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STUDIES ON WATER QUALITY PARAMETERS AND BIOMASS IN A MODEL POND FOR NETWORK ANALYSIS

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Physico-chemical parameters were analyzed in a model pond located in Phulwari Sharif, Patna (India) [25.560262N and 85.039013E] in relation to seasonal variations along with the biomass of the producer and consumer organisms including fish with an aim to carry out network analysis and study the features of the ecosystem.

INTRODUCTION

Fish culture is about 2000 years old practice but only a small fraction of the fish that man consumes is derived from the source (Weatherly and Cogger, 1977). In recent times, interest in fish culture has increased in many countries including India. It is because of the fact that the public and national governments have realized that global over-fishing and marine pollution will destroy fish harvest. Coastal, estuarine and inland waters constitute a system on which a country or its part can make claim over in terms of water quality, labour deployment and fishing intensity, and man should obtain all aquatic products from pollution-free ecosystems that are properly managed.

With a view to investigate the water quality parameters, ecosystem homeostasis and fish output in relation to other consumer organisms, the present study was undertaken in a model pond with an area of 24281.138 m^2 (2.428 hectare).

These findings would further be used for detailed network analysis of the habitat and fish modeling with the aid of an effective analytical software such as EwE (Christensen *et al.* 2005).

MATERIALS AND METHODS

Sampling in the model pond was done in winter, summer and monsoon seasons separately. Water samples were collected in the morning between 9 to 10 a.m. Physico-chemical parameters such as TDS, TSS, BOD, COD, Chloride, DO, pH, Temperature, conductivity, Free CO_2, Alkalinity, T.P. as PO_4, TH (Hardness), Na, K, SO_4 and N(NO_3) were analyzed (APHA, 2005). Temperature and pH were estimated by centigrade thermometer and pH meter respectively. Electrical conductivity was recorded by conductivity meter. TDS and TSS were measured by evaporation method. Sampling of the water body, physico-chemical parameters of the pond during all three seasons and biomass of planktons and consumer organisms (except the fish and detritus) were estimated according to Saxena (1987). Biomass of fish and detritus was estimated separately in 10 x 10 area at each side of the pond and the centre for mean values. For application of EwE 6 (Ecopath with Ecosim 6), mean values of the three seasons were converted into tonne/ Km^2 (Christensen *et al.* 2005). However, the values presented here are all in gm/m^2 and gm/l (planktons).

DISCUSSION

Physico-chemical parameters of the pond are presented in Table 1 and biomass of producer organisms is presented in Table 2 while biomass of consumer organisms and detritus are presented in Table 3.

pH of the pond was found to fluctuate between 7.58 and 8.18 between summer and winter respectively. It is understood that an aquaculture pond should have a pH between 6.5 and 9.00 (Bhatnagar *et al.* 2004). A fish culture pond should understandably be on the side of alkanity. More commonly, it is recommended to be between 6.5 and 9.00.

Minimum temperature was recorded in winter (15.6ºC) while in summer, it went up to 29.8ºC on an average.

Conductivity is related with salt. The higher is the salt content, EC is higher. In the model pond, the minimum conductivity was recorded in the winter and maximum in the monsoon. Ideally for fish pond, the conductivity should be 60-2000 µ/cm, (Stone *et al.* 2013). TDS is a good measure of total amount of salt present in water which is indicated by

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electrical conductivity. It is an excellent indicator of TDS (Krishnamoorthi and Selvakumar, 2010). TDS and TSS were found maximum in monsoon and minimum in winter (Table 1). They are very useful parameters which describe the chemical constituents of water. It can be considered as edaphically related contributing to the productivity within the water body (Goher, 2002).

Free CO_2 was maximum in summer (5.21 mg/l) and minimum in winter (4.78 mg/l). To support good fish culture, the free CO_2 should be 5 mg/l (Santosh and Singh, 2007).

The degree of pollution is inversely proportional to DO in water bodies. In the present study, it was observed that DO declined with increase in temperature. The result shows negative correlation between temperature and DO. Fish can die if DO concentration is less than 0.3 mg/l for a long period of time. Minimum DO concentration of 1.0 mg/l is essential for survival of the fish for long period and DO concentration of 5.0 mg/l is, however, adequate in fish ponds (Ekubo and Abowei, 2011). The BOD value ranged from 3.28 mg/l in winter to 9.1 mg/l in the summer in the model pond. The unpolluted water has BOD < 1.00 mg/l, moderately polluted water has 2.00-9.00 mg/l of BOD value while the BOD > 2.00-9.00 indicates highly polluted water (Yadav *et al.* 2013). As per the guidelines for Water Quality Management for fish culture, the desirable value of COD should be < 50 mg/l for fish culture. In the present study, the COD value was minimum in winter (10.65 mg/l) and maximum in summer (19.34 mg/l).

Minimum value of alkalinity was recorded 112.87 in summer and maximum value recorded was 154.54 mg/l in winter. Wurts and Durborow (1992) reported that the desired limit of alkalinity is between 75 to 200 mg/l, but not less than 20 mg/l for an aquaculture pond. Minimum value of chloride obtained was 11.8 mg/l in summer and maximum observed value of chloride was 13.6 mg/l in monsoon. The desirable value is 250 mg/l (BIS, 1991). In this study, minimum value of total phosphate was observed 0-15 mg/l in winter and maximum 0.21 mg/l in monsoon. The phosphate level of 0.06 mg/l is desirable for fish culture (Stone and Thomforde, 2004). The phosphate level 0.05-0.07 ppm is optimum and productive while 1.0 ppm is good for plankton / shrimp production (Bhatnagar *et al.* 2004).

In this investigation, TH (Total hardness) was recorded between 144.54 mg/l-184.24 mg/l in summer and winter respectively.

Bhatnagar *et al.* (2004) found that hardness values less than 20 ppm cause stress, 75-150 ppm is optimum for fish culture and > 300 ppm is lethal to fish life as it increases pH, resulting in non-availability of nutrients. However, some species of euryhaline may have high tolerance limits to hardness.

Sodium was recorded minimum 38 mg/l in summer and maximum 64 mg/l in monsoon. Potassium ranged between 12 to 26 mg/l in winter and monsoon respectively. Sulphate was recorded minimum in winter (88.53 ppm) and maximum in summer (110.45 ppm). Nitrate ranged from 11.53 mg/l to 16.21 mg/l in summer and winter respectively. Santosh and Singh (2007) reported that the preferable range of nitrate is 0.1 mg/l to 4.0 mg/l for fish culture water. However, OATA (2008) found that the nitrate levels in marine systems never exceed 100 mg/l.

There is a close relationship between plankton abundance and fish production as plankton is at the base of the food web (Smith, and Swingle, 1938).

The utility of Ecopath with Ecosim (EwE) is somehow significant for ecosystem analysis and network analysis. Its model uses mass-balance principles to link functional biomass groups within a dynamic system to create a static snapshot of the resources and energy flows within the ecosystem (Christensen and Pauly, 1992; Pauly *et al.* 2000; Christensen and Walters, 2004). A functional group includes a group of tropically similar species, a single species, or a group of species split into age categories (multi-stanza group). The role of ecopath is to specify initial conditions for biomass (B) and production (P) of each functional group. Ecopath, with the help of biomass and production of each functional group at a single point of time, provides a static time invariant description of the ecosystem.

TABLE 1

Water quality parameters of the model pond

Sl. No.	Parameters	Unit	Winter	Summer	Monsoon
1	pH		8.18	7.58	7.78
2	Temperature	°C	15.6	29.8	25.2
3	Conductivity	µ/cm	489.5	540.4	610.9
4	TDS	mg/l	386	456	538
5	TSS	mg/l	80	85	90
6	Free CO_2	mg/l	4.78	5.21	5.1
7	DO	mg/l	7.32	5	5.45
8	BOD	mg/l	3.28	9.1	7.86
9	COD	mg/l	10.65	19.34	15.56
10	Alkalinity	mg/l	154.54	112.87	149.48
11	Chloride	mg/l	12.59	11.8	13.6
12	T.P. as PO_4	mg/l	0.15	0.17	0.21
13	TH (Hardness)	mg/l	184.24	144.54	160.72
14	Na	mg/l	38	54	64
15	K	mg/l	12	24	26
16	SO_4	ppm	88.53	110.45	95.43
17	$N(NO_3)$	ppm	16.21	11.53	15.04

TABLE 2

Biomass of Producers			
Macrophytes		15.6	g/m^2
Phytoplankton			
	Chlorophyceae	1.6×10^{-6}	g/l
	Cyanophyceae	2.89×10^{-8}	g/l
	Euglenophyceae	9.879×10^{-7}	g/l

TABLE 3

Biomass of Consumers and Detritus		
Zooplankton	1.5×10^{-5}	g/l
Amphibian	5.9	g/m^2
Snails	11.6	g/m^2
Tortoise	5.2	g/m^2
Snake	2.1	g/m^2
Labeo rohita	124.54	g/m^2
Catla catla	37.36	g/m^2
Cirrhinus mrigala (Naini/Mrigal)	31.13	g/m^2
Cyprinus carpio (Common carp)		g/m^2
Ctenopharyngodon idella (Grass carp)	65.38	g/m^2
Hypophthalmichthys molitrix (Silver carp)	28.02	g/m^2
detritus	893.71	g/m^2

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