Seasonal Variation of Water Quality and Nutrient Contents of *Wallagoattu* (Bloch & Schneider, 1801) in Different Freshwater Habitats of Bangladesh

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DEDICATED TO

MY

BELOVED PARENTS AND BROTHER

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THE AUTHOR **DECEMBER, 2015**

ABSTRACT

The purpose of the study was to assess the levels and seasonal variation of physical, chemical properties and nutrient contents of Boal fish (*Wallagoattu*) collected from AshoolarBeel and Jamuneswari River in order to provide current information on habitats water characteristics, fish nutrient contents and hence propose suitable measures for sustainable management. This study was conducted from May 2015 to December 2015, covering among pre-monsoon, monsoon and post-monsoon periods. AshoolarBeel and Jamuneswari River are very important resource to peoples, stakeholders and has a fragile ecosystem that experiences rapid changes associated with natural and anthropogenic factors such as huge water abstraction for irrigation agriculture, fertilizer residues runoffs from the agro-based farms and sediments discharged.They are playing an important role in the regional economy and food security of the local people. Among different water quality parameters dissolved oxygen, transparency, pH, and depth varied significantly among the sampling sites. During the study period Air temperature (Mean ± SD) ranged between 27.42 ± 1.84 °C to 31.68 ± 1.12 °C atAshoolarBeel and 26.70 ± 1.48 °C to 31.66 ± 1.07 °C atJamuneswari River in the different season. Water temperature was found vary from 25.40 ± 2.75 °C to 30.30 ± 1.08 °C atAshoolarBeel and 26.10 ± 2.70 °C to 30.10 ± 1.03 °C atJamuneswari River in the different season in the study period. Mean (±SD) transparency values showed a peak of 49.45 ± 8.84 cm in post-monsoon and lowest values of 41 ± 14 cm in pre-monsoon both in the two habitats respectively. The water depth was showed very wide changes in each habitats as well as seasons. The depth of water column varied between 2.20 to 14.00 ft at AshoolarBeel and 2.00 to 14.00 ft respectively in the pre-monsoon and post-monsoon session. Mean (±SD) dissolved oxygen values for the two habitats a general decline as from pre-monsoon, with a peak value of 10.12 ± 1.5 mg/l in post-monsoon at AshoolarBeel and the lowest value of 6.22 ± 0.879 mg/l in pre-monsoon at Jamuneswari River. During these investigations, pH value was found to high (8.10) in pre-monsoon season in comparison to monsoon & post-monsoon season both in the two habitats. In the study, the maximum value of alkalinity 45.20 mg/l was recorded in the pre-monsoon in AshoolarBeel and the minimum value 27.45mg/l atJamuneswari River during post-monsoon period. Alkalinities in all sampling season were not similar. The study was also conducted to determine the chemical composition of *Wallagoattu*based on the moisture basis.Biochemical composition indicates the percentage of many important nutrients that

are essential to the human body. Nutritional quality of an edible variety of fish is important for formulation of balanced food products. The maximum value of Moisture contents of Boal fish 79.03 % was reported in the post-monsoon at Jamuneswari River and the minimum value 72.38 % at AshoolarBeel during pre-monsoon period. The mean (±SD) values of ash contents were 2.43±0.46 %, 2.20±0.22 % and 2.55±0.67 % at AshoolarBeel and 2.31 ± 0.58%, 1.91 ± 0.88% and 2.76 ± 0.60% atJamuneswari River in the pre-monsoon, monsoon and post-monsoon period respectively. Protein contents were significantly higher in the post-monsoon and lower in the pre-monsoon period. The maximum value of protein contents of Boal fish 19.72 % was reported in the post-monsoon atJamuneswari River and the minimum value 16.82 % at AshoolarBeel during pre-monsoon period. In the present study, the range of lipid contents of the fish was found to vary from 3.10-5.14 %, 2.57-4.21% and 2.24-3.37 % atAshoolerBeel and 3.49-4.78 %, 2.63-4.17 % and2.02-3.83 %atJamuneswari River during experiment in the three different seasons. There was significant differences (P<0.05) of all the water quality parameters and nutrient contents observed among pre-monsoon, monsoon and post-monsoon period both at the Jamuneswari River and AshoolarBeel. But there was no significant differences show between the two different freshwater habitats except water depth in post-monsoon season. Seasonal influences of all the water quality parameters and nutrient contentswere more or less same for each habitat.The above findings have shown most of the parameters studied are within permissible limits of still exceed the enviable range given by some agencies and nutrient composition of the fish species might be a good source of protein in this study area.

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LIST OF ABBREVIATIONSAND SYMBOLS

ABBREVIATON&SYMBOLS	ELABORATION
BBS	Bangladesh Bureau of Statistics
BFDC	Bangladesh Fisheries Development Corporation
BFRI	Bangladesh Fisheries Research Institute
BMDRS	Bangladesh Meteorological Department Regional Station
CFC	Chloro-Fluoro Carbon
CIFRI	Central Inland Fisheries Research Institute
DoF	Department of Fisheries
EEZ	Exclusive Economic Zone
FAO	Food and Agricultural Organization
Mg/l	Milligram per liter
GDP	Gross Domestic Production
GO	Government Organization
Ha	Hectare
Hrs	Hours
cm	Centimeter
%	Percentage
SD	Standard deviation
IUCN	International Union for Conservation of Nature
ANOVA	Analysis of Variance
G	Gram
^{o}C	Degree Celsius
SPSS	Statistical package for the social science

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Freshwater fisheries are blessed with multiple geographical features which include vast wetland and water bodies in Bangladesh. This total inland area at present is 46, 99,394 hectors (DoF, 2015). This retains a tremendous scope of fish habitat and diversity of aquatic organisms. Inland fisheries contribute about 83.22% (DoF, 2015) of countries total fish production. Fish and Fisheries sector play an immensely important role on the socio-economic development of Bangladesh from time immemorial and it is the part of our cultural heritage. Fisheries sector contributes about 2.01% of the total export earning, 3.69% to GDP and 22.60% to agricultural sector (DoF, 2015). Annual fish production was 35, 48,115 metric tons in 2013-2014 financial years. Fish also contributed about 60% to the nation's animal protein intake during 2013-2014 (DoF, 2015). At present annual fish intake by an individual is 19.60 kg and the annual fish demand is 33.90 metric tons (DoF, 2015). So it can reduce malnutrition problem by increasing the production of fish.

The vast area and high content of nutrient made the fresh water habitats an ideal feeding and breeding grounds for the fishes, so a larger number of fishes are the permanent resident of the area. About 265 species of freshwater fish available in Bangladesh of these it is estimated that about 200 species are truly freshwater while the rest are examples of estuarine and marine species (Rahman, 2005). Over 140 species are classified as small indigenous species (SIS) of fish and 56-73 species mostly consumed by the poorer section (Felts *et al.,* 1997).

There are many freshwater habitats in northern Bangladesh. These are enriched with many ecosystem services and have substantial impact on the ecology, biodiversity and socio-economy of the surrounding localities. These resources are a critical source of protein for the people who live around. They are playing an important role in the regional economy and food security of the local people. But at present the status of these freshwater habitats ecosystems is not very encouraging. Some parts of the habitats are completely dried up during winter session. Moreover, unplanned urban and agricultural developments and the related anthropogenic disturbances, predominantly throwing of

garbage, discharge of sewage and municipal wastes into water body, unload of sand, overexploitation of aquatic resources are reported as increasing problems responsible for destroying the overall ecosystem.

The most important compounds of an ecosystem are water. The better quality of a water body depends on its physical, chemical and Biological characteristics. But some correlation was possible among these parameters and the significant one would be useful to indicate quality of water (Manjare *et al.,* 2010). In freshwater ecosystems, it is well recognized that the biotic and physical attributes of habitats have a major influence on the diversity, distribution, and survival of organisms. Changes in nature of freshwater habitats can cause rapid changes in biodiversity composition, (Dc Pauw and Vanhooren, 1983). Plankton abundance depends on the physic-chemical characteristics of the water body. The maximum productivity may be obtained when the physical and chemical parameters are at the optimum level. Therefore, water quality is a paramount factor in ecosystem productivity (Huet, 1986).

Any ecosystem provides significant information about the available resources for supporting life in that ecosystem by its water quality. Monitoring of these water quality parameters is essential for any water resources. Researchers are being carried out till present (Mrinal *et al.,* 2012; Melek *et al.,* 2012; Abujam *et al.,*2011; Mondal *et al.,* 2010; Brcnda and Achuthankutty, 2010; Chandra *et al.,* 2010; Mustafa and Brooks, 2009; Ganesan and Khan, 2008; Muzaffar and Ahmed, 2007; Nurullah *et al.,*2002). These include seasonal variations in the physical and chemical characteristics and nutrient dynamics in the network of water bodies found across the country. However, very little information is available in relation to physical and chemical characteristics of water in the Dinajpur district. Hence, the present study was conducted to study the physio-chemical properties of water in the AshoolarBeel and Jamuneswari River under Dinajpurdistrict, Bangladesh for a period of May 2015 to November 2015.

Therefore, the present study also concentrated on Boal fish (*wallago attu*), an endangered fish species in Bangladesh to assess its nutritional composition in Bangladesh in three different seasons of the year.

Boal fish, *Wallagoattu*(Bolch & Schenider, 1801) is a common species of minor carps under silurinidae family. The fish is commonly known by its genus name, *wallago* or 'lanchi'. It is found in large rivers and lakes in much of the Indian subcontinent and in

parts of Southeast Asia. The species can reach 2.4 m (8 feet) total length. It ranges in India, Pakistan and Bangladesh, in Thailand, Cambodia, Vietnam and Malaysia, and is also reported from Afghanistan. In Bangladesh this fish is normally captured from the natural sources belonging to haors, baors, beels, river in set of Dinajpur,Kishoreganj, Narsingdi,Rajshahi, Nator andNoakhali districts and now being cultured in Captive condition (DoF, 2012).

Moisture, protein, fat and ash as major components and carbohydrates, vitamins and minerals as minor components form the main constituents of fish body (Begum and Minar, 2012). Protein is considered as the main building block for the animal body. For human diet most of the portion comes from the fish and fisheries product (Minar *et al.,* 2012). Fish protein is highly digestible compared with other protein sources. It consists of all the 10 essential amino acids in an amount desirable for human consumption. Fish protein is very rich in amino acid such as methionine, lysine and tryptophan low in comparison with mammalian protein (Begum *et al.,* 2012). Besides fishes is a rich source of essential nutrients required for supplementing both infant and adult diets (Minar*et al.,* 2012 and Azim*et al.,* 2012).

It is very important to know biochemical analysis to judge the nutritive value of the raw fish and its consequence if any on the health status of the consumer. It is therefore, obvious that an understanding of the chemical composition and nutritional quality of an edible variety of fish is important for formulation of balanced food products. Since the past century significant work on biochemical composition of fish is carried out both in India & abroad. Atwater (1888) was the pioneer in this field who published first record of chemical composition of 52 fishes from Atlantic & Pacific waters. Hughes (1891) worked on variation in fat in some species from Plymouth. Milroy (1908) investigated the chemical composition of the herring during reproductive period. Kiran (2011); Dewan *et al.* (2003); Chowdhury (2004); Nurullah *et al.* (2002); Banu *et al.* (1985); Rao (1967); Brogstrom (1961); Milory (1908); Brogstrom (1961); Malek *et a*l, (1966); Rao (1967); Islam and Saha (1975); Islam and Mendes (1976); Ahmed *et al.* (1981); Govindan (1985); are some well known workers who pioneered the study of chemical composition of some fish species.

The freshwater fishes provide a great amount of nutrient food source for human. Presently, a large part of these fish species are in cultivated forms. Therefore,

information about the chemical composition of various species and their nutritional properties, biochemical structure and habitat condition is greatly needed. Impact of seasonal variations on the nutrient of the fish for its economical importance is of utmost necessary. The present study was aimed to investigate the impact of both the seasonal and habitat variations in the amount of total nutrient contents of fish from northern Bangladesh.

1.2 Problem Statement

Industrialization, increased human population anduse of fertilizers in agricultural land are causing heavy and varied pollution in aquatic environment leading to water quality and depletion of aquatic biota. Unfortunately no data on the immunological aspects of Ahsoolar Beel and Jamuneswari River is available because this river has never been extensively studied. Therefore, considering the significance of Ahsoolar Beel and Jamuneswari River particularly in the field of ecology, the present study was undertaken to provide baseline data and determine their occurrence for management decision in the management of the fishery.

Freshwater is the main and great fisheries resource in Bangladesh. It is very easy for all to manage it and make it a good source of nutrient and utilization of unproductive area. But proper management and utilization of this resource may provide additional production to the main stream of fisheries as well as national protein requirements of the country. Moreover, it may also help the livelihood of surrounding people and contribute in the foreign exchange earnings from freshwater fish.

Reduction the areas of freshwater results in low production rate of fish, which is a threat to the national protein supply especially for the poor people. There has been a gradual decline in the production of fish from freshwater over the last two decades due to the reduction of wetlands and biodiversity, over fishing, siltation and management problem (Middendorp and Balarin, 1999).

In this regard, a few studies have done on the floodplains of Bangladesh by Government or regional organizations. So, more studies are required to find out the better management technique for freshwater habitats with a view to enhancing the fisheries production of Bangladesh.

1.3 Rationale

Freshwater contribute to more than 80% of country's total fish production (DOF, 2015). Freshwater inundated during monsoons are nutrient rich and play a significant role as nurseries for many larvae and juvenile fish species (Welcome, 1985; Bayley, 1988 and Junk *et al.,* 1989). Bangladesh has the third largest aquatic fish biodiversity in Asia, after China and India, with about 800 species in fresh, brackish and marine waters (Hussain and Mazid, 2001). It has relatively vast area of freshwater which leads to the larger fish diversity with high production.

Therefore, this study covers the compare of fish diversity, habitat quality and fish nutrient contents in different natural freshwater resources of northern Bangladesh to help in finding out a suitable management technique of seasonal freshwater. Besides these, it also provides the present nutritional condition of natural fishes in the found in the studied area. So, the result of this study will be very essential in formulation of comprehensive and effective utilization of freshwater habitats.

1.4 Research Needs

Natural degradation and harmful human activities destroying aquatic resourcesday by day. In this point of view, fresh water has huge opportunity to utilize the potentiality to enhance the fish production and protein demand of the country.Capture fisheries production is decreasing day by day rapidly due to decreasing of wetlands especially freshwater. The aquaculture can conserve local biodiversity in better way. On the other hand, free access in open water allows fishing by using all types of gears. In case of, the ditches are not dried completely which allows some indigenous and residual fish to survive. As the contribution of inland open water fisheries is declining and the contribution of marine fisheries is growing slowly, it is necessary to think of culture fisheries as the appropriate means to increase fish production for the growing population.

Once the Beels and Rivers of Bangladesh are filled with floodwater from the neighboring river or canals, there happens automatic introduction of all kinds of natural fish available in local habitat. So, at the onset of monsoon, the fish can breed; spawn can grow and survive safely because of no public fishing takes place inside the area.So, culture fisheries are needed to recover the total fish production decrease of the country.

The environment of Beels and Rivers in plain land or high land (i.e. North Bangladesh) is an unstable one and instability is evident over both seasonal and geological times scale. This instability is reflected in, for example constantly changing patterns of fish diversity and physiochemical parameter. Thus, in addition to the complexity water body system poses difficulties for research. This pertinent literature has been found related to the habitats seasonal variation and relation to the fish biodiversity, habitat quality and the proximate composition.

1.5 Objectives

The main objectives of the study are to investigate the present status of fish habitat parameters and comparison of proximate composition in some seasonal freshwater habitats. The specific objectives are-

1. to compare the nutrient quality of natural fish in the different freshwater habitats;
2. to know the importance of fish habitat quality in the study area;
3. to assess the water quality in the study area;
4. to know the importance of the freshwater resources in the study area.

CHAPTER 2

MATERIALS AND METHODS

Quality of water body and qualities of the aquatic environment are the main elements of successful aquaculture. In tern the quality of the aquatic environment depends on the quality of the environment of that geographic region. Water quality are generally influenced by the Physical factors, chemical factors, biological factors and meteorological factors and determined by the general environment of that geographical region.

2.1 Study Area

The present study was conducted of two different fresh water habitats, Ahsoolar Beel and Jamuneswari River which are situated in Nawabganj Upazila under Dinajpur district of Bangladesh. Two distinct habitats are different geographical characteristics.

2.1.1 Geographical location of Ahsoolar Beel and Jamuneswari River

The study was conducted at three different stations in the Ahsoolar Beel and Jamuneswari River. The geographical location of the area is in between latitude 25.4167°N and longitude 89.0833°E . Fish samplings were done at various parts of these stations for estimation of fish biodiversity, collection of water for determination of habitat quality and collection of fishes for nutrient analysis at specific time.

Seasonal waterlogged area of various depths is available in Ahsoolar Beel and Jamuneswari River. The water types support multitudes of species of plants fish, prawns and other organisms suitable for culture. Of all these living organisms, fish are the most important element in the freshwater ecosystem that generates major source of employment for the poor and also the main dietary source of protein for the rural population. Distance between the two habitats about 5 km.

The total area of Ahsoolar Beel is 150 hector in dry season and 251.728 hector in rainy season.It has 34999 households (among them about 1.36% are involved in fishing) and total area 314.68 sq km. Many people consume their required protein from these two habitats. There are no alternative sources of fish protein in this area.

Figure 1: Geographical location of the study area

Ashoolar Beel

Jamuneswari River

Figure 2: Study Area

2.2 Experimental Fish, *Wallago attu*(Bolch & Schenider, 1801)

The Boal fish, *Wallago attu*obtaining from Ashoolar Beel and Jamuneswari River used as a experimental fish.

The taxonomic classification of the species is given below:

Phylum: Chordata

Class: Teleostomi

Order: Siluriformes

Family: Silurinidae

Genus: *Wallago*

Species: *W. attu* **(**Bolch & Schenider, 1801)

Figure 3: Experimental fish, Boal (*Wallago attu*)

2.3 Study Period

The total study period was **May 2015 to December 2015** which was segmented into two phases. First one (May to November 2015) was involved in sampling from the field three times in a year as May-June (Pre-monsoon), July-August (Monsoon) and October-November (Post-monsoon). The second phase (November to December 2015) was sample analysis in the laboratory and data analysis. All types of sample analysis were done in the aquatic laboratory and nutrition laboratory of the Department of Fisheries, University of Dhaka.

2.4 Sample Collection

Boal fishsamples were collected from Ashoolar Beel and Jamuneswari River area, Dinajpur, Bangladesh (Figure 1 indicates the collection place of fish) during May to November. Then the samples were brought into the Laboratory of Fish nutrition, University of Dhaka for biochemical composition. The sample was cut into very small pieces for testing various examinations.

2.5 Water Quality of Stations

Water samples were collected seasonally (June to November), generally during the middle of each season. Collections of samples were done from the selected marked areas between 10.00 A.M. to 3.00 P.M on the sampling days.

The surface water sample was collected directly from the undisturbed surface of each station. The sample was usually collected 10 inches below the water surface. The sampling pot was dipped into water for filling and immediately sealed under water.

2.6 Chemicals

All chemicals, including Chloroform, Methanol, Ethanol, Isopropanol, Magnesiumchloride, *n*-Hexane, Sulfuric acid, Hydrochloric acid, 35% Hydrogen per oxide, Potassiumhydroxide, Sodium thiosulphate, Sodium chloride, Potassium sulphate, Mercuric oxide, Sodium hydroxide, Boric acid, Copper sulphate, Diethyl ether, Carbon tetra chloride, Octanol, Glacial acetic acid, Potassium iodide, Starch, Wijs solution, Methyl red andbromocresol green and Phenolphthalein indicator used for analysis were of analytical grade purchased from Merk (Darmstadt, Germany).

2.7 Physical parameters

2.7.1 Air and Water temperature

Air and Water temperature was taken by the digital thermometer. The thermometer was dipped at 6 cm in water and stable reading was taken.

2.7.2 Transparency

Transparency was measured by Secchi disc 20cm diameter with alternating black and white quadrants and a long rope. Drove the disc into water & observed lower point of disc and measured by measuring tape.

2.7.3 Water depth

Water depth was taken by bamboo and normal measuring meter tape.

2.8 Chemical parameters

2.1 Dissolved oxygen

The sources from which oxygen become dissolve in water are atmosphere and photosynthesis. Dissolved oxygen was estimated by Dissolve Oxygen (DO) meter with the range 0.00 to 45 mg/l O_2.

2.8.2 Hydrogen ion concentration (pH)

The P^H was measured by pH meter. P^H was calculated by direct method which was pH meter. P^H meter was dipped at 5 cm in water and stable reading was taken.

2.8.3 Alkalinity

Alkalinity commonly means the concentration of carbonate, bicarbonate and hydroxide ions in water expressed as $CaCO_3$. Alkalinity was measured by Alkalinity test kit with the range of 0.0 to 100.00 mg/l (ppm). The determination of alkalinity in water is based on titration method. The samples water is treated with bromocresol green indicator to give a light yellow solution. Then drop until the solution color changes from light yellow to colorless. The amount of titrate EDTA added is directly proportional to the concentration of the Alkalinity.

2.9 Proximate Composition of Fishes

All the homogenized fish meat samples were subjected to moisture, Ash, protein and lipid analysis.

2.9.1 Moisture (%) contents

Moisture content in muscles was calculated by using Association of the Official Analytical Chemists (AOAC, 1995) procedure via the sample drying method in oven at 102 °C temperatures for 16-18 hours till constant weight.

The moisture content was calculated as follows:

Moisture content of the sample (%) $= \frac{\{(w1-w0)(w1-w0)\}}{(w1-w0)} \times 10$

Moisture factor = (100 - moisture) / 100

Dry matter = 100- Moisture

Where,

Weight of the foil cup = W_0

Weight of the foil t wet sample = W_1

Weight of the foil t dry sample = W_2

2.9.2 Ash (%) contents

Ash content in meat samples was calculated by using Association of the Official Analytical Chemists (AOAC, 1995) methods. First crucibles were dried at 102 ^{0}C for 2 hours in an oven and placed in desiccators, cooled and recorded their weights to about 0.1 mg. two of sample was placed into the crucible, recording weight of crucible with cover and sample to the nearest 0.1 mg. The samples were then placed in a furnace for 12 hours at 550^{0}C until all carbon removed.

Weight of ash obtained in percentage as follows:

Ash content of the fresh sample (%) = $\left(\frac{w2-w0}{w1-w0} \times 100\right) \times$moisture factor

Where,

Weight of dry crucible = W_0

Weight of dry + dry sample = W_1

Weight of dry + ash = W_2

2.9.3 Crude Protein (%) contents

Crude protein content was determined by Kjeldahl method (method 981.10, AOAC 1995). About 0.5g dry powdered sample was taken in a kjeldhal flask.1g digestion mixture and 25ml concentrated H_2SO_4 was added in kjeldhal flask. Then kjeldhal flask was set in the digestion chamber for 2.5-3hr until the solution become colorless. After that the digested product was transferred to 100 ml volumetric flask and was made product to 100 ml with distilled water. At the time heat was produced. So, cooled the product in the Refrigerator for decreasing the temperature at room temperature. Then three new kjeldhal flask and three new conical flask was taken.5 ml diluted solution, 10ml NaOH, 150 ml distil water was added in kjeldhal flask. In conical flask 5 ml boric acid and 2 drop Phenopthaline was taken. Then, transferred the Kjeldhal flask and the conical flask in the Kjeldhal distillation unit. Kjeldhal flask was boiled for 30 minute and condensed water vapour was collected in the conical flask.Titrated the solution in the conical flask against 0.01 N HCl until the color becomes pink.

The percentage of nitrogen in the sample was calculated by using the following formula:

$$\% \text{ of nitrogen} = \frac{(S-B)\times A\times C\times 100}{Weight of Sample\times 1000}$$

Where,

S = Titration reading for sample

B = Titration reading for blank

A = Strength of 0.01N HC1 (0.01)

C = Digest taken for distillation (dilution factor) ≃20

So, the percentage of crude protein is,

% crude protein (fresh sample) = N_2 x 6.25 x moisture factor

2.9.4 Crude Lipid (%) contents

Crude lipid was determined by using the Soxhlet system (model Tecator Soxtec System HT 1043-001 Manual. 1983) for extracting lipids of samples by petroleum ether.

The percentage of Lipid in the sample was calculated by using the following formula:

% of crude lipid (fresh sample) = $\left(\frac{w2-w1}{S} \times 100\right)$ x moisture factor

Where,

W_2= Final weight of the conical flask

W_1= Initial weight of the empty conical flask

S = Weight of the sample taken

3.10 Statistical Analysis

Statistical analysis was performed with the Statistical Package for the Social Sciences (SPSS) v. 20.0 software package (SPSS, SAS Institute Inc. Gary, USA). The data were analyzed to determine the descriptive statistics such as Standard Error of Mean, Standard Deviation, Statistic Mean, Minimum and Maximum value and Ranges of variables. Multiple comparisons were done with Tukey's test with one way ANOVA (Analysis of Variance) at 5% level of significance.

CHAPTER 3

RESULTS

3.1 Water Quality Parameters

In this experiment, Water quality parameters of a large number of samples were analyzed to observe any appreciable changes that might have occurred in response to different season. Comparative value of physical and chemical parameters of surface water area recorded from two freshwater habitats between the three different seasons of the study is described below separately. A wide difference was observed in the pattern of fluctuation within the season. The average value of water quality parameters of different season are presented in Table 1 and Table 2.

3.1.1 Physical parameters

The main physical parameters of a water body are air and water temperature, water depth, transparency and water depth. Seasonal variation of Physical parameters from two freshwater habitats is described below separately.

3.1.1.1 Air Temperature Variation

The air temperature of the two freshwater habitats fluctuated with season. Figure 4 shows the temperature fluctuation of the different season. The range of air temperature was found to vary from 30.00 - 32.80 °C, 27.00-30.50 °C and 23.30-30.40 °C in Ashoolar Beel and 29.50-32.70 °C, 27.00-30.90 °C , 24.20-29.10 °C at Jamuneswari River during experiment in the three different seasons (Table-1). The mean (±SD) values of air temperature were 31.68 ± 1.12 °C,29.34 ± 1.15°Cand27.42 ± 1.84 °C at Ashoolar Beel and 30.10 ± 1.0°C3 ,29.02 ± 1.32 °C and 26.10 ± 2.70°Cat Jamuneswari River in the pre-monsoon, monsoon and post-monsoon period (Table-1). The maximum value of air temperature 32.80 °C was recorded in the pre-monsoon at Ashoolar Beel and the minimum value 21.00 °C at Jamuneswari River during post-monsoon period. On the whole, the seasonal influences of air temperature were more or less same for each habitat.

Air temperature was significant differences (P<0.05) from one season to another (Table 1). But there was no significant different between the two habitats (Appendix-23 and 24). Air temperature was significantly higher in the pre-monsoon and lower in the post-

monsoon period. On the whole, the seasonal influences of air temperature were same for each habitat.

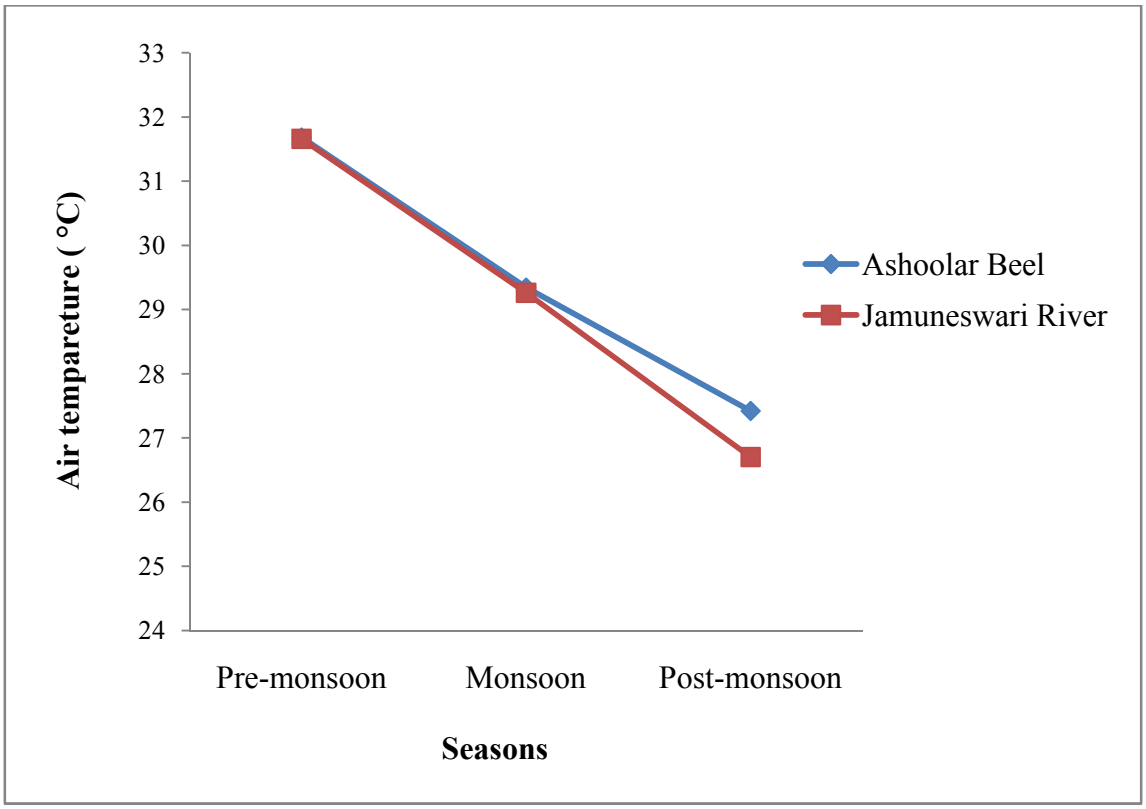

Figure 4: Fluctuation of Air Temperature in different season

3.1.1.2 Water Temperature Variation

The water temperature plays a vital role in aquaculture production through influencing physical, chemical, and biological condition of water body. Figure 5 shows the water temperature fluctuation of the different season. During these investigations, maximum water temperature 32.30 °C was observed at Ashoolar Beelin the pre-monsoon period. In post-monsoonJamuneswari River has shown minimum temperature.

Temperature has shown significant variations at ($p<0.05$) level in its values among various seasons.Water temperature was significantly higher in the pre-monsoon and

lower in the post-monsoon season. But there was no significant differences show between the two different freshwater habitats.On the whole, the seasonal influences of water temperature were same for each habitat.

Water temperature range was found to vary from 29.10-32.30 °C, 27.40-31.00 °C and21.20-30.30 °C°C at Ashoolar Beel and 28.60-32.00 °C, 26.60-30.40 °C and21.00-29.80 °C at Jamuneswari River during experiment in the three different seasons (Table 1). The mean (±SD) values of water temperature were 30.30 ± 1.08 °C,29.28±1.20 °Cand 25.40 ± 2.75°Cat Ashooler Beel and 30.10 ± 1.03 °C, 29.02 ± 1.32 °C and 26.10 ± 2.70 °Cat Jamuneswari River in the pre-monsoon, monsoon and post-monsoon period (Table 1).

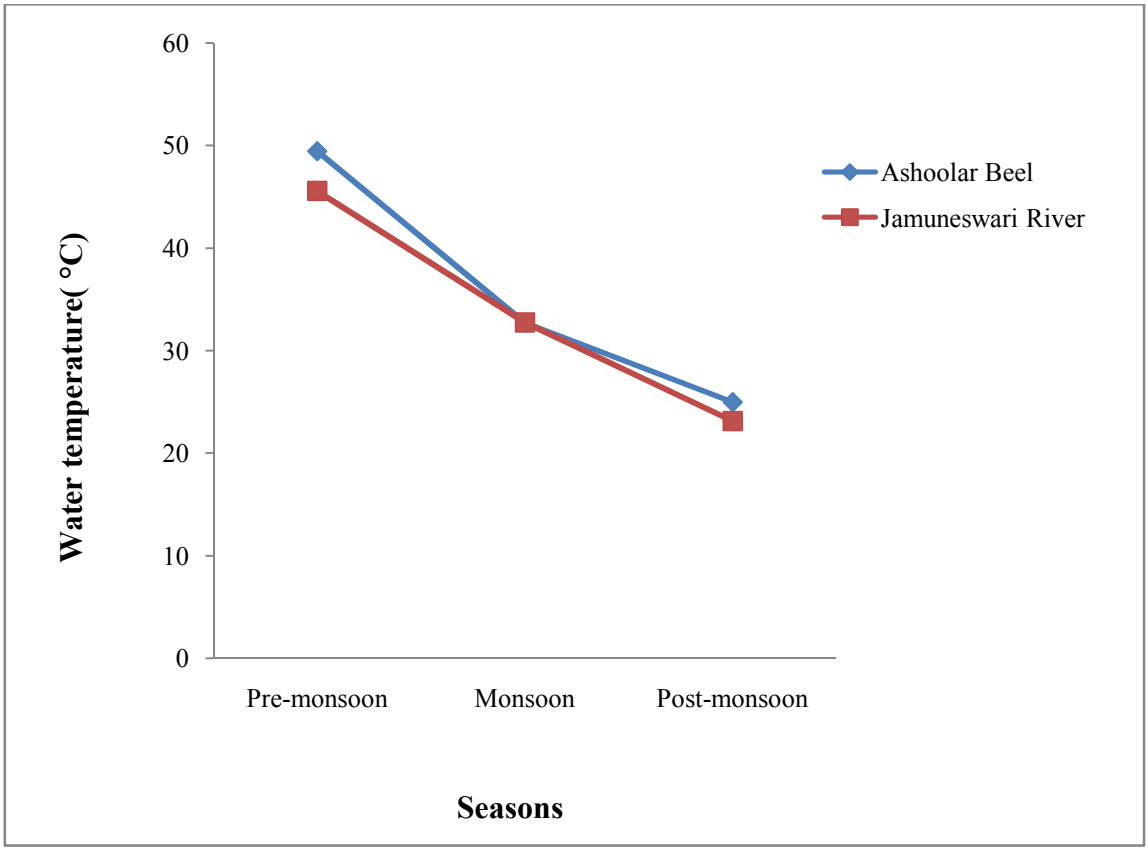

Figure 5: Fluctuation of Water Temperature in different season

Table 1: Mean values (±SD), ranges and comparison of physical parameters by using ANOVA (N=10) at different season throughout the study period at two different freshwater habitats

Habitats	Parameters	Seasons			ANOVA Significance (*p* value)	
		Pre-monsoon	Monsoon	Post-monsoon		
Ashooler Beel	Air temperature(°C)	31.68±1.12[a] (30.00-32.80)	29.34±1.15[b] (27.00-30.50.50)	27.42±1.84[c] (23.30-30.47)	*	
	Water temperature(°C)	30.30±1.08[a] (29.10-32.30)	29.28±1.20 [ac] (27.40-31.00)	25.40±2.75[b] (21.20-30.30)		*
	Transparency (cm)	49.45±8.84[a] (39.00-61.00)	29.93±16.35[b] (20.70-56.00)	24.99±4.31[ac] (18.00-34.50)		*
	Water depth(ft)	5.50±1.62[a] (2.20-7.60)	10.70±1.98[b] (7.50-14.00)	7.00±1.41[ac] (5.00-9.00)	*	
Jamuneswari River	Air temperature(°C)	31.66±1.07[a] (29.50-32.70)	29.26±1.35[b] (27.00-30.97)	26.70±1.48[c] (24.20-29.10)	*	
	Water temperature(°C)	30.10±1.03[a] (28.60-32.00)	29.02±1.32[ac] (26.60-30.40)	26.10±2.70[b] (21.00-29.80)	*	
	Transparence (cm)	45.56±8.73[a] (35.00-58.60)	32.75±4.53[b](26. 80-40.20)	23.15±4.14[ac](15.40-30.40)		*
	Water depth(ft)	2.66±0.478[a] (2.00-3.20)	10.16±1.63[b](8.3 0-14.00)	7.31±1.50[ac](5 .20-10.00)	*	

NS= Values are not significantly different ($P > 0.05$)

* Values with different superscript letters in the same row indicate a significant difference at 5 % significance level based on one-way ANOVA followed by Tukey's test.

3.1.1.3 Transparency Variation

Mean (±SD)transparency values showed a peak of 49.45 ± 8.84 cm in post-monsoon and lowest values of 23.15 ± 4.14cm in pre-monsoon (Table 1). The value of transparency ranging from 18.00-34.50 cm,20.70-56.00 cm and 39.00-61.00 cm at Ashoolar Beel and 15.40-30.40 cm, 26.80-40.20cm and 35.00-58.60 cmat Jamuneswari River during experiment in the three different seasons (Table 1). The transparency was showed very wide changes in each habitats as well as seasons. Thefluctuation of the transparency in different season shows by the figure 1 both in each habitat.

There was significant differences (P<0.05) of transparency observed in pre-monsoon with monsoon and monsoon and post-monsoon period both at the Jamuneswari River and Ashoolar Beel (Table 1).But there was no significant differences show between the two different freshwater habitats. Seasonal influences of transparency were more or less same for each habitat (appendix 27 and 28).

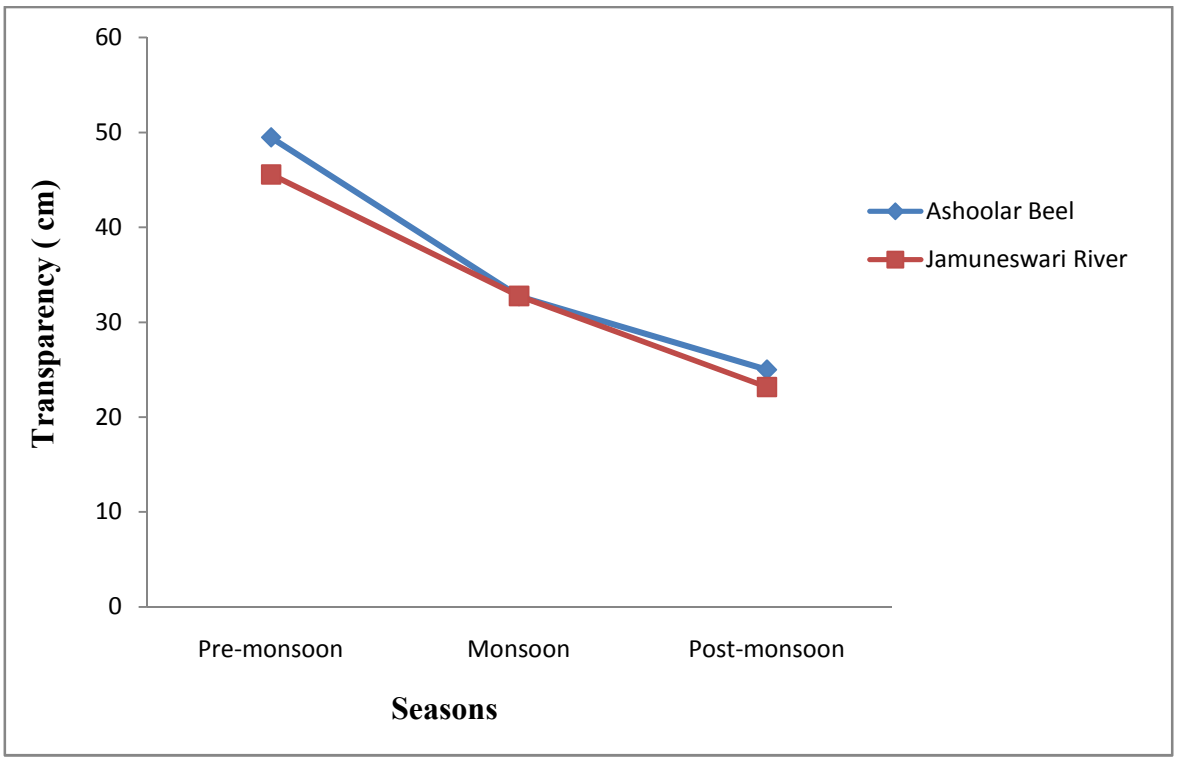

Figure 6: Fluctuation of Transparency in different season

3.1.1.4 WaterDepthVariation

The water depth was showed very wide changes in each habitats as well as seasons. The depth of water column varied between 2.20-14.00 ft at Ashoolar Beel and 2.00-14.00 ft respectively in the pre-monsoon and post-monsoon session (Table 1). The seasonal Variation of the water depth was showed higher during monsoon season and lower during pre-monsoon season (Figure 7).

The maximum value of waterdepth 14.00 ft was recorded in the monsoon at Ashooler Beel and the minimum value 2.00 ft at Jamuneswari River during pre-monsoon period.The mean (±SD) values of waterdepth were 5.50 ± 1.62ft,10.70 ± 1.98ft and 7.00 ± 1.41 ft at Ashoolar Beel and 2.66 ± 0.47ft, 10.16 ± 1.63ft and 7.31 ± 1.50 ft at Jamuneswari River in the pre-monsoon, monsoon and post-monsoon period (table-1). The seasonal influences of water depth were same for each habitat.

Water depth was significantly higher in the monsoon and lower in the pre-monsoon period. But there was no significant differences show between the two fresh water habitats except post-monsoon. Seasonal influences of water depth were same for each habitat. Significant differences (P<0.05) in water depth observed between pre-monsoon, monsoon and post-monsoon period both at the Ashoolar Beel and Jamuneswari River

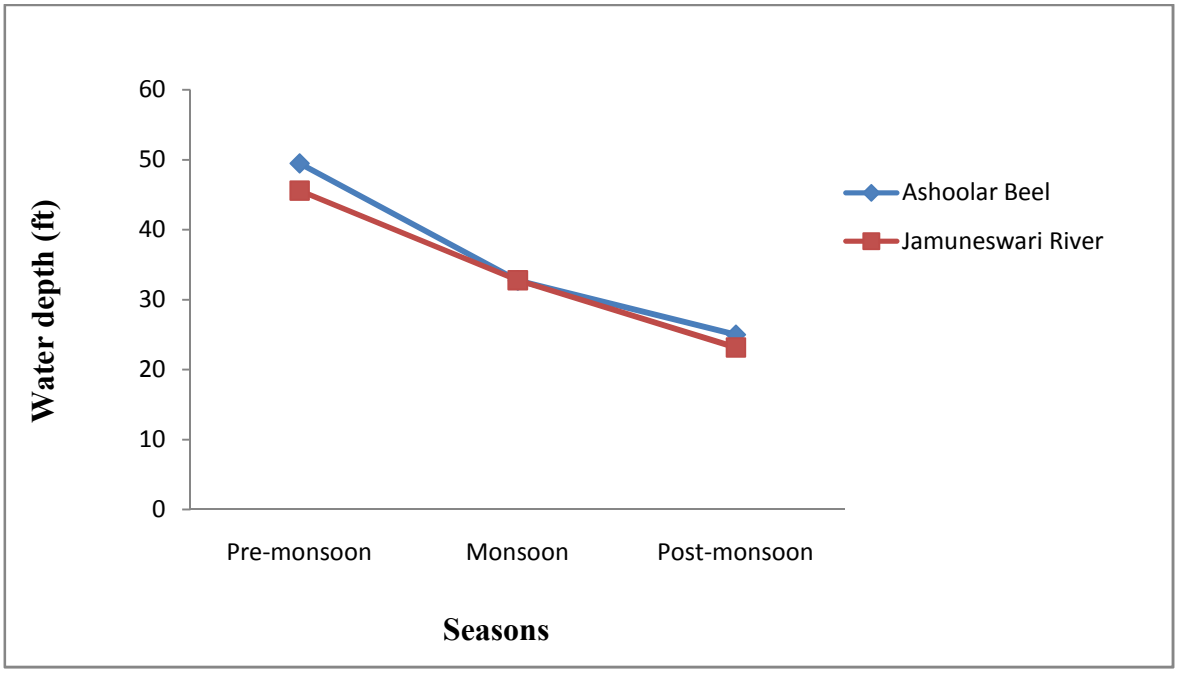

Figure 7: Fluctuation of Water depth in different season

3.1.2Chemical parameters

Dissolved oxygen, P^H,Alkalinity is the main physical parameters of a water body. Seasonal variation of chemical parameters from two freshwater habitats is described below separately.

3.1.2.1 Dissolved oxygen variation

Mean (±SD) dissolved oxygen values for the two habitas a general decline as from pre-monsoon with a peak value of 10.12 ± 1.5 mg/l in post-monsoon at Ashoolar Beel and the lowest value of 6.22± .879 in pre-monsoonat Jamuneswari River (Table 2). Figure 8 shows the fluctuation of DO. From Table-2 the range of dissolved oxygene was found to vary from 5.70-8.20 mg/l,5.90-7.50 mg/l and 5.90-10.60 mg/lin Ashooler Beel and 5.60-8.50 mg/l,5.70-7.50 mg/l and 5.60-8.50 mg/lin Jamuneswari River during experiment in the three different seasons.

Single factor ANOVA showed that there were significant variations ($P<0.05$) on mean dissolved oxygen values among session (Table 2). However there was significant difference between pre-monsoon and post-monsoon season butthere was no significant differences show between the two fresh water habitats. Seasonal influence of DO more or less same both in the two habitats.

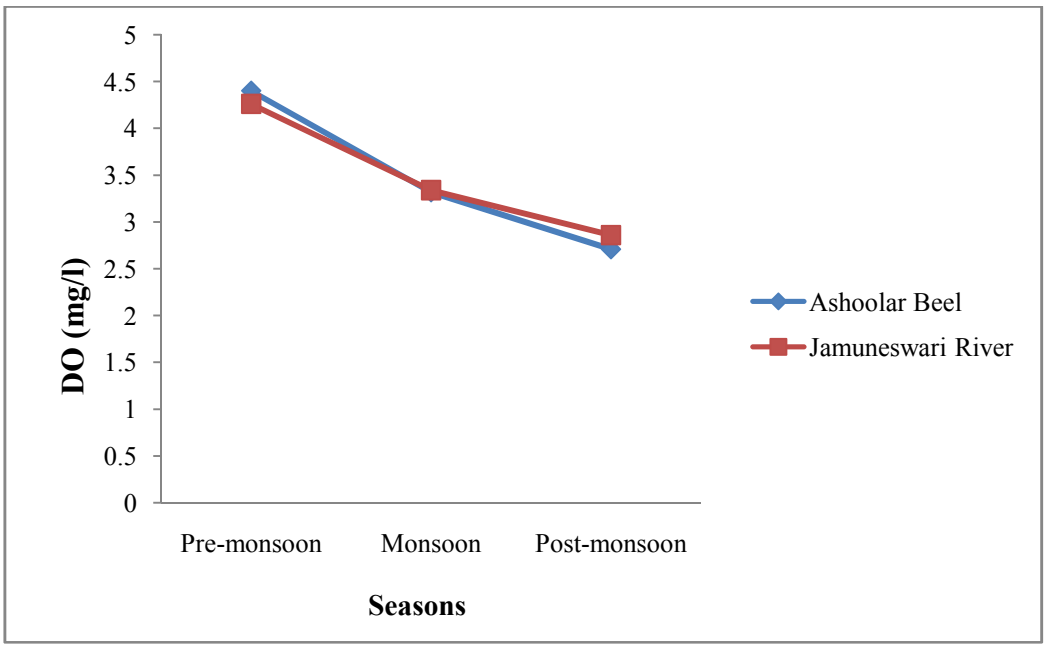

Figure 8: Fluctuation of DO in different season

3.1.2.2 P^H(Hydrogen ion concentration) variation

During these investigations, pH value was found to be high in pre-monsoon season in comparison to monsoon &post-monsoon season both at the two habitats. Figure 9 shows the variation of P^Hin the different season both at the two habitats. In pre-monsoon, maximum value of pH 8.10 was observed at Jamuneswari River followed by Ashoolar Beel. The range of P^H was found to vary from 6.20-7.30, 6.20-7.80 and 7.10-7.50in Ashoolar Beel and 6.50-7.80, 6.20-7.80 and 6.60-7.40in Jamuneswari River during experiment in the three different seasons (Table 2). The mean (±SD) values of pH were 6.90±0.38,7.01±0.44 and 7.27±0.49 in Ashoolar Beel and 7.06±0.42,6.89±0.32 and 7.05±0.27in Jamuneswari River in the pre-monsoon, monsoon and post-monsoon period. In pre-monsoon, maximum value of pH 8.10 was observed at Jamuneswari River followed by Ashoolar Beel

Significant differences (P<0.05) of pH shown between pre-monsoon, monsoon and post-monsoon period both in Jamuneswari River but no difference shown in Ashoolar Beel . But seasonal influences of water depth were more or less same for each habitat. There was significant difference in pre-monsoon with post-monsoon and monsoon with post-monsoon.

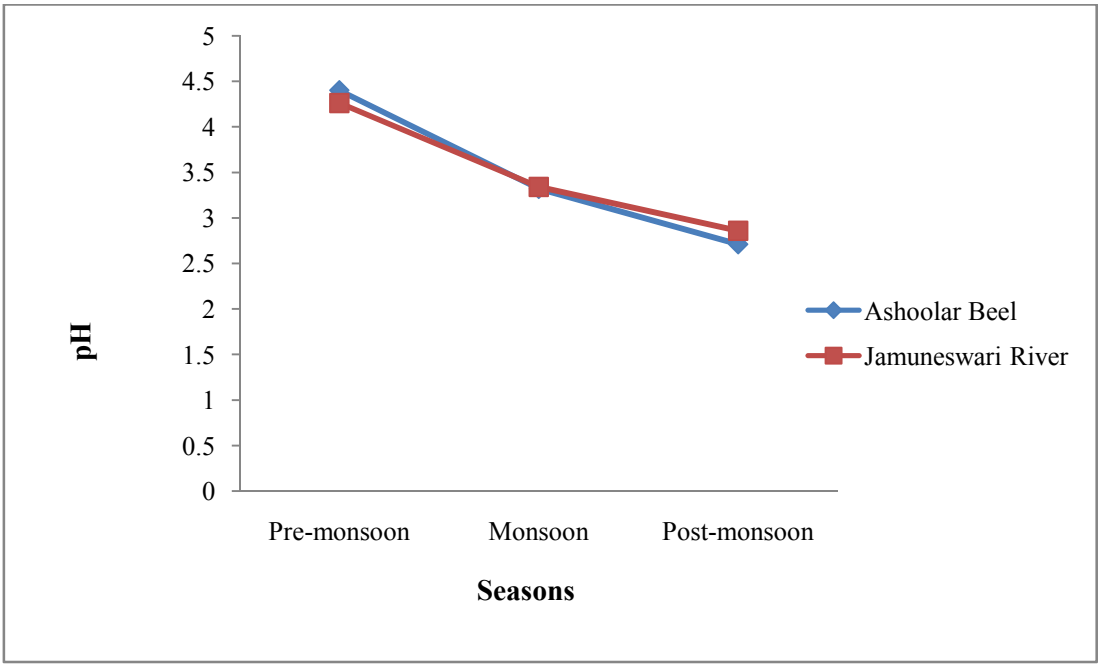

Figure 9: Fluctuation of pH in different season

3.1.2.3Alkalinity variation

In the study, the maximum value of alkalinity 10.60 mg/l was recorded in the post-monsoon in Ashoolar Beel and the minimum value 5.60 in Jamuneswari River during pre-monsoon period. The alkalinities in all sampling season werenot similar. Alkalinity found ranging from 28.00-51.00 mg/l, 40.00-52.00 mg/l and 26.00-44.00 at Ashoolar Beel and 19.10-43.20 mg/l, 21.00-43.20 mg/l and17.00-61.00 at Jamuneswari River during experiment in the three different seasons (table-1). The mean (±SD) values of hydrogen ion concentrations alkalinity were 34.60±6.88 mg/l33.20±0.20 mg/l and 45.20±0.70 at Ashoolar Beel and 37.62±5.02 mg/l, 32.30±4.57 mg/l and29.65±8.52 mg/l at Jamuneswari River in the pre-monsoon, monsoon and post-monsoon period (Table-2).

There was significant differences (P<0.05) of alkalinity observed in pre-monsoon period with post- monsoon and monsoon with post-monsoon but there was no significant different among pre-monsoon with post-monsoon both at the two habitats.There was no significant differences show between the two fresh water habitats. On the whole, the seasonal influences of water depth were more or less same for each habitat.

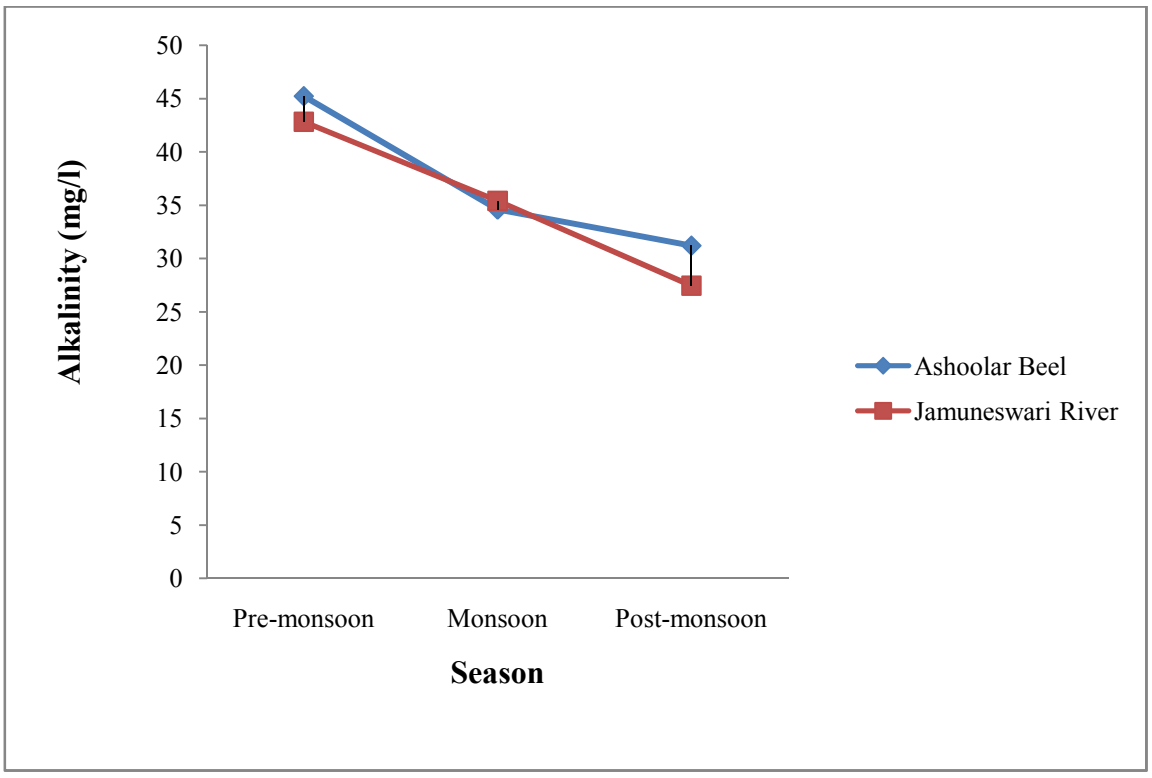

Figure 10: Fluctuation of Alkalinity in different season

Table 2: Mean values (±SD), ranges and comparison of Chemical parameters by using ANOVA (N=10) at different season throughout the study period at two different freshwater habitats

Habitats	Parameters	Seasons			ANOVA Significance (*p* value)
		Pre-monsoon	Monsoon	Post-monsoon	
Ashooler Beel	Dissolved oxygen(mg/l)	6.32±1.24[a](0.70-8.20)	7.52±0.874[ac](6.50-9.20)	10.12±1.75[b] (7.90-13.60)	*
	P^H	7.30±0.382 (6.80-7.90)	7.06±0.195 (6.80-7.30)	6.96±0.263 (6.40-7.20)	NS
	Alkalinity(mg/l)	45.20±6.35[a] (36.00-58.00)	34.60±3.92[b] (29.00-42.00)	31.20±5.45[ab] (21.00-40.00)	*
Jamuneswari River	Dissolved oxygen(mg/l)	6.22±0.87[a] (4.90-7.40)	6.72±0.89[ac](5.30-8.10)	8.34±1.36[b] (6.50-10.80)	*
	P^H	7.33±0.48[a] (6.80-8.10)	7.21±0.29[ab] (6.80-7.70)	6.96±0.231[b] (6.60-7.30)	*
	Alkalinity(mg/l)	42.82±9.34[a] (32.00-61.00)	35.40±4.88[ac] (30.00-45.00)	27.45±5.80[b] (19.10-40.20)	*

NS= Values are not significantly different ($P > 0.05$)

* Values with different superscript letters in the same row indicate a significant difference at 5 % significance level based on one-way ANOVA followed by Tukey's test.

3.2 Nutrient Quality of Boal Fish, *Wallago attu* (Bolch & Schenider, 1801)

The major components of food are moisture, proteins, carbohydrate, fats, miners & vitamins. Fish proteins can be broadly divided into three groups according to their solubility viz, sarcoplasmic proteins, myofibrillar proteins and connective tissue protein. Protein provides the necessary materials for the repair and building of muscle and tissues. The proportion in which different constituents of the body occur in the organism is called its 'proximate Composition', the study of which helps to estimate the seasonal variation of the nutrient quality of the fish. Table 3 depicts the nutrient quality of raw muscles tissue of fish *Wallago attu*(Bolch& Schenider, 1801).

3.2.1 Moisture (%) contents variation

Moisture contents in the Bangladeshi fishes generally vary between 70-80%. Figure 11 shows the Moisture contentsfluctuation of Boal fish of the different season. The maximum value of Moisture contents of Boal fish 79.03 % was reported in the post-monsoon at Jamuneswari River and the minimum value 72.38 % at Ashooler Beel during pre-monsoon period. In the present study, the range of Moisture contents of the fish was found to vary from 72.94-74.21 %, 75.21-78.35% and 75.66-79.03 % in Ashooler Beel and 72.38-75.25 %, 75.82-76.92 % and77.11-78.16 %in Jamuneswari River during experiment in the three different seasons (Table-3).

The mean (±SD) values of Moisture contents of were 73.37±0.72%, 76.791± 1.38 % and77.541± 1.72% in Ashooler Beel and 73.52± 1.52%, 76.23±0.60% and 77.81±0.60% in Jamuneswari River in the pre-monsoon, monsoon and post-monsoon period (Table-3).

Moisture contents were significantly different from one season to another though in the same fish. Post-monsoon season showed significantly (P<0.05) higher and pre-monsoon season lower of moisture contents in the fish muscles both at the Jamuneswari River and Ashooler Beel between the three season. There was also significant difference observed in the pre-monsoon season with monsoon and post-monsoon but there was no significant difference between monsoons with post-monsoon

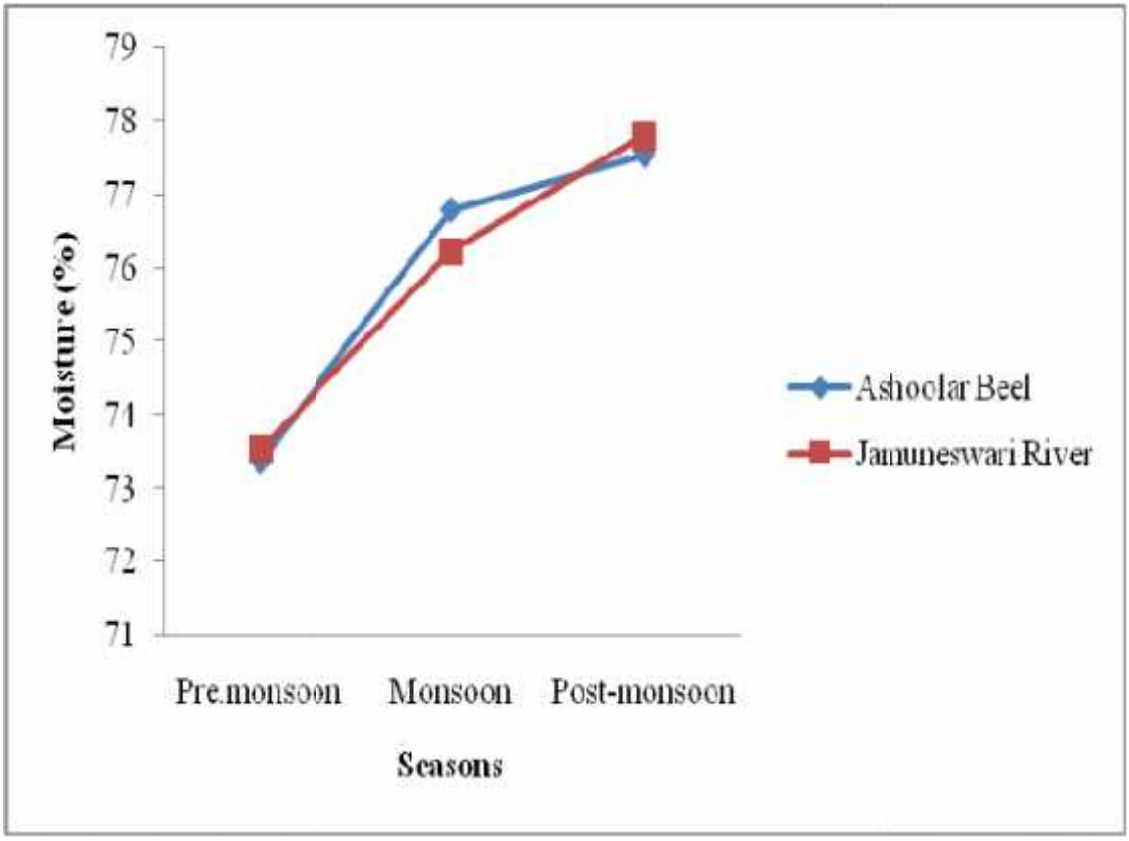

Figure 11: Fluctuation of Moisture (%) contents in different season

3.2.2Ash (%) contents variation

The maximum value of ash contents of Boal fish 2.76% was reported in the post-monsoon in Jamuneswari River and the minimum value 2.20 % in Ashoolar Beel during pre-monsoon period. Fig-1 shows the Moisture contentsfluctuation of Boal fish of the different season. The mean (±SD) values of ash contents of were 2.43±0.46 %, 2.20±0.22 % and 2.55±0.67 in Ashoolar Beel and 2.31 ± 0.58%, 1.91 ± 0.88% and 2.76 ± 0.60% in Jamuneswari River in the pre-monsoon, monsoon and post-monsoon period (Table-3& fig.12).

There was no significant differences (P>0.05)observed between the three different seasons both in the Ashoolar Beel and Jamuneswari River as well as the two different habitats.The seasonal influences of ash contents were more or less same for each habitat.

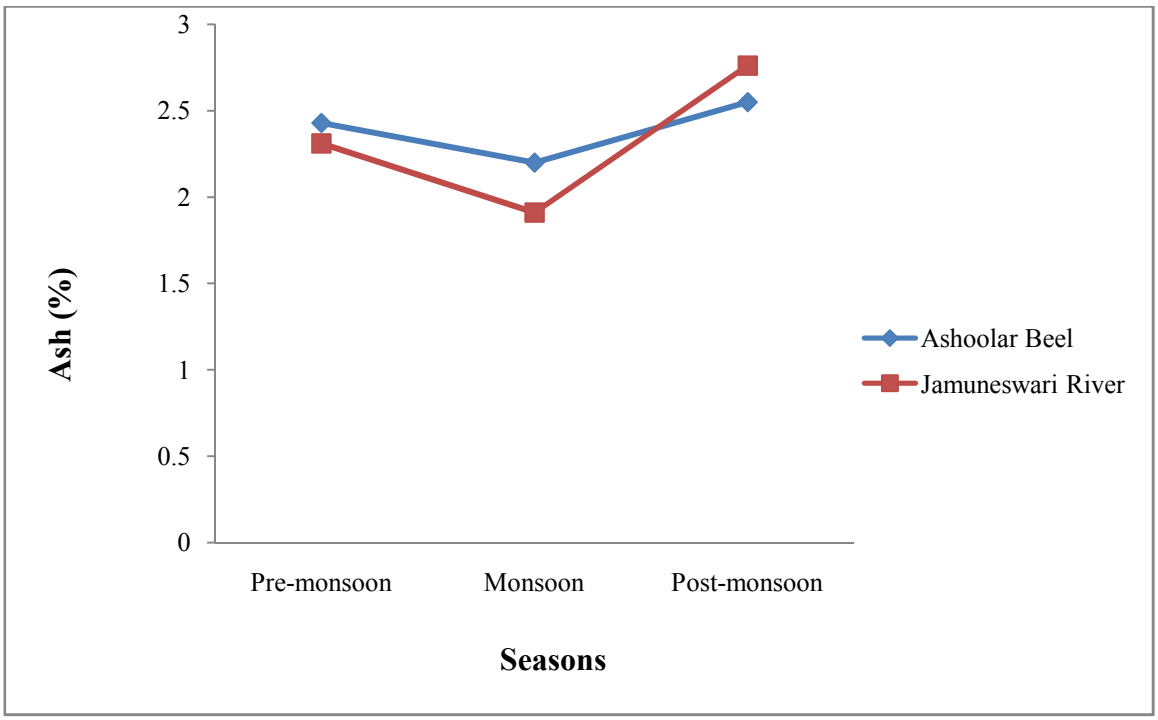

Figure 12: Fluctuation of Ash contents in different season

3.2.3 Protein (%)contents variation

Protein contents were significantly higher in the post-monsoon and lower in the pre-monsoon period.On the whole, the seasonal influences of water depth were same for each habitat. Significant differences (P<0.05) of protein contents observed in pre-monsoon with post-monsoon and monsoon with post-monsoon period but there was no significant between pre-monsoon and post-monsoon period of the studyboth in the Jamuneswari River and Ashoolar Beel between the three season.Fig-13 shows the protein contents fluctuation of Boal fish of the different season.

The maximum value of protein contents of Boal fish 19.72 % was reported in the post-monsoon in Jamuneswari River and the minimum value 16.82% in Ashooler Beel during pre-monsoon period. In the present study, the range of protein contents of the fish was found to vary from 17.94-74.21 %, 17.21-78.35% and 17.66-17.03 % in Ashooler Beel and 17.38-75.25 %, 75.82-76.92 % and77.11-78.16 %in Jamuneswari River during experiment in the three different seasons (Table-3). The mean (±SD) values ofpProtein contents of were 73.37±0.72%, 76.791±0.38 % and77.541±0.72% in Ashooler Beel and 73.52±0.52%, 76.23±0.60% and 77.81±0.60% in Jamuneswari River in the pre-monsoon, monsoon and post-monsoon period (Table-3). On the whole, the seasonal influences of protein contents of the fishwere same for each habitat.

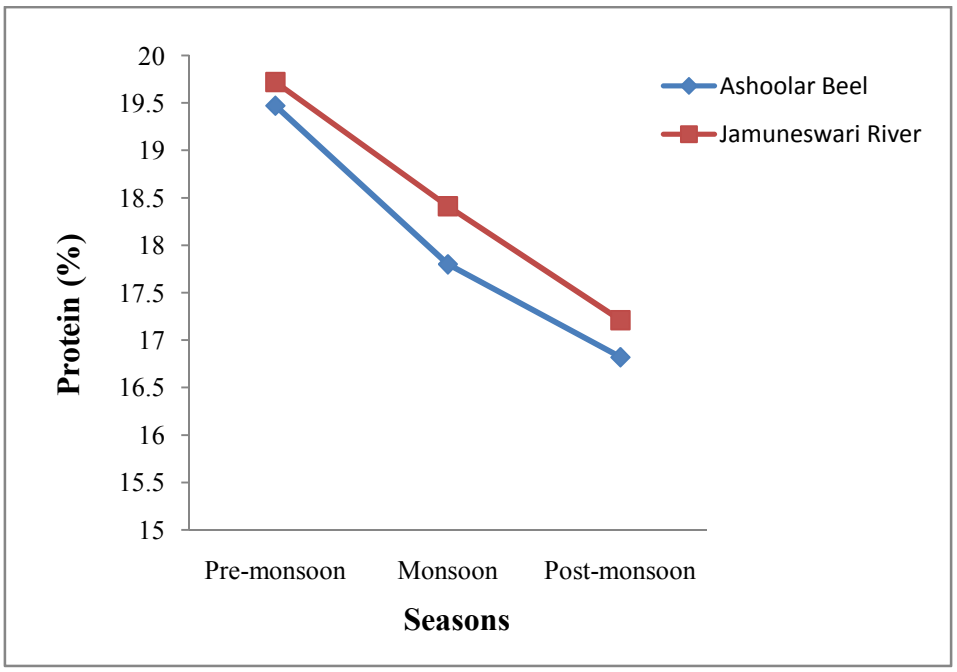

Figure 13: Fluctuation of Protein contents in different season

3.2.4Lipid (%) Contentsvariation

The lipid contents fluctuation of Boal fish of the different season (Fig. 14). The maximum value of lipidcontents of Boal fish 4.4 % was reported in the post-monsoon in Jamuneswari River and the minimum value 2.71 % in Ashoolar Beel during pre-

monsoon period. In the present study, the range of lipid contents of the fish was found to vary from 3.10-5.14 %, 2.57-4.21% and 2.24-3.37 % in Ashoolar Beel and 3.49-4.78 %, 2.63-4.17 % and2.02-3.83 %in Jamuneswari River during experiment in the three different seasons (Table-3). The mean (±SD) values of lipidcontents of were 4.40±1.12%, 3.32±0.82 % and2.71±0.58% in Ashoolar Beel and 4.26±0.68%, 3.34±0.77% and 2.86±0.91% in Jamuneswari River in the pre-monsoon, monsoon and post-monsoon period (Table-3).

Lipid contents were significantly higher in the post-monsoon and lower in the pre-monsoon period.On the whole, the seasonal influences of lipid contents of the fishwere same for each habitat. Significant differences (P<0.05) of lipid contents observed in pre-monsoon with post-monsoon and monsoon with post-monsoon period but there was no significant between pre-monsoon and post-monsoon period of the study both in the Jamuneswari River and Ashoolar Beel between the three season.

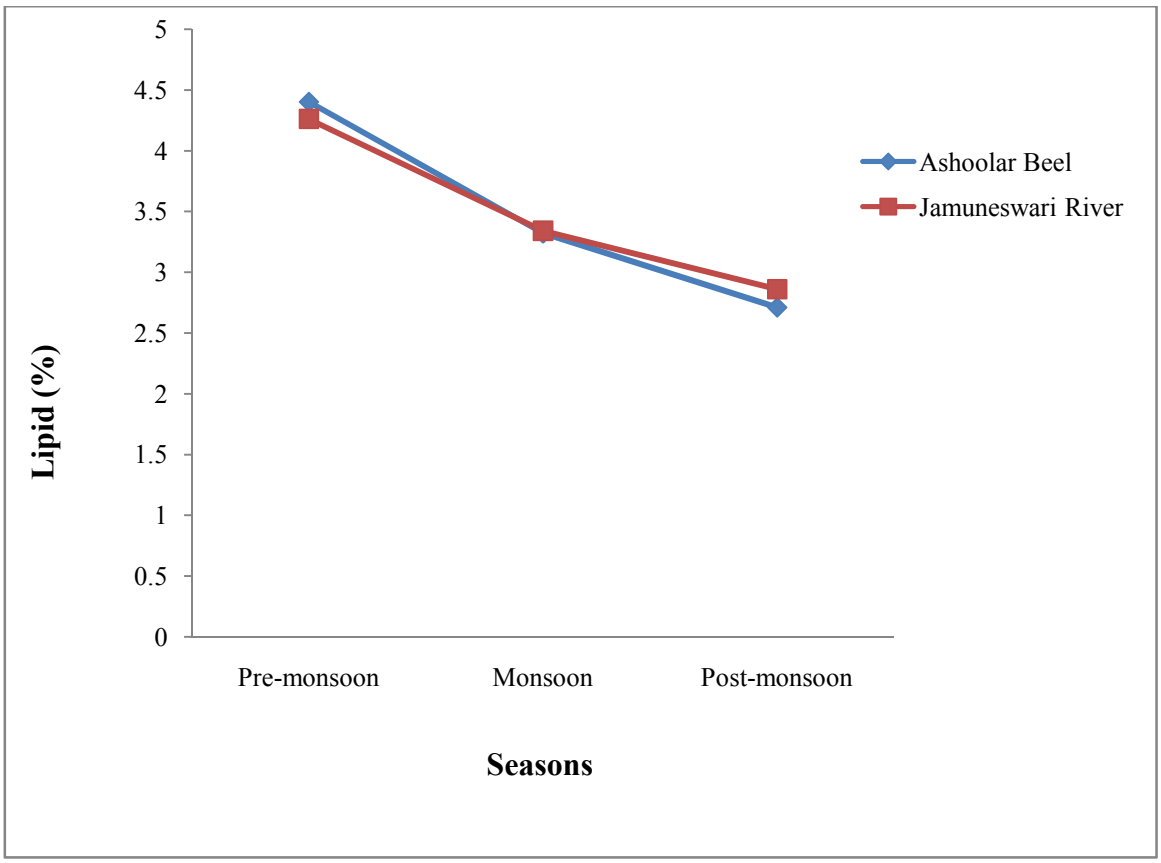

Figure 14: Fluctuation of lipid contents in different season

Table 3: Mean values (±SD), ranges and comparison of nutrient quality of Boal fish (*Wallagoattu*) by using ANOVA (N=3) at different season throughout the study period at two different freshwater habitats.

Habitats	Parameters	Seasons			ANOVA Significance (*p* value)
		Pre-monsoon	Monsoon	Post-monsoon	
Ashooler Beel	Moisture (%)	73.37±0.72[a] (72.94-74.21)	76.791±0.38[ab] (75.21-78.35)	77.541±0.72[b] (75.66-79.03)	*
	Ash (%)	2.43±0.46 (1.94-2.86)	2.20±0.22 (1.78-2.23)	2.55±0.67 (1.92-3.27)	NS
	Protein (%)	19.47±0.92[a] (18.42-20.16)	17.80±0.68[ab] (17.02-18.30)	16.82±0.87[b] (16.22-17.84)	*
	Lipid (%)	4.40±1.12[a] (3.10-5.14)	3.32±0.82[ab] (2.57-4.21)	2.71±0.58[b] (2.24-3.37)	*
Jamuneswari River	Moisture (%)	73.52±0.52[a] (72.38-75.25)	76.23±0.60[ab] (75.82-76.92)	77.81±0.60[b] (77.11-78.16)	*
	Ash (%)	2.31±0.58 (1.84-2.97)	1.91±0.88 (1.28-2.92)	2.76±0.33 (2.43-3.09)	NS
	Protein (%)	19.72±0.53[a] (19.13-20.16)	18.410±.76[ab] (17.63-19.16)	17.21±0.53[b] (16.34-17.39)	*
	Lipid (%)	4.26±0.68[a] (3.49-4.78)	3.34±0.77[ab] (2.63-4.17)	2.860±0.91[b] (2.02-3.83)	*

NS= Values are not significantly different ($P > 0.05$)

* Values with different superscript letters in the same row indicate a significant difference at 5 % significance level based on one-way ANOVA followed by Tukey's test.

CHAPTER-4
DISCUSSION

4.1 Water Quality Parameters

Production of sufficient fish product depends on the suitable water quality parameters which are prerequisite for healthy aquatic environment. The physical and chemical variable of the present study areais subjected to wide spatial temporal variation.Primary productivity of a waterbody depends on the physical, chemical and others factors of the environment (Rahman, 1992).

Air and Water temperature influences the chemical, biochemical and biological characteristics of water body. Water quality is highly sensitive to change in temperature as it affects the aquatic life present in that water. High water temperature enhances the growth of microorganisms and may increase taste, odor, colour, and corrosion problems. Water temperature is one of the most important among the external factors which influence the aquatic ecology (Huet, 1986). The temperature variation is one of the factors in the swamp and estuarine system, which may influence the physio-chemical characteristics and also influence the distribution and abundance of flora and fauna (Soundarapandian *et al.,* 2009).

In the present study, it has been observed that temperature (Mean ± SD) varied between 25.40 ± 2.75 °C to 30.10 ± 1.08 °C both in the habitats*,* high temperatureisnoticed in the pre-monsoon session associated with longer photoperiod, bright sunshine and dry wind and lower temperature in the post-monsoon was due to cloudy sky and rainfall brought down the temperature to the minimum. Similar observations have been reported by Senthilkumar *et al.* (2002), Santhanam and Perumal (2003), Gupta *et al*. (2008), Sundaramanickam *et al*. (2008) and Jayabhaye 2009) from different wetlands.Statistical analysis revealed no significance differences (P>0.05) in temperatures among Ashoolar Beel and Jamuneswari River. But there was significant differences observed among three different seasons. In addition, the variations in water temperature may also be attributed to water level fluctuations due to use of water for irrigation and for dry season. The variations were further aggravated by heavy precipitation during the monsoon. The range of water temperature of the two habitats is not similar to that obtained for river Talar 10.10- 29.7°C (Alavi and Jafari, 2010) and for river Mouri 22.1- 23.5°C (Khan *et al.,* 2007). These might be different geological position of this river. Water temperature greatly influences physiological process such as respiration rates, efficiency of feeding

and assimilation, growth behavior and reproduction (Meade, 1989, Tucker and Robinson, 1990).

The transparency of both habitats was fluctuated with the change of seasons. Water transparency (Mean ± SD) ranged between the highest and the lowest value of 49.45±8.84 cm and 24.99 ± 4.31 cm was recorded in post-monsoon and pre-monsoon respectively at Ashoolar Beel. Throughout the period of study the average value of the two habitats transparency was 22.99 cm while in Shibsha and Buriganga River the average value were 37.25 cm (Khan *et al.,* 2007 and Hossain, 1992).

Depth is very important factor in limnological studies.Fluctuation of water level both in Ashoolar Beel and Jamuneswari River mainly in the line of seasonal changes and geological position. During thestudy period highest water depth 14.00 ft was observed in monsoon at Ashoolar Beel and lowest water level 2.00 ft was observed in pre-monsoon at Jamuneswari River. Statistical analysis revealed there were significant differences observed among three different seasons.Singh *et al.* (2010) observed highest water depth in monsoon and lowest in summer season in Manipur river. This finding is similar to the finding of the present study.

The oxygen dissolved in water is a very importantparameter in water analysis as it serves as an indicator ofthe physical, chemical and biological activities of theWater bodyIn the present study dissolved oxygen values (Mean ± SD) ranged from 6.32 ± 1.24 mg/l to 10.12±1.75 mg/l of which greatest amount (10.12± mg/l) was noted in post-monsoon and lowest amount (6.32 ± 1.24 mg/l) in pre-monsoon at Ashoolar Beel. Low level of DO is again indicative of polluted nature of water body. Such low level of oxygen was also noted by Iqbal *et al.* (2006) on addition of sewage waste from human settlements to habitats.

Dissolved oxygen shows an inverse relationship with water temperature. Higher values of DO observed during winter, when temperature was lowest, might be due to the fact that the solubility of oxygen in water increases with decrease in temperature (Singh et al., 1980; Ali, 1999).The quantity of DO in water is directly or indirectly dependent on water temperature. Minimum dissolved oxygen concentration has to be at least 5.00 mg/l for maintaining aquatic life in healthy condition and dissolved oxygen concentration less than 5.00 mg/l are indicative of pollution (Khandaker, 1986).There was significant

difference observed between pre-monsoon and post-monsoonboth in the two habitats. Higher dissolved oxygen concentrationobserved during monsoon season may be due to theeffect of higher wind velocity joined withheavy rainfall and the resultant freshwater mixing (Das *et al.,* 1997; Prabu *et al.,* 2008; Sundaramanickam *et al*.,2008).Dissolved oxygen concentration in the both habitats was above 5 mg/l which indicate a better condition for aquatic organisms. In the Buriganga River DO concentration was found 2-3 mg/l that indicates high rate of pollution (Moniruzzaman *et al.,* 2009). Khandaker (1986) recorded 5.1 mg/l dissolved oxygen in Karnafully river which is lower (7.47 mg/l) from the findings of the present study.

Measurement of pH is one of the most important and frequently used tests in water chemistry. pH is important in almost all phases of water and waste water treatment. Aquatic organisms are sensitive to pH change and biological treatment requires either pH control or monitoring.

Seasonal changes influence the pH value of water of both habitats.The pH values during the study ranged from 6.40 to 8.10. Slightly alkaline water (8.10) observed in Jamuneswari River in pre-monsoon, this may be due to low level of water and slightly acidic value (6.40) also observed in Ashoolar Beel in post-monsoon. The pH value in the present investigation remained a buffer condition. Begum and Khanam (2009) observed 6.6-8.0 pH in Shitalakhya river water which is similar to the present study. The pH value (8.3-8.4) in Hoogly river by Roy (1955) and (7.3-8.3) in Mouri river by Khan *et al.* (2007) also showed a buffer condition which are in agreement with the finding of the present study.

Alkalinity is not a pollutant. It is a total measure of the substances in water that have "acid-neutralizing" ability. It is not to be confusing alkalinity with pH. pH measures the strength of an acid or base; alkalinity indicates a solution’s power to react with acid and "buffer" its pH — that is, the power to keep its pH from changing. Therefore, Alkalinity is important for fish and aquatic life because it protects or buffers against pH changes and makes water less vulnerable to acid rain.The peak values of alkalinity (61.00 mg/l) observe during the monsoon may be attributes to the influence of seasonal rainfall. Alkalinity showed significant difference among the sampling sites. Similar seasonal fluctuation in total alkalinity in Talar River, Iran was also observed by Alavi and Jafari (2010).

4.2 Nutrient Contents

Seasonally the lowest percentage of moisture content (79.55%) was observed in the fish collected from Ashoolar beel during the post-monsoon season. The highest percentage of moisture content (83.69%) was observed in the fish from Jamuneswari Riverduring the post-monsoon season. There exists an inverse relationship between waterand fat content. Low water content was usually associated with relatively high fat content and viceversa.The water content was inversely related to the protein and lipid contents in seasons analyzed in the present study.Similar observations are reported in the present investigation.Like other fishes it has the greater percentage of moisture and may vary according to size, season of the year (Mahfuz *et al.,* 2012; Minar *etal.,* 2012b; Azim *et al.,* 2012; Begum and Minar, 2012). In the present study Moisture contents were significantly different from one season to another though in the same fish. Post-monsoon season showed significantly (P<0.05) higher and pre-monsoon season lower of moisture contents in the fish muscles both at the Jamuneswari River and Ashoolar Beel between the three season. Similar seasonal fluctuation in total moisture contents in was also observed by Alavi and Jafari (2010).

Ash may be defined as the residue that lackswater and volatile constituents containing carbondioxide, oxides of nitrogen, etc. The ash percentage was higher in July and lower in Augustwhen subjected to experiment. The averagevalues was 5.53° 1.40 which is more than *Labeobata* (Mahfuz *et al.,* 2012) and some other smallfishes of Bangladesh such as *G. chapra, C.soborna, A. punctata, C. psendeutropiusatherinoides, T. ilisha, M. rosenbergii, P. monodonis* 1.68, 1.54, 2.87, 1.92, 2.27, 2.68 and, 2.91respectively (Begum *et al.,* 2012). ButChowdhury (1981) found the values of ash werevery high and may be due to habitat, season, sexand size in fishes. In the present study, the maximum value of ash contents of Boal fish 2.76 % was reported in the post-monsoon in Jamuneswari River and the minimum value 2.31 % in Ashoolar Beel during pre-monsoon period.

In the present study, the amount of protein contents of the fish was significantly higher in the pre-monsoon and lower in the post-monsoon period.The maximum value of protein contents of Boal fish 19.72 % was reported in the pre-monsoon in Jamuneswari River and the minimum value 16.82 % in Ashoolar Beel during pre-monsoon period.Deka *etal.*(2012a) found highest amount of protein inmuscle and liver tissue in pre-monsoon

(138.22°6.82 And 148.41° 8.96) and the lowest was observed in retreating monsoon (42.8° 1.49 and52.40° 1.41). Since monsoon and post-monsoon coincides with the breeding season, the pre-monsoon elevation in the muscle protein content could be allocated to the gonad maturation in anticipation of increased energy requirement during the latter period breeding & spawning. The present result showed that this fish has a good source of protein and helpful to mitigate the protein demand of the People.

The presents study depicts that the variation inthe level of lipid may be due to season which inturn affect the fish diet. Increased amount of lipidwas found in pre-monsoon. It may be noted that both thehabitat condition along with the changes ofseason have a significant impact on the synthesisof fat in fish.The maximum value of lipid contents of Boal fish 4.40 % was reported in the pre-monsoon collected from Jamuneswari River that gradually declined during the breeding season with lowest value amounting to 2.71 % from Ashoolar Beel during post-monsoon period .In general an inverse relationship is observed between the moisture and lipid contents. Similar observations are reported in the present investigation.In the body of fish mobilization of lipids from various organs to gonads occurs during gonadal maturation. An increasing trend in total lipid content was observed post-spawning that could be attributed to the re-absorption of mature gonads thereby mobilizing the lipids to storage tissues in the body. Teraiya *et al.* (2013) observed that metabolites like Lipid in Ovary increase during the active process of gametogenesis in both the fish species. While the Glycogen level decreased in *Sillago sihama*, whereas in *Otolithus ruber*, these metabolites showed an increased trend.

Biochemical composition of the fish varies, depending on several factors such as species, age, maturity, method of catch, fishing grounds, geographical regions, season of the year, anthropogenic activities in the environment, etc. Even within a single species in different portions of the body in the same fish, biochemical composition may vary significantly as suggested by Govindan, 1985; FAO, 1995. These biochemical constituents along with other aspects of fishery science such as feeding & breeding biology of fish, habit & habitat study will provide a better insight into the sustainable management of these marine aquatic resources apart from health consequences of the consumer.

CHAPTER 5
CONCLUSION

Seasonal changes in pH & alkalinity can cause stress, poor growth and even death of the farmed animals. In these investigations, pH and alkalinity have also shown significant variation among various sampling spots that can pose a threat to aquatic life in future. If pH & alkalinity levels keep on increasing at the same rate, it may have a disastrous effect by accelerating the process of eutrophication. The above findings have shown of the parameters are not within permissible limits of BSI, 1991 & WHO, 1993 still exceed the desirable range given by these agencies both in the pre-monsoon and post-monsoon. Therefore, it is concluded that this water is not fit for drinking purpose without proper treatment but can be used for irrigation. The present baseline information of the physical and chemical properties of water would form a useful tool for further ecological assessment and monitoring of this wetland of Point Wildlife Sanctuary. Insight into the biochemical constituents of the fish tissue reveals the health condition of the fish under study as also provides momentous data from nutrition perspective of the local populace of the consuming the same as rich protein source. The present work has elucidated that the nutrient composition of this species might be a good source of protein.

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APPENDICES

Appendix 1. Statistical analysis of Air temperature at Ashoolar Beel of each season

Descriptive Statistics of Air temperature at Ashoolar Beel

Air temperature

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	10	31.6800	1.11535	.35270	30.8821	32.4779	30.00	32.80
Monsoon	10	29.3400	1.15489	.36521	28.5138	30.1662	27.00	30.50
Post-monsoon	10	27.4270	1.83599	.58059	26.1136	28.7404	23.30	30.47
Total	30	29.4823	2.23052	.40724	28.6494	30.3152	23.30	32.80

ANOVA table of Air temperature at Ashoolar Beel

Air temperature

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	90.744	2	45.372	22.882	.000
Within Seasons	53.538	27	1.983		
Total	144.282	29			

Multiple Comparisons table of Air temperature at Ashoolar Beel

Dependent Variable: Air temperature

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	2.34000*	.62974	.003	.7786	3.9014
	Post-monsoon	4.25300*	.62974	.000	2.6916	5.8144
Monsoon	Pre-monsoon	-2.34000*	.62974	.003	-3.9014	-.7786
	Post-monsoon	1.91300*	.62974	.014	.3516	3.4744
Post-monsoon	Pre-monsoon	-4.25300*	.62974	.000	-5.8144	-2.6916
	Monsoon	-1.91300*	.62974	.014	-3.4744	-.3516

*The mean difference is significant at the 0.05 level.

Appendix 2. Statistical analysis of Air temperature at Jamuneswari River of each season

Descriptive table of Air temperature at Jamuneswari River

Air temperature

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	10	31.6600	1.07827	.34098	30.8887	32.4313	29.50	32.70
Monsoon	10	29.2640	1.35470	.42839	28.2949	30.2331	27.00	30.97
Post-monsoon	10	26.7080	1.48072	.46824	25.6488	27.7672	24.20	29.10
Total	30	29.2107	2.41666	.44122	28.3083	30.1131	24.20	32.70

ANOVA table of Air temperature at Jamuneswai River

Air temperature

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	122.654	2	61.327	35.446	.000
Within Seasons	46.714	27	1.730		
Total	169.368	29			

Multiple Comparisons of Air temperature at Jamuneswari River

Dependent Variable: Air temperatureTukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	2.39600*	.58824	.001	.9375	3.8545
	Post-monsoon	4.95200*	.58824	.000	3.4935	6.4105
Monsonn	Pre-monsoon	-2.39600*	.58824	.001	-3.8545	-.9375
	Post-monsoon	2.55600*	.58824	.001	1.0975	4.0145
Post-monsoon	Pre-monsoon	-4.95200*	.58824	.000	-6.4105	-3.4935
	Monsoon	-2.55600*	.58824	.001	-4.0145	-1.0975

*The mean difference is significant at the 0.05 level.

Appendix 3. Statistical analysis of water temperature at Ashoolar Beel of each

Descriptive table of water temperature at Ashoolar Beel

Water temperature

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	10	30.3000	1.07827	.34098	30.8887	32.4313	29.10	32.30
Monsoon	10	29.2840	1.35470	.42839	28.2949	30.2331	27.40	31.00
Post-monsoon	10	25.4080	1.48072	.46824	25.6488	27.7672	21.20	30.30
Total	30	29.2107	2.41666	.44122	28.3083	30.1131	24.20	32.70

ANOVA table of water temperature at Ashoolar Beel

Water temperature

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	122.654	2	61.327	35.446	.000
Within Seasons	46.714	27	1.730		
Total	169.368	29			

Multiple Comparisons of water temperature at Ashoolar Beel

Dependent Variable: Water temperatureTukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	2.39600*	.58824	.001	.9375	3.8545
	Post-monsoon	4.95200*	.58824	.000	3.4935	6.4105
Monsoon	Pre-monsoon	-2.39600*	.58824	.001	-3.8545	-.9375
	Post-monsoon	2.55600*	.58824	.001	1.0975	4.0145
Post-monsoon	Pre-monsoon	-4.95200*	.58824	.000	-6.4105	-3.4935
	Monsoon	-2.55600*	.58824	.001	-4.0145	-1.0975

*The mean difference is significant at the 0.05 level.

Appendix 4: Statistical analysis of Water temperature at Jamuneswari River of each season

Descriptive table of Water temperature at Jamuneswari river

Water temperature

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	10	30.1070	1.03904	.32857	29.3637	30.8503	28.60	32.00
Monsoon	10	29.0200	1.32899	.42026	28.0693	29.9707	26.60	30.40
Post-monsoon	10	26.1040	2.70281	.85470	24.1705	28.0375	21.00	29.80
Total	30	28.4103	2.47090	.45112	27.4877	29.3330	21.00	32.00

ANOVA table of Water temperature at Jamuneswari River

Water temperature

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	85.695	2	42.848	12.663	.000
Within Seasons	91.359	27	3.384		
Total	177.055	29			

Multiple Comparisons table of Water temperature at Jamuneswari River

Dependent Variable: Water temperatureTukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	1.08700	.82264	.396	-.9527	3.1267
	Post-monsoon	4.00300*	.82264	.000	1.9633	6.0427
Monsoon	Pre-monsoon	-1.08700	.82264	.396	-3.1267	.9527
	Post-monsoon	2.91600*	.82264	.004	.8763	4.9557
Post-monsoon	Pre-monsoon	-4.00300*	.82264	.000	-6.0427	-1.9633
	Monsoon	-2.91600*	.82264	.004	-4.9557	-.8763

*The mean difference is significant at the 0.05 level.

Appendix 5. Statistical analysis of transparency at Ashoolar Beel of each season

ANOVA table of Transparency at Ashoolar Beel

Transparency

Transparenc			Sum of Squares	df	Mean Square	F	Sig.		
	Between Seasons		3125.560	2	1562.780	23.026	.000		axim
	Within Season		1832.474	27	67.869				um
	Total		4958.034	29					
Pre-monsoon	10	49.4500	8.84575	2.79727	43.1221	55.7779	39.00	61.00	
Monsoon	10	32.7350	10.33016	3.26668	25.3452	40.1248	20.70	56.00	
Post-monsoon	10	24.9900	4.31842	1.36561	21.9008	28.0792	18.00	34.50	
Total	30	35.7250	13.07542	2.38723	30.8426	40.6074	18.00	61.00	

Multiple Comparisons table of transparency at Ashollar Beel

Dependent Variable: Transparency

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	16.71500*	3.68428	.000	7.5801	25.8499
	Post-monsoon	24.46000*	3.68428	.000	15.3251	33.5949
Monsoon	Pre-monsoon	-16.71500*	3.68428	.000	-25.8499	-7.5801
	Post-monsoon	7.74500	3.68428	.108	-1.3899	16.8799
Post-monsoon	Pre-monsoon	-24.46000*	3.68428	.000	-33.5949	-15.3251
	Monsoon	-7.74500	3.68428	.108	-16.8799	1.3899

* The mean difference is significant at the 0.05 level.

Appendix 6. Statistical analysis of Transparency at Jamuneswari River of each season

Descriptive table of Transparency at Jamuneswari River

Transparency

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	10	49.4500	8.84575	2.79727	43.1221	55.7779	39.00	61.00
Monsoon	10	32.7350	10.33016	3.26668	25.3452	40.1248	20.70	56.00
Post-monsoon	10	24.9900	4.31842	1.36561	21.9008	28.0792	18.00	34.50
Total	30	35.7250	13.07542	2.38723	30.8426	40.6074	18.00	61.00

ANOVA table of transparency at Jamuneswari River

Transparency

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	3125.560	2	1562.780	23.026	.000
Within Seasons	1832.474	27	67.869		
Total	4958.034	29			

Multiple Comparisonstable of transparency at Jamuneswari River

Dependent Variable: Transparency

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	16.71500*	3.68428	.000	7.5801	25.8499
	Post-monsoon	24.46000*	3.68428	.000	15.3251	33.5949
Monsoon	Pre-monsoon	-16.71500*	3.68428	.000	-25.8499	-7.5801
	Post-monsoon	7.74500	3.68428	.108	-1.3899	16.8799
Post-monsoon	Pre-monsoon	-24.46000*	3.68428	.000	-33.5949	-15.3251
	Monsoon	-7.74500	3.68428	.108	-16.8799	1.3899

*The mean difference is significant at the 0.05 level.

Appendix 7. Statistical analysis of Water depth at Ashoolar Beel of each season

Descriptive table of Water depth at Ashoolar Beel

Water depth

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	10	5.5000	1.62481	.51381	4.3377	6.6623	2.20	7.60
Monsoon	10	10.690	1.98631	.62813	9.2691	12.1109	7.50	14.00
Post-monsoon	10	7.0000	1.41421	.44721	5.9883	8.0117	5.00	9.00
Total	30	7.7300	2.75395	.50280	6.7017	8.7583	2.20	14.00

ANOVA table of Water depth at Ashoolar Beel

Water depth

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	142.674	2	71.337	24.927	.000
Within Seasons	77.269	27	2.862		
Total	219.943	29			

Multiple Comparisons table of Water depth at Ashoolar Beel

Dependent Variable: Water depthTukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	-5.19000*	.75655	.000	-7.0658	-3.3142
	Post-monsoon	-1.50000	.75655	.136	-3.3758	.3758
Monsoon	Pre-monsoon	5.19000*	.75655	.000	3.3142	7.0658
	Post-monsoon	3.69000*	.75655	.000	1.8142	5.5658
Post-monsoon	Pre-monsoon	1.50000	.75655	.136	-.3758	3.3758
	2Monsoon	-3.69000*	.75655	.000	-5.5658	-1.8142

* The mean difference is significant at the 0.05 level.

Appendix 8. Statistical analysis of Water depth at Jamuneswari River of each season

Descriptive table of Water depth at Jamuneswari River

Water depth

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	10	2.6600	.47889	.15144	2.3174	3.0026	2.00	3.20
Monsoon	10	10.160	1.63245	.51623	8.9922	11.3278	8.30	14.00
Post-monsoon	10	7.3100	1.50292	.47527	6.2349	8.3851	5.20	10.00
Total	30	6.7100	3.38876	.61870	5.4446	7.9754	2.00	14.00

ANOVA table of Water depth at Jamuneswari River

Water depth

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	286.650	2	143.325	83.442	.000
Within Groups	46.377	27	1.718		
Total	333.027	29			

Multiple Comparisons table of Water depth at Jamuneswari River

Dependent Variable: Water depthTukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	-7.50000*	.58612	.000	-8.9532	-6.0468
	Post-monsoon	-4.65000*	.58612	.000	-6.1032	-3.1968
Monsoon	Pre-monsoon	7.50000*	.58612	.000	6.0468	8.9532
	Post-monsoon	2.85000*	.58612	.000	1.3968	4.3032
Post-monsoon	Pre-monsoon	4.65000*	.58612	.000	3.1968	6.1032
	Monsoon	-2.85000*	.58612	.000	-4.3032	-1.3968

*. The mean difference is significant at the 0.05 level.

Appendix 9. Statistical analysis of Dissolved Oxygen (DO) at Ashoolar Beel of each season

Descriptives

DO

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	10	6.3200	1.24347	.39322	5.4305	7.2095	3.70	8.00
Monsoon	10	7.5200	.87407	.27641	6.8947	8.1453	6.50	9.20
Post-monsoon	10	10.120	1.75740	.55574	8.8628	11.3772	7.90	13.60
Total	30	7.9867	2.06827	.37761	7.2144	8.7590	3.70	13.60

ANOVA table of DO at Ashoolar Beel

DO

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	75.467	2	37.733	20.968	.000
Within Groups	48.588	27	1.800		
Total	124.055	29			

Multiple Comparisons table of DO at Ashoolar Beel

Dependent Variable: DO

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	-1.20000	.59993	.131	-2.6875	.2875
	Post-monsoon	-3.80000*	.59993	.000	-5.2875	-2.3125
Monsoon	Pre-monsoon	1.20000	.59993	.131	-.2875	2.6875
	Post-monsoon	-2.60000*	.59993	.001	-4.0875	-1.1125
Post-monsoon	Pre-monsoon	3.80000*	.59993	.000	2.3125	5.2875
	Monsoon	2.60000*	.59993	.001	1.1125	4.0875

* The mean difference is significant at the 0.05 level.

Appendix 10.Statistical analysis of Dissolved Oxygen (DO) at Jamuneswari River of each season

Descriptive table of DO at Jamuneswari River

DO

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	10	6.2200	.87914	.27801	5.5911	6.8489	4.90	7.40
Monsoon	10	6.7200	.89666	.28355	6.0786	7.3614	5.30	8.10
Post-monsoon	10	8.3400	1.36561	.43184	7.3631	9.3169	6.50	10.80
Total	30	7.0933	1.38388	.25266	6.5766	7.6101	4.90	10.80

ANOVA table of DO at Jamuneswari River

DO

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	24.563	2	12.281	10.705	.000
Within Seasons	30.976	27	1.147		
Total	55.539	29			

Multiple Comparisons table of DO at Jamuneswari River

Dependent Variable: DO

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	-.50000	.47901	.556	-1.6877	.6877
	Post-monsoon	-2.12000*	.47901	.000	-3.3077	-.9323
Monsoon	Pre-monsoon	.50000	.47901	.556	-.6877	1.6877
	Post-monsoon	-1.62000*	.47901	.006	-2.8077	-.4323
Post-monsoon	Pre-monsoon	2.12000*	.47901	.000	.9323	3.3077
	Monsoon	1.62000*	.47901	.006	.4323	2.8077

*The mean difference is significant at the 0.05 level.

Appendix 11. Statistical analysis of pH at Ashoolar Beel of each season

Descriptive table of pH at Ashoolar Beel

pH

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	10	7.3000	.38297	.12111	7.0260	7.5740	6.80	7.90
Monsoon	10	7.0600	.19551	.06182	6.9201	7.1999	6.80	7.30
Post-monsoon	10	6.9600	.26331	.08327	6.7716	7.1484	6.40	7.20
Total	30	7.1067	.31616	.05772	6.9886	7.2247	6.40	7.90

ANOVA table of pH at Ashoolar Beel

pH

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	.611	2	.305	3.603	.041
Within Seasons	2.288	27	.085		
Total	2.899	29			

Multiple Comparisons table of pH at Ashoolar Beel

Dependent Variable: pH

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	.24000	.13019	.175	-.0828	.5628
	Post-monsoon	.34000*	.13019	.037	.0172	.6628
Monsoon	Pre-monsoon	-.24000	.13019	.175	-.5628	.0828
	Post-monsoon	.10000	.13019	.725	-.2228	.4228
Post-monsoon	Pre-monsoon	-.34000*	.13019	.037	-.6628	-.0172
	Monsoon	-.10000	.13019	.725	-.4228	.2228

*The mean difference is significant at the 0.05 level.

Appendix 12. Statistical analysis of pH at Jamuneswari River of each season

Descriptive table of pH at Jamuneswari River

pH

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	10	7.3300	.48546	.15351	6.9827	7.6773	6.80	8.10
Monsoon	10	7.2100	.29231	.09244	7.0009	7.4191	6.80	7.70
Post-monsoon	10	6.9600	.23190	.07333	6.7941	7.1259	6.60	7.30
Total	30	7.1667	.37539	.06854	7.0265	7.3068	6.60	8.10

ANOVA table of pH at Jamuneswari River

pH

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	.713	2	.356	2.852	.075
Within Seasons	3.374	27	.125		
Total	4.087	29			

Multiple Comparisons table of pH at Jamuneswari River

Dependent Variable: pH

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	.12000	.15809	.731	-.2720	.5120
	Post-monsoon	.37000	.15809	.067	-.0220	.7620
Monsonn	Pre-monsoon	-.12000	.15809	.731	-.5120	.2720
	Post-monsoon	.25000	.15809	.271	-.1420	.6420
Post-monsoon	Pre-monsoon	-.37000	.15809	.067	-.7620	.0220
	Monsoon	-.25000	.15809	.271	-.6420	.1420

*The mean difference is significant at the 0.05 level.

Appendix 13. Statistical analysis of Alkalinity at Ashoolar Beel of each season

Descriptive table of Alkalinity at Ashoolar Beel

Alkalinity

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	10	45.2000	6.35610	2.00998	40.6531	49.7469	36.00	58.00
Monsoon	10	34.6000	3.92145	1.24007	31.7948	37.4052	29.00	42.00
Post-monsoon	10	31.2000	5.45283	1.72434	27.2993	35.1007	21.00	40.00
Total	30	37.0000	7.95678	1.45270	34.0289	39.9711	21.00	58.00

ANOVA table of Alkalinity at Ashoolar Beel

Alkalinity

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	1066.400	2	533.200	18.706	.000
Within Seasons	769.600	27	28.504		
Total	1836.000	29			

Multiple Comparisons table of Alkalinity at Ashoolar Beel

Dependent Variable: Alkalinity

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	10.60000*	2.38762	.000	4.6801	16.5199
	Post-monsoon	14.00000*	2.38762	.000	8.0801	19.9199
Monsoon	Pre-monsoon	-10.60000*	2.38762	.000	-16.5199	-4.6801
	Post-monsoon	3.40000	2.38762	.343	-2.5199	9.3199
Post-monsoon	Pre-monsoon	-14.00000*	2.38762	.000	-19.9199	-8.0801
	Monsoon	-3.40000	2.38762	.343	-9.3199	2.5199

*The mean difference is significant at the 0.05 level.

Appendix 14. Statistical analysis of Alkalinity at Jamuneswari River of each season

Descriptive table of Alkalinity at Jamuneswari River

Alkalinity

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	10	42.8200	9.34164	2.95409	36.1374	49.5026	32.00	61.00
Monsoon	10	35.4000	4.88080	1.54344	31.9085	38.8915	30.00	45.00
Post-monsoon	10	27.4500	5.80081	1.83438	23.3003	31.5997	19.10	40.20
Total	30	35.2233	9.25556	1.68983	31.7673	38.6794	19.10	61.00

ANOVA table of Alkalinity at Jamuneswari River

Alkalinity

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	1181.653	2	590.826	12.246	.000
Within Seasons	1302.641	27	48.246		
Total	2484.294	29			

Multiple Comparisons table of Alkalinity at Jamuneswari River

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	7.42000	3.10631	.061	-.2819	15.1219
	Post-monsoon	15.37000*	3.10631	.000	7.6681	23.0719
Monsoon	Pre-monsoon	-7.42000	3.10631	.061	-15.1219	.2819
	Post-monsoon	7.95000*	3.10631	.042	.2481	15.6519
Post-monsoon	Pre-monsoon	-15.37000*	3.10631	.000	-23.0719	-7.6681
	Monsoon	-7.95000*	3.10631	.042	-15.6519	-.2481

*The mean difference is significant at the 0.05 level.

Appendix 15. Statistical analysis of Moisture (%) contents at Ashoolar Beel of each season

Descriptive table of Moisture (%) contents at Ashoolar Beel

Moisture

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	3	73.3700	.72753	.42004	71.5627	75.1773	72.94	74.21
Monsoon	3	76.7967	1.38048	.79702	73.3674	80.2260	75.71	78.35
Post-monsoon	3	77.5467	1.72082	.99352	73.2719	81.8214	75.66	79.03
Total	9	75.9044	2.25116	.75039	74.1741	77.6348	72.94	79.03

ANOVA table of Moisture (%) contents at Ashoolar Beel

Moisture

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	29.749	2	14.875	8.269	.019
Within seasons	10.793	6	1.799		
Total	40.542	8			

Multiple Comparisons of Moisture (%) contents at Ashoolar Beel

Dependent Variable: Moisture

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	-3.42667*	1.09507	.046	-6.7866	-.0667
	Post-monsoon	-4.17667*	1.09507	.021	-7.5366	-.8167
Monsoon	Pre-monsoon	3.42667*	1.09507	.046	.0667	6.7866
	Post-monsoon	-.75000	1.09507	.781	-4.1100	2.6100
Post-monsoon	Pre-monsoon	4.17667*	1.09507	.021	.8167	7.5366
	Monsoon	.75000	1.09507	.781	-2.6100	4.1100

*The mean difference is significant at the 0.05 level.

Appendix 16. Statistical analysis of Moisture (%)contents at Jamuneswari River of each season

Descriptive table of Moisture (%)contents at Jamuneswari River

Moisture

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	3	73.5233	1.52133	.87834	69.7441	77.3025	72.38	75.25
Monsoon	3	76.2300	.60108	.34704	74.7368	77.7232	75.82	76.92
Post-monsoon	3	77.8100	.60622	.35000	76.3041	79.3159	77.11	78.16
Total	9	75.8544	2.07016	.69005	74.2632	77.4457	72.38	78.16

ANOVA table of Moisture (%)contents at Jamuneswari River

Moisture

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	28.198	2	14.099	13.899	.006
Within seasons	6.086	6	1.014		
Total	34.284	8			

Multiple Comparisons table of Moisture (%)contents at Jamuneswari River

Dependent Variable: Moisture

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	-2.70667*	.82236	.038	-5.2299	-.1834
	Post-monsoon	-4.28667*	.82236	.005	-6.8099	-1.7634
Monsoon	Pre-monsoon	2.70667*	.82236	.038	.1834	5.2299
	Post-monsoon	-1.58000	.82236	.213	-4.1032	.9432
Post-monsoon	Pre-monsoon	4.28667*	.82236	.005	1.7634	6.8099
	Monsoon	1.58000	.82236	.213	-.9432	4.1032

*The mean difference is significant at the 0.05 level.

Appendix 17. Statistical analysis of Ash (%) contents at Ashoolar Beel of each season

Descriptive table of Ash (%) contents at Ashoolar Beel

Ash

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	3	2.4367	.46436	.26810	1.2831	3.5902	1.94	2.86
Monsoon	3	2.0233	.22723	.13119	1.4589	2.5878	1.78	2.23
Post-monsoon	3	2.5500	.67949	.39230	.8621	4.2379	1.92	3.27
Total	9	2.3367	.48977	.16326	1.9602	2.7131	1.78	3.27

ANOVA table of Ash (%) contents at Ashoolar Beel

Ash

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	.461	2	.231	.949	.439
Within Seasons	1.458	6	.243		
Total	1.919	8			

Multiple Comparisons table of Ash (%) contents at Ashoolar Beel

Dependent Variable: Ash

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	.41333	.40248	.588	-.8216	1.6483
	Post-monsoon	-.11333	.40248	.958	-1.3483	1.1216
Monsoon	Pre-monsoon	-.41333	.40248	.588	-1.6483	.8216
	Post-monsoon	-.52667	.40248	.441	-1.7616	.7083
Post-monsoon	Pre-monsoon	.11333	.40248	.958	-1.1216	1.3483
	Monsoon	.52667	.40248	.441	-.7083	1.7616

*The mean difference is significant at the 0.05 level.

Appendix 18. Statistical analysis of Ash (%) at Jamuneswari River of each season

Descriptive table of Ash (%) at Jamuneswari River

Ash

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	3	2.3133	.58688	.33884	.8554	3.7712	1.84	2.97
Monsoon	3	1.9133	.88144	.50890	-.2763	4.1029	1.28	2.92
Post-monsoon	3	2.7633	.33005	.19055	1.9434	3.5832	2.43	3.09
Total	9	2.3300	.66573	.22191	1.8183	2.8417	1.28	3.09

ANOVA table of Ash (%) at Jamuneswari River

Ash

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	1.085	2	.542	1.323	.334
Within Seasons	2.461	6	.410		
Total	3.546	8			

Multiple Comparisons table of Ash (%) at Jamuneswari River

Dependent Variable: Ash

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	.40000	.52288	.736	-1.2043	2.0043
	Post-monsoon	-.45000	.52288	.682	-2.0543	1.1543
Monsoon	Pre-monsoon	-.40000	.52288	.736	-2.0043	1.2043
	Post-monsoon	-.85000	.52288	.306	-2.4543	.7543
Post-monsoon	Pre-monsoon	.45000	.52288	.682	-1.1543	2.0543
	Monsoon	.85000	.52288	.306	-.7543	2.4543

*The mean difference is significant at the 0.05 level

Appendix 19. Statistical analysis of Protein (%) contentsat Ashoolar Beel of each season

Descriptive table of Protein (%) contentsat Ashoolar Beel

Protein

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	3	19.4733	.92614	.53471	17.1727	21.7740	18.42	20.16
Monsoon	3	17.8067	.68857	.39755	16.0962	19.5172	17.02	18.30
Post-monsoon	3	17.2133	.87002	.50231	15.0521	19.3746	16.22	17.84
Total	9	18.1644	1.24574	.41525	17.2069	19.1220	16.22	20.16

ANOVA table of Protein (%) contentsat Ashoolar Beel

Protein

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	8.237	2	4.119	5.915	.038
Within Seasons	4.178	6	.696		
Total	12.415	8			

Multiple Comparisons table of Protein (%) contentsat Ashoolar Beel

Dependent Variable: contents

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	1.66667	.68131	.109	-.4238	3.7571
	Post-monsoon	2.26000*	.68131	.037	.1696	4.3504
Monsoon	Pre-monsoon	-1.66667	.68131	.109	-3.7571	.4238
	Post-monsoon	.59333	.68131	.677	-1.4971	2.6838
Post-monsoon	Pre-monsoon	-2.26000*	.68131	.037	-4.3504	-.1696
	Monsoon	-.59333	.68131	.677	-2.6838	1.4971

*The mean difference is significant at the 0.05 level.

Appendix 20. Statistical analysis of protein (%) contents at Jamuneswari River of each season

Descriptive table of protein (%) contents at Jamuneswari River

Protein

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	3	19.7200	.53113	.30665	18.4006	21.0394	19.13	20.16
Monsoon	3	18.4100	.76544	.44193	16.5085	20.3115	17.63	19.16
Post-monsoon	3	16.8200	.53075	.30643	15.5015	18.1385	16.34	17.39
Total	9	18.3167	1.36719	.45573	17.2658	19.3676	16.34	20.16

ANOVA table of protein (%) contents at Jamuneswari River

Protein

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	12.654	2	6.327	16.510	.004
Within Seasons	2.299	6	.383		
Total	14.954	8			

Multiple Comparisons table of protein (%) contents at Jamuneswari River

Dependent Variable: Protein
Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	1.31000	.50546	.091	-.2409	2.8609
	Post-monsoon	2.90000*	.50546	.003	1.3491	4.4509
Monsoon	Pre-monsoon	-1.31000	.50546	.091	-2.8609	.2409
	Post-monsoon	1.59000*	.50546	.045	.0391	3.1409
Post-monsoon	Pre-monsoon	-2.90000*	.50546	.003	-4.4509	-1.3491
	Monsoon	-1.59000*	.50546	.045	-3.1409	-.0391

*. The mean difference is significant at the 0.05 level.

Appendix 21. Statistical analysis of Lipid (%) contents at Ashoolar Beel of each season

Descriptive table of Lipid (%) contents at Ashoolar Beel

Lipid

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	3	4.4000	1.12942	.65207	1.5944	7.2056	3.10	5.14
Monsoon	3	3.3267	.82730	.47764	1.2715	5.3818	2.57	4.21
Post-monsoon	3	2.7167	.58535	.33795	1.2626	4.1708	2.24	3.37
Total	9	3.4811	1.05848	.35283	2.6675	4.2947	2.24	5.14

ANOVA table of Lipid (%) contents at Ashoolar Beel

Lipid

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.358	2	2.179	2.839	.016
Within Groups	4.605	6	.768		
Total	8.963	8			

Multiple Comparisons table of Lipid (%) contents at Ashoolar Beel

Dependent Variable: Lipid Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	1.07333	.71533	.355	-1.1215	3.2682
	Post-monsoon	1.68333	.71533	.123	-.5115	3.8782
Monsoon	Pre-monsoon	-1.07333	.71533	.355	-3.2682	1.1215
	Post-monsoon	.61000	.71533	.687	-1.5848	2.8048
Post-monsoon	Pre-monsoon	-1.68333	.71533	.123	-3.8782	.5115
	Monsoon	-.61000	.71533	.687	-2.8048	1.5848

*. The mean difference is significant at the 0.05 level.

Appendix 22. Statistical analysis of Lipid (%) at Jamuneswari River of each season

Descriptive table of Lipid (%) at Jamuneswari River

Lipid

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pre-monsoon	3	4.2600	.68037	.39281	2.5699	5.9501	3.49	4.78
Monsoon	3	3.3467	.77552	.44775	1.4202	5.2732	2.63	4.17
Post-monsoon	3	2.8600	.91198	.52653	.5945	5.1255	2.02	3.83
Total	9	3.4889	.92352	.30784	2.7790	4.1988	2.02	4.78

ANOVA table of Lipid (%) at Jamuneswari River

Lipid

	Sum of Squares	df	Mean Square	F	Sig.
Between Seasons	3.031	2	1.516	2.398	.002
Within Seasons	3.792	6	.632		
Total	6.823	8			

Multiple Comparisons table of Lipid (%) at Jamuneswari River

Dependent Variable: Lipid

Tukey HSD

(I) season	(J) season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pre-monsoon	Monsoon	.91333	.64911	.395	-1.0783	2.9050
	Post-monsoon	1.40000	.64911	.158	-.5916	3.3916
Monsoon	Pre-monsoon	-.91333	.64911	.395	-2.9050	1.0783
	Post-monsoon	.48667	.64911	.745	-1.5050	2.4783
Post-monsoon	Pre-monsoon	-1.40000	.64911	.158	-3.3916	.5916
	Monsoon	-.48667	.64911	.745	-2.4783	1.5050

*. The mean difference is significant at the 0.05 level.

Appendix 23. ANOVA of Air temperature at two Habitats in three different seasons

ANOVA of Air temperature in pre-monsoon season at two habitats

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.019	1	.019	.014	.908
Within Habitats	24.248	18	1.347		
Total	24.267	19			

ANOVA of Air temperature in Monsoon season at two habitats

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.040	1	.040	.026	.874
Within Habitats	28.149	18	1.564		
Total	28.190	19			

ANOVA of Air temperature in Post-monsoon season at two habitats

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.703	1	.703	.207	.655
Within Habitats	61.131	18	3.396		
Total	61.834	19			

Appendix 24. ANOVA of Water temperature at two Habitats in three different seasons

ANOVA of Water temperature in pre-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.200	1	.200	.175	.680
Within Habitats	20.520	18	1.140		
Total	20.720	19			

ANOVA of Water temperaturein Monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.338	1	.338	.211	.652
Within Habitats	28.872	18	1.604		
Total	29.210	19			

ANOVA of Water temperaturein Post-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	5.202	1	5.202	.629	.438
Within Habitats	148.876	18	8.271		
Total	154.078	19			

Appendix 25. ANOVA of Transparency at two Habitats in three different seasons

ANOVA of Transparency in pre-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	85.698	1	85.698	1.070	.315
Within Groups	1441.474	18	80.082		
Total	1527.172	19			

ANOVA of Transparency in Monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.025	1	.025	.000	.985
Within Groups	1155.805	18	64.211		
Total	1155.830	19			

ANOVA of Transparency in Post-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16.928	1	16.928	1.007	.329
Within Groups	302.614	18	16.812		
Total	319.542	19			

Appendix 26. ANOVA of Water depth at two Habitats in three different seasons

ANOVA of Water depthin Pre-monsoon season

	Sum of Squares	Df	Mean Square	F	Sig.
Between Habitats	40.328	1	40.328	28.110	.000
Within Habitats	25.824	18	1.435		
Total	66.152	19			

ANOVA of Water depth in Monsoon season

	Sum of Squares	Df	Mean Square	F	Sig.
Between Habitats	3.872	1	3.872	1.544	.230
Within Habitats	45.138	18	2.508		
Total	49.010	19			

ANOVA of Water depth in post-monsoon season

	Sum of Squares	Df	Mean Square	F	Sig.
Between Habitats	1.201	1	1.201	.486	.495
Within Habitats	44.449	18	2.469		
Total	45.649	19			

Appendix 27. ANOVA of Dissolved Oxygenat two Habitats in three different seasons

ANOVA of Dissolved Oxygen in pre-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	3.200	1	3.200	4.082	.058
Within Habitats	14.112	18	.784		
Total	17.312	19			

ANOVA of Disslved Oxygen in Monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	15.842	1	15.842	6.397	.021
Within Habitats	44.580	18	2.477		
Total	60.422	19			

ANOVA of Disslved Oxygen in Post-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.050	1	.050	.043	.838
Within Habitats	20.872	18	1.160		
Total	20.922	19			

Appendix 28. ANOVA of PH at two Habitats in three different seasons

ANOVA of pH in pre-monsoon season

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.003	1	.003	.016	.900
Within Groups	3.473	18	.193		
Total	3.476	19			

ANOVA of pH in Monsoon season

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.000	1	.000	.000	1.000
Within Groups	1.108	18	.062		
Total	1.108	19			

ANOVA of pH in Post-monsoon season

	Sum of Squares	Df	Mean Square	F	Sig.
Between Habitats	57.122	1	57.122	.782	.388
Within Habitats	1315.396	18	73.078		
Total	1372.518	19			

Appendix 29. ANOVA of Alkalinity at two Habitats in three different seasons

ANOVA table of Alkalinity in pre-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	2.450	1	2.450	.124	.729
Within Habitats	356.500	18	19.806		
Total	358.950	19			

ANOVA table of Alkalinity in Monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	72.200	1	72.200	2.288	.148
Within Habitats	568.000	18	31.556		
Total	640.200	19			

ANOVA of Air temperature in post-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.018	1	.018	.044	.844
Within Habitats	1.657	4	.414		
Total	1.675	5			

Appendix 30. ANOVA of Moisture contents at two Habitats in three different seasons

ANOVA of Moisture contents in pre-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.037	1	.037	.026	.880
Within Habitats	5.671	4	1.418		
Total	5.708	5			

ANOVA of Moisture contents in monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.928	1	.928	.715	.445
Within Habitats	5.194	4	1.299		
Total	6.122	5			

ANOVA table of Moisture contents n post-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.104	1	.104	.062	.815
Within Habitats	6.657	4	1.664		
Total	6.761	5			

Appendix 31. ANOVA of Ash content at two Habitats in three different seasons

ANOVA of Ash contents in pre-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.023	1	.023	.081	.789
Within Habitats	1.120	4	.280		
Total	1.143	5			

ANOVA of Ash contents in monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.018	1	.018	.044	.844
Within Habitats	1.657	4	.414		
Total	1.675	5			

ANOVA of Ash contents in post-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.068	1	.068	.239	.650
Within Habitats	1.141	4	.285		
Total	1.210	5			

Appendix 32. ANOVA of proteincontentsat two Habitats in three different seasons

ANOVA of proteincontents in pre-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.277	1	.277	.374	.574
Within Habitats	2.965	4	.741		
Total	3.243	5			

ANOVA of protein contents in monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.546	1	.546	1.030	.368
Within Habitats	2.120	4	.530		
Total	2.666	5			

ANOVA of protein contents in post-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.232	1	.232	.447	.540
Within Habitats	2.077	4	.519		
Total	2.309	5			

Appendix 33. ANOVA of lipid contents at two Habitats in three different seasons

ANOVA of lipid contents in pre-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.029	1	.029	.034	.863
Within Habitats	3.477	4	.869		
Total	3.506	5			

ANOVA of lipid contents in monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.031	1	.031	.052	.830
Within Habitats	2.349	4	.587		
Total	2.379	5			

ANOVA of lipid contents in post-monsoon season

	Sum of Squares	df	Mean Square	F	Sig.
Between Habitats	.001	1	.001	.001	.977
Within Habitats	2.572	4	.643		
Total	2.572	5			

Appendix-34: Photos for proximate analysis

Collection of fish musclesCollected Fish muscles

Weighting of the fishmusclesOven for the moisture contents

Appendix 35: Photos for proximate analysis


Burning of fish musclesfor ash Muffle furnace


Ash in crucible Kjeldhal flask for protein

Appendix 36: Photos for proximate analysis

Digestion chamber

volumetric flask with sample

Titration for protein contents

conical flask with titrated sample

Appendix 37: Photos for proximate analysis

Soxhlet machine for lipid contents

Fish muscles for lipid contents

Dried muscles

Dried muscles