ISSN: 2347-5129
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2016; 4(5): 516-520

www.fisheriesjournal.com
Received: 10-07-2016
Accepted: 11-08-2016

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Water quality assessment of capture and culture fishery in Barpeta district, Assam, India

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Abstract
The state Assam has an excellent sub-tropical climate for development of freshwater fish culture. Barpeta is the highest fish seed producing district in Assam. The district is a low-lying flood affected area having a lot of water bodies which is used for the purpose of fish culture, irrigation and domestic uses etc. In the present study collected water samples were subjected to physico-chemical analysis in order to evaluate the quality of water in the ponds of the area. This paper deals with the comparisons of water quality assessment of culture and capture fishery on thirteen Physico-chemical parameters such as water temperature, pH, Dissolved Oxygen, Free Carbon dioxide and Total Hardness, Chlorides, Alkalinity, Total dissolved solid and Electric conductivity following standard methods. The study reveals in both the capture and culture fisheries that water quality index is found as 68.8 and 62.4 respectively indicating poor water quality status, which suggests for a proper management of the fisheries to yield better growth dynamics.

Keywords: Water quality analysis, water quality index, fishery, barpeta, Assam

Introduction
Barpeta, one of the flood affected districts of lower Assam covers an area of 3,245 sq. kms occupies a unique position in the state of Assam in terms of fish production and aquaculture during the last few decades. The study areas are located in between having 161 registered beels and 39 registered riverine northern tributaries i.e. Manas, Beki, Palla, Pahumara of large Asian river Brahmaputra with innumerable swamps, ponds, marshy area. The people of the area have been maintaining an intrinsic relationship with pisciculture as the main source of income. The Freshwater is of vital concern for aquatic organisms, since it is directly linked to it's growth perspectives. Among the water bodies, ponds are mostly used for fisheries in the rural areas of Assam, India. Water quality is used to describe the condition of the water, including its chemical, physical and biological characteristics, usually with respect to its suitability for a particular purpose (i.e., drinking, swimming or fishing) [1, 2, 3]. The productivity of a pond depends on the quality of water and is essential for the existence of organisms. The important physico-chemical factors influencing water quality are depth, temperature, turbidity, light, oxygen, carbon dioxide, pH, Total hardness, Alkalinity, calcium, magnesium. Measurement of water quality index, will therefore decide whether the water is or suitable for various uses including drinking, pisciculture, agriculture, domestic use not. Water quality index should provide a single number that expresses overall water quality. Various researchers [4, 5, 6, 7, 8, 9] worked on the water quality index of ponds and found different ranges of it from 42 to 106. Water quality assessment in culture fisheries portrays the overall water characteristics suitable for the growth of spawn, fry and fingerling. On the other hand, the well-being condition and growth of fishes in capture fisheries are dependent on the overall water characteristics from commercial point of view. The number of fishes are in the region is declining day by day due to anthropogenic and natural threats. So, it has become very important to check the physico-chemical characteristics of water from time to time for culture purposes. An investigation on water quality assessment of nursery pond in the vicinity was carried out and the water quality status of the pond was found poor [9]. Keeping the view, the present work was undertaken with a view to study the comparative water quality index based on physico-chemical characteristics from two ponds along with recommendation for future uses.

Materials and Methods

The study was carried out in two ponds i.e. Culture fisheries (station 1) near Howly which lies in latitude 26.4232^{0}N and longitude 90.9801^0 E and a capture fisheries (station 2) near Pathsala 26.5119^{0}N and 91.1801^0 E.

Fig 1: Map of Barpeta distrct, Assam, India

In the study periods, various physico-chemical parameters from culture and capture fisheries were collected for one year duration in 2015. The samples were collected in 5 liter plastic bottles in the late afternoon. Some physico-chemical parameters such as water temperature, pH, odour, colour were recorded at the spot and the other physico-chemical parameters were analyzed using standard methods (APHA, 1995) [10]. All values except pH and Electrical Conductivity are in mg/L.EC in mmhos/cm The water quality index has been calculated by using the standards of drinking water quality recommended by the World Health Organization (WHO) [11], Bureau of Indian Standards (BIS,1992) [12]. The weighted arithmetic index method has been used for the calculation of WQI of the water body. The quality rating or sub index (qn) was calculated using the following expression:

$$Qn - 100\ [Vn - Vio]/\ [Sn - Vio]$$

Where, Qn = Quality rating for the nth water quality parameter.
Vn = Estimated value of the nth parameter at a given sampling station.
Sn = Standard permissible value of the nth parameter.
Vio = Ideal value of nth parameter in pure water i.e., 0 for all other parameters except the parameter pH and Dissolved oxygen (7.0 and 14.6 mg/L respectively). Unit weight was calculated by a value inversely proportional to the emended standard value Sn of the corresponding parameter.
Wn = 1/Sn Where, Wn = Unit weight for the nth parameter
Sn = Standard value for the nth parameters.
The overall water quality index (WQI) was calculated by aggregating the quality rating with the unit weight linearly.

$$WQI = \sum qn\ Wn\ /_{\sum Wn}$$

The water quality index (WQI) level and status of water quality as suggested by Chatterji and Raziuddin (2002) has been presented in Table 1.

Table 1: Water quality index (WQI) level and status of water quality

Water quality Index Level	Water Quality Status
0-25	Excellent water quality
26-50	Good water quality
51-75	Poor water quality
76-100	Very poor water quality
>100	Unsuitable for drinking

The drinking water standards as recommended by recommending agencies and unit weight have been presented in table 2

Table 2: Drinking water standards recommending Agencies and unit weights

Sl no.	Parameters	Standards	Recommending agency, Bureau of Indian Standards (1992)	Unit Weight for the nth parameter (Wn)
1	pH	6.5-8.5	BIS	.1176
2	Total alkalinity	250	BIS	.0040
3	Total hardness	300	BIS	.0033
4	Dissolved oxygen	5	BIS	.2000
5	Total chloride	250	BIS	.0040
6	Calcium	75	BIS	.0133
7	Magnesium	50	BIS	.0200
8	Potassium	200	BIS	.0050
9	B.O.D	6	BIS	.1666
10	Electrical conductivity	300	BIS	.0033
11	T.D.S	500	BIS	.0020
12	Na	200	BIS	.0050

Result and Discussion

The mean values of the physico-chemical parameters of the water in the culture and capture fisheries has been presented in the figure 2. The values of thirteen physicochemical parameters of both the capture and culture fisheries for calculation of Water Quality Index (WQI) for the year 2015 are presented in Tables (3, 4) respectively. The WQI of the both capture and culture fisheries are established from important various physicochemical parameters namely; pH (Hydrogen ion concentration), EC (Electrical conductivity), DO (Dissolved oxygen), turbidity, TH (Total hardness), ions of Ca2 + (Calcium), Mg2+ (Magnesium), Na+ (sodium), K+ (potassium), Cl- (chloride).

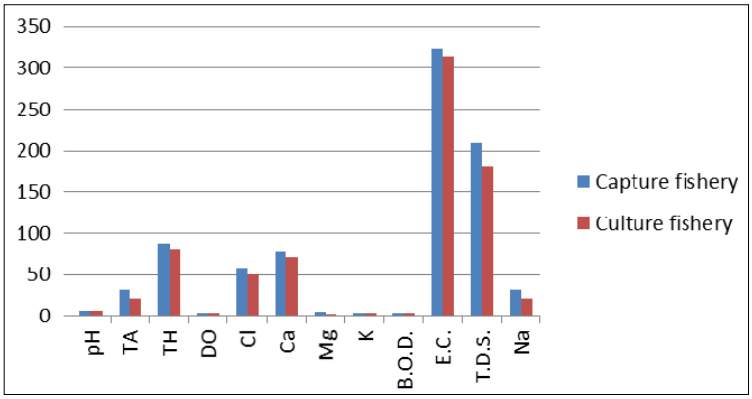

Fig 2: Comparative physico-chemical parameters in captive and culture fishery

Table 3: Calculation of water quality index in Culture fishery

Sl No.	Parameters	Observed Value	Quality rating (qn)	Unit Weight (Wn)	Wnqn
1	pH	6.4	12	.1176	1.4112
2	Total alkalinity	21	8.4	.0040	.0336
3	Total hardness	80	26.66	.0033	.08797
4	Dissolved oxygen	4	110.41	.2000	22.082
5	Total chloride	50.05	20.02	.0040	.08008
6	Calcium	71.4	95.2	.0133	1.2661
7	Magnesium	2.09	4.18	.0200	.0836
8.	Potassium	3.4	1.7	.0050	.0085
9.	B.O.D	3.01	50.16	.1666	8.356
10	Electrical Conductivity	314.5	104.83	.0033	.3459
11.	Total dissolved solids	180.5	36.1	.0020	.0722
12.	Na	20.5	10.25	.0050	.0512
			∑qn = 478.21	∑Wn =.5441	∑Wnqn = 33.8783
Water quality Index = 62.24					

Table 4: Calculation of water quality index in Capture fisheries

Sl No.	Parameters	Observed Value	Quality rating (qn)	Unit Weight (Wn)	Wn (unit weight) qn
1	pH	6.7	6	.1176	.7056
2	Total alkalinity	31	12.4	.0040	.0496
3	Total hardness	87	29	.0033	.0957
4	Dissolved oxygen	3.7	115.62	.2000	23.124
5	Total chloride	56.4	22.56	.0040	.0902
6	Calcium	78.3	114.66	.0133	1.524
7	Magnesium	4.7	9.4	.0200	0.188
8.	Potassium	4.2	2.1	.0050	.0105
9.	B.O.D	4.03	67.16	.1666	11.18
10	E.C	323..7	107.90	.0033	.35607
11.	T.D.S.	209.6	41.92	.0020	.08384
12.	Na	31.3	15.65	.0050	.07825
			∑qn = 544.37	∑Wn =.5441	∑Wnqn = 37.48
Water quality Index = 68.8					

The water samples taken for the study were light yellowish in colour and odourless in both stations. Temperature of water is basically important because it effects bio-chemical reactions in aquatic organisms. A rise in temperature of water leads to the speeding up of chemical reactions in water, reduces the solubility of gases and amplifies the tastes. The average water temperature was 23 ºC in the both station. This study reveals that water quality of the culture fishery was better than the capture fishery and needs some strategies to maintain the physico-chemical characteristics for the growth of the algae, insects, microorganisms, phytoplankton and zooplankton which are considered as essential component of an aquatic ecosystem.

pH: The permissible limit of pH in drinking water is within 6.5 – 8.5 [12]. The value of pH in capture fishery ranging from 5–7 with average 6.7 and in culture fishery ranging between 5–7 with average of 6.4. The pH of capture fishery is between the desirable range and incase of culture fishery, it lies just below the desirable range. Ideally, a culture pond should have a pH between 6.5 [12].

Alkalinity: Most aquatic organism, fish for example can live in a wide range of alkalinity concentration. The desired alkalinity level for most fishery lies between 50-150 mg/L [13]. But in the analysis, alkalinity of culture fishery was found only 21 mg/L, and in the capture fishery it was in the range of 24 -38 mg/L. and found only 31 mg/L, which is very low in both cases.

Total hardness: The average total hardness was 80 mg/L in the culture fishery and in capture fishery it was in the range of total hardness was 64 – 110 with average 87 mg/L. The recommended ideal value for total hardness is 30-180 mg/L [14].

Total chloride: The average total chloride was found 50.05 mg/L. in the culture fishery. The range of total chloride in capture fishery was 47.5 – 65.5 with average 56.4 mg/L. The desirable range of chlorides for commercial catfish production is above 60 mg/L [15].

Dissolved oxygen: The DO of culture fisheries was found in between the range 3 to 5 with avg. 4 mg/L and in capture fishery, it was found between the range 1.3 - 4.1 with 3.7 mg/L and in both case it is suitable for survival of the fish fry in nursery pond but the growth is slow. It is an important parameter which is essential to the metabolism of all aquatic organisms that possess aerobic respiration [16].

Free Carbon di-oxide: The average free CO_2 in culture fisheries was found in between the range. 9 - 1.6 with average 1.1 mg/L and capture fisheries it was found in between the range. 8 – 2.0 with average 1.4 mg/L within the desirable range [12].

Magnesium: The concentration of Magnesium in the culture fishery ranged between 0 to 5.42 mg/l. with average 2.09 mg/L. and in capture fishery the concentration of Magnesium ranged between 3.2 to 6.2 mg/l. with average 4.7 mg/L. The maximum permissible limit of calcium hardness is 50 mg/l [12]. Magnesium is often associated with calcium in all kind of water, but it's concentration was found much lower than that of calcium in both fisheries.

B.O.D: The Biochemical Oxygen Demand or BOD is a measure of the amount of food for bacteria which is found in water and it provides a general idea of the amount biodegradable waste is present in the water. In the culture fishery, it was found between the range of 2.01 – 4.01 with average of 3.01 mg/L and in the capture fisheries it was found between the range of 3.01 – 5.01 with average of 4.03 mg/L and both results are within desirable limit [12]. The optimum BOD level for aquaculture should be less than 10 mg/L but the water with BOD less than 10-15 mg/L can be considered for fish culture [14]. The BOD <1.6 mg/L level is suitable for pond fish culture [17]. The aquatic system with BOD levels between 1.0 and 2.0 mg L-1-considered clean; 3.0 mg L-1 fairly clean; 5.0 mg L-1 doubtful and 10.0 mg L-1 definitely bad and polluted [18].

Electrical conductivity: Conductivity is a measure of current carrying capacity. Thus, as concentration of dissolved salts increases conductivity also increases. The electrical conductivity is found in capture fishery was 323.7 and culture fishery was found 314.05 and both are above the standard limit.

Conclusion

Thus from the study on water quality assessment of culture and capture fisheries, it may be concluded that the present observation on the both the fisheries indicates poor water quality index. Hence, application of water quality index technique for the development of fisheries in particular and socio-economic development in general is a useful technique.

Acknowledgement

We acknowledge the help and guidance of Dr. B. Sarma, Associate Professor and Head of P.G. Department of Zoology in preparing the article.

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