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Seasonal movement of fish species of Rajshahi and Khulna division in Bangladesh

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Abstract
In the present study 40 species were recorded as seasonal migratory. Out of 40 species recorded in concurrent swimming mode sample, only 29 species were recorded in counter current swimming mode samples. In counter current swimming mode more species were recorded to migrate from beel to river. On the other hand more species were recorded to migrate from upland to beel. The most frequently occurring taxa were small fish species like *Chanda sp., Puntius sp.* and *Chela sp*. etc. Major carps (*Labeo rohita, L. bata, L. gonius, Cyprinus carpio, Ompok pabda*) were less frequently present in the samples.
Body length data of the fish sampled indicate that even the smallest fish made use of the fish pass. The values ranges between 1.0 to 1.5 cm were frequently recorded and lengths as small as 1.5 cm were recorded in countercurrent swimming mode against relatively high-calculated velocity. However, a few large individuals *L. calbasu* (7.5 – 22.0 cm), *L. gonius* (4.5 – 25.7 cm), *Catla catla* (20 – 40 cm), *Wallago attu* (36.0 – 60.0 cm) and *Notopterus chitala* (17.0 – 27.0 cm) in particular found to be migrated through the water channel During the month of May to July, it causes a heavy rainfall. At that time live fishes *Anabas testudineus, Clarias batrachus, Heteropneustes fossilis* etc. migrated to upland from beel against the water current. Their fry and fingerling migrate actively or passively to the beel during the month of August to November.

Keywords: Fish Species, Species Sizes, Migratory nature, Migration nature, Rajshahi and Khulna division

Introduction
Fisheries production in Bangladesh, as in other exploited floodplain fisheries around the world, is strongly related to flood sequence. Floodplains inundated during monsoons are nutrient rich and play a significant role as nurseries for many larvae and juvenile fish species [1, 16, 4, 9]. Between 1970 and 1990, around 2.1 million ha of floodplain were removed from river fisheries production because of the construction of levees [13]. In Bangladesh, like in many other countries, water-entering floodplains are controlled in one-way or the other. One way to manage the water entering a floodplain is with a regulator and over the last 20 years, about 7000 regulators were constructed for this purpose in Bangladesh. However, the water entering the floodplain (mainly in the beginning of the monsoon) contains large numbers of riverine fish larvae [7] and a major problem is to manage the water without adverse impact on fisheries.
There are few direct observations on the migration of fish in the rivers of Bangladesh. It is necessary, therefore, to infer the most probable pattern of events from observations elsewhere in the Gangetic or Brahmaputra systems or from other regions with hydrological conditions which are essentially tropical. It would appear that by far the greatest number of migratory species in Bangladesh exhibit Category (ii) type migrations (FPCO, 1992b). However, it has been suggested that the major carps migrate long distances even beyond the borders of Bangladesh, to spawn [14] but evidence of fry catches along the banks of the Padma suggest local spawning grounds given that there is little possibility for upstream migration because of the Farrakah Barrage just over the border in India. It is probable that the spawn is locally produced, as in the Kaptai River [15]. The position of catfish in Bangladesh is least clear. The common catfish has been mentioned as migrating onto the floodplain and show movements of the Category (ii) type. The diafromous Hilsa shows large scale movements from the estuary into the river during the monsoon season, such as typical of Category (iii) migration.
In the present study an endeavour has been made to study the seasonal movement of the fishes in the western parts of Bangladesh.

Materials and Methods

The study was conducted during July 2007 to June 2010.

For the study of seasonal movement of the fishes in the study area different sampling devices were used in the fish pass. Fish passes are connected with beel to river and beel to brained tract. Initially low cost bamboo barricade and one way collapsible bamboo gears and traps were used. During the months of June to November observations were made in those spots. All sampled fishes, therefore, were assumed to have successfully traversed the entire length of the structure, either upstream or downstream, depending on which observation chamber was being sampled and the direction of water flow was also noted.

Samples taken in the riverside chambers were interpreted as fish migrating from beel to river and samples taken from the countryside chambers were interpreted as fish migrating from river to beel. Similar samples were taken in the brained tract side, chamber were interpreted as fish migrating from beel to brained tract. Fishes caught were quickly observed, measured and released again. Some specimen samples were preserved into 5-10% percent formalin.

Study Area and Duration

Geography of Rajshahi Division

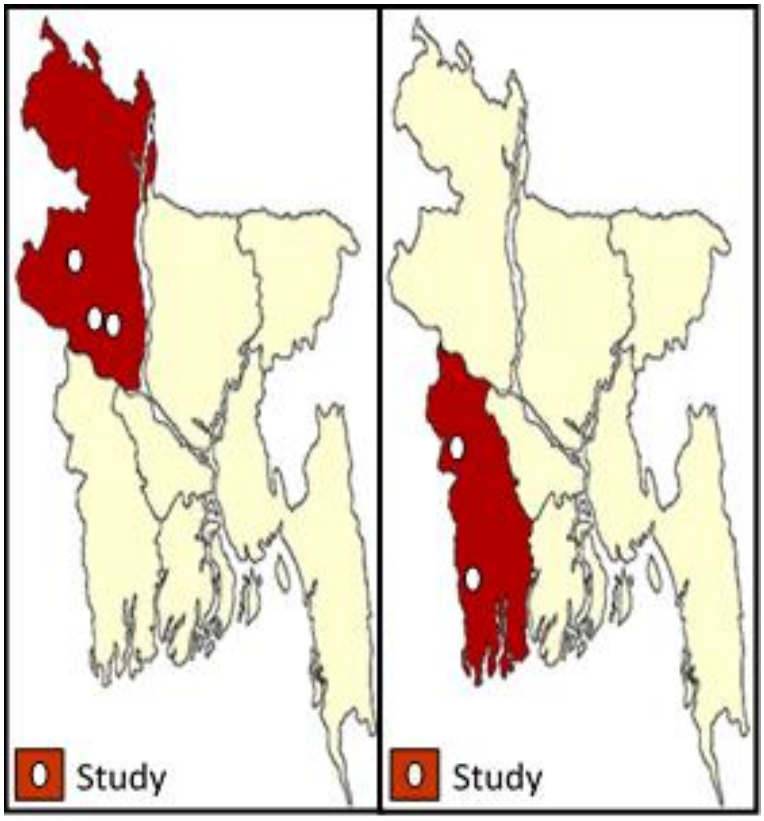
Rajshahi Division is one of the six administrative divisions of Bangladesh. It has a population of almost 30 million and area of about 34,513 km². Rajshahi division consists of 16 districts, 128 Upazilas (the next lower administrative tier) and 1,092 Unions (the lowest administrative tier). This division is characterized by its cheap labour force. It has an excellent rail and road communication infrastructure. The divisional city Rajshahi is only four hours road journey away from Dhaka, the capital city of Bangladesh.

Rajshahi division is in the north western corner of Bangladesh. It lies between 24°40′0″ North latitude and 88°50′0″ East longitudes. The famous river Padma (Ganges) borders Rajshahi division on the south and another famous river, Jamuna, lies across the eastern border. In the North and West, Rajshahi division shares a border with India.

Geography of Khulna Division

Khulna Division is one of the six divisions of Bangladesh and is located in the south-west of the country. It has an area of 22,274 sq. km. and a population of 14.47 million. Its headquarters is Khulna city in Khulna District. It lies between 22°49′0″ North latitude and 89°33′0″ East longitudes.

The Khulna division borders the Rajshahi Division to the north, the Dhaka Division to the north-east, Barisal Division to the east, the Bay of Bengal to the south and the state of West Bengal (in India) to the west. It is a part of the Ganges River delta or Greater Bengal Delta. Other rivers include the Madhumati River, the Bhairob River and the Kopotokkho River. The region also includes several islands in the Bay of Bengal.



Rajshahi Division Khulna Division

Fig 1: Showing the study area Rajshahi and Khulna Divisions

Results

Seasonal movement

It was difficult to record migratory nature of all the species in the study area. In the present study 40 species were recorded. This might be the highest number of species recorded by using fish pass in Bangladesh. It was observed that swimming mode had a major effect on the number of species trapped. Out of 40 species recorded in concurrent swimming mode sample, only 29 species were recorded in counter current swimming mode samples. Direction of migration appears to exert a secondary effect on the number of species recorded. In counter current swimming mode more species were recorded

to migrate from beel to river. On the other hand more species were recorded to migrate from upland to beel. Because most cases fingerlings migrated to the beel for feeding/foraging or refuge migration. The most frequently occurring taxa were small fish species like *Chanda sp., Puntius sp. and Chela sp*. etc. Major carps (*Labeo rohita, L. bata, L. gonius, Cyprinus carpio, Ompok pabda*) were less frequently present in the samples.

Body length data of the fish sampled indicate that even the smallest fish made use of the fish pass. The values ranges between 1.0 to 1.5 cm were frequently recorded and lengths as small as 1.5 cm were recorded in countercurrent swimming mode against relatively high-calculated velocity. The sampling gear was strongly in favour of small body size, and this accounts for the absence of larger individual of major crap and large catfish from the samples. Visual sighting indicate the absence of larger individuals of major carps and catfishes from the samples. However, a few large individuals *L. calbasu* (7.5 – 22.0 cm), *L. gonius* (4.5 – 25.7 cm), *Catla catla* (20 – 40 cm), *Wallago attu* (36.0 – 60.0 cm) and *Notopterus chitala* (17.0 – 27.0 cm) in particular found to be migrated through the water channel (Tables 1 and 2). Thus for most species both juveniles and sexually mature adult make use of the channel. During the month of May to July, it causes a heavy rainfall. At that the live fishes

Anabas testudineus, Clarias batrachus, Heteropneustes fossilis etc. migrated to upland from beel against the water current. Their fry and fingerling migrate actively or passively to the beel during the month of August to November (Table 3).

Migratory Nature

Major Carps

Major carps (*Labeo rohita, Cirrhinus mrigala, Labeo calbasu, Catla catla*) and only one introduced species Cyprinus carpio occurred in samples during most of the monsoon. The minor carps (*Labeo. gonius, Cirrhinus reba, L. bata*) were also occurred in samples during most of the monsoon. *Tor tor, L. nandina,*

L. angra, L. boga and *Hypophthalmicthys molitrix, Ctenopharyngodon idellus* were not found in the fish pass (only some species were caught in the Chalan beel area during the heavy flood when the ponds were over flooded). Big *size L. rohita* (18.5 – 40.5 cm) moved from river to beel during the month of July to August may be for breeding migration. The small size *L. rohita* (3.5 – 17.0 cm) moved both from river to beel (concurrent) and from beel to river (mainly counter current during the mid monsoon) indicates ranging behaviour, rather than active migration. Small size *Cirrhinus mrigala* was found to move from beel to river in the late monsoon may the refuge migration. The big size *C. mrigala* moved from river to beel during the early monsoon for breeding and feeding migration. Very small size *L. calbasu* (2.5 – 3.5cm) were recorded during the mid monsoon (July to September) moving from river to beel (concurrent) possibly for nursery migration. Intermediate sizes (7.2 – 14 cm) moved in both directions, and were possibly refuge or foraging migration. Big size *Catla catla* moved during the early monsoon from river to beel for breeding migration and medium size moved from beel to river during the late monsoon possibly refuge migration. *Hilsa ilisha* is not a fish of fresh water. During the monsoon various size group of *H. ilisha* were caught in the fish pass. This suggests foraging behaviour. The introduced species *Cyprinus carpio* (14.00 – 24.00 cm) moved from beel to river may refuge or foraging migration. During the month of June to September *C. carpio* (6.0 – 24.0 cm) moved from river to beel for breeding/ feeding/ nursing or foraging migration (Table1).

Minor Carps

Adult *L. gonius* (12.0 – 16.7 cm) were caught during the pre-monsoon flood moving from river to beel, and that was for breeding migration. The small sized fishes (4.5 – 8.0 cm) moved from river to beel possibly a feeding migration. Juvenile size groups (4.5 – 10.0 cm) were recorded to move in the both directions and during the mid to late monsoon (July to September) sometimes in schools indicating foraging behaviour. Adult groups (12.0 – 15.0 cm) were recorded during the late monsoon (October) also moving in the both direction. Large *L. gonius* (16.7 cm) were visually observed within the fish pass during mid and late monsoon (August – October) and direction of their movement was unknown. Very small sized *C. reba* (3.0 – 4.5 cm) were recorded during the mid monsoon moving from river to beel (August) possibly a nursery migration. Larger schooling fishes (average size 5.9 cm) moved from beel to river during the late monsoon (September –October) possibly a refuge migration. The smaller L. bata (3.6 – 4.2 cm) were only recorded moving from river to beel direction during mid monsoon (August) possibly a nursery migration. During the late monsoon (September – October) schooling juveniles and adult (6.0 – 13.5 cm) moved predominantly from river to beel as refuge migration. During the late monsoon (9.0 – 10.0 cm) fish moved from beel to river for refuge migration (Table 1).

Cat Fishes

The species of large catfish *Mystus aor, Wallago attu* and *Rita rita* and knife fish (*Notopterus chitala*) were recorded in fish pass samples. *Bagharius bagharius* occurs in the area (small number) but was not recorded in the fish pass. *M. aor* including data for guzza (*M. seenghala*), which are common in the area were found in the fish pass (Table 1).

During the early monsoon (June to August) (36.00 – 60.0 cm) size group *W. attu* were moved from river to beel possibly for breeding migration because they contained enough ova in their gonads. During the mid and late monsoon small sized fishes were moved from the beel to river may refuge or foraging migration. Different size group of *M. aor* were recorded moving from river to beel during the early monsoon (June – July). This was probably a mixture of nursery and feeding migrations. A small number of *M. aor* was recorded, moved from beel to river, may refuge or foraging migration. During the late monsoon *M. seenghala* (16 – 30cm) were moved from beel to river may refuge or foraging migration. During the monsoon (July to September) small size *M. Seenghala* (9.0 – 23 cm) moved possibly for nursery, feeding or foraging migration. During the monsoon *Mystus tengara* (3.5 – 8.0 cm) moved from beel to river for refuge or foraging migration. On the other hand (3.0 – 10.0 cm) size group of some species moved from river to beel for breeding/ nursery/ feeding migrations. During the late monsoon (September to November) *M. cavasius* (7.5 – 10.5 cm) moved from beel to river for refuge or foraging migration. In the early monsoon (May to July) (10.5-13.00) cm size group of *M. cavasius* moved from river to beel for breeding/nursery or feeding migration *Rita rita* is a fish of river. During the month of August to October about 60 specimen of *R. rita* (5.0 – 8.0 cm) were found to move from river to beel. This may be foraging

migration. Big size of *R. rita* (4.0 – 12 cm) migrated from beel to river during the month of September to November. That was probably the refuge or foraging migration (Table 1).
A small number (40 specimen) of *Eutropiichthys vacha* were found to move from river to beel during the month of July to September possibly a foraging or feeding migration. During the month of July to November 50 specimen were recorded passing from beel to river which may refuge migration. *Ompok pabda* is a rare species in the Chalan beel area. During the month of July to September only 20 specimen (12.0 – 18.0 cm) were found to moved from river to beel possibly feeding or foraging migration. On the other hand only 13 specimen were moved from beel to river probably refuge or foraging migration (Table 2).

Knife Fish
Juvenile *Notopterus chitala* (25.0 – 30.0 cm) were recorded moving from beel to river during the monsoon (August to October) possibly refuge or foraging migration. Only 4 specimen (17.0 – 27.0 cm) passed from river to beel as feeding or foraging migration. Herrings, *Gadusia chapra* is a riverine fish. During the early monsoon (June to August) it passed from river to beel for foraging or feeding migration. During the late monsoon it was only recorded moving from beel to river, possibly refuge or foraging migration (Table 2).

Glass perch
Chanda nama, C. baculis and *C. ranga* was abundant and occurred in schools in most samples. Early monsoon big size Chanda sp. moved from river to beel suggests either breeding or feeding migration. Mid and late monsoon traffic was heavy in both directions, perhaps due to foraging or feeding migration (Table 2).

Barbs
During the early monsoon, the recorded traffic of *Puntius sophore, Puntius. ticto* was moving from river to beel for breeding or feeding migration. Evidence from mid and late monsoon samples were equivocal, suggesting foraging. *Amblyphryngodon mola* is a beel fish. So their moving from beel to river may foraging behaviour. On the other hand there enter to the beel from river may feeding migration (Table 2).

Minnows
Heavy schooling of small and medium sized *Salmostoma phulo* and *S. bacaila* occurred during the early monsoon, moving from river to beel (concurrent) possibly a feeding migration. Traffic slowed considerably during mid monsoon in August, but picked up again during the late monsoon. In 2). October and November schools of larger Chela sp. moved from river to beel (Table 2).

Small Fishes
Movement of *Xnentodon cancila* during the early monsoon was generally from the river to beel was due to breed or feeding migration. Traffic during the monsoon was much reduced, but picked up during the late monsoon. During the late monsoon heavy traffic was recorded moving from beel to river. Several small species (*Botia dario, Gadusia chapra, chanda sp., Puntius sp., Amblypharyngodon mola, Chela sp., Xnentodon cancila*) had high frequency of occurrence in fish pass samples, samples data is summarized in Table 2. Various sizes *Botia dario* passed from beel to river and river to beel during the monsoon. Direction of movement was not clear because it is a riverine species, so its occurrence in the fish pass is interesting and perhaps represent foraging behaviour.

Black Fishes
There are some native species in the Chalan beel area. Such as *Clarias batrachus, Heteropneustes fossilis, Anabas testudineus* etc. Their migratory nature is different from others. During the early monsoon it causes a heavy rainfall. Then water comes towards the lower part of the beel from the upland area (barind tract) through the small and big canals. Rainwater, cloudy day and hot moisture condition are the stimulating breeding condition of the live fishes. During the month of May to July remarkable number of adult *Clarius. batrachus, Heteropneustes fossilis, Anabas testudineus* and *Colisa fasciata* passed from beel to upland area. This is for the breeding and nursery migrations. On the other hand in the month of August to November many adult, fry and fingerlings moved from upland to the beel. This may be feeding, refuge or foraging migrations (Table 3).

Discussion
For fish inhabiting seasonal floodplain river systems, the extreme spatial and temporal differences in the distribution of resources mean that the optimum habitat for feeding rarely coincides with that for breeding. The two sites may be isolated and separated and migrations between the two will have to be undertaken to optimize available resources. With breeding grounds upstream of the feeding grounds (floodplains), the relatively immobile eggs and hatchlings drift downstream towards the feeding grounds in the first stages of their development. The developing fish are then transported and dispersed by the floods through the secondary river systems and by the time they reach the floodplains they are at a stage in their development when they are able to exploit the rich food resources.
The flood cycle is an essential element in the life history of most of the fish in the rivers of the study area. The inundation of the floodplain provides the spawning grounds, nursery areas and the major feeding opportunities for many of the 256 species which have been recorded as found in Bangladesh [10]. Many of these species migrate considerable distances upstream, under the stimulus of the rising waters, to reach the spawning areas, and also move out over the floodplain as the waters spread. These fish depend upon the flood cycle to provide feeding grounds, space for reproduction and the environmental triggers that synchronize their life cycles with the flood cycle of the rivers. The movements of fish populations for spawning and feeding must be coordinated and it is the information derived from the changing water conditions during the flood cycle which provides the basis for such co-ordination.
Between 1970 and 1990, over two million ha of floodplain became unavailable for inland fisheries production because of the construction of levees [13]. To control water entering the floodplains, 7 000 regulators have been constructed in Bangladesh to allow the smooth movement of adult fishes (local migrants) and drifting larvae. These fish passes and fish friendly regulators were built, under the Fourth Fisheries Project, to facilitate and maintain natural fish migration, reduce larval mortality rates significantly, maintain smooth connectivity between the river and floodplains, reduce turbulence, provide enough flow and depth to attract fish to and fro between river and floodplain and provide an exit and entrance velocity within the swimming speed of fish. There

are four examples of such installations in Bangladesh.

Sariakandi fish pass is located at the western part of the Bolai canal under Sariakandi Upazila, Bogra. Among all the fish passes Sariakandi fish pass is the largest and newest fish pass in Bangladesh allowing fish movement between the Jamuna and Bangali River. Kasimpur regulator and fish pass is on the Manu River, at the western end of Korakadi canal, located between Kushiyara River and Kawadighi Haor at Moulovibazer and Jugini regulator and fish pass is at the east bank of the river Jamuna at Tangail, located on the Lohajong River in Jugni village. Moricherdana fish pass is at the confluence with the Mohanonda River, Chapai-Nawabganj district [8].

Few flood river fish are confined to one habitat. The species that reside on the flood plain and beels at the height of the dry season tend to be those that have adapted to withstand limiting conditions (such as desiccation, isolation and deoxygenation) in the dry season pools. Of these, some are restricted to a small geographical area and make only short migrations (20-30 km). Others, however, migrate substantial distances, between very different habitats.

On the basis of their behaviour, mainly related to migration and reproduction, the fish species of Bangladesh can be divided in two groups: "whitefish" and "blackfish" [11]. "Blackfish" species are able to tolerate the de-oxygenated water conditions of dry season floodplain waterbodies and may spend most of their lives in a single water-body. These include species such as snakeheads (Channidae), catfish (Heteropneustidae) and climbing perch (Anabas testudineus). "Whitefish" migrate upstream and laterally to the inundated floodplains adjacent to the river channel in the late dry season or early rainy season in order to spawn in the nutrient-rich waters. The eggs and larvae of these species are drifting downstream and are entering the floodplain with the floodwater, where they feed on the developed plankton. At the end of the rainy season, the adults and young of the year escape/migrate to the main river channel in order to avoid the harsh conditions of the floodplain during the dry season. Whitefish or riverine fish in Bangladesh consist mainly of the Indian carp like *Catla catla, Labeo rohita, and Cirrhinus mrigala*, and they compose 5-10% of the total inland catch of Bangladesh [5-7].

Migration and spawning of the major carp in Bangladesh was first studied by Tsai and Ali in 1983-85 [14]. They found that the major carp in Bangladesh were comprised of three stocks: the Brahmaputra stock, Padma stock and the Upper Meghna stock. The Brahmaputra stock is the largest stock in Bangladesh, and its spawning grounds are located in the Southern tributaries of the Brahmaputra river in the Assam Hills and Letha Range, Assam, India [1]. Upstream migration of adult major carps in the Jamuna/Brahmaputra River starts in March, coinciding with the gradual rise of water level. Spawning starts in May, with the onset of the Southwest monsoon, and continues until the end of July [2, 3, 12, 14].

The long range of the migration of riverine fish and the return of the larvae makes them vulnerable. Large numbers of adults are caught before they reach the spawning places. The newborn larvae are searched for by predators and fishermen, and encounter numerous water management structures such as sluices and regulators before they are back in the floodplains. Consequently, their numbers decline significantly on their way down towards the floodplain as indicated by Tsai and Ali (1986).

The sampling results for carps in the present study generally suggest foraging behavior across the fish pass during the mid monsoon for all recorded size classes. Active refuge migration is indicated during the late monsoon; especially for larger classes. The evidence also suggests a pre-monsoon breeding migration of *L. gonius, C. mrigala, C. catla, C. carpio* from river to beel and a nursery migration of *C. reba, L. calbasu, L. bata, C. carpio* during the mid monsoon. The results are in approximate conformity with the existing carp life history information. Riverine fish in Bangladesh consists mainly major carps and large catfishes and they compose 5-10% of the total inland catch of Bangladesh. On the basis of behaviour mainly related to migration and reproduction in particularly the fish species of Bangladesh can divide in two groups. "Whitefish" and "blackfish". Blackfish may spend most of their lives in a single water body and are able to tolerate even in de-oxygenated water conditions of the flood plains during dry season. In order to spawn in the nutrient rich waters, whitefish migrate upstream and laterally to the inundated flood plains adjacent to the river channel in the late-dry or early dry season. The substantial amount (44% reported by CPP 1994) of eggs and larvae in planktonic stages of their life cycle has been died due to predation natural mortality, fishing activities and water regulators before reached in flood plans.

The sampling results suggest that *N. chitata, M. aor, M. seenghala, M. cavasius, E. vacha* may use the fish pass for feeding migration while most of species migrates from beel to river during the late monsoon may be refuge migration. The movement and inferred migration patterns of the small fish species (with the apparent exception of clupeids) appear to be more complex than for carps and for large catfishes and knife fish. Many small species are known to spawn several times during the monsoon, thus some schooling movements during the mid and even late monsoon could be due to spawning migrations rather than feeding or refuge migration. The absence of information on the state of sexual maturity and the lack of samples create serious gaps in understanding migration patterns.

Table 1: Migratory behaviors of carp and some others cat fishes of the study area during the investigation period (2007-2010).

Species	Beel to river migration			River to beel migration		
	Period	Size group in cm (N)	Migration pattern	Period	Size group in cm (N)	Migration pattern
Rui, *Labeo rohita*	Jul. to Oct	3.5-30 (50)	Foraging	July to Aug	4.0-40 (51)	Breeding foraging
Kalibaush, *Labeo calbasu*	Jul. to Oct	7.5-22 (43)	Refuge/ Foraging	June to Nov	2.5-22.0 (45)	Breeding/ Nursing
Bata, *Labeo bata*	Augto Nov	4-10 (90)	Refuge/ Foraging	June to Nov	3.5-13.5 (90)	Nursing /Refuse
Ghonia, *Labeo gonius*	Augto Nov	4.5-16 (45)	Foraging/ Refuge	July to Nov	4.5-16 (80)	Breeding/ Feeding
Mrigal, *Cirrhinus mrigala*	Sep to Nov	12.0-18.0 (90)	Refuge/ Foraging	June to Sep.	18.9-30 (40)	Breeding/ Feeding
Rhekhor, *Cirrhinus reba*	Sep. to Oct.	5.6-6.9 (500)	Refuge/ Foraging	July to sep.	3.0-4.5 (800)	Nursing/ Foraging/ Feeding
Catla, *Catla catla*	Sep. to Dec.	10.0-20.0 (60)	Refuge	June to Sep.	20-40 (80)	Breeding
Japanirui, *Cyprinus carpio*	July to Nov.	14.0-24.0 (45)	Refuge Foraging	June to sep.	6.0-24.0 (50)	Breeding/ feeding Nursing/ Foraging
Ilisha, *Hilsu ilisha*	Aug. to Sep.	17.0-27.0 (5)	Refuge Foraging	Jul to Sep.	16.0-32.0 (20)	Foraging

Chitol, *Notopterus chitala*	Aug. to Oct.	25.0-30.0 (15)	Refuge Foraging	June to Sep.	17.0-27.0 (16)	Feeding/ Foraging/ Breeding
Boal, *Wallgo attu*	Aug. to Dec.	20.0-50.0 (109)	Refuge Foraging	June to Aug.	36.0-60.0 (20)	Breeding
Eta, *Rita rita*	Sep. to Nov	4.0-12.0 (97)	Refuge Foraging	Aug. to Oct.	5.0-8.0 (60)	Foraging

Table 2: Migratory behaviours of small fishes and catfishes of the study area during the investigation period (2007-2010).

Species	Beel to river migration			River to beel migration		
	Period	Size group in cm (N)	Migration pattern	Period	Size group in cm (N)	Migration pattern
Aayr *Mystus aor*	Aug-Nov	11-35 (30)	Refuge/ Foraging	Jun. - Jul.	6-24 (30)	Nursing/Feeding
Guza, *Mystus seenghala*	Sep.-Nov	16-32 (22)	Refuge/ Foraging	Jul.– Sep.	9-23 (32)	Foraging/Nursing/Feeding
Tengra, *Mystus tengara*	Jul. - Sep.	3.5-8 (400)	Refuge/ Foraging	Jun.– Oct.	3-10 (300)	Feeding/Breeding
Gulsa tengra, *Mystus cavasius*	Sep.- Nov	7.5-10.5 (75)	Refuge/ Foraging	May – Jul.	10.5-13 (170)	Breeding/Nursing/Feeding
Bacha, *Eutropiichthys vacha*	Jul. - Nov	8-14 (50)	Refuge	Jul. – Sep.	12-18 (140)	Foraging/Feeding
Poba, *Ompok pabda*	Sep.- Nov	9-15 (10)	Refuge/ Foraging	Jul. – Sep.	12-18 (20)	Foraging/Feeding
Rani, *Botia dario*	Jun. - Oct.	2.5-6.6 (330)	Refuge	Jul. – Nov.	3-6.9 (310)	Foraging
Khoira, *Gadusia chapra*	Jun. - Oct.	4.7-7 (209)	Refuge/ Foraging	Jun. – Aug.	2.6-8 (200)	Foragig/Feeding
Chanda, *Chanda sp.*	Jun. - Oct.	1.5-6.5 (3400)	Foraging	Jun. – Oct.	2.2-6 (2000)	Feedin/Foraging
Puti, *Puntius sp.*	Jun.- Nov	5.2-8 (9000)	Foraging	Jun. – Oct.	2.6-8.3 (400)	Feeding/Breedin/ Foraging
Mola, *Amblypharyngodon mola*	Jun. - Oct.	2.5-6.8 (302)	Foraging	May – Nov.	2.1-6 (2000)	Feeding/ Foraging
Chela, *Chela sp.*	Jun.- Nov	4.1-12 (500)	Foraging/Feeding	Jun. – Nov.	1.6-8.5 (1045)	Feeding
Kakila, *Xenentodon cancila*	Jun.- Nov.	8.5-17 (308)	Refuge/ Foraging	Jun. – Nov.	6.9-9.7 (100)	Feeding/ Breeding/ Foraging

Table 3: Migratory behaviours of some native fishes of the study area during the investigation period (2007-2010).

Species	Beel to river migration			River to beel migration		
	Period	Size group in cm (N)	Migration pattern	Period	Size group in cm (N)	Migration pattern
Magur, *Clarias batrachus*	May - Jul	12-24 (30)	Breeding/ Nursing	Aug– Nov	6-17 (90)	Refuge/ Foraging/Feeding
Shing, *Heteropneustes fossilis*	May - Jul.	13-18 (56)	Breeding/Nursing	Aug– Nov	6-17 (180)	Refuge/ Foraging/Feeding
Koi, *Anabas testudineus*	May - Jul	3-11 (80)	Breeding/ Nursing	Aug– Nov	3-11 (300)	Refuge/ Foraging/ Feeding
Colisa, *Colisa fasciatus*	Jun. – Oct.	3-6.5 (409)	Breeding/ Nursing	Jul. – Oct.	2.5-5.5 (350)	Refuge/ Foraging/ Feeding

Plate 1: Fishpass (allowing fish movement between Gher to Gher)

Plate 2: Billdohor fishpass (allowing fish movement among the Karatoya river, Atrai river and the Chalan beel)

Plate 3: Baromasha Khal fishpass (allowing fish movement between the Baluhar Baor and Kapotakshi river

Conclusion

Bangladesh is one of the world's most densely populated countries. Approximately half of its 138 million population is considered to be poor and very vulnerable to climate change. Rajshahi and Khulna has extensive water bodies that have a high potential for fisheries production. But fisheries are generally undervalued in terms of their contribution to food security, income generation and ecosystem functioning. Conventional economic approaches aim to provide detailed quantification using a cost-benefit framework, which may not sufficiently value the role and function of pond, beel and riverine fisheries.

The taxonomic account of fish biodiversity in the present study comprises 160 species, 97 genera, 44 families, 12 orders. There were 130 species of fishes found in Rajshahi division and 126 species in Khulna division. Ninety six

species are common in both divisions. The endemic species of Rajshahi division is 34 and Khulna division is 30 species.

The biodiversity of Bangladesh's water resources, especially in the floodplains, is one of the richest in the world. However, it is under threat due to overexploitation, loss of habitat, water pollution, etc. Surveys need to be undertaken to assess the fauna in these water resources, identify the species extinct or endangered, identify causative factors, and suggest remedial measures for conservation of threatened species and biodiversity. Systematic studies of the fresh water fish fauna of the study area with reference to ecology and distribution, seasonal availability, feeding habits, breeding season and migration need more research.

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