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Fish Diversity and Fisheries Potential of Some Wetlands in Assam

Bul bul Acharjee
Associate Professor,
Deptt.of Zoology,
University of Science and Technology, Meghalaya.

Arup Nama Das
Assistant Professor,
Deptt.of Zoology,
University of Science and Technology, Meghalaya.

Amalesh Dutta
Retd. Professor & Head,
Deptt. of Zoology,
Gauhati University,
Ghy-14

Abstract

India is endowed with vast expanse of freshwater resources which can be broadly put under two categories depending on basic ecological consideration. They are ponds and lakes and streams and rivers. The country has extensive freshwater wetlands of the first category mainly located in eastern U.P, Bihar, West Bengal, Assam and the other NE states. In Assam alone nearly one lakh hectare of waterspread area is covered under beels but despite high fish production, the average fish production from these water bodies is not even 100Kg yr^{-1} .In Assam which has got immense fish production potential in the form of beels very few systematic studies have been made pertaining to ecological status and fisheries of beels of lower Assam. A study was carried out in two wetlands from Kamrup District of Assam, Dighali (91^0 40'E longitude & $26^0$14'N latitude) and Ghorajan (26^0 13'N latitude and $91^0$42'E longitude) during the years 2015 and 2016 respectively. The monthly average plankton concentration was 703 $UL^{-1}$and 726UL^{-1}in Dighali and Ghorajan .Dissolved oxygen was comparatively satisfactory with 9.2mgl^{-1}in Dighali and5.6 mgl^{-1}in Ghorajan. Among macrophytes, Hydrilla verticellata remained the most dominant species in Dighali and Eichhornia crassipes dominated in Ghorajan. The annual commercial yield from Dighali has been estimated as14.9kg $ha^{-1}yr^{-1}$and Ghorajan recorded an estimated yield of 13.5 kg ha^{-1} y^{r-1}.Wallago attu was the most dominant species recorded from both the beels.The study suggested that unscientific management and man-made environmental degradation resulted in drastic decline in fish production and dominance of trash fishes reflected the sorry state of affairs in these two beels.

Keywords: Potential, Degradation, Production, Management

Introduction

Wetlands since time immemorial have been perceived as life sustaining units of the world. They are considered as future food and fodder resources for human population and its related allies. Ecologically, wetlands are of great significance as they support varied food chains and food webs, regulate hydrological cycle, recharge ground water and maintain its quality by acting as filters, provide refuge to a large number of endangered flora and fauna help in trapping of energy and carbon-di-oxide and in nutrient cycling treatment of waste water and provide natural check to floods. Wetlands also have great recreational and aesthetic values. As a part of the non–traditional agriculture the wetlands also support agricultural economy. Around 6.4% of the earth's surface is covered with wetlands. They are continuum of rivers and are locally known as beels, pats, mauns, jheels etc and are biologically sensitive ecosystems which play a vital role in the inland fish production of the eastern and northeastern part of the country. The beels are unique water bodies which need in depth scientific study before undertaking any management measure.

Fishes make up most of the abundant class of vertebrates, both in terms of number of species and of individuals. They exhibit enormous diversity of size, shape and biology, and in the habitats they occupy.Researchers have arrived at different estimates, most of which range between 17,000 and 30,000 for the numbers of currently recognized fish species. The eventual number of living fish species may be close to 28,000 in the world. Jayaram (1981) listed 742 freshwater species of fishes under 233 genera, 64 families and 16 orders from the Indian region. Talwar and Jhingran (1991) estimated 2,546 species of fish belonging to 969 genera, 254 families and 40 orders. The Indian fish population represents 11.72 per cent of species, 23.96 per cent of genera, 57 per cent of families and 80 per cent of the global fishes.

The work on limnological features of beels have been reported by Pathak (1989) and on macrovegetation dynamics by Mitra (1989).By virtue of their unique position, location and carrying capacity, these two lakes have emerged as major life sustaining entities. These water bodies are extremely rich in nutrients and have immense production potential as reflected by their rich nutrient status in the water phase.The shallow nature of these beels with their rich nutrient status and penetration of light upto the bottom have led to the infestation of weeds to such an extent that both these beels have remained choaked with macrophytes. Studies made in some beels of Assam give valuable information regarding limnological features, productivity status and management measures for these resources. However, as beels are peculiar ecosystems each having a separate identity, a general study on the various limnochemical parameters and assessment of the fisheries potential is very essential. With these objectives in mind, the present investigation was undertaken to study the ecological parameters and formulate a general management measures for optimizing fish production from such waters. In order to gather systematic information two beels Dighali and Ghorajan were taken as case studies. Dighali beel (91^0 40'E longitude & $26^0$14'N latitude) with a waterspread area of 250 ha lies 35 Km northwest of Guwahati city within Hajo circle of Kamrup District at an elevation of 55 MSL while Ghorajan beel (26^0 13'N latitude and $91^0$42'E longitude), a floodplain lake of the river Brahmaputra is situated near North Guwahati at about a distance of 25 km from Guwahati. The present investigation deals with hydrological features of the beels, the qualitative and quantitative spectrum of biotic communities present in the system, fish production potential together with various management measures for optimizing fish production from such systems.

Materials and Methods

A survey was carried out in two wetlands of Kamrup District, Assam, Dighali (91^0 40'E longitude & $26^0$14'N latitude) and Ghorajan (26^0 13'N latitude and $91^0$42'E longitude) during 2015 and 2016 respectively. The selected beels were divided into sectors for collecting information on ecological parameters. Monthly sampling was done from all the sectors for the analysis of water, biotic communities like plankton, benthos, macrophytes etc. For the analysis of water quality parameters, samples were collected from the surface from various sectors. To maintain uniformity of data the time of collection was kept almost similar. The physico-chemical parameters were analyzed as per Welch (1948) and APHA (1998). Benthos samples were collected from various zones of the beel during the period 2015 and 2016 with Ekman's dredge and passed through sieve No. 40. The samples were preserved in formalin and brought to the laboratory for analysis. Identification was done under a field microscope and analyzed seasonally as per standard procedures. Macrophytes were collected seasonally from different sectors in each beel with the help of a quadrant sampler and fresh weight was taken with the help of a balance. Dry weight of macrophytes was also determined. Plankton samples were collected seasonally using a plankton net (nylo volt no.25) and analyzed after Edmondson (1956) and Needham and Needham (1966). Fish catch statistics of commercially important species have been collected covering all the months of the year. Landing sites were visited once a week and data collected have been supplemented by direct enquiries from fishermen and fishtraders. Composition and identification of fish fauna have been done following Day (!878, 1889), Mishra (1959), Menon (1974), Jay ram (1981) and Talwar and Jhingran (1991).

Results and Discussion

Physico-Chemical Parameters of Water

Water Temperature

In Dighali water temperature ranged between 17.0 and 30.6 ^{0} C in 2015 and 18.2 and 31.4 ^{0} C in 2016 while seasonal variation of temperature of Ghorajan (2007) ranged between 21.5 and 30.5 ^{0}C with an average of 27.1 ^{0} C.

Transparency

Transparency of water in Dighali beel ranged between 49.2 and 104 cm during 2015 and 2016.The maximum value recorded was (104cm) in 2006 and 94 cm in November 2016. The seasonal variation in Ghorajan ranged between 62 and 110cm.

Dissolved Oxygen

The water quality with respect to dissolved oxygen was quite rich in both the beels. The range of variations was between 5.2 to 9.2mgl^{-1}in 2006 and 5.2 to 8.8 mgl^{-1}in 2007 in Dighali and 3.7 to 5.6 mg l^{-1}in Ghorajan. The maximum values recorded was in January 2006 (9.2mgl^{-1}) and January 2007 (8.8mgl^{-1}) in Dighali. Increase in dissolved oxygen values was observed in Ghorajan. The monthly trend of dissolved oxygen showed a gradual decline from February onwards reaching minimum in June (2015) and August (2016) and subsequently increasing trend was noticed till January.

pH

Water in Dighali and Ghorajan was almost neutral to acidic, pH ranging between 6.4 and 7.4 in 2015 and 6.2 and 7.1 in 2016 in Dighali and 6.3 and 6.8 in Ghorajan respectively. The monthly fluctuation in pH showed one primary peak during June/ July. However, in the first year, one secondary peak was observed in May. No significant seasonal variation in pH was observed in Ghorajan.

Free Carbon-di-Oxide

The free carbon-di-oxide in Dighali beel fluctuated between 2.0 and 15.0 mgl^{-1} in 2015 and 3.2 and 15.8 mgl^{-1}in 2016. Ghorajan showed very high values ranging between 23.1 to 33.8 mgl$^{-1.}$ Peak period of carbon-di-oxide was observed in monsoon for the two beels.

Total Alkalinity

Total alkalinity ranged from 25.0 to 37.2 mgl^{-1}in 20015 and 24.8 to 38 mgl-1 in 2016 was low in Dighali beel. The alkalinity showed maximum values either in November 2006 or in December 2007. Seasonal variation in Ghorajan was 31.3 to 38.4 mgl^{-1} respectively.

Specific Conductance

Specific conductance ranging between 52.6 and 80.0µmhos in 2015 and 52.0 and 82.0 µmhos in 2016 was low in Dighali beel . Maximum conductance was observed in December and minimum in July. In Ghorajan beel conductance ranged between 60.4 and 69.5 µmhos respectively. Retreating monsoon recorded the highest conductance.

Total Dissolved Solids

Total dissolved solids was low in both the beels. The range of variations in Dighali was 27.5 to 40.2 mgl^{-1}in 2015 and 26.4 to 42.0 mgl^{-1} in 2016 and 28.2 to 39.8 mgl^{-1}in Ghorajan respectively. Highest values of Total Dissolved Solids was recorded during retreating monsoon and winter.

Total Hardness

Total hardness was quite low in Dighali ranging between 24.0 and 36.5 mgl^{-1} in 2015 and 25.2 and 33.4mgl in 2016 respectively. In Ghorajan it ranged between 29.2 and 38.0 mgl^{-1}.

Nitrate

Nitrate values was low ranging between 0.18 to 0.40 mgl-1 in 2015 and 0.12 to 0.42 mgl^{-1} in 2016.Maximum values were recorded in July during the first year while in the second year maximum values were recorded during August. Nitrate fluctuated between 0.18 and 0.32 mgl^{-1} in Ghorajan.

Phosphate

Like nitrate phosphate was also poor in both the beels. The range of variations was 0.04 to 0.12 mgl^{-1} in 2015 and 0.03 to 0.18 mgl^{-1} in 2016 in Dighali and 0.03 to 0.05 mgl^{-1} in Ghorajan beel respectively.Seasonal variation showed higher values during July to September and minimum during December to February.

Silicate

Silicate was poor in both the beels with range of variations 2.2 to 7.0 mgl^{-1} in 2015 and 3.2 to 6.8mgl^{-1} in 2016 in Dighali and 4.5 to 12.8 mgl^{-1} in Ghorajan.

Iron

Iron was also poor in these beels ranging between 0.02 to 0.18 in 2006 and 0.04 to 0.20 mg l^{-1} in 2007 in Dighali and in Ghorajan ranging between 0.09 to 0.22 mgl-1.Maximum and minimum values were observed during July to August and December to January respectively.

Dissolved Organic Matter

Dissolved organic matter in Dighali beel ranging between 1.8 to 3.4 mgl^{-1} in 2006 and 1.8 to 3.4 mgl^{-1} in 2007 was rich. Ghorajan beel was also quite rich in dissolved organic matter ranging between 1.5 and 2.9 mgl^{-1}.

pH is one of the determining factors of productivity. The investigation reveals fairly productive nature of the beels as the water is slightly alkaline to acidic. Dissolved oxygen exhibited higher values during winter and lower during monsoon. The impact of rain washings seem to influence the increase in free carbon-di-oxide in the form of carbonic acid. Total dissolved solids , specific conductance, nitrate, phosphate and silicate in the beels are poor. Based on the observation of hardness, these beels can be considered soft-water bodies.

Plankton

Beels in Assam are generally characterized by poor concentration of plankton but consist of diverse assemblage of nearly all the taxonomic groups despite the fact that different plankters have different environmental requirement. The present investigation carried out in three beels of lower Assam showed poor occurrence of plankton. The monthly average plankton concentration of plankton was found to be 703 UL $^{-1}$in 2015 and 689 UL $^{-1}$in 2016 in Dighali beel and 726 UL $^{-1}$ in Ghorajan. In general, plankton showed two primary peaks, a primary peak during retreating monsoon and a secondary one in winter. The present study clearly indicates the dominance of phytoplankton in Dighali beel (63.6% in 2006 and 64.9% in 2007) and Ghorajan (73 %). Out 196 species of phytoplankton distributed in Assam beels (Bordoloi, 1973 ; Devi, 1981, Lahon, 1983), 60 species of phytoplankton have been identified in these two beels and most of the two species are common to these two beels.Bacillariophyceae dominated in both the beels represented by species like Spirogyra sps., Navicula sps., Synedra sps., Nitzschia sps., Tabellaria sps., Fragillaria sps etc. Occurence of desmids in Ghorajan beel is substantial but it was negligible in Dighali beel. Desmids occurrence in Ghorajan beel is clear indication of unproductive waters and it is probable that these species can withstand unfavorable environmental condition. The groups dominating the zooplankton in Dighali beel are copepods (35.2 % in 2015 and 35.4% in 2016) while rotifers dominated the zooplankton in Ghorajan .The richness of rotifers may be attributed to dense accumulation of macrophytes and high accumulation of organic nutrients due to their annual decomposition.(Edmondson, 1944, 1945, 1946).

Macrobenthos

Qualitatively the average benthic population was found to be 318 and 276 nos m^{-2} in Dighali and 413 nos m^{-2} in Ghorajan (2016). Both the beels can be classified in one category in terms of its biomass quantity. According to Thienemann (1925),water bodies having less than 1000 nos m^{-2} is poor and on the basis of such classification these two beels may be regarded poor in benthos production. The poor growth of bottom biomass may be attributed to frequent fluctuation of water level in these beels. During monsoon, these beels are over flooded and as winter approaches, the water level suddenly goes down leaving extensively exposed. As a result, bottom fauna especially insect larvae, nymph and oligochaetes which are not capable of moving fast die in stress. Only molluscan population are able to withstand this pressure to a certain extent. Gastropoda (33.6% in 2015 and 34.4% in 2016) in Ghorajan was the most dominant form in all the seasons. In Ghorajan its contribution was 19.1%. Benthic population in Ghorajan was dominated by dipteran larvae and its abundance was predominant during winter as water level recedes.

Macrophytes

Beels in Assam are threatened by rapid proliferation of vascular aquatic plants as they upset

the ecological plants, viz balance of biota in the aquatic ecosystem.The present findings depict extensive development of submerged, emergent, marginal and floating type of vegetation supported by optimum environmental conditions like temperature, alkalinity ,light etc.Among the commonly encountered species in the two beels are Eichhornia sps., Hydrilla sps., Potamogeton sps and miscellaneous species. The present findings exhibit high biomass in Ghorajan (average 181.4 g.m $^{-2}$during 2015) while Dighali exhibited comparatively lower bio-mass (average 161.7 and 157.6g.m^{-2}) during 2015 and 2016 respectively. No definite reason can be attributed to the significant difference in biomass in these two beels. However, their growth is dependant on temperature, insolation, and length of growing season. Besides these factors, nutrient availability may also be held responsible for their growth. As the response to these factors is species specific, the infestation of 50% Eichhornia in Ghorajan may account for increased biomass. Eichhornia being able to survive in changing chemical environment and constituting a large portion of the beel waters may account for high biomass in Ghorajan as compared to Dighali..

Fish and Fisheries

Fisheries resources in Assam, particularly beel fisheries is facing resource depletion mainly due to environmental degradation coupled with lack of scientific management practices. Though the average fish production from the beels of Assam is 160 Kg ha $^{-1}$ yr $^{-1}$(Dutta and Lahon, 1987), the average fish production from the beels under investigation is far from below. Dighali beel depicted an yield of 34.7 Kg ha $^{-1}$ yr $^{-1}$ and 37.27 kg ha $^{-1}$ yr $^{-1}$ during 2015 and 2016 respectively while in Ghorajan , the yield was represented by 13.5 kg ha $^{-1}$ yr $^{-1}$. Low production in many of the beels have been reported by Lahon (1983) in Salsella beel (116 Kg ha^{-1} yr $^{-1}$), Kar (1984) in Sone beel (90 Kg ha $^{-1}$yr $^{-1}$), Bhagawati and Kalita (1987) in Rangai beel (31 kg ha -1 yr -1) and Hagal beel (70 Kg ha^{-1} yr $^{-1}$), Yadava (1987) in Dhir beel (377 kg ha $^{-1}$ yr $^{-1}$) recorded high fish production. The dominance of trash fishes and those feeding on the higher food chain reflected upon the poor fishery of the beels. The uneconomic minnows, demios, barails etc provide forage base for the development of predatory catfishes, feather backs, and live fish population of the beel which in turn affect the recruitment potential of the commercially important important carps.Wallago attu contributes more than 20%, live fishes 20% and Notopterus notopterus 5% clearly reflect the prevailing situation in the beels.The dominance of Wallago attu and its occurrence round the year provide ample proof of its extremely predatory habits and existence of favourable condition for reproduction.

The knowledge of natural stock from which it comes is very important(Gulland, 1955). It has been observed that majority of the recruits in these beels come to the fishery from the adjoining rivers. Most of the fishable stock enters into the beels during the first year of life and are constantly vulnerable to regular capture. However, the stock is supplemented by fresh recruits every year.

During monsoon catch is low in all the beels because of higher water level and restricted fishing activities. Post monsoon and winter facilitates the operation of almost all types of gears and hence fetches more catches. Various indigenous gears and traps are operated during different seasons. During monsoon, hooks, lines and traps are used for fishing. Cast net, gill net and dip net are prominent nets used in these beels. Katal and banas fishing are done during winter and monsoon respectively. Odum (1960) felt that a harvest of 1.2% of primary production of fish would be excellent. Based on Odum's theory, the fish production potential of Dighali beel was found to be 865 kg ha^{-1} yr^{-1} against actual harvest of only 14.4 Kg ha $^{-1}$yr^{-1} showing utilization of 1.7%.Ghorajan beel has production potential of 728 kg ha^{-1}yr^{-1} against actual yield of only 14 Kg ha^{-1}yr^{-1}showing utilization of only 1.9%.

Conservation Strategies

1. The first and foremost task is to eradicate the weeds by taking up pilot projects wherein both chemical and biological control measures should be applied. Removal of macrophytes is likely to increase nutrient status and phytoplankton density.
2. Beels are connected with channels which are subjected to continuous siltation during floods. Continuous siltation and petrified nutrients have led to the shallowness of these channels. As a result autostocking process have been hindered to a great extent and hence these channels should be desilted by some manual means.
3. Restriction of paddy fields in marginal areas and pockets of these beels is necessary to increase fish production. This practice reduces the effective water area of the beels.Also during late winter, necessary water is provided from the feeding cannal affecting the main fishery of the beel.
4. Breeding season should be practically closed season for fishing. Catching of brood fishes should be restricted.
5. Beels should be brought under fisherman's co-operative societies which can exercise control both at production and market level so that maximum receipt accrue to fisherman.
6. Stocking of seed in beels according to abundance of food in different trophic levels.
7. Marginal areas should be utilized through pen culture.
8. Construction of sluice/spill for maintaining optimum water level.
9. Bio-degradable pollution should be converted to fertilizers.
10. Leasing policy should be such which can encourage stocking and proper management of beels.

Conclusion

The wetlands discussed above are under facing environmental degradation due to natural and anthropogenic factors. The main emphasis should be to conserve these natural habitats and hence

formulation of management measures with proper application of scientific technologies is essential. Fisheries management can serve to conserve the ecosystem along with the existing flora and fauna which will directly benefit humans, terrestrial and also aquatic life. A major policy, financial and technological support are the requirements of the hour to utilize the vast potential resources present in the beel ecosystem. The different stakeholders including scientists, planners, entrepreneurs should put their heads together for weland development both from ecological and fisheries point of view. India currently needs to produce about 8.2 millions fish to cater to the domestic demands. With the present fish production at the rate of 6.4 million tonnes, the country's current deficit is at the rate of 22% of the domestic demand.India's future fisheries development plans are aimed at making substantial contributions for doubling fish production for the welfare of the fishermen population as well as the consumers. In this context fish culture in the wetlands would be playing a significant role for increasing the aquaculture production of the nation in the coming years.

Table 1: Specieswise catch in Dighali beel during 2015-2016

SL. No	Species	2015 Total catch (Kg)	%	2016 Total catch (kg)	%
1.	*Catla catla*	155	4.47	140	3.76
2.	*Cirrhinus mrigala*	25	0.72	20	0.54
3.	*Labeo rohita*	240	6.91	210	5.63
4.	*Cyprinus carpio*	60	1.73	72	1.93
5.	*Cirrhinus reba*	20	0.58	21	0.56
6.	*Labeo bata*	46	1.33	40	1.07
7.	*Mystus seenghala*	15	0.43	12	0.32
8.	*Mystus tengara*	98	2.82	84	2.25
9.	*Wallago attu*	710	20.46	790	21.20
10.	*Mystus aor*	6	0.17	4	0.11
11.	*Notopterus chitala*	45	1.30	62	1.66
12.	*Notopterus notopterus*	225	6.48	130	3.49
13.	*Live fishes*	810	23.34	840	22.54
14.	*Prawns*	60	1.73	42	1.13
15.	*Miscellaneous group.*	955	27.52	1260	33.81
		3,470		3,727	

Table 2
Specieswise catch in Ghorajan beel – 2016

Sl. No	Species	Ghorajan (2016) Total catch	%
A	**Major Carps**	223	16.52
1	*Catla catla*	*17*	*1.26*
2	*Cirrhinus mrigala*	*48*	*3.56*
3	*Labeo calbasu*	*49*	*3.63*
4	*Labeo rohita*	*109*	*8.07*
B.	***Minor carps***	*61*	*4.52*
1	*Cirrhinus reba*	*17*	*1.27*
2	*Labeo bata*	*18*	*1.33*
3	*Labeo gonius*	*26*	*1.93*
C.	***Catfishes***	*297*	*22.00*
1	*Mystus seenghala*	*10*	*0.74*
2	*Mystus tengara*	*22*	*1.63*
3	*Wallago attu*	*265*	*19.63*
D.	***Featherback***	*95*	*7.04*
1.	*Notopterus chitala*	*32*	*2.37*
2.	*Notopterus notopterus*	*63*	*4.67*
E.	***Live fishes***.	*238*	*17.63*
1.	*Anabas testudineus*	*82*	*6.07*
2.	*Clarius batrachus*	*39*	*2.89*
3.	*Channa marulius*	*22*	*10.63*
4.	*Channa punctatus*	*36*	*2.67*
5.	*Heteropneustes fossilis*	*59*	*4.37*
F.	***Prawns***	*70*	*5.18*
G.	***Others***	*366*	*27.11*
	Total	***1,350***	

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Fig : Dighali Beel