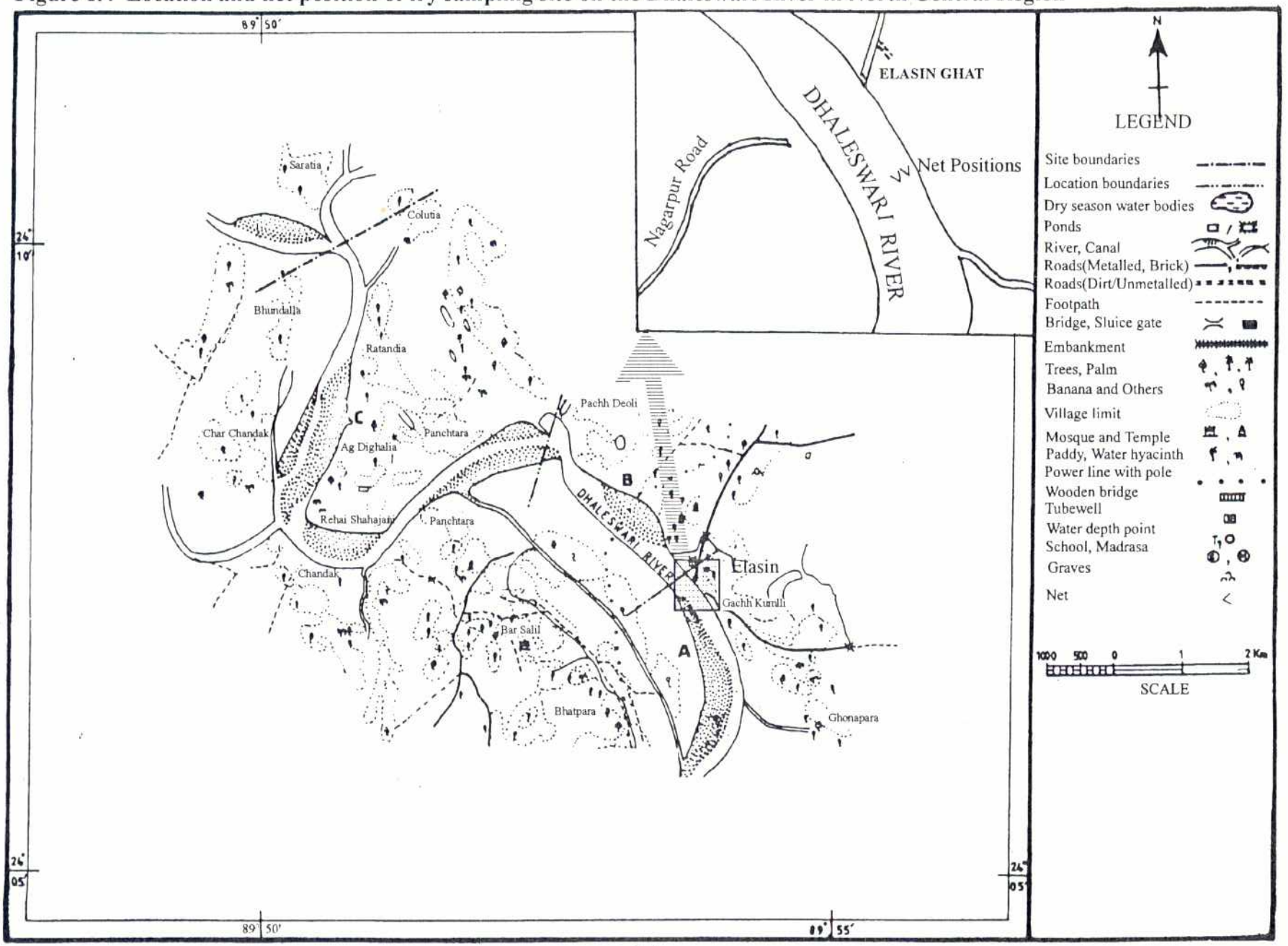


Figure 1.5 Location and net position of fry sampling site on the Lohajang River in North Central Region

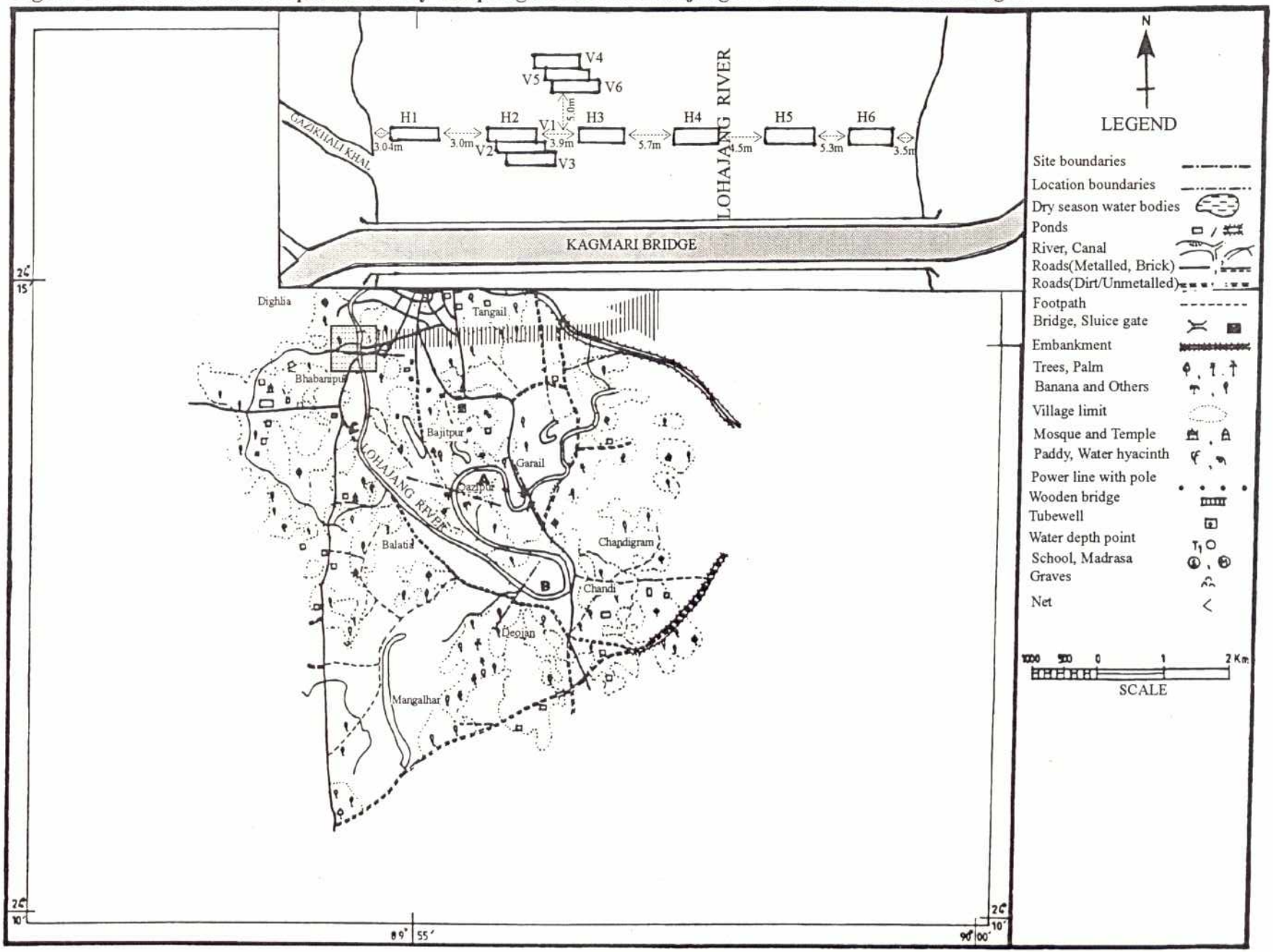


Figure 1.6 Location and net position of fry sampling site on the Surma River at Sunamganj in North East Region

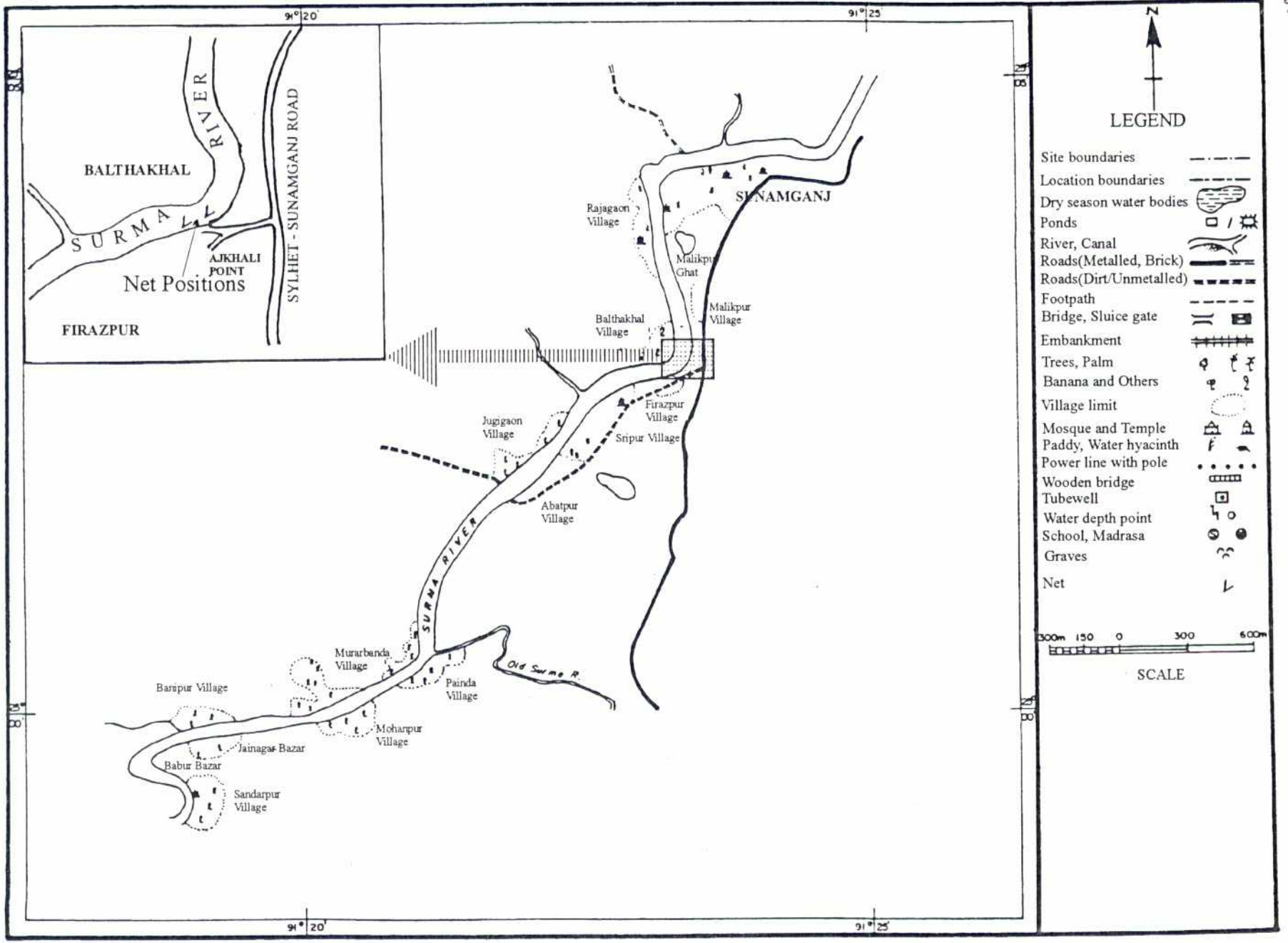


Figure 1.7 Location and net position of fry sampling site on the Surma River at Sylhet in North East Region

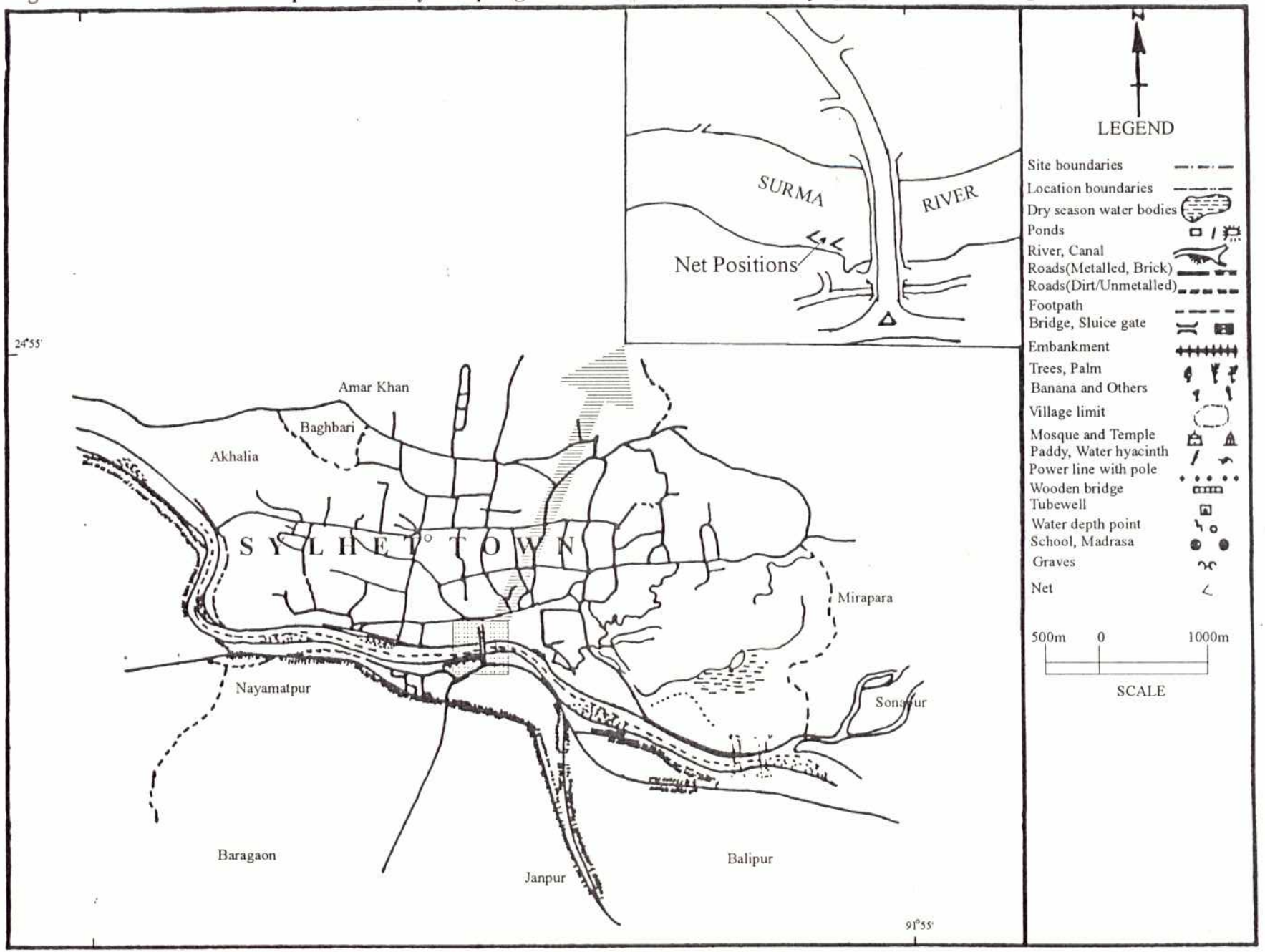


Figure 1.8 Location and net position of fry sampling site on the Kushiyara River at Sherpur in North East Region

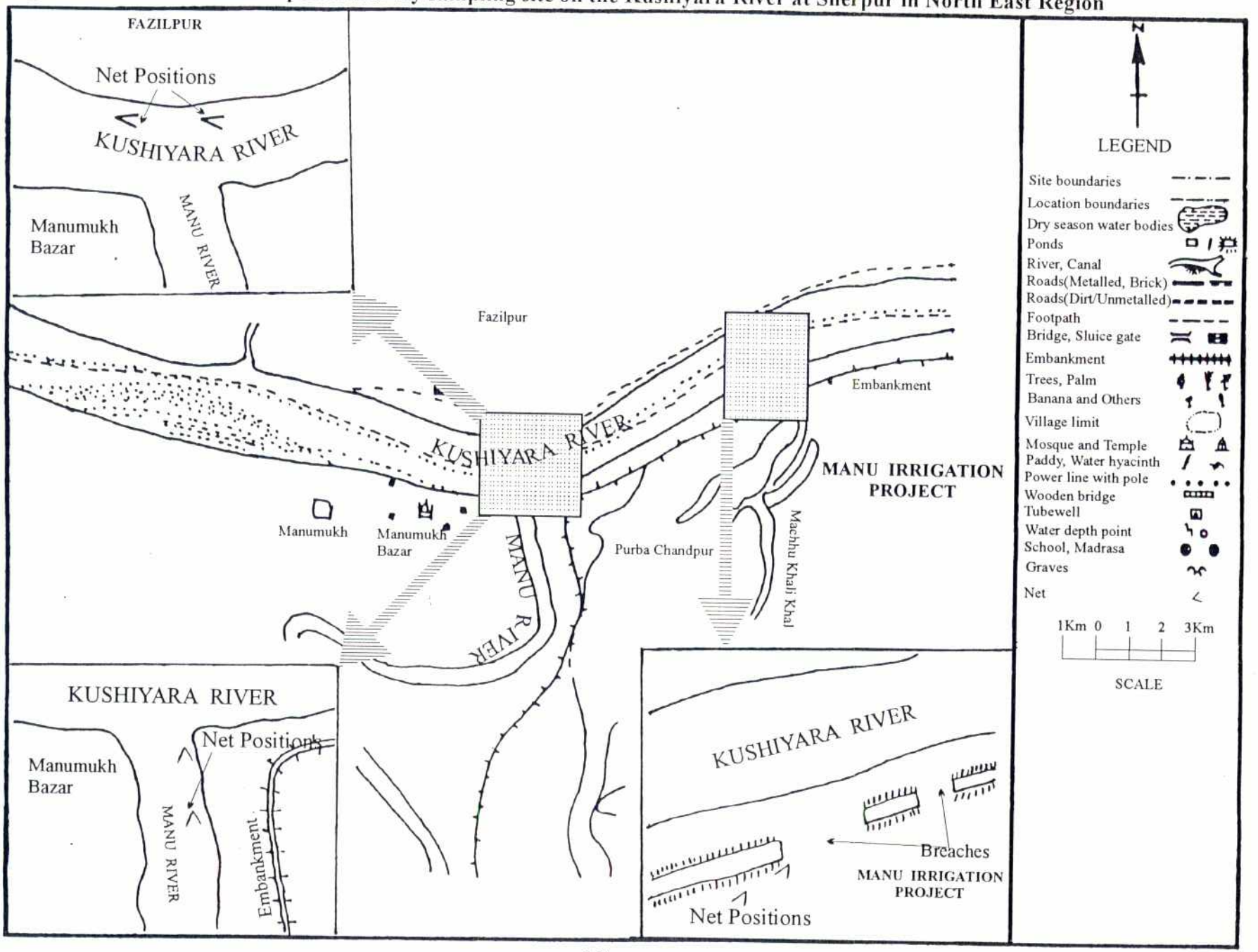


Figure 1.9 Location and net position of fry sampling site on the Kushiyara River at Fenchuganj in North East Region

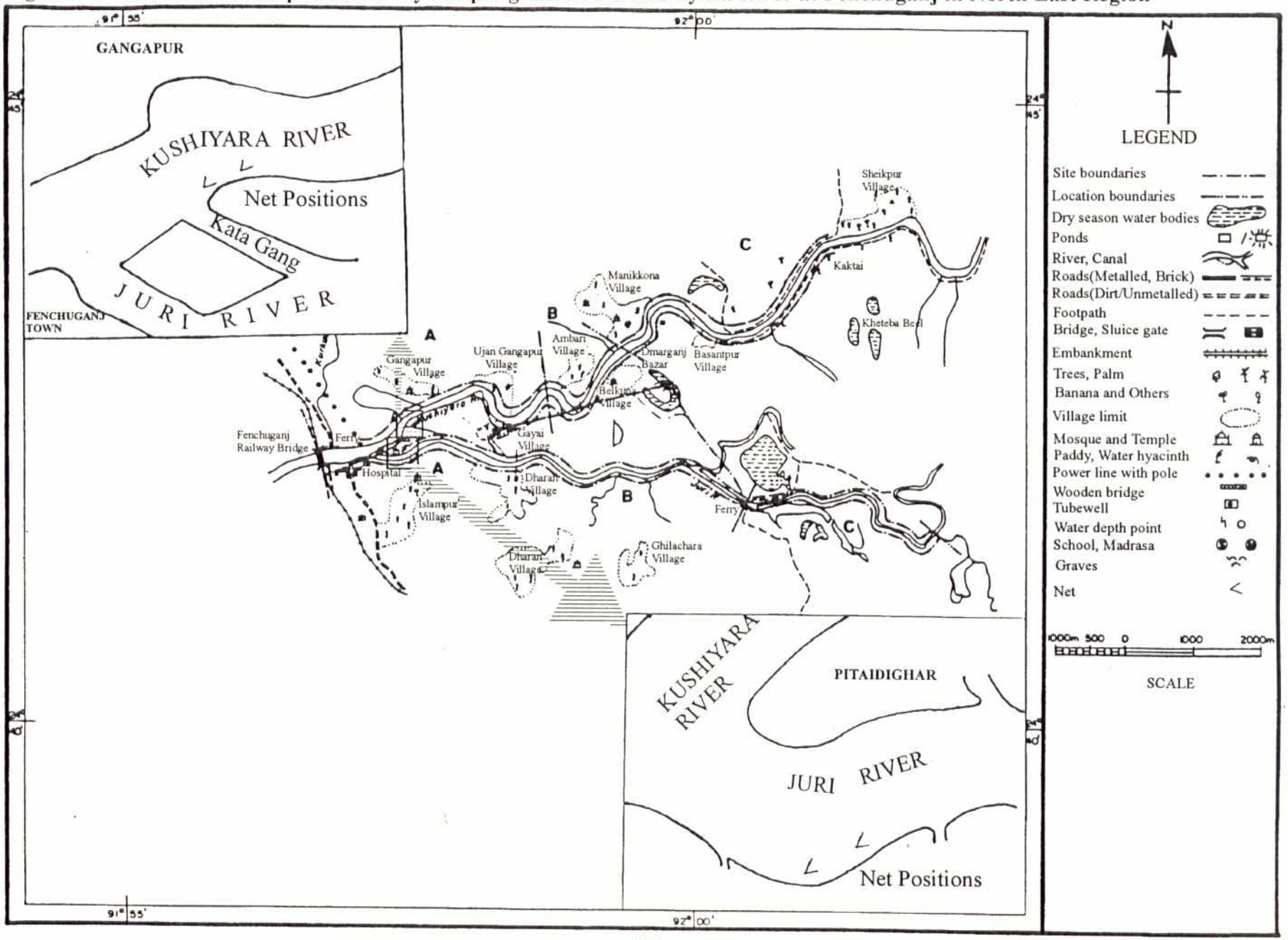


Figure 1.10 Location and net position of fry sampling site for the Khorodari regulator in North East Region

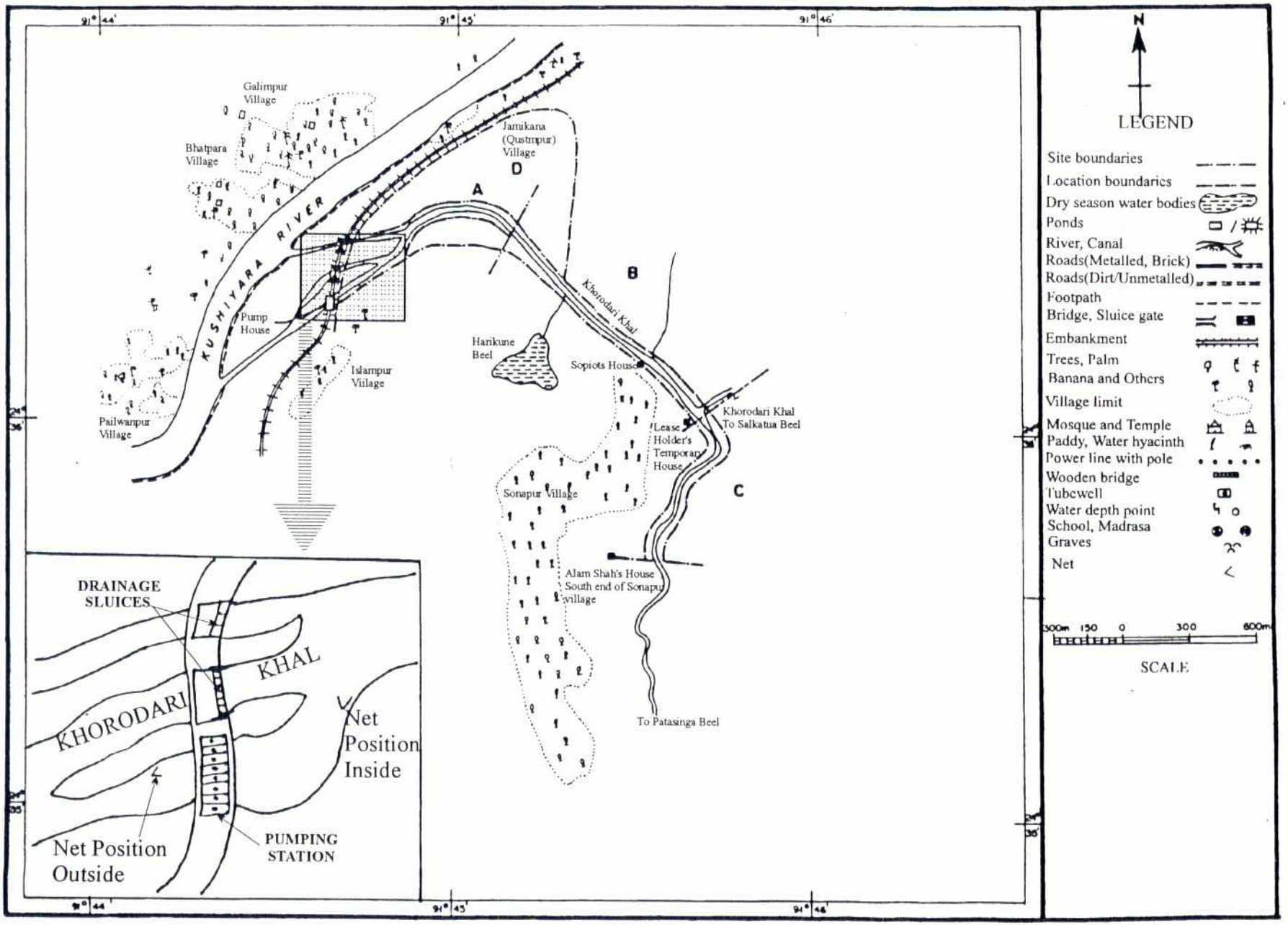
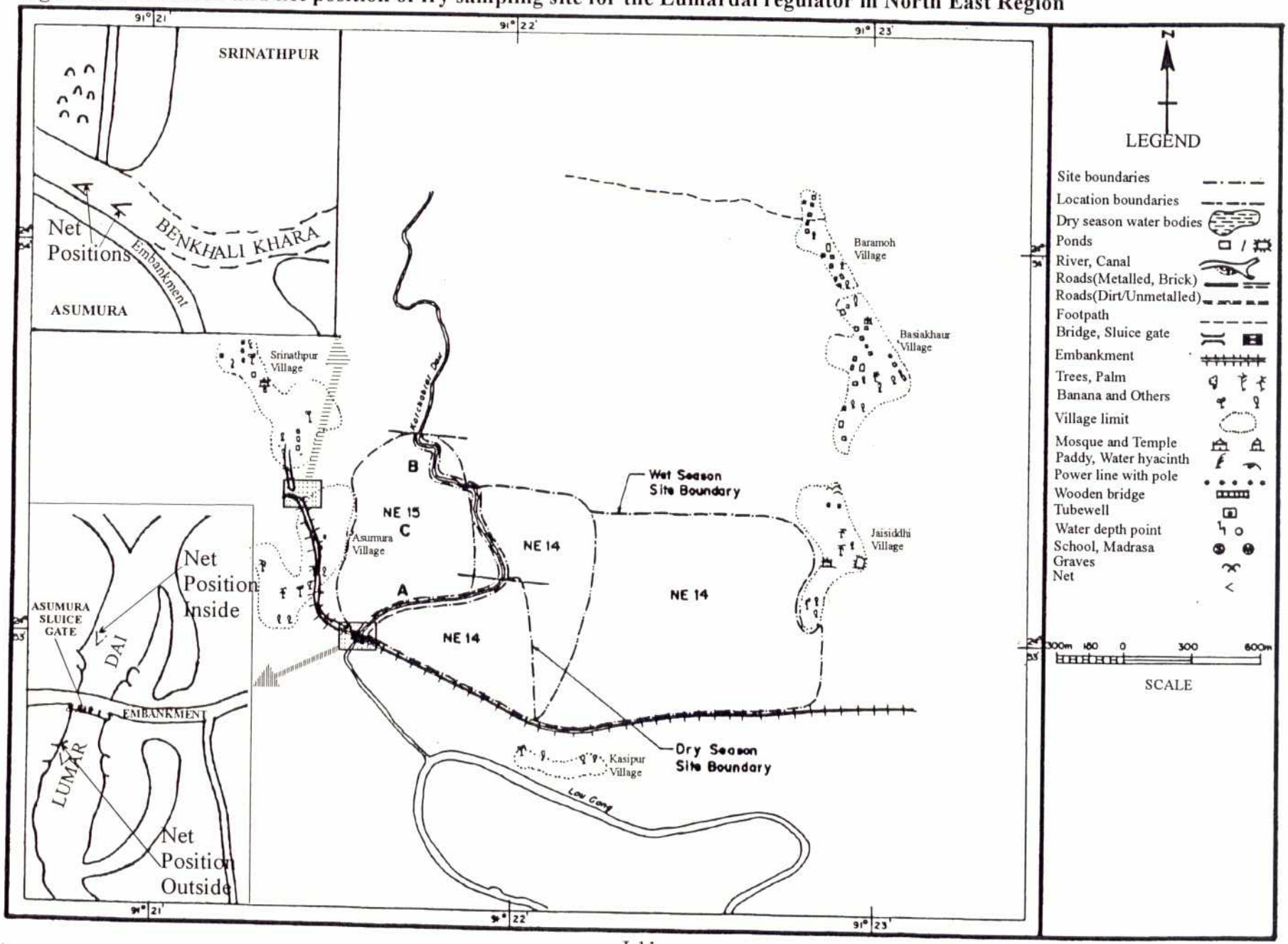


Figure 1.11 Location and net position of fry sampling site for the Lumardai regulator in North East Region



APPENDIX 2
Year: 1992

North Central Region

Region :	North Central	Habitat :	River	Site Code :	NC16
Site Name:	Main Dhaleswari	Location :	Tangail (Elasin)		

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
18-Jun-92	3	46.50	9.98		9
19-Jun-92	3	43.50	14.00		12
21-Jun-92	3	34.50	34.35		8
22-Jun-92	3	44.25	10.31		8
23-Jun-92	11	34.00	15.15		5
24-Jun-92	8	24.00	49.71		5
25-Jun-92	17	55.00	12.57		11
26-Jun-92	11	60.00	15.17		12
27-Jun-92	15	45.00	26.67		12
28-Jun-92	11	29.00	468.39		14
29-Jun-92	18	54.00	131.57		14
30-Jun-92	17	51.00	79.16		19
01-Jul-92	24	68.58	375.76		22
02-Jul-92	11	33.00	102.39		18
03-Jul-92	21	69.00	52.22		17
04-Jul-92	17	51.00	19.76		16
05-Jul-92	17	51.00	13.20		19
06-Jul-92	19	57.00	9.33		22
07-Jul-92	12	36.00	7.61		13
08-Jul-92	17	51.00	3.61		12
09-Jul-92	18	54.00	9.69		14
10-Jul-92	18	54.00	7.94		12
11-Jul-92	18	54.00	2.56		8
12-Jul-92	17	51.00	4.04		10
13-Jul-92	16	48.00	4.58		15
14-Jul-92	18	54.00	6.76		12
15-Jul-92	18	54.00	6.07		14
16-Jul-92	20	60.00	5.62		23
17-Jul-92	15	45.00	19.47		25
18-Jul-92	18	54.00	28.48		27
19-Jul-92	18	54.00	12.06		18
20-Jul-92	18	54.00	17.33		19
21-Jul-92	17	51.00	19.31		21
22-Jul-92	18	54.00	18.40		25
23-Jul-92	17	51.00	12.95		14
24-Jul-92	18	54.00	9.81		17
25-Jul-92	18	54.00	57.54		31
26-Jul-92	18	54.00	31.67		31
27-Jul-92	19	55.00	10.70		28
28-Jul-92	18	54.00	10.54		25
29-Jul-92	12	36.00	19.56		25
02-Aug-92	1	1.00	153.00		4
12-Aug-92	1	1.00	1057.00		5
26-Aug-92	2	2.00	333.50		8
01-Sep-92	1	1.00	431.00		3
13-Sep-92	2	2.00	728.00		11
22-Sep-92	1	1.00	4.00		1
29-Sep-92	1	1.00	24956.00		9
06-Oct-92	1	1.00	768.00		4
07-Oct-92	1	1.00	1984.00		4
11-Oct-92	1	1.00	69.00		5
20-Oct-92	3	6.00	1196.17		13
22-Oct-92	2	4.00	762.25		9
25-Oct-92	2	4.00	295.25		9
29-Oct-92	2	4.00	5288.50		9
04-Nov-92	2	4.00	10181.25		13
05-Nov-92	2	4.00	17426.00		14

Note: Mean density could not be calculated becuase of absence of water velocity data

(Contd.)

Region :	North Central	Habitat :	River	Site Code :	NC16
Site Name:	Main Dhaleswari	Location :	Tangail (Elasin)		

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
09-Nov-92	2	4.00	9100.00		5
11-Nov-92	2	4.00	4781.25		5
16-Nov-92	2	4.00	1100.00		2
19-Nov-92	2	4.00	45.25		1
22-Nov-92	2	4.00	31.00		2
23-Nov-92	3	6.00	8.67		2
30-Nov-92	2	4.00	2.25		2
02-Dec-92	1	2.00	0.50		1
05-Dec-92	2	4.00	10.75		2
12-Dec-92	2	4.00	11.50		2
13-Dec-92	2	4.00	17.75		2
20-Dec-92	2	4.00	1.50		2
28-Dec-92	1	2.00	1.00		2
30-Dec-92	2	4.00	1.50		2
03-Jan-93	2	4.00	5.00		2
05-Jan-93	2	4.00	17.00		3
11-Jan-93	2	4.00	1.25		1
13-Jan-93	2	4.00	6.50		2
18-Jan-93	2	4.00	2.75		3
19-Jan-93	2	4.00	5.75		4
25-Jan-93	1	2.00	4.00		4
27-Jan-93	2	4.00	0.50		2

North West Region

Region :	North West	Habitat :	River	Site Code :	NW25
Site Name:	Baral River	Location :	Charghat	In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
25–Aug–92	1	24.00	3.33	0.001	19
26–Aug–92	4	24.00	22.58	0.01	30
27–Aug–92	2	24.00	34.79	0.01	26
28–Aug–92	4	24.00	64.33	0.02	39
29–Aug–92	4	24.00	83.17	0.02	40
30–Aug–92	4	24.00	83.63	0.02	37
31–Aug–92	4	24.00	37.08	0.01	33
01–Sep–92	4	24.00	30.54	0.01	41
02–Sep–92	4	24.00	10.13	0.004	33
03–Sep–92	4	24.00	33.67	0.01	38
04–Sep–92	3	24.00	38.67	0.02	33
05–Sep–92	4	24.00	29.58	0.02	36
06–Sep–92	4	24.00	12.33	0.01	23
07–Sep–92	3	24.00	40.21	0.01	30
08–Sep–92	4	24.00	38.83	0.01	29
09–Sep–92	4	24.00	109.63	0.03	47
10–Sep–92	4	24.00	54.13	0.02	26
11–Sep–92	4	24.00	63.17	0.02	46
12–Sep–92	4	24.00	178.42	0.06	38
13–Sep–92	4	24.00	60.46	0.02	27
14–Sep–92	4	24.00	28.33	0.01	32
15–Sep–92	4	24.00	11.08	0.004	28
16–Sep–92	4	24.00	25.54	0.005	26
17–Sep–92	4	24.00	40.54	0.01	34
18–Sep–92	4	24.00	29.75	0.01	34
19–Sep–92	4	24.00	11.58	0.003	31
20–Sep–92	4	24.00	17.96	0.005	32
21–Sep–92	4	24.00	18.54	0.01	36
22–Sep–92	4	24.00	22.33	0.01	34
23–Sep–92	4	24.00	26.04	0.01	34
24–Sep–92	5	24.00	264.38	0.06	49
25–Sep–92	1	24.00	189.83	0.04	45
26–Sep–92	1	24.00	123.29	0.03	49
27–Sep–92	3	24.00	285.38	0.08	55
28–Sep–92	1	24.00	1320.08	0.30	61
29–Sep–92	1	24.00	223.63	0.06	39
30–Sep–92	1	24.00	293.46	0.08	50
01–Oct–92	1	24.00	282.63	0.09	54
02–Oct–92	1	24.00	107.96	0.03	45
03–Oct–92	1	24.00	45.88	0.01	46
04–Oct–92	1	24.00	105.25	0.03	46
05–Oct–92	1	24.00	103.21	0.04	39
06–Oct–92	1	24.00	83.46	0.03	45
07–Oct–92	1	24.00	53.83	0.01	41
08–Oct–92	1	24.00	146.04	0.04	41
09–Oct–92	1	24.00	112.58	0.03	43
10–Oct–92	1	24.00	87.79	0.02	46
11–Oct–92	1	24.00	50.50	0.01	38
12–Oct–92	1	24.00	41.25	0.01	39

(Contd.)

Region :	North West	Habitat :	River	Site Code :	NW25
Site Name:	Baral River	Location :	Charghat	In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
13–Oct–92	1	24.00	45.00	0.01	30
14–Oct–92	4	24.00	15.17	0.004	29
15–Oct–92	1	24.00	21.83	0.01	35
16–Oct–92	1	24.00	38.96	0.01	42
17–Oct–92	1	24.00	21.50	0.01	32
18–Oct–92	1	24.00	35.63	0.01	33
19–Oct–92	1	24.00	21.63	0.01	34
20–Oct–92	1	24.00	26.88	0.01	19
21–Oct–92	1	24.00	22.21	0.01	24
22–Oct–92	1	24.00	38.88	0.01	30
23–Oct–92	1	24.00	91.79	0.02	28
24–Oct–92	1	24.00	109.63	0.03	25
25–Oct–92	1	24.00	76.63	0.02	33
26–Oct–92	1	24.00	98.79	0.03	34
27–Oct–92	1	24.00	100.08	0.03	29
28–Oct–92	1	24.00	81.92	0.02	30
29–Oct–92	1	24.00	99.63	0.03	29
30–Oct–92	1	24.00	52.08	0.02	32
31–Oct–92	1	24.00	41.17	0.02	39
01–Nov–92	1	24.00	29.42	0.01	37
02–Nov–92	1	24.00	23.83	0.01	30
03–Nov–92	1	24.00	24.08	0.01	29
04–Nov–92	1	24.00	61.88	0.03	33
05–Nov–92	1	24.00	58.08	0.04	21
06–Nov–92	1	24.00	34.21	0.02	18
07–Nov–92	1	24.00	35.92	0.02	23
08–Nov–92	1	24.00	44.21	0.03	28
09–Nov–92	1	24.00	57.00	0.04	28
10–Nov–92	1	24.00	18.92	0.01	26
11–Nov–92	1	24.00	21.04	–	27

Region :	North West	Habitat :	River	Site Code :	NW25
Site Name:	Baral River	Location :	Charghat	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
25-Aug-92	2	24.00	3.38	0.001	19
26-Aug-92	4	24.00	77.54	0.03	39
27-Aug-92	3	24.00	49.54	0.02	37
28-Aug-92	4	24.00	72.38	0.03	36
29-Aug-92	3	24.00	26.29	0.01	36
30-Aug-92	2	24.00	50.04	0.02	38
31-Aug-92	4	24.00	89.79	0.04	49
01-Sep-92	4	24.00	57.00	0.03	44
02-Sep-92	4	24.00	38.38	0.01	37
03-Sep-92	4	24.00	112.13	0.03	43
04-Sep-92	4	24.00	150.04	0.05	46
05-Sep-92	4	24.00	106.67	0.03	46
06-Sep-92	4	24.00	51.08	0.01	38
07-Sep-92	4	24.00	58.29	0.01	43
08-Sep-92	4	24.00	189.50	0.04	54
09-Sep-92	4	24.00	217.58	0.04	52
10-Sep-92	4	24.00	168.67	0.03	51
11-Sep-92	4	24.00	112.58	0.02	44
12-Sep-92	4	24.00	140.33	0.03	50
13-Sep-92	4	24.00	86.29	0.02	45
14-Sep-92	4	24.00	85.92	0.02	38
15-Sep-92	4	24.00	57.92	0.02	48
16-Sep-92	4	24.00	86.63	0.03	45
17-Sep-92	4	24.00	90.67	0.03	50
18-Sep-92	4	24.00	48.13	0.01	52
19-Sep-92	4	24.00	38.33	0.01	48
20-Sep-92	4	24.00	46.46	0.01	52
21-Sep-92	3	24.00	59.79	0.01	51
22-Sep-92	4	24.00	67.21	0.02	51
23-Sep-92	4	24.00	68.13	0.02	49
24-Sep-92	3	24.00	51.08	0.01	39
25-Sep-92	2	24.00	156.08	0.03	55
26-Sep-92	1	24.00	252.75	0.04	59
27-Sep-92	2	24.00	175.71	0.04	56
29-Sep-92	1	24.00	425.83	0.09	55
30-Sep-92	4	24.00	162.88	0.04	58
01-Oct-92	1	24.00	183.38	0.05	53
02-Oct-92	1	24.00	260.21	0.07	50
03-Oct-92	1	24.00	77.58	0.02	54
04-Oct-92	1	24.00	146.25	0.04	52
05-Oct-92	1	24.00	277.83	0.08	41
06-Oct-92	1	24.00	344.08	0.10	43
07-Oct-92	1	24.00	55.00	0.01	42
08-Oct-92	1	24.00	197.33	0.04	44
09-Oct-92	1	24.00	147.08	0.03	40
10-Oct-92	1	24.00	76.83	0.02	32
11-Oct-92	1	24.00	55.04	0.01	41
12-Oct-92	1	24.00	126.75	0.02	43
13-Oct-92	1	24.00	98.79	0.02	32
14-Oct-92	1	24.00	199.96	0.05	39

(Cont.)

Region :	North West	Habitat :	River	Site Code :	NW25
Site Name:	Baral River	Location :	Charghat	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
15–Oct–92	1	24.00	151.21	0.03	40
16–Oct–92	1	24.00	122.88	0.04	34
17–Oct–92	1	24.00	169.83	0.05	27
18–Oct–92	1	24.00	169.04	0.06	29
19–Oct–92	1	24.00	203.63	0.07	35
20–Oct–92	1	24.00	80.75	0.02	25
21–Oct–92	1	24.00	96.96	0.02	37
22–Oct–92	1	24.00	59.29	0.01	29
23–Oct–92	1	24.00	145.25	0.04	36
24–Oct–92	1	24.00	188.79	0.05	39
25–Oct–92	1	24.00	429.25	0.10	44
26–Oct–92	1	24.00	349.38	0.08	30
27–Oct–92	1	24.00	89.96	0.02	34
28–Oct–92	1	24.00	86.46	0.02	21
29–Oct–92	1	24.00	93.71	0.03	29
30–Oct–92	1	24.00	138.29	0.04	30
31–Oct–92	1	24.00	68.50	0.02	25
01–Nov–92	1	24.00	37.75	0.01	35
02–Nov–92	1	24.00	41.21	0.02	29
03–Nov–92	1	24.00	70.50	0.03	25
04–Nov–92	1	24.00	24.79	0.01	28
05–Nov–92	1	24.00	36.54	0.02	33
06–Nov–92	1	24.00	12.42	0.01	23
07–Nov–92	1	24.00	35.50	0.02	22
08–Nov–92	1	24.00	41.50	0.03	27
09–Nov–92	1	24.00	20.83	0.01	26
10–Nov–92	1	24.00	16.75	0.01	26
11–Nov–92	1	24.00	9.13	–	24

APPENDIX 3
Year: 1993

North Central Region

Region :	North Central	Habitat :	River	Site Code :	NC16
Site Name:	Main Dhaleswari	Location :	Tangail (Elasin)		

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
17–May–93	2	8.0	22.1	–	5
18–May–93	2	8.0	20.9	–	12
19–May–93	2	13.0	57.4	–	14
22–May–93	2	8.0	39.4	–	15
23–May–93	2	12.0	22.1	–	14
24–May–93	2	12.0	9.8	–	10
25–May–93	2	12.0	4.2	–	8
26–May–93	2	14.0	8.7	–	12
29–May–93	2	12.0	15.7	–	12
30–May–93	2	12.0	23.0	–	16
31–May–93	1	6.0	18.0	0.02	9
01–Jun–93	1	6.0	44.0	0.06	18
05–Jun–93	2	14.0	83.0	0.02	24
06–Jun–93	2	18.0	286.7	0.05	20
07–Jun–93	2	8.0	17.0	–	13
08–Jun–93	2	16.0	21.8	–	14
09–Jun–93	2	16.0	8.3	–	7
10–Jun–93	2	16.0	47.6	–	14
12–Jun–93	2	12.0	74.2	–	13
13–Jun–93	2	32.0	30.8	–	27
14–Jun–93	2	12.0	21.3	–	19
15–Jun–93	2	20.0	27.0	0.06	14
16–Jun–93	2	32.0	47.2	0.10	23
17–Jun–93	2	12.0	80.0	0.16	15
19–Jun–93	2	12.0	903.5	2.48	14
20–Jun–93	2	20.0	199.4	0.83	16
21–Jun–93	2	24.0	105.4	0.17	22
22–Jun–93	2	36.0	64.7	0.08	21
23–Jun–93	2	12.0	82.2	0.12	25
26–Jun–93	2	20.0	166.8	0.21	17
27–Jun–93	2	4.0	98.8	–	10
28–Jun–93	2	24.0	668.0	0.87	15
30–Jun–93	2	12.0	27.6	0.05	19
01–Jul–93	2	12.0	30.8	0.05	26
05–Jul–93	2	16.0	63.0	0.06	12
07–Jul–93	2	16.0	22.4	–	24
10–Jul–93	2	14.0	1.9	0.002	8
13–Jul–93	2	16.0	14.8	0.04	12
17–Jul–93	2	16.0	5.9	–	10
20–Jul–93	2	18.0	34.2	0.08	18
24–Jul–93	2	16.0	87.2	0.13	25
27–Jul–93	2	16.0	73.0	0.12	15
31–Jul–93	2	16.0	2.4	0.01	7
03–Aug–93	2	16.0	6.9	0.04	5
07–Aug–93	2	16.0	43.7	0.08	8
10–Aug–93	2	16.0	101.9	0.27	16
17–Aug–93	2	16.0	56.3	0.05	20
21–Aug–93	2	16.0	88.9	0.10	16
24–Aug–93	2	16.0	33.5	0.04	19
31–Aug–93	2	16.0	5.5	0.01	12
03–Sep–93	2	16.0	22.6	0.03	15
10–Sep–93	2	16.0	28.9	0.03	22
17–Sep–93	2	20.0	8.5	0.01	13
20–Sep–93	2	16.0	47.9	0.03	25
29–Sep–93	2	16.0	29.2	0.01	16
03–Oct–93	2	12.0	308.8	0.18	11
05–Oct–93	2	20.0	69.3	0.05	11

(Contd.)

Region :	North Central	Habitat :	River	Site Code :	NC16
Site Name:	Main Dhaleswari	Location :	Tangail (Elasin)		

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
11–Oct–93	2	16.0	300.3	0.39	14
13–Oct–93	2	12.0	364.0	0.48	21
14–Oct–93	2	16.0	299.6	0.54	19
17–Oct–93	2	16.0	84.9	0.21	17
18–Oct–93	2	16.0	12.1	0.04	8
19–Oct–93	2	16.0	85.9	0.31	18
20–Oct–93	2	16.0	56.3	0.07	12
25–Oct–93	2	16.0	136.2	0.28	14
26–Oct–93	2	16.0	464.6	0.94	15
27–Oct–93	2	16.0	340.9	0.49	14
30–Oct–93	2	16.0	835.1	1.11	11
31–Oct–93	2	16.0	1027.8	1.82	13
01–Nov–93	2	16.0	6334.9	6.66	13
05–Nov–93	2	16.0	1595.6	2.28	12
10–Nov–93	2	16.0	999.5	1.14	8
14–Nov–93	2	16.0	9.9	0.03	7
17–Nov–93	2	16.0	755.0	0.97	5
21–Nov–93	2	16.0	369.4	0.61	5
24–Nov–93	2	16.0	77.9	0.13	4
28–Nov–93	2	16.0	17.1	0.05	3
01–Dec–93	2	16.0	3.8	0.01	2
06–Dec–93	2	16.0	1.7	0.005	2
13–Dec–93	2	16.0	0.3	0.001	2
20–Dec–93	2	16.0	0.2	0.001	–
27–Dec–93	2	16.0	1.6	0.01	1

Region :	North Central	Habitat :	River	Site Code :	NC21
Site Name:	Lohajang	Location :	Tangail	In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
13-Jun-93	6	9.0	11.0	0.09	8
14-Jun-93	6	12.0	6.0	0.04	14
15-Jun-93	6	24.0	5.8	0.05	15
16-Jun-93	6	24.0	27.8	0.25	11
17-Jun-93	6	24.0	14.5	0.11	17
19-Jun-93	6	24.0	11.6	0.13	15
20-Jun-93	6	18.0	46.5	0.74	12
21-Jun-93	6	24.0	67.4	0.49	10
22-Jun-93	6	42.0	19.1	0.15	12
24-Jun-93	6	24.0	36.8	0.19	12
27-Jun-93	6	24.0	62.9	0.41	14
29-Jun-93	6	24.0	65.0	0.26	15
04-Jul-93	6	24.0	38.5	0.11	18
06-Jul-93	6	48.0	38.3	0.09	23
08-Jul-93	4	32.0	15.1	0.06	22
11-Jul-93	6	36.0	9.7	0.02	27
12-Jul-93	6	48.0	8.1	0.01	23
14-Jul-93	6	48.0	533.3	1.54	22
15-Jul-93	6	48.0	358.1	1.48	26
18-Jul-93	6	60.0	49.2	0.24	21
19-Jul-93	6	48.0	66.5	0.37	17
21-Jul-93	4	8.0	37.5	0.15	14
22-Jul-93	6	36.0	32.9	0.08	38
25-Jul-93	4	40.0	12.2	0.02	31
26-Jul-93	6	48.0	7.0	0.02	31
28-Jul-93	6	48.0	15.4	0.04	14
29-Jul-93	6	60.0	18.8	0.05	32
01-Aug-93	6	48.0	49.7	0.27	11
02-Aug-93	6	48.0	24.4	0.08	20
04-Aug-93	6	48.0	29.4	0.11	14
05-Aug-93	6	48.0	10.6	0.04	14
08-Aug-93	6	48.0	34.8	0.10	18
09-Aug-93	6	48.0	8.3	0.02	15
11-Aug-93	6	48.0	38.4	0.07	21
12-Aug-93	6	48.0	9.1	0.01	24
15-Aug-93	6	24.0	17.1	0.03	16
16-Aug-93	6	48.0	6.3	0.01	21
18-Aug-93	6	36.0	9.6	0.02	19
19-Aug-93	6	48.0	5.4	0.01	13
22-Aug-93	6	40.0	20.8	0.04	21
23-Aug-93	6	48.0	6.3	0.01	19
25-Aug-93	6	40.0	18.4	0.04	24
26-Aug-93	6	48.0	7.0	0.01	23
29-Aug-93	6	40.0	8.4	0.01	16
30-Aug-93	6	48.0	3.4	0.01	15
01-Sep-93	6	40.0	4.9	0.01	14
02-Sep-93	6	48.0	1.9	0.003	10
04-Sep-93	6	48.0	23.2	0.04	26
06-Sep-93	6	48.0	3.9	0.01	13
08-Sep-93	6	40.0	12.0	0.03	19
09-Sep-93	6	36.0	10.6	0.03	14
11-Sep-93	6	40.0	31.1	0.09	23
12-Sep-93	6	48.0	15.7	0.05	20
15-Sep-93	6	40.0	30.6	0.13	18
16-Sep-93	6	48.0	13.4	0.05	19
18-Sep-93	6	40.0	50.8	0.22	23
19-Sep-93	6	48.0	20.9	0.09	19
27-Sep-93	6	36.0	24.1	0.10	12
28-Sep-93	6	40.0	180.5	0.64	13
30-Sep-93	6	40.0	148.9	0.46	13
02-Oct-93	6	48.0	22.9	0.08	10
04-Oct-93	6	32.0	64.4	0.22	11
06-Oct-93	4	48.0	33.1	-	13
09-Oct-93	6	40.0	84.1	-	18
10-Oct-93	6	24.0	16.6	-	13
12-Oct-93	4	40.0	36.2	-	12

Region :	North Central	Habitat :	Canal		Site Code :	NC22
Site Name:	Indrobelta	Location :	Tangail		In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
05–Sep–93	1	6.0	47.1	–	11
09–Sep–93	1	4.0	39.0	0.08	8

Region :	North Central	Habitat :	Canal		Site Code :	NC23
Site Name:	Indrobelta	Location :	Tangail		In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
05–Sep–93	1	6.0	8.1	–	5
09–Sep–93	1	4.0	63.8	0.10	8

North East Region

Region :	North East	Habitat :	River	Site Code :	NE01
Site Name:	Surma River	Location :	Sunamganj	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
18-Mar-93	2	4.0	62.0	0.06	8
29-Mar-93	2	4.0	36.0	0.03	8
05-Apr-93	2	4.0	9.5	0.07	2
12-Apr-93	2	4.0	76.5	0.25	12
19-Apr-93	2	4.0	19.5	0.02	5
27-Apr-93	2	4.0	187.5	0.28	8
05-May-93	2	4.0	128.0	0.50	23
19-May-93	2	3.0	362.3	4.23	37
29-May-93	1	3.0	1173.7	1.59	12
08-Jun-93	1	1.5	220.0	0.23	15
10-Jun-93	1	3.0	21.3	0.02	10
14-Jun-93	1	2.0	–	–	–
16-Jun-93	1	2.0	12.0	0.01	6
25-Jun-93	1	3.0	2.7	0.003	4
28-Jun-93	1	2.0	6.0	0.02	6
05-Jul-93	1	2.0	3.0	0.01	5
07-Jul-93	1	2.0	2.0	0.01	3
11-Jul-93	1	2.0	2.5	0.01	2
15-Jul-93	1	2.0	2.0	0.01	3
18-Jul-93	1	2.0	4.5	0.01	3
26-Jul-93	1	4.0	1.5	0.01	2
02-Aug-93	1	2.0	1.5	0.004	2
04-Aug-93	1	3.0	0.7	0.001	–
09-Aug-93	1	3.0	0.3	0.001	1
19-Aug-93	1	2.0	6.0	0.01	3
22-Aug-93	1	3.0	0.7	0.001	1

Region :	North East	Habitat :	River	Site Code :	NE02
Site Name:	Old Surma River	Location :	Sunamganj	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
18-Mar-93	2	4.0	68.5	0.05	3
28-Mar-93	1	2.0	14.0	0.004	3
05-Apr-93	2	4.0	5.0	0.03	3
12-Apr-93	2	4.0	112.3	0.13	12
19-Apr-93	2	4.0	17.3	0.10	6
27-Apr-93	2	4.0	86.0	0.10	12
05-May-93	2	4.0	348.8	3.33	20
19-May-93	1	1.5	32.0	0.59	7
29-May-93	1	3.0	23.7	0.03	4
10-Jun-93	1	3.0	45.3	0.03	12
16-Jun-93	1	3.0	5.7	0.01	3
21-Jun-93	1	2.0	4.0	0.01	4
26-Jun-93	1	3.0	2.7	0.01	5
01-Jul-93	1	2.0	1.0	0.003	1
08-Jul-93	1	2.0	2.5	0.01	1
11-Jul-93	1	3.0	1.3	0.004	3
17-Jul-93	1	2.0	6.0	0.02	2
23-Jul-93	1	2.0	1.5	0.005	1
01-Aug-93	1	2.0	0.5	0.002	–
10-Aug-93	1	2.0	2.5	0.01	1
19-Aug-93	1	2.0	4.0	0.01	4
22-Aug-93	1	3.0	0.7	0.001	1

Region :	North East	Habitat :	River	Site Code :	NE03
Site Name:	Mahasing River	Location :	Sunamganj	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
17–Mar–93	2	4.0	13.0	0.14	4
28–Mar–93	1	3.0	0.7	0.002	2
04–Apr–93	2	4.0	9.8	0.09	1
12–Apr–93	2	2.0	25.5	0.25	4
18–Apr–93	2	4.0	6.0	0.01	4
26–Apr–93	2	1.5	806.7	10.35	8
04–May–93	1	1.5	2.7	0.05	2
20–May–93	2	2.0	5.0	0.05	6
29–May–93	1	3.0	1.7	0.003	3
09–Jun–93	1	3.0	2.7	0.01	6
15–Jun–93	1	3.0	4.0	0.02	5
25–Jun–93	1	3.0	1.0	0.01	2
27–Jun–93	1	3.0	1.3	0.01	2
08–Jul–93	1	3.0	1.3	0.004	2
12–Jul–93	1	3.0	0.7	0.003	2
19–Jul–93	1	2.0	2.5	0.01	1
23–Jul–93	1	2.0	3.0	0.01	3
04–Aug–93	1	2.0	0.5	0.001	1
09–Aug–93	1	2.0	1.0	0.002	1
15–Aug–93	1	3.0	0.7	0.001	2
24–Aug–93	1	3.0	0.7	0.001	1

Region :	North East	Habitat :	River	Site Code :	NE04
Site Name:	Surma River	Location :	Sylhet	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
17–Mar–93	2	4.0	39.0	0.02	10
29–Mar–93	2	4.0	15.3	0.01	9
04–Apr–93	1	3.0	6.0	0.01	5
13–Apr–93	2	4.0	94.3	0.38	18
18–Apr–93	2	4.0	125.3	0.05	4
22–Apr–93	2	4.0	120.8	0.18	4
14–May–93	1	3.0	13.3	0.12	9
21–May–93	1	3.0	2.3	0.06	5
28–May–93	2	2.0	1477.5	1.44	20
24–Jun–93	1	2.0	7.5	0.02	5
14–Jul–93	1	3.0	4.0	0.01	5
21–Jul–93	1	2.0	2.0	0.01	2
24–Jul–93	1	2.0	2.5	0.01	2
05–Aug–93	1	2.0	0.5	0.001	–
12–Aug–93	1	3.0	1.0	0.002	2
18–Aug–93	1	3.0	0.3	0.001	1
25–Aug–93	1	2.0	1.0	0.003	1

Region :	North East	Habitat :	River	Site Code :	NE05
Site Name:	Kushiyara	Location :	Sherpur	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
13-Mar-93	1	3.0	108.0	0.07	8
20-Mar-93	2	4.0	7416.8	3.35	14
27-Mar-93	2	4.0	491.0	0.25	17
03-Apr-93	1	3.0	52.0	0.03	8
11-Apr-93	2	4.0	419.3	0.65	11
21-Apr-93	2	2.0	2865.0	1.75	18
28-Apr-93	2	4.0	7426.3	7.50	32
15-May-93	1	3.0	213.0	0.42	25
21-May-93	1	3.0	191.7	0.11	27
27-May-93	1	3.0	97.3	0.58	16
11-Jun-93	1	3.0	33.7	0.01	21
14-Jun-93	1	3.0	86.0	0.06	18
18-Jun-93	1	3.0	88.3	0.08	27
24-Jun-93	1	3.0	16.7	0.02	19
28-Jun-93	1	3.0	41.0	0.15	16
09-Jul-93	1	3.0	9.3	0.01	9
13-Jul-93	1	3.0	25.7	0.04	14
20-Jul-93	1	3.0	16.0	0.01	19
26-Jul-93	1	3.0	40.3	0.04	17
04-Aug-93	1	3.0	83.7	0.06	10
09-Aug-93	1	3.0	11.0	0.01	9
17-Aug-93	1	3.0	44.0	0.05	6
24-Aug-93	1	3.0	30.7	0.03	8

Region :	North East	Habitat :	River	Site Code :	NE06
Site Name:	Khorodari	Location :	Manu (MIP)	In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
13-Mar-93	1	3.0	42.0	0.03	2
20-Mar-93	1	3.0	19.3	0.02	5
27-Mar-93	1	1.5	8.7	0.005	8
07-Apr-93	1	1.5	318.7	0.24	6
11-Apr-93	1	1.5	37.3	1.82	5
20-Apr-93	1	1.5	12.7	0.01	2
30-Apr-93	1	1.5	65.3	0.07	13
15-May-93	1	1.5	3.3	0.11	4
22-May-93	1	1.5	61.3	0.25	10
27-May-93	1	1.5	954.7	4.24	21
08-Jun-93	1	1.5	8.0	0.02	7

Region :	North East	Habitat :	River	Site Code :	NE07
Site Name:	Juri River	Location :	Fenchuganj	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
14-Mar-93	2	4.0	389.3	0.14	18
21-Mar-93	2	4.0	151.3	0.08	21
30-Mar-93	2	4.0	3.5	0.005	5
06-Apr-93	2	4.0	254.8	0.43	13
10-Apr-93	2	4.0	2941.3	2.79	28
17-Apr-93	2	4.0	188.3	0.07	6
23-Apr-93	2	4.0	2980.0	2.73	20
14-May-93	1	1.5	132.7	0.58	16
21-May-93	1	1.5	88.7	0.16	9
25-May-93	1	1.5	10.7	0.01	11
09-Jun-93	1	3.0	20.0	0.01	7
16-Jun-93	1	3.0	18.3	0.01	8
22-Jun-93	1	3.0	11.0	0.01	10
11-Jul-93	1	3.0	5.3	0.004	4
27-Jul-93	1	3.0	11.7	0.02	4
05-Aug-93	1	3.0	17.0	0.01	8
12-Aug-93	1	3.0	7.0	0.01	6
19-Aug-93	1	3.0	19.7	0.02	7
23-Aug-93	1	3.0	5.7	0.004	9

Region :	North East	Habitat :	River	Site Code :	NE08
Site Name:	Juri Continala	Location :	Juri	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
19–Mar–93	2	4.0	4.5	0.002	3
30–Mar–93	2	4.0	1.8	0.002	1
06–Apr–93	2	4.0	13.8	0.03	4
13–Apr–93	2	3.0	9.3	0.01	6
21–Apr–93	2	4.0	87.3	0.19	7
29–Apr–93	2	2.0	7.5	0.004	12
13–May–93	2	2.0	12.0	0.08	8
18–May–93	2	3.5	58.8	1.73	11
26–May–93	2	2.0	5.0	0.07	5
10–Jun–93	1	3.0	1.3	0.001	2
22–Jun–93	1	1.5	4.7	0.01	5
29–Jun–93	1	3.0	4.7	0.01	6
08–Jul–93	1	3.0	1.3	0.002	1
21–Jul–93	1	3.0	32.7	0.05	14
28–Jul–93	1	3.0	1.3	0.004	2
03–Aug–93	1	3.0	4.7	0.01	5
10–Aug–93	1	3.0	0.7	0.001	1
18–Aug–93	1	3.0	9.7	0.02	2
22–Aug–93	1	3.0	16.3	0.03	5

Region :	North East	Habitat :	Canal	Site Code :	NE09
Site Name:	Lumardai In	Location :	Shanghair Haor	In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
18–Mar–93	1	1.5	130.0	0.50	6
05–Apr–93	1	1.5	2.0	0.03	2
12–Apr–93	1	1.5	4.7	0.01	–
19–Apr–93	1	1.5	1.3	0.004	2
27–Apr–93	1	1.5	52.7	1.62	1

Region :	North East	Habitat :	Canal	Site Code :	NE10
Site Name:	Lumardai Out	Location :	Shanghair Haor	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
18–Mar–93	1	1.5	288.7	1.12	9
05–Apr–93	1	1.5	–	–	–
12–Apr–93	1	1.5	64.7	0.08	11
19–Apr–93	1	1.5	88.0	0.09	6
27–Apr–93	1	1.5	300.7	0.59	2

Region :	North East	Habitat :	Canal	Site Code :	NE11
Site Name:	Khorodari Out	Location :	Manu (MIP)	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
20–Mar–93	1	3.0	28.3	0.02	6
27–Mar–93	1	1.5	210.7	0.10	14
07–Apr–93	1	1.5	10.0	0.01	3
20–Apr–93	1	1.5	62.0	0.06	6
30–Apr–93	1	1.5	103.3	0.14	15

Region :	North East	Habitat :	Canal	Site Code :	NE12
Site Name:	Benkhali Khara	Location :	Shanghair Haor	In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
20-May-93	1	1.0	55.0	0.28	3
29-May-93	1	1.5	38.7	0.03	14
11-Jun-93	1	3.0	10.7	0.01	7
26-Jun-93	1	3.0	2.3	0.01	4
13-Jul-93	1	3.0	6.0	0.02	5
25-Jul-93	1	3.0	1.7	0.004	3
07-Aug-93	1	2.0	3.5	0.01	2
11-Aug-93	1	3.0	1.7	0.003	1
17-Aug-93	1	3.0	0.7	0.001	2
23-Aug-93	1	2.0	1.0	0.002	1

Region :	North East	Habitat :	Canal	Site Code :	NE13
Site Name:	Jaykalas	Location :	Dekker Haor	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
29-Jun-93	1	3.0	0.3	0.002	1
20-Jul-93	1	2.0	5.5	0.02	1

Region :	North East	Habitat :	Canal	Site Code :	NE14
Site Name:	Janpur Khara	Location :	Shanghair Haor	In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
20-May-93	1	0.5	2.0	0.02	1

Region :	North East	Habitat :	Canal	Site Code :	NE15
Site Name:	Nabinkhali	Location :	Shanghair Haor	In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
20-May-93	1	0.5	2.0	0.05	1
09-Jun-93	1	1.5	32.0	0.09	8
14-Jun-93	1	3.0	8.3	0.01	6
21-Jun-93	1	3.0	3.7	0.01	4
27-Jun-93	1	3.0	1.7	0.01	4
05-Jul-93	1	3.0	1.0	0.005	1
12-Jul-93	1	3.0	2.0	0.01	2
20-Jul-93	1	2.0	4.0	0.02	2
10-Aug-93	1	3.0	1.0	0.002	1
16-Aug-93	1	3.0	1.0	0.002	2
23-Aug-93	1	2.0	2.5	0.01	3

Region :	North East	Habitat :	River	Site Code :	NE18
Site Name:	Manu River	Location :	Sherpur	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
01-Jul-93	1	3.0	13.0	0.01	12
10-Jul-93	1	3.0	3.3	0.002	3
18-Jul-93	1	3.0	7.3	0.01	7
29-Jul-93	1	3.0	6.7	0.01	2
01-Aug-93	1	3.0	5.7	0.01	5
08-Aug-93	1	3.0	9.7	0.01	10
15-Aug-93	1	3.0	25.0	0.06	10
25-Aug-93	1	3.0	12.7	0.02	3
30-Aug-93	1	3.0	17.7	0.03	5

Region :	North East	Habitat :	River	Site Code :	NE19
Site Name:	Kushiyara	Location :	Fenchuganj	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
11–Jul–93	1	3.0	5.7	0.01	3
27–Jul–93	1	3.0	7.0	0.01	7
05–Aug–93	1	3.0	9.3	0.01	7
12–Aug–93	1	3.0	6.0	0.004	4
19–Aug–93	1	3.0	13.7	0.01	8
23–Aug–93	1	3.0	22.0	0.02	9

Region :	North East	Habitat :	Canal	Site Code :	NE20
Site Name:	Machhuakhali	Location :	Manu (MIP)	In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
23–Jun–93	1	3.0	512.0	0.83	25
07–Jul–93	1	3.0	130.3	0.06	12
12–Jul–93	1	3.0	49.3	0.03	8
25–Jul–93	1	3.0	525.7	0.27	35
02–Aug–93	1	3.0	243.3	0.17	19
09–Aug–93	1	3.0	170.3	0.23	5
17–Aug–93	1	3.0	251.0	0.18	4
24–Aug–93	1	3.0	25.0	0.03	4

North West Region

Region :	North West	Habitat :	River	Site Code :	NW30
Site Name:	Old Hurasagar	Location :	Sirajganj (Bauitara)	In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
14-Jun-93	1	3.0	65.0	0.05	22
15-Jun-93	1	3.0	212.3	0.12	27
16-Jun-93	1	3.0	63.3	0.15	9
17-Jun-93	1	4.0	41.3	0.10	11
22-Jun-93	1	3.0	332.7	0.90	12
23-Jun-93	1	3.0	1209.7	1.81	15
24-Jun-93	1	4.0	407.8	0.51	11
25-Jun-93	1	3.0	126.7	0.18	12
29-Jun-93	1	4.0	1.0	0.03	3
30-Jun-93	1	3.0	1.3	0.01	1
07-Jul-93	1	3.0	5.3	0.03	6
12-Jul-93	1	3.0	22.7	0.07	9
23-Jul-93	1	6.0	35.8	0.07	8
25-Jul-93	1	6.0	6.3	0.01	12
26-Jul-93	1	3.0	33.0	0.14	6
30-Jul-93	1	6.0	2.8	0.02	3
31-Jul-93	1	3.0	0.7	0.002	2
01-Aug-93	1	6.0	1.5	0.003	4
02-Aug-93	1	6.0	0.7	0.002	1
03-Aug-93	1	3.0	0.3	0.001	1
10-Aug-93	1	6.0	1.2	0.004	2
11-Aug-93	1	3.0	0.7	0.003	2
18-Aug-93	1	3.0	2.7	0.01	5
23-Aug-93	1	6.0	0.8	0.004	1
24-Aug-93	1	6.0	2.5	0.02	4
25-Aug-93	1	4.0	0.8	0.004	1
31-Aug-93	1	6.0	1.2	0.03	3
01-Sep-93	1	4.0	4.3	0.13	1
08-Sep-93	1	6.0	0.3	0.01	1
09-Sep-93	1	4.0	0.8	0.002	1
15-Sep-93	1	6.0	8.7	0.03	12
16-Sep-93	1	4.0	16.5	0.06	7
23-Sep-93	1	6.0	2.0	0.01	2
24-Sep-93	1	6.0	4.2	0.02	4
25-Sep-93	1	4.0	847.5	1.81	8
28-Sep-93	1	6.0	284.7	1.52	15
29-Sep-93	1	4.0	895.3	2.94	14
05-Oct-93	1	6.0	83.7	0.21	10
06-Oct-93	1	6.0	59.7	0.17	11
07-Oct-93	1	4.0	200.5	0.57	8
12-Oct-93	1	6.0	40.8	0.05	9
13-Oct-93	1	6.0	67.2	0.08	15
14-Oct-93	1	4.0	124.5	0.52	12
19-Oct-93	1	6.0	10.5	0.03	10

Region :	North West	Habitat :	River	Site Code :	NW31
Site Name:	Old Hurasagar	Location :	Sirajganj (Bauitara)	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
14–Jun–93	1	3.0	10.3	0.04	4
15–Jun–93	1	3.0	88.3	0.20	5
16–Jun–93	1	3.0	115.7	0.31	7
17–Jun–93	1	4.0	28.3	0.07	9
22–Jun–93	1	3.0	4.0	0.01	3
23–Jun–93	1	3.0	111.3	0.27	8
24–Jun–93	1	4.0	271.5	0.62	8
25–Jun–93	1	3.0	40.3	0.07	5
29–Jun–93	1	4.0	0.5	0.01	2
30–Jun–93	1	3.0	–	–	–
07–Jul–93	1	3.0	4.0	0.02	5
12–Jul–93	1	3.0	7.3	0.02	8
23–Jul–93	1	6.0	2.5	0.01	6
25–Jul–93	1	6.0	4.0	0.02	8
26–Jul–93	1	3.0	0.7	0.003	2
30–Jul–93	1	6.0	0.7	0.002	3
31–Jul–93	1	3.0	–	–	–
01–Aug–93	1	6.0	1.3	0.004	4
02–Aug–93	1	6.0	0.5	0.001	2
03–Aug–93	1	3.0	0.7	0.002	1
10–Aug–93	1	6.0	1.0	0.003	4
11–Aug–93	1	3.0	2.3	0.01	3
18–Aug–93	1	3.0	1.3	0.005	3
23–Aug–93	1	6.0	0.2	0.001	1
24–Aug–93	1	6.0	6.2	0.04	6
25–Aug–93	1	4.0	1.5	0.01	3
31–Aug–93	1	6.0	1.3	0.01	3
01–Sep–93	1	4.0	30.8	–	8
08–Sep–93	1	6.0	0.3	0.004	2
09–Sep–93	1	4.0	1.3	0.01	3
15–Sep–93	1	6.0	144.5	0.55	15
16–Sep–93	1	4.0	270.5	0.94	5
23–Sep–93	1	6.0	1402.8	5.32	14
24–Sep–93	1	6.0	1591.0	4.41	10
25–Sep–93	1	4.0	2293.8	14.03	12
28–Sep–93	1	6.0	481.7	1.49	8
29–Sep–93	1	4.0	777.0	2.76	10
05–Oct–93	1	6.0	1147.3	3.35	7
06–Oct–93	1	6.0	3.3	0.05	5
07–Oct–93	1	4.0	4.3	–	5
12–Oct–93	1	6.0	275.5	0.96	16
13–Oct–93	1	6.0	1421.3	2.46	18
14–Oct–93	1	4.0	472.8	1.16	10
19–Oct–93	1	6.0	85.0	0.17	13

Region :	North West	Habitat :	River	Site Code :	NW32
Site Name:	Badai River	Location :	Talimnagar	In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
17–Jun–93	1	3.0	101.3	0.05	11
18–Jun–93	1	5.0	122.6	0.02	22
08–Jul–93	1	3.0	8.3	0.04	3
22–Jul–93	1	3.0	38.3	0.11	13
27–Jul–93	1	1.0	11.0	0.04	2
29–Jul–93	1	3.0	0.3	0.002	1
12–Aug–93	1	6.0	77.0	0.09	16
16–Aug–93	1	6.0	8.0	0.03	7
17–Aug–93	1	3.0	23.7	0.10	6
21–Aug–93	1	6.0	0.5	–	–
22–Aug–93	1	4.0	–	–	–
02–Sep–93	1	4.0	–	–	–
07–Sep–93	1	4.0	0.5	–	2
12–Sep–93	1	6.0	5.3	0.01	3
13–Sep–93	1	4.0	7.5	0.01	3
21–Sep–93	1	6.0	1.2	0.002	–
26–Sep–93	1	6.0	0.7	0.001	4
27–Sep–93	1	4.0	1.8	0.01	4
03–Oct–93	1	6.0	1.5	0.003	4
10–Oct–93	1	6.0	4.5	0.005	5
11–Oct–93	1	4.0	1.8	0.002	1
17–Oct–93	1	6.0	8.5	0.01	4

Region :	North West	Habitat :	River	Site Code :	NW33
Site Name:	Badai River	Location :	Talimnagar	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
08–Jul–93	1	3.0	1.7	0.01	4
22–Jul–93	1	3.0	31.0	0.15	10
27–Jul–93	1	1.0	–	–	–
29–Jul–93	1	3.0	–	–	–
12–Aug–93	1	6.0	28.0	0.02	13
16–Aug–93	1	6.0	1.0	0.004	3
17–Aug–93	1	3.0	0.7	0.003	2
21–Aug–93	1	6.0	0.7	0.004	2
22–Aug–93	1	4.0	0.5	0.004	2
02–Sep–93	1	4.0	0.5	–	–
07–Sep–93	1	4.0	0.8	–	–
12–Sep–93	1	6.0	9.3	0.01	8
13–Sep–93	1	4.0	2.3	0.002	3
21–Sep–93	1	6.0	–	–	–
26–Sep–93	1	6.0	0.3	0.001	1
27–Sep–93	1	4.0	2.5	0.01	2
03–Oct–93	1	6.0	22.0	0.03	5
10–Oct–93	1	6.0	2.5	0.002	4
11–Oct–93	1	4.0	2.3	0.001	3
17–Oct–93	1	6.0	6.8	0.004	4

Region :	North West	Habitat :	River	Site Code :	NW34
Site Name:	Baral River	Location :	Charghat	In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
04-Jul-93	1	5.0	235.4	1.20	15
05-Jul-93	1	6.0	244.7	0.43	19
06-Jul-93	1	6.0	117.8	0.15	18
07-Jul-93	1	5.0	194.6	0.16	20
08-Jul-93	1	3.0	153.0	0.23	11
11-Jul-93	1	6.0	16.7	0.03	15
12-Jul-93	1	6.0	28.7	0.04	14
13-Jul-93	1	5.0	23.0	0.03	14
14-Jul-93	1	6.0	23.2	0.05	17
15-Jul-93	1	4.0	28.5	0.05	21
18-Jul-93	1	8.0	33.0	0.07	16
19-Jul-93	1	10.0	30.5	0.06	19
20-Jul-93	1	10.0	15.1	0.04	16
21-Jul-93	1	6.0	27.5	0.07	19
22-Jul-93	1	4.0	28.3	0.05	13
25-Jul-93	1	7.0	25.0	0.11	17
26-Jul-93	1	6.0	78.7	0.09	25
27-Jul-93	1	6.0	64.2	0.12	18
28-Jul-93	1	3.0	85.3	0.16	19
02-Aug-93	1	6.0	60.2	0.08	21
03-Aug-93	1	6.0	75.8	0.08	23
04-Aug-93	1	6.0	32.0	0.04	18
05-Aug-93	1	6.0	60.0	0.08	21
08-Aug-93	1	6.0	16.3	0.02	14
09-Aug-93	1	6.0	9.2	0.01	12
10-Aug-93	1	6.0	8.5	0.01	15
11-Aug-93	1	6.0	12.3	0.02	16
12-Aug-93	1	4.0	21.3	0.04	13
15-Aug-93	1	6.0	63.7	0.06	30
16-Aug-93	1	6.0	86.5	0.15	26
17-Aug-93	1	6.0	89.0	0.17	30
18-Aug-93	1	6.0	21.7	0.03	16
19-Aug-93	1	4.0	29.0	0.04	18
23-Aug-93	1	6.0	76.3	0.12	40
24-Aug-93	1	6.0	213.5	0.25	46
25-Aug-93	1	6.0	29.8	0.04	25
26-Aug-93	1	6.0	29.5	0.05	27
29-Aug-93	1	4.0	28.3	0.03	18
31-Aug-93	1	6.0	18.2	0.02	22
01-Sep-93	1	6.0	8.8	0.01	20
02-Sep-93	1	6.0	12.8	0.02	21
06-Sep-93	1	6.0	22.3	0.03	23
07-Sep-93	1	6.0	35.7	0.05	24
08-Sep-93	1	6.0	14.7	0.02	17
09-Sep-93	1	6.0	34.0	0.04	24
12-Sep-93	1	6.0	38.7	0.04	23
13-Sep-93	1	6.0	34.0	0.04	23
14-Sep-93	1	6.0	19.8	0.02	21
15-Sep-93	1	6.0	46.8	0.03	29

(Cont.)

Region :	North West	Habitat :	River	Site Code :	NW34
Site Name:	Baral River	Location :	Charghat	In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
16-Sep-93	1	6.0	24.5	0.02	23
19-Sep-93	1	6.0	14.5	0.01	28
20-Sep-93	1	6.0	25.8	0.02	30
21-Sep-93	1	6.0	22.7	0.02	28
22-Sep-93	1	6.0	22.0	0.02	27
23-Sep-93	1	6.0	20.8	0.02	22
26-Sep-93	1	6.0	21.3	0.02	27
27-Sep-93	1	6.0	44.2	0.03	31
28-Sep-93	1	6.0	36.5	0.03	33
29-Sep-93	1	4.0	48.3	0.04	27
01-Oct-93	1	6.0	52.2	0.04	30
04-Oct-93	1	6.0	178.3	0.10	36
05-Oct-93	1	6.0	47.5	0.04	22
06-Oct-93	1	6.0	143.8	0.09	34
07-Oct-93	1	4.0	200.8	0.13	30
10-Oct-93	1	6.0	81.7	0.05	25
11-Oct-93	1	6.0	98.5	0.09	26
12-Oct-93	1	6.0	145.5	0.10	22
13-Oct-93	1	6.0	485.8	0.34	31
14-Oct-93	1	6.0	278.8	0.16	24
17-Oct-93	1	6.0	172.0	0.15	20
18-Oct-93	1	6.0	91.3	0.08	22
19-Oct-93	1	6.0	130.3	0.11	24
20-Oct-93	1	3.0	82.3	0.06	14

Region :	North West	Habitat :	River	Site Code :	NW35
Site Name:	Baral River	Location :	Charghat	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
04-Jul-93	1	6.0	5434.3	8.97	22
05-Jul-93	1	6.0	803.5	1.05	27
06-Jul-93	1	6.0	370.8	0.24	29
07-Jul-93	1	5.0	215.0	0.14	26
08-Jul-93	1	3.0	136.0	0.10	24
11-Jul-93	1	6.0	45.0	0.05	17
12-Jul-93	1	6.0	34.7	0.03	20
13-Jul-93	1	5.0	16.0	0.02	15
14-Jul-93	1	6.0	21.5	0.03	13
15-Jul-93	1	4.0	55.3	0.08	15
18-Jul-93	1	8.0	130.0	0.20	21
19-Jul-93	1	10.0	50.1	0.13	19
20-Jul-93	1	10.0	74.4	0.18	18
21-Jul-93	1	6.0	98.2	0.18	18
22-Jul-93	1	4.0	89.3	0.19	16
25-Jul-93	1	7.0	191.8	0.50	26
26-Jul-93	1	6.0	186.2	0.28	24
27-Jul-93	1	6.0	155.7	0.18	30
28-Jul-93	1	3.0	81.0	0.15	19
02-Aug-93	1	6.0	99.7	0.13	27
03-Aug-93	1	6.0	104.7	0.09	29
04-Aug-93	1	6.0	86.3	0.11	28
05-Aug-93	1	6.0	32.7	0.04	19
08-Aug-93	1	6.0	48.2	0.16	16
09-Aug-93	1	6.0	53.5	0.12	19
10-Aug-93	1	6.0	39.8	0.11	16
11-Aug-93	1	6.0	13.2	0.04	17
12-Aug-93	1	4.0	17.5	0.06	11
15-Aug-93	1	6.0	129.7	0.23	33
16-Aug-93	1	6.0	219.8	0.72	32
17-Aug-93	1	6.0	49.0	0.16	26
18-Aug-93	1	6.0	48.0	0.20	24
19-Aug-93	1	4.0	57.0	0.13	21
23-Aug-93	1	6.0	186.2	0.39	36
24-Aug-93	1	6.0	191.0	0.33	36
25-Aug-93	1	6.0	54.0	0.10	27
26-Aug-93	1	6.0	26.8	0.05	25
29-Aug-93	1	4.0	45.8	0.14	23
31-Aug-93	1	6.0	20.8	0.06	23
01-Sep-93	1	6.0	13.3	0.03	18
02-Sep-93	1	6.0	27.7	0.06	26
06-Sep-93	1	6.0	23.3	0.05	21
07-Sep-93	1	6.0	28.3	0.05	24
08-Sep-93	1	6.0	36.3	0.05	27
09-Sep-93	1	6.0	47.0	0.06	26
12-Sep-93	1	6.0	49.2	0.08	31
13-Sep-93	1	6.0	51.3	0.08	25
14-Sep-93	1	6.0	27.7	0.04	22
15-Sep-93	1	6.0	85.5	0.14	36

(Contd.)

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Region :	North West	Habitat :	River	Site Code :	NW35
Site Name:	Baral River	Location :	Charghat	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
16-Sep-93	1	6.0	48.5	0.06	28
19-Sep-93	1	6.0	26.8	0.04	33
20-Sep-93	1	6.0	47.3	0.06	31
21-Sep-93	1	6.0	48.3	0.07	29
22-Sep-93	1	6.0	43.3	0.06	36
23-Sep-93	1	6.0	59.2	0.09	27
26-Sep-93	1	6.0	33.2	0.06	27
27-Sep-93	1	6.0	76.5	0.13	31
28-Sep-93	1	6.0	83.0	0.13	29
29-Sep-93	1	4.0	100.5	0.18	33
01-Oct-93	1	6.0	87.7	0.17	18
04-Oct-93	1	6.0	178.2	0.21	37
05-Oct-93	1	6.0	103.2	0.17	25
06-Oct-93	1	6.0	261.7	0.30	40
07-Oct-93	1	4.0	426.3	0.46	31
10-Oct-93	1	6.0	236.5	0.23	39
11-Oct-93	1	6.0	209.5	0.20	30
12-Oct-93	1	6.0	296.2	0.23	26
13-Oct-93	1	6.0	427.3	0.31	27
14-Oct-93	1	6.0	290.7	0.20	28
17-Oct-93	1	6.0	255.7	0.15	22
18-Oct-93	1	6.0	74.0	0.05	24
19-Oct-93	1	6.0	108.0	0.09	22
20-Oct-93	1	3.0	69.7	0.05	16

Region :	North West	Habitat :	River	Site Code :	NW36
Site Name:	Baral River	Location :	Baghabari	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
19–Jun–93	1	3.0	1503.6	0.91	21
22–Jun–93	1	5.8	23.9	0.02	9
01–Jul–93	1	3.0	7.7	0.04	3
14–Jul–93	1	6.0	10.5	0.06	11
28–Jul–93	1	6.0	1.5	0.01	3
20–Aug–93	1	3.0	11.0	0.01	2
26–Aug–93	1	6.0	21.8	0.10	4
06–Sep–93	1	4.0	23.3	0.11	5
22–Sep–93	1	4.0	2.8	0.02	3
04–Oct–93	1	4.0	25.8	0.09	10
18–Oct–93	1	4.0	59.5	0.14	12

Region :	North West	Habitat :	River	Site Code :	NW39
Site Name:	Kageswari	Location :	Kaitala	In/Out FCD/I:	In

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
14–Sep–93	1	1.5	131.3	0.27	10

Region :	North West	Habitat :	River	Site Code :	NW40
Site Name:	Kageswari	Location :	Kaitala	In/Out FCD/I:	Out

Date	Number of nets set	Total net hours	Mean nos./hr.	Mean Density	Total number of species per day
14–Sep–93	1	1.5	106.7	0.14	12

APPENDIX 4

Appendix 4 List of fish species recorded by FAP 17 study

Species Code	Species name	
	Scientific	Bengali
Riverine species		
133	*Mystus gulio*	*Nuna tengra*
957	*Mystus punctatus*	*Gagur*
186	*Rita rita*	*Rita*
99	*Labeo angra*	*Angrot*
106	*Labeo pangusia*	*Longu*
963	*Osteochilus neilli*	
12	*Aspidoparia jaya*	*Piali*
13	*Aspidoparia morar*	*Piali*
17	*Barilius barila*	*Barali*
18	*Barilius barna*	*Bani koksa*
19	*Barilius bendelisis*	*Koksa*
218	*Barilius evezardi*	
21	*Barilius shacra*	*Koksa*
22	*Barilius tileo*	*Tila koksa*
23	*Barilius vagra*	*Koksa*
67	*Danio dangila*	*Nipati*
967	*Danio sp*	
20	*Raiamas bola*	*Bhol*
59	*Crossocheilus latius*	*Kalabata*
139	*Nemacheilus botia*	*Balichata*
941	*Neoeucirrhichthys maydelli*	*Gutum*
1	*Pangio pangia*	*Panga*
198	*Somileptes gongota*	*Gharpoia*
28	*Botia dario*	*Rani*
29	*Botia lohachata*	*Putul*
951	*Botia sp*	
94	*Ilisha motius*	*Choukka*
89	*Hilsa ilisha*	*Ilish*
90	*Hilsa toli*	*Chandana*
8	*Anodontostoma chacunda*	*Koi puti*
85	*Gonialosa manmina*	*Goni chapila*
58	*Corica soborna*	*Kachki*
70	*Eleotris fusca*	*Budh bailla*
71	*Eleotris lutea*	*Kuli*
193	*Setipinna phasa*	*Phasa*
194	*Setipinna taty*	*Teli phasa*
10	*Apocryptes bato*	*Chiring*
27	*Boleophthalmus boddarti*	*Dahuk*
159	*Parapocryptes batoides*	*Dali chewa*
170	*Pseudapocryptes lanceolatus*	*Chewa*
31	*Scartelaos histophorus*	*Dahuk*
190	*Scartelaos viridis*	*Dahuk*
952	*Awaous grammepomus*	*Nonda baila*
14	*Awaous stamineus*	*Bele*
940	*Awaous sp*	*Bele*
30	*Brachygobius nunus*	*Nunabailla*
964	*Dermogenys pussillus*	*Ke thota*
92	*Hyporhampus gaimardi*	*Ek thota*
112	*Lobotes surinamensis*	*Samudra koi*
125	*Moringua raitaborua*	*Rata boura*
127	*Liza melinoptera*	*Bata*
128	*Liza parsia*	*Bata*
126	*Liza subviridis*	*Bata*
922	*Liza sp*	*Bata*
185	*Rhinomugil corsula*	*Khorsula*
923	*Sicamugil cascasia*	*Bata*
163	*Pisodonophis boro*	*Kharu*
164	*Platycephalus indicus*	*Mur bailla*
165	*Plotosus canius*	*Gang magur*
167	*Polynemus paradiseus*	*Tapasi*
2	*Ailia coila*	*Kajuli*
3	*Ailia punctata*	*Kajuli*
51	*Clupisoma garua*	*Ghaura*
52	*Clupisoma naziri*	*Muri bacha*
196	*Silonia silondia*	*Shillong*
16	*Bagarius bagarius*	*Baghair*
74	*Erethistes pussilus*	*Kutakanti*
77	*Gagata cenia*	*Kauwa*
78	*Gagata gagata*	*Gang tengra*

(Contd.)

Appendix 4 (Continued)

Species Code	Species name	
	Scientific	Bengali
79	*Gagata nangra*	*Gang tengra*
80	*Gagata viridescens*	*Gang tengra*
81	*Gagata youssoufi*	*Gang tengra*
84	*Glyptothorax telchitta*	*Telchitta*
958	*Glyptothorax sp*	*Lal moina*
87	*Hara hara*	*Kutakanti*
197	*Sisor rhabdophorus*	*Sisor*
93	*Ichthyocampus carce*	*Kumirer khil*
961	*Microphis deocata*	
95	*Johnius coitor*	*Koitor*
155	*Pama pama*	*Poa*
156	*Pampus argenteus*	*Fali chanda*
157	*Pampus chinensis*	*Rup chanda*
191	*Scatophagus argus*	*Bishtara*
195	*Sillaginopsis panijus*	*Tular dandi*
108	*Leiognathus equulus*	*Tak chanda*
192	*Secutor ruconius*	*Tak chanda*
45	*Chelonodon fluviatilis*	*Potka*
199	*Arius gagora*	*Gagla*
200	*Tachysurus nenga*	*Kata*
171	*Psilorhynchus balitora*	*Balitora*
172	*Psilorhynchus sucatio*	*Titari*
158	*Pangasius pangasius*	*Pangas*
26	*Batrachocephalus mino*	*Katabukha*
152	*Osteogeneiosus militaris*	*Apuia*
146	*Odontamblyopus rubicundus*	*Lal chewa*
202	*Taenioides buchanani*	*Raja chewa*
208	*Trypauchen vagina*	*Sada chewa*
953	*Cynoglossus cynoglossus*	*Khongi*
954	*Cynoglossus sp*	
956	*Euryglossa orientalis*	*Kathal pata*
969	*Euryglossa pan*	*Kathal pata*
968	*Himantura sp*	*Shangus*
955	*Amblyceps mangois*	*Magur*
962	*Olyra longicaudata*	
Migratory species		
7	*Anguilla bengalensis*	*Bamosh*
130	*Aorichthys aor*	*Ayre*
135	*Aorichthys seenghala*	*Guizza*
24	*Batasio batasio*	*Tengra*
25	*Batasio tengana*	*Tengra*
131	*Mystus bleekeri*	*Golsha tengra*
132	*Mystus cavasius*	*Kabashi*
134	*Mystus menoda*	*Ghagla*
909	*Carp sp*	*Carp*
32	*Catla catla*	*Catla*
47	*Cirrhinus mrigala*	*Mrigel*
48	*Cirrhinus reba*	*Raik*
100	*Labeo bata*	*Bata*
101	*Labeo boga*	*Bhangan*
102	*Labeo calbasu*	*Kalbaus*
103	*Labeo dero*	*Kursha*
104	*Labeo gonius*	*Goni*
105	*Labeo nandina*	*Nandina*
107	*Labeo rohita*	*Rui*
44	*Chela laubuca*	*Kash khaira*
965	*Chela sp*	
188	*Salmostoma bacaila*	*Katari*
189	*Salmostoma phulo*	*Fulchela*
154	*Securicula gora*	*Chora chela*
141	*Nemacheilus savona*	*Savon khorka*
86	*Gudusia chapra*	*Chapila*
54	*Coilia ramcarati*	*Olua*
76	*Eutropiichthys vacha*	*Bacha*
169	*Pseudeutropius atherinoides*	*Batasi*
944	*Ompok pabo*	*Pabda*
209	*Wallagu attu*	*Boal*
144	*Notopterus chitala*	*Chital*
140	*Nemacheilus corica*	*Koirka*
142	*Nemacheilus scaturigina*	*Dari*
216	*Nemacheilus zonalternans*	
161	*Pellona ditchela*	*Chouka*

(Contd.)

Appendix 4 (Continued)

Species Code	Species name	
	Scientific	Bengali
Floodplain resident species		
6	*Anabas testudineus*	*Koi*
136	*Mystus tengara*	*Bajari tengra*
137	*Mystus vittatus*	*Tengra*
942	*Rama chandramara*	*Laia*
61	*Ctenops nobilis*	*Neftani*
55	*Colisa fasciatus*	*Khalisha*
211	*Colisa labiosus*	*Khalisha*
56	*Colisa lalia*	*Lal khalisha*
57	*Colisa sota*	*Khalisha*
210	*Xenentodon cancila*	*Kaikka*
60	*Ctenopharyngodon idellus*	*Gheso carp*
62	*Cyprinus carpio*	*Karfu*
63	*Cyprinus communis*	*Scale carp*
64	*Cyprinus nudus*	*Leather carp*
65	*Cyprinus specularis*	*Mirror carp*
129	*Mylopharyngodon pisceus*	*Kalo carp*
187	*Osteobrama cotio cotio*	*Keti*
174	*Puntius chola*	*Chala puti*
175	*Puntius conchonius*	*Canchan puti*
173	*Puntius cosuatis*	*Kosuati*
176	*Puntius gelius*	*Giliputi*
970	*Puntius gonianotus*	*Thai sarputi*
177	*Puntius guganio*	*Mola puti*
178	*Puntius phutunio*	*Phutani puti*
179	*Puntius sarana*	*Sarputi*
180	*Puntius sophore*	*Puti*
181	*Puntius terio*	*Teri punti*
212	*Puntius ticto*	*Tit puti*
939	*Puntius sp.*	
183	*Rasbora elanga*	*Sephatia*
4	*Amblypharyngodon microlepis*	*Mola*
5	*Amblypharyngodon mola*	*Mola*
69	*Brachydanio rerio*	*Anju*
68	*Danio devario*	*Chebli*
75	*Esomus danricus*	*Darkina*
182	*Rasbora daniconius*	*Darkina*
184	*Rasbora rasbora*	*Leuzza darkina*
83	*Glossogobius giurus*	*Bailla*
11	*Aristichthys nobilis*	*Bighead carp*
91	*Hypophthalmichthys molitrix*	*Silver carp*
43	*Chela cachius*	*Chep chela*
920	*Lepidocephalus*	
219	*Lepidocephalus annandalei*	*Puiya*
109	*Lepidocephalus berdmorei*	*Puiya*
110	*Lepidocephalus guntea*	*Gutum*
111	*Lepidocephalus irrorata*	*Puiya*
217	*Lepidocephalus thermalis*	*Puiya*
9	*Aplocheilus panchax*	*Kanpona*
38	*Channa barca*	*Tila shol*
39	*Channa marulius*	*Gajar*
40	*Channa orientalis*	*Cheng*
41	*Channa punctatus*	*Taki*
42	*Channa striatus*	*Shol*
49	*Clarias batrachus*	*Magur*
50	*Clarias gariepinus*	*African magur*
150	*Oreochromis mossambica*	*Tilapia*
151	*Oreochromis nilotica*	*Nilotica*
88	*Heteropneustes fossilis*	*Shingi*
121	*Macrognathus aculeatus*	*Tara baim*
123	*Macrognathus pancalus*	*Guchi*
122	*Mastacembelus armatus*	*Baral baim*
138	*Nandus nandus*	*Bheda*
15	*Badis badis*	*Napit koi*
124	*Monopterus cuchia*	*Kuchia*
149	*Ophisternon bengalense*	*Bamosh*
147	*Ompok bimaculatus*	*Kani pabda*
148	*Ompok pabda*	*Madhu pabda*
220	*Ompok sp*	*Ompok sp.*
145	*Notopterus notopterus*	*Foli*
203	*Tetraodon cutcutia*	*Potka*
33	*Chaca chaca*	*Cheka*
911	*Colisa sp*	*Khalisha*
35	*Chanda baculis*	*Chanda*
36	*Chanda nama*	*Nama chanda*
37	*Chanda ranga*	*Lal chanda*
910	*Chanda sp*	*Chanda*
214	*Oryzias melastigma*	*Kanpona*
906	*Baim sp*	*Baim*