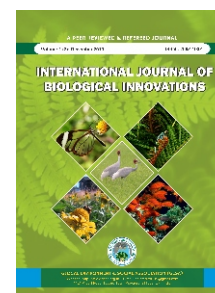




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Research Article

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Status of Indian major carps spawn in the Halda River along with marketing and economic condition of the Fishers and related collectors

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Abstract: The spawn of Indian major carps makes the Halda River an irreplaceable heritage of Bangladesh. The study was conducted to observe present status of Indian major carp breeding and collection management procedures of carp spawn and fry from the Halda River along with marketing process and economic conditions of the fishers and spawn collector. Data were collected through direct interview. In marketing system of carp eggs, spawn and fry in the Halda River, a number of intermediaries were involved actively in the marketing system. Four different types of marketing systems were identified in Halda spawn and fry distribution fry seller to final consumer. Fertilized eggs and spawn were collected and hatched by the local fisher's and collectors using their indigenous method. Those egg collectors sold to the hatchery owners per kg spawn at the rate of 50,000-80,000 BdTk. Again hatchery owners sold each and every fry at the rate of 5.0-6.0 BDTk. to the local fish farmers. Yearly survey information on Halda River's egg, spawn and fry collection showed an ups and downs production rate during last 07 years. The production status in the year 2011, 2012, 2013, 2014, 2015, 2016 and 2017 was 230, 1569, 526, 508, 107, 320 and 338kg respectively and these types of ups and downs indicated poor number of broods, poor breeding ground and poor ecosystem of the Halda River. Different types of transports were used to carry fertilized eggs and spawn of Halda River. Investigation was also done to find out the economic condition, average income during breeding season and off season, educational background and family status of the local people of Halda region involving in fry collecting and marketing system. The study recommends that ecosystem health and breeding ground of Halda River should be protected for ensuring availability of pure line fertilized eggs and spawn of Indian major carp.

Keywords: Economic resources, Fertilized egg, Halda River, Marketing, Production, Spawn.

INTRODUCTION

Halda river once had an abundance of native wild fishes. Due to over-exploitation and various ecological changes in the river, aquatic resources in the open water are under severe threat. This river is under great stress and its existence is in danger because of changing aquatic ecosystems. The up and downstream of the river system is silted, which reduces the rate of water flow and causes habitat degradation. Feeding

and breeding grounds of fishes in and around the Halda River have been reducing drastically from various human created problems. Indiscriminate destructive fishing practices, soil erosion, siltation, construction of flood control and drainage structures and agro-chemicals have caused havoc to the Halda River (Diaster 1990; Alam 1996; Hussain and Hossain 1999).

Halda River is situated in the southern-east area of Khagrachari and Chittagong District of Bangladesh. This is the only river in Bangladesh from where fertilized eggs of major Indian carps are collected (Patra and Azadi 1985; Tsai 1981). This river is famous as a breeding ground for pure Indian carp population. As a tidal river, this is the only in the world from where fishermen collect fertilized eggs and spawn directly (Kibria, 2009). The fishers and collectors stocked these fertilized eggs and spawn in their own ponds near the River Halda. They collect all the eggs and spawn at a time and hatch the fertilized eggs rear these spawns in their ponds. Necessary aeration facilitates the hatching. Hatchery owners from the different corners of the country come here to buy these spawns. These spawns are mostly disease resistant, inbreeding free, higher survival rate and able to live in stressed conditions. It is very important to collect spawn and fry from River Halda to avoid inbreeding. Therefore, identification of proper marketing channel of spawn and fry of River Halda would provide more information for the hatchery owners.

According to DoF, different research works have been done on the River Halda, such as, Conservation and Management, Impact of Climate change and its Remedy (Azadi 2005), Restoration of natural Breeding habitat etc. (Rahman *et al.*, 2012), but no initiatives were taken for the development of marketing channels of spawn and fry of Halda River. The socio-economic conditions of personnel who are involved

with Halda spawn and fry are unknown. Besides this quality of spawn and fry and their transportation systems are also unknown.

This study was done to identify a clear conception about natural breeding status, spawn and fry production, collection system and marketing channels of spawn and fry of Halda River. The study was mainly focused on Raozan area, where spawn and fry of Halda River are available. The marketing channel was tested in all regions where Halda river spawn and fry were abundant. The objectives were to find out breeding status and information on spawn and fry, collection and hatching method of fertilized eggs by the local fishers and collectors, marketing system and transportation process of spawn and fry and finding the socio-economic conditions of the people involved with this management.

MATERIALS AND METHODS

Location and area of the Halda River

Halda River originates from the Badantali Hill Ranges in Ramgarh Upazila in the Chittagong Hill Tracts, flows through Fatikchhari, Bhuipur, Hathazari, Raozan, Upazilla and Chandgaon Thana of the Chittagong district, and falls into the Karnaphuli River. The data was collected mainly from Nangalmora, Dalai nagar and Raozan. During study period, the 81 km long river had a very turbulent tributary, the Dhurung River. The depth of the Halda River was 6.4 m in depth and 9.1 m in deepest point.

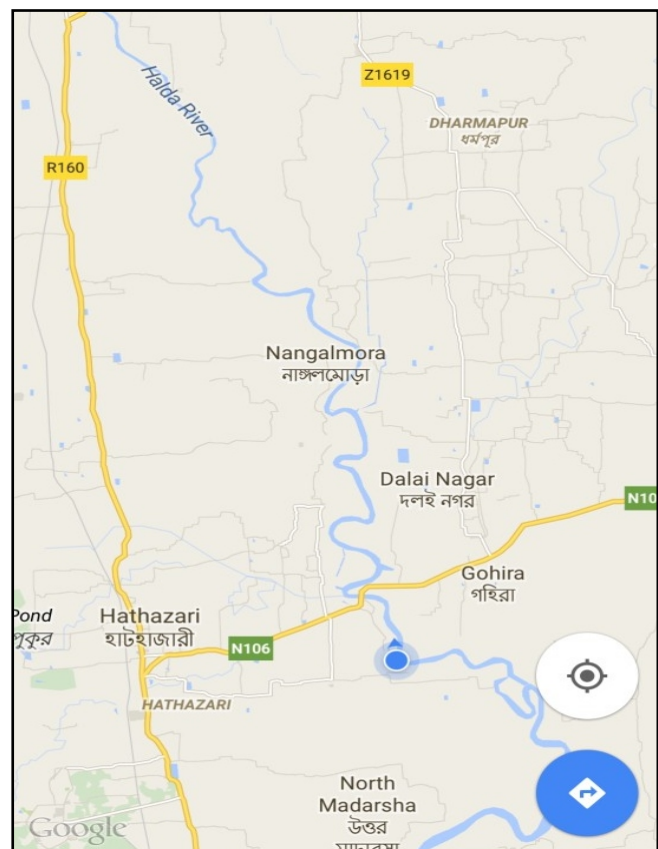


Fig. 1: Map of Halda River with three study areas (GPS location).

Experimental procedure

The study was carried out during January, 2011 to October, 2017. The research was operationalized through collection of both primary and secondary data, comprehensive literature review and extracts of local knowledge and information. Collection of primary data were prepared by field observation of the collecting procedure of egg from Halda River, stocking method of collected egg and spawn, spawn and fry sellers, involving people of fry rearing and in government hatcheries, fry buyer and fish farmers etc. Secondary data were collected from Upazila Fisheries Officer (UFO) and from internet.

Formation of committee and Awareness meeting

Local management committee was formed with the community living in the vicinity of Halda river region like Gohira, Machuagona and Madunaghat, consisting of 25 members from fry collectors, and fishers. Through participatory discussion the members of the management committee formulated necessary rules and regulations for sharing benefits from Halda river resources. Regular meetings were arranged fortnightly where all spawn and fry collector representatives along with Upazila Fisheries Officer were present and discussed the progress of the management activities of the Halda River.

Data Collection

A set of questionnaires was developed consistent with the objectives for collecting relevant information. A total of 45 interviewees were selected for questionnaire interviews at three different places. There were many egg and spawn collectors, hatchery workers and Jolodas (Fishermen) in Halda region, but interview was taken from 45 persons of three different regions such as, Gohira, Dalainagar and Nangalmora by random sampling method. In Govt. hatchery of Raozanareas, interview was taken from 17 different persons. Among them 11 were involved in different Hatchery whereas 6 were involved in fish farming.

Method of data collection

The data were collected by using snowball technique. It was divided into 3 steps. These were focus group discussion with hatchery workers, questionnaire interviews with egg and spawn collectors and fish farmers, and cross-check interviews with key informants.

Analysis of experimental data

The data were analyzed using Duncan's Multiple Range Test to find out whether any significant difference existed among collected data (Duncan, 1955; Zar, 1984). Standard deviation in each Parameter was calculated and expressed as mean \pm S.D.

RESULTS

The results of the experiment were linked regarding the present status of fertilized eggs, spawn and fry collection of Halda River and marketing systems and the socio-economic conditions of the fisher's and collectors involved in these areas.

1. Production and management

a. Testing of brood

Brood of the Halda River was tested to identify responsive percentage in ovulation. In the breeding season about 98% mature brood ovulated.

b. Identification of species

In the River Halda, highest percentage ($55.80 \pm 3.66\%$) of *Catla catla* species was identified. About $24.70 \pm 2.12\%$ of *Labeo rohita*, ($9.70 \pm 1.02\%$) of *Cirrhinus mrigala* and lowest percentage ($5.50 \pm 1.09\%$) of *Labeo calbasu* was recorded. About $4.30 \pm 0.08\%$ of others fishes including cat fish, minor carp etc, were also available (Table 1).

Table 1: Information about Percentage of spawn in the river.

Sl. No.	Name of species	Percentage of spawn	Remarks
1.	<i>Catla catla</i> (Catla)	55.80 ± 3.66	Highest
2.	<i>Labeo rohita</i> (Rui)	24.70 ± 2.12	Medium
3.	<i>Cirrhinu smrigala</i> (Mrigal)	9.70 ± 1.02	Lower
4.	<i>Labeo calbasu</i> (Calbasu)	5.50 ± 1.09	Lowest
5.	Others fishes	4.30 ± 0.08	-

c. Egg collection techniques

During the full moon in monsoon, when it rains torrentially with thunderstorm, strong current of hill flood from upstream comes to Halda with nutrient rich turbid water. It brings about changes in the physico-chemical characteristics of water in Halda River which creates the favorable environment for brood fishes to lay eggs. This is locally known as JOW. During JOW, the local fishers and egg collectors waited for favorable ebb and tide. Brood fishes laid eggs when the current became stable right after the ebb or following the tide.

However before laying eggs finally, brood fishes laid small quantity of eggs experimentally, to which the local people call NOMUNA, meaning samples. When the sign of NOMUNA became discernible, the locals take their position on the river with boats, nets and other tools needed for collecting eggs. The technology used in collection of eggs was totally indigenous to the local people living on the banks of Halda. They had developed and perfected the use of their technology from the experience derived knowledge over generations. When favorable environment of natural breeding was

ensured, brood fishes laid eggs. The whole river gets flooded with small pearl-like carp eggs within few minutes (Fig. 3).



Fig. 3: Pearl-like eggs of Carps.

d. Uses of fishing craft and gears

In general egg collectors used a 10-12 feet long wooden boat (Fig. 4) with two fishermen, a mosquito net specially prepared for egg collection, two anchors, two long bamboos, a big plastic bucket and a bowl. The egg collectors collect eggs together in a festive mood (Fig. 5). This indescribable heavenly scene is unique to the River Halda only.



Fig. 4: Egg collection Boats.



Fig. 5: Egg collection methods.

e. Egg Hatching Techniques

The collectors collected eggs and return home. They hatch eggs by using two different methods. Firstly, eggs hatched in mud scoops dug by the local people on the river bank using their indigenous knowledge. The egg collectors were used this method since time unknown. Secondly, in the government hatchery cement tanks or plastic built rectangular tanks used for hatching. They used also mosquito net on the tank and released the eggs on it. During that time, they maintained a continuous water flow for hatching. The local collectors reared the spawn for 4 days and grew up to fry. They sold fry to the fish farmers in the different areas of the country.

f. Price variations in spawn and fry

Prices of Halda spawn and fry varied in different stages of the marketing channel. Egg collectors sold spawn at a cost of Bd. Tk. 50,000-80,000/kg to the hatchery owners (Fig. 6), Farmer reared the spawn and sold it at a cost of Bd. Tk. 5-6/fry to the local fish farmers.

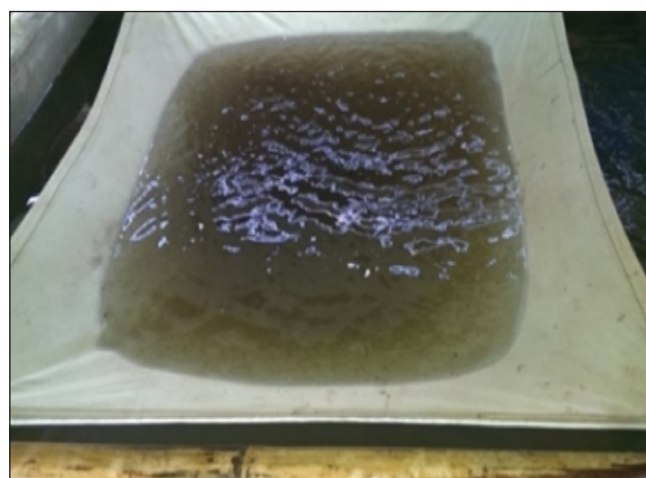


Fig. 6: Spawn and fry collected from circular tank for sell.

g. Production

The catch statistics indicate that ecosystem health and egg collecting pressure of the Halda River was increased day by day. Total catch of spawn was recorded 230 kg in 2011 and it was increased to 1569 kg in 2012. But a decreasing trend of production of spawn was recorded 526, 508 and 107 kg during the year 2013, 2014 and 2015 and an increasing trend was recorded 320 and 338 kg consecutively in between 2016 and 2017 (Fig. 7). So, yearly production percentage of the river was increased 6.39% to 43.6% in between 2011 and 2012, and decreasing trend of production percentage of the river was recorded 14.62% to 2.97%. Finally production of spawn was increased 8.9% to 9.4% in between 2016 and 2017 (Fig. 8). Total number of eggs and spawn collected was 684 and 753 between 2011 and 2012. But the number of egg collectors was decreased in 2013. But the tendency of egg collector number was increased at 298 to 519 during the year 2012 to 2017 (Fig. 7).

a. Survival of Spawn and Fry

According to hatchery workers, the survival of the spawn and fry during different stages of the rearing process was more than 95% and mortality rate was less than 5%. The spawn and

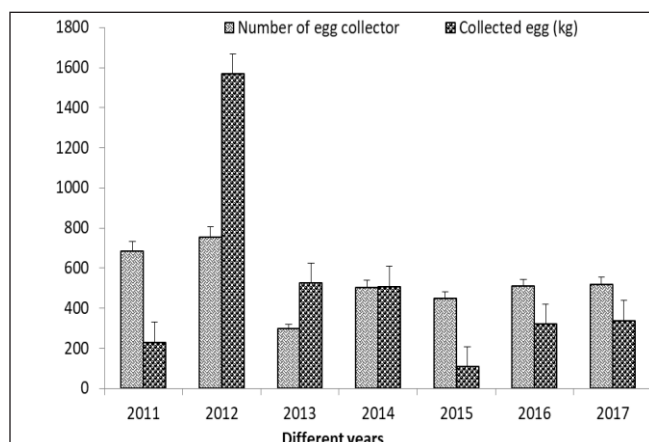


Fig. 7: Production of fry in Halda River in between 2011 and 2015.

fry of River Halda showed healthier during transportation. They were more disease resistance and had capacity to adapt any environment easily.

i. Spawn and Fry rearing technique in the Hatchery

Two types of ponds were used in case of Halda spawn and fry rearing in private Hatcheries. One type was nursing pond (Locally called, Atur Pukur) and another was rearing pond (Locally called, Lalon Pukur). In the nursing pond, the spawn and fry became 2.5-3.5cm in size and then they were transferred to the rearing pond. In the rearing pond, fries were reared up to 3,50,000 fry/ha.

In the nursery pond, 1st feed was given after 6-8 hours of spawn release. Yolk sac of the larvae was dissolved within 72 hours. At that time one boiled egg's yolk of hen or duck was supplied for one 0.10 million spawn for its ration. After two days only nursery feed was provided at 400% daily ration for 1st to 5th days, 200% daily ration maintained for 6th to 10th days and 50% daily ration maintained for 11th to 15th days of total biomass. In order to meet up the increasing dietary demand nursery feed was supplied at 5 to 10% of the total biomass per day. Daily ration was adjusted by estimating the standing crop once in each five days by random sampling of the stock. The daily ration was divided in three equal parts for feeding the fish three times at early morning, noon and afternoon. After feeding 15-20 days Halda fries were shifted from the nursery to the rearing pond. In this case, fry were bathed in 10 liter salt water. Locally, this process was called, *Pona Shodhon*. After bathing, the fries were transferred to rearing pond. When the size of fry was about 3-4 inch, they were ready for selling to the fish farmer.

Proximate composition of the supplementary nursery feed was analyzed according to AOAC (1995) and nitrogen free extract (NFE) was calculated by subtraction sum of crude protein, other extract, crude fibre and total ash (Castell and Tiews, 1980). Proximate composition such as crude protein,

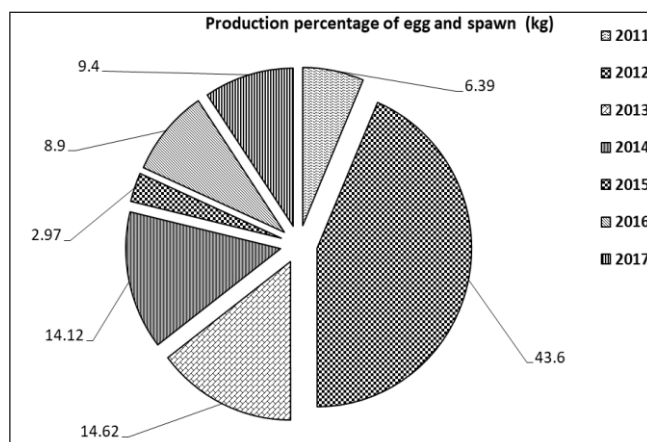


Fig. 8: Yearly Production rate of egg and fry in Halda River's.

crude lipid, crude fiber, ash and calcium (on % dry matter basis) of the supplementary nursery feeds was 39.0, 8.0, 5.0, 2.6 and 5.5%, respectively.

k. Marketing systems of Halda Spawn and fry

There were a number of middlemen involved in the spawn and fry marketing system of Halda River. Spawn and fry of the river were distributed in four different ways.

Firstly, most of them were marketed from egg collectors to the local fish consumers by following channels:

Spawn and fry seller's → *Local fish farmers* → *Pond owners and other fish farmers* → *Local Markets/Consumers*.

Secondly, a number of them spawn and fry were marketed from egg collectors to the consumers of nationwide by the following channels:

Fry sellers → *Agents of Hatchery owners'* → *Hatchery Supervisor* → *Hatchery workers* → *Fry distributor* → *Fish cultivator's* → *Market consumers*.

Thirdly, some of them were distributed to the government Halda brood restoration projects to restore the brood fish of Halda River by the following channels:

Fry seller's → *Govt. Halda Brood Restoration Projects* → *River Halda*. (Fig. 2)

Fourthly, a few numbers of spawn and fry were marketed from egg collectors to the renowned public hatchery owners in order to grow up mother fishes by following channels:

Fry seller's → *Hatchery Owner's* → *Persons involved in making mother fishes*.

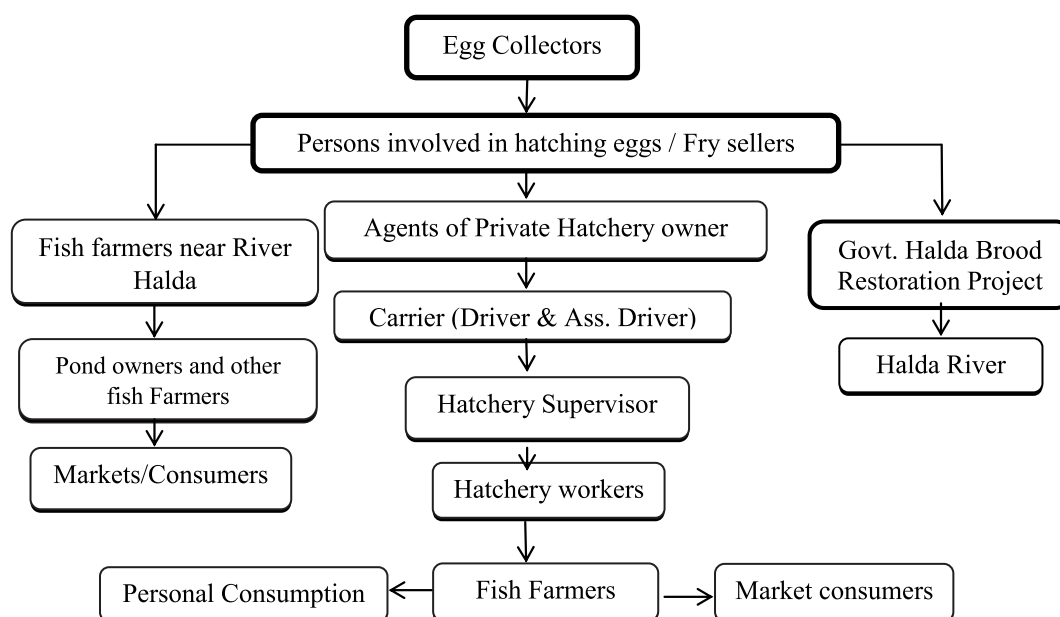


Fig. 2: Marketing processes of Halda River spawn and fry.

k. Spawn and Fry Transportation System

Different types of equipments are used in spawn and fry transportation. Fry was transported from the Halda River to the nearest hatchery by using buckets. In the hatchery, eggs were released in a hatching tank and maintained continuous

water flow on it. During transportation to the long distance places, spawn and fry are transported using oxygenated polybags. In this case, Micro, CNG, auto-rickshaw etc. are used as transport vehicles (Table 2).

Table 2: Vehicles and equipment's involved in spawn and fry transportation.

Places	Vehicles/Equipment's	Percentage
From Halda River to Nearest hatchery	Hand carry by Bucket	03
From Seller to Buyer	Oxygenated poly bag	62
From Carrier to Private Hatchery	Micro/CNG/Auto-rickshaw etc.	18
From Private Hatchery to Fish farmer	Hand carry/Rickshaw/Honda/Micro	07
From Fish Farmer to Fish Market	Rickshaw/CNG	10

1. Socio-economic Condition of the traders

a. Formation of committee and Awareness meeting

About 5 meetings were held with the community people living in the vicinity of Halda river through participatory discussion during the study period. The members of the management committee and Upazilla Fisheries Officer discussed the activities and progress of management and measures taken to stop illegal fishing of brood fish from the river. A large number of stakeholders attended almost all the awareness meetings and the progress of the management activities were remarkable.

b. Average Age of the Interviewee

About 42 different persons from 3 riverside were interviewed. Most of the interviewees were more than 30 years and represent 32% in the age distribution chart. More than 70 years old people represent minimum (4%) number of interviewees in the age distribution chart. Their age

distribution is represented by pie chart (Fig.9) as given below:

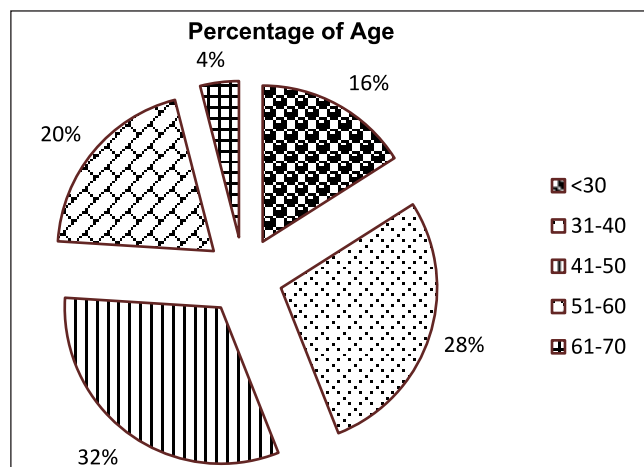


Fig. 9: Age distribution chart of people involved in marketing channel.

c. Educational Background

Educational background varies greatly in the studied area. Only 15% of respondents had no education. They could sign only and are mainly fishermen. About 28% people of this area had primary education and 30% had secondary education such as, fishermen, egg collector, driver, fish farmer etc. About 18% respondents were basically technicians and had under graduate education. About 7% and 2% interviewee were graduate and post graduate and were Hatchery owner, Hatchery Manager, Technician etc. Their educational background is shown in the figure 10.

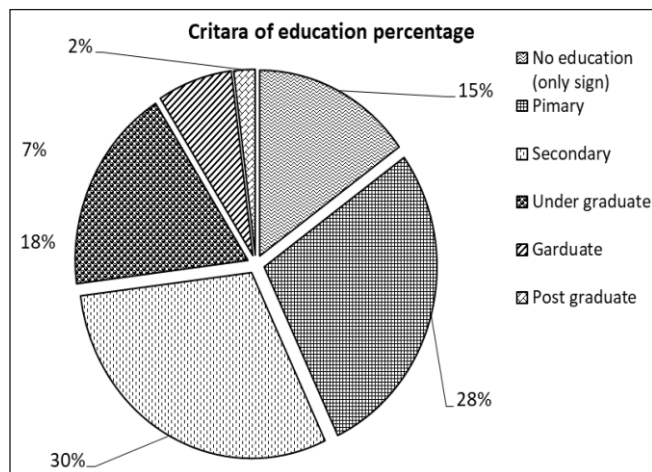


Fig. 10: Education percentages of responsive persons involved in Halda river channels.

e. Income Source

In the “On season” of Halda eggs and fry, the income source of most of the interviewees is egg and spawn collection,

d. Family Type

Most of the interviewees are married and living in single or joint families. In some cases they are only earning member of their family. Families are classified into two types: I) Nuclear families – married couples with children, and II) Joint families– group of people related by blood and/or by law.

In this study 60% interviewees were found to live in nuclear and 40% interviewees were found to live in joint families (Fig. 11).

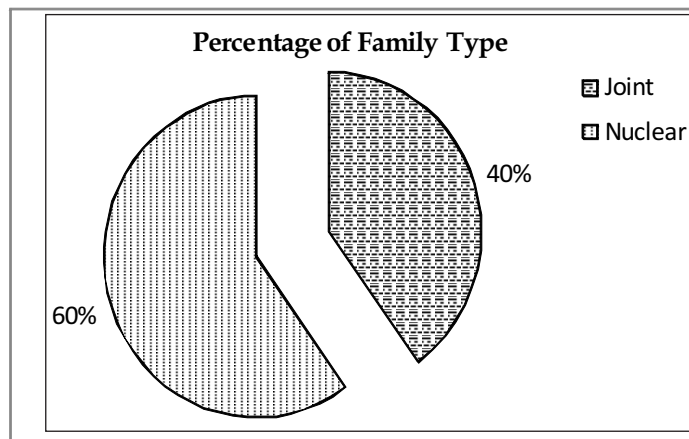


Fig. 11: Family type of the interviewees.

hatching, rearing, selling etc. But in the “Off season” interviewees earn money by involving themselves in daily labor, agriculture, fish culture etc (Table 3).

Table 3: On season and off season income sources.

On season income source	Interviewee (%)	Off season income source	Interviewee (%)
Egg and spawn collection	30%	Fish culture	3%
Net setting and fishing	10%	Day labor	23%
Hatchery advising	3%	Poultry business	7%
Hatchery management	20%	Agriculture	34%
Pond preparation and feeding	11%	Business	7%
Feed apply	8%	Hatchery advising	2%
Sampling & reporting	5%	Hatchery management	5%
Fish culture	10%	Hatchery technician	3%
Driving	3%	Hatchery work	4%
		Service holder	3%
		Driving	9%

In this study 25 egg collectors were interviewed. An average income varied among egg collectors and persons involved in hatchery. Average incomes of egg collectors were depended on the availability of fertilized eggs and spawn in River Halda

in a given year. But average income of hatchery workers is the same throughout the year. On season income of egg collectors/day and off-season income of egg collectors/day has been shown in pie chart (Figs. 12 & 13)

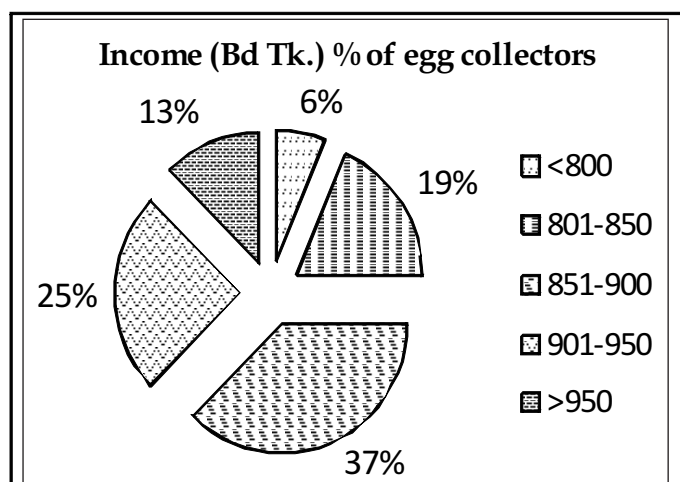


Fig. 12: On season income of egg collectors/day.

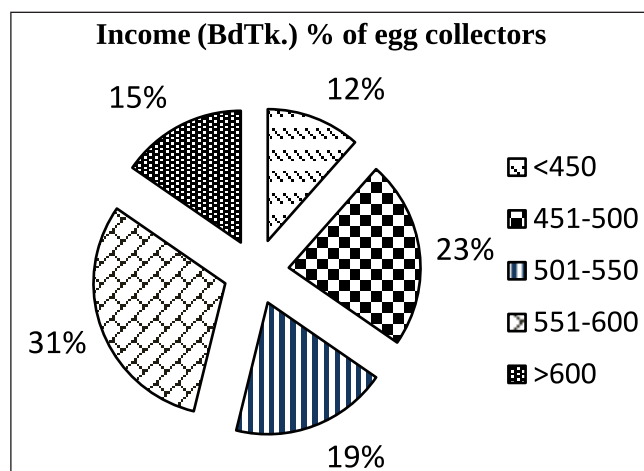


Fig.13: Off season income of egg collectors/day.

a. Income of Drivers

A driver and an assistant driver were involved in carrying fry from River Halda to the Hatchery of different districts. In that case, the driver was paid 6,000 BDTk. whereas the assistant driver paid 1,800 BDTk. for transporting the fry.

b. Locations, persons, vehicles, materials and chemicals used in the marketing channel of Halda spawn and fry

Different types of vehicles, materials, and chemicals were

used by different persons at each rearing stage in the marketing channels of carp spawn and fry of River Halda. In table 4, it is showed that responsive percentage of egg collectors, boatmen, Jolodas, persons involved in hatching eggs and fry sellers were 92%, 97%, 95%, 93% and 91%, respectively.

Table 4: Responsive percentage, persons, vehicles, materials and chemicals used in the collection of Halda fry.

Sl. No.	Persons	Vehicles/	Materials with chemical	Responsive percentage n=45
1.	Egg Collectors	Boat (Sampan)	One mosquito net, two ropes, two bamboo sticks (locally called- Tuni), two mathal, one gamla (Tank), bowl, KMnO ₄ , NaCl	92
2.	Boatman	Boat (Sampan)	One boat, two anchors, two boitha, torch, umbrella, mathal (Jhungur), NaCl.	97
3.	Jolodash	Boat (Sampan)	Mosquito Net, Fishing Net, Boat, NaCl.	95
4.	Persons involved in hatching eggs	Hand carry with bucket	Mosquito net, Water sprayer, Hatching Tanks, such as- Cemented Tank (12ft by 6ft), Bottle Hatchery, Plastic Cistern (8ft by 4ft), Circular Tank, Bucket (Small, 12 inch bucket contains 10-12kg eggs and Large, 18 inch bucket contains 18-20kg eggs), Ponds, KMnO ₄ , NaCl.	93
5.	Fry Seller	Hand carry with Poly Bag	Poly bag, Weight machine, NaCl.	91

DISCUSSION

In this study, three different areas of Halda River were studied for collection and distribution channel of Halda spawn and fry. Rahaman *et al.*, (2013) identified three different marketing channels in Mymensingh district of Bangladesh. Prices of Halda spawn and fry switched in different stages of the marketing channel. Egg collectors sold spawn at the rate of BDTk. 50,000-80,000/kg to the hatchery owners. On the other hand, the hatchery owners sold fry at the rate of BDTk.5-6/piece to the local fish farmers. Generally, an ordinary hatchery fry of 1-1.5 inch size was sold at the rate of BDTk. 1-2/piece whereas similar sized Halda fry was sold at the rate of BDTk. 5-6/piece. Sharif and Abdulla-Al-Asif (2015) reported that the average prices of Rui, Katla, Mrigal and Calbasu spawns at different hatcheries in Jessore were 1900, 2400 and 1500 BDTk, respectively. He also reported that the prices were high at the beginning and end of the season but comparatively less when the supplies of fries were available. Considering both government and private Fish Seed Farms (FSFs), sale price of spawn for government fish seed farm (BDTk. 2250/kg) was higher as compared to private fish seed farm (BDTk. 1660/kg). It is clear that the price of Halda spawn and fry was much higher than the ordinary hatchery produced spawn and fry. The price of Halda River spawn and fry was higher than government and private farms due to quality and pure spawn is certified (Ahmad, 1955).

Halda River spawn and Fry were transported in a sophisticated manner at every stage of marketing channel. Adequate oxygen (O₂) was supplied in the polythene bags during transportation of fry. Fluctuation of dissolve oxygen concentration and consumption of dissolve oxygen by spawn was maintained at optimum level to control mortality (Boyd, 1982). Oxygenated polythene bags were handled carefully in micro bus. Air conditioning (AC) micro bus was used to control the temperature of the water in polythene bag. Transportation cost varied with time and distance of place. However, Roy (2008) reported that transportation cost was negligible in West Bengal, India due to less interference of middlemen and short distance of places.

The survival rate of the Halda River spawn and fry during different stages of the rearing process and transportations was more than 95% and as a result the mortality rate was less than 5%. Rahaman *et al.*, (2012) found that the fry mortality was 24% due to improper management in Jessore district of Bangladesh which is much more than this finding. The fry of river Halda was more disease resistant and had capacity to adapt with little environmental stress. As a result, their survival rate was highly satisfactory.

Most of the interviewees aged more than 30 years (32%) and more than 70 years old people represent minimum (4%) number of interviewees, which is very similar to the study of Pravakar *et al.*, (2013). Most of the interviewees were married and lived in single or joint families. 60% interviewees were in nuclear and 40% interviewees were in joint families (Abdulla-Al-Asif *et al.*, 2013). He found that

73% had single family but only 27% had joint family in Chachra of Jessore which is more or less similar to present study.

Some of the interviewees were highly educated, such as, hatchery owners, hatchery managers, technicians etc. They occupied only 2% in the education percentage category and 30% interviewees had secondary and 15% had no education and could sign only which is more or less similar study of Abdulla-Al-Asif *et al.*, (2015).

Average income of egg collectors depended on the availability of eggs in river Halda in a given year. But average income of hatchery workers was the same throughout the year. In this study, the 'On-season' income of (37%) egg collectors was BDTk. 851-900 and (6%) egg collectors was less than BDTk 800 per day. Besides, 'Off-season' income of (30%) egg collectors was BDTk 451-500 and (10%) egg collectors was less than BDTk 450 (Abdulla-Al-Asif *et al.*, 2015).

The catch statistics indicate that ecosystem health of the river declined and fertilized egg and spawn collecting pressure was increased day by day. Total catch of spawn was recorded 230 kg in 2011 and it increased to 1569 kg in 2012. A decreasing trend of production of spawn was recorded from 526 kg to 107 kg in between 2013 and 2015. It was found that an increasing trend was recorded at 320.0 and 338.0 kg consecutively in between 2016 and 2017 (YFSB 2011-12 to 2017-18). Hence, total production percentage of the river was increased from 6.39% to 43.6% in between 2011 and 2012, and decreasing trend of production percentage of the river was recorded from 14.62% to 2.97%. Finally production of spawn increased from 8.9% to 9.4% in between 2016 and 2017. This study was very much similar to the study of Moyle and Leidy, 1992. They found that worldwide 20% of all freshwater species are extinct, endangered or vulnerable. Hence, commercially important brood fishes e.g., rui, catla, mrigal and other carp species were facing high risk in the breeding ground of Halda River, which is more or less similar to IUCN, Bangladesh 1998. According to IUCN 2000, Bangladesh, about 56 freshwater fish species were critically endangered. Due to over-exploitation and various ecological changes in natural aquatic ecosystem health of Halda River, this breeding ground is at high risk, which was similar to the investigation of Sarker (1993).

The study clearly indicated that the spawn and fry of Indian major carps of the Halda River were over exploited and thus, poor brood stock population was recorded in the different years. In addition, aquatic ecosystem health was changed due to soil erosion, siltation, drainage structures, use of agro-chemicals, construction of Rubber dam and flood control barrage. The genetic stock structure of aquatic populations was reduced due to pollution and destructive fishing practices. Therefore, the ecosystem health and biological diversity of the Halda River have been depleting in an unprecedented rate, which was similar to the investigation of Chakraborty *et al.*, 2019; Chakraborty, 2018; Chakraborty

and Mirza, 2007. Intervention to control floods, adoption of new agricultural technologies and construction of road networks has changed the ecology of River significantly, which was similar to the investigation by Khan, 1995 and Ali, 2010. Stock of the wildlife brood fishes and other species in the breeding ground have suffered significant damages, resulting in a reduction of biodiversity as well as a decline in the socio-economic importance of Halda River as a source of brood fish which was found to be very similar to the investigation of Nishat, 1993 and Zaman, 1993.

The action plans for saving the stock of aquatic lives are to develop community based co-management and management policies; to declare the river as sanctuary; enforcement of fishing rules; prevention of killing brood fish and juveniles; stocking every year with original Halda fingerlings; to ensure unplanned construction of flood control, embankments, drainage systems and sluice gates; controlling use of pesticides and agrochemicals; and controlling use of water in irrigation.

CONCLUSION

Halda River is the only pure Indian major carp breeding ground in Bangladesh from where fertilized eggs, spawn and fry were collected by local fisher's and collectors during March to June every year. Fertilized egg, spawn and fry collection in Halda River from the year 2011 to 2018 was 230, 1569, 526, 508, 107,320 and 338 kg, respectively and these types of ups and downs indicated poor number of broods, poor management of breeding grounds and unhealthy ecosystem of the Halda River.

RECOMMENDATIONS

On the basis of the findings of the present study specific recommendations should be incorporated:

- a. Establishment of rubber dam in the upstream of the Halda River would be removed to develop healthy ecosystem for Indian major carp's breeding ground and continuation of water flow of the river;
- b. Presence of sluice gate in different regions of Halda River would be used eco-friendly for natural breeding of Indian major carps;
- c. A sustainable technology should be developed and need based training for collection system of spawn and fry, transport, handling and shipment must be organised;
- d. To establish a sanctuary and form a permanent management committee to improve the ecosystem, health and habitat of breeding ground of the river.
- e. To control the inflow of industrious waste product in the river and oil spills from engine boat used for carrying sand.
- f. Specify marketing channel need to establish and ensuring the supply of the original Halda river spawn and fry to avoid dishonest farmers supply other normal spawn and fry as Halda fry.

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