ISSN: 2347-5129
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.352
IJFAS 2016; 4(3): 254-260

www.fisheriesjournal.com
Received: 22-03-2016
Accepted: 23-04-2016

Francis Nuestro Baleta
Institute of Fisheries, Isabela State University, San Fabian, Echague 3309, Isabela, Philippines

Jonathan Mallillin Bolaños
Institute of Fisheries, Isabela State University, San Fabian, Echague 3309, Isabela, Philippines

Correspondence
Francis Nuestro Baleta
Institute of Fisheries, Isabela State University, San Fabian, Echague 3309, Isabela, Philippines.

Phytoplankton identification and water quality monitoring along the fish-cage belt at Magat dam reservoir, Philippines

Francis Nuestro Baleta, Jonathan Mallillin Bolaños

Abstract
The present study was conducted to identify phytoplankton and characterize the physico-chemical parameters of waters from the fish cage belt at Magat Dam Reservoir, Philippines. Five stations were established along the fish cage belt at Magat Reservoir, namely: Station 1 (Magat Aqua Park), Station 2 (Namnama), Station 3 (Halag 1), Station 4 (Halag 3) and Station 5 (Baligatan). Water samples were collected twice weekly for three months.
Water parameters that were monitored includes: temperature, transparency, dissolved oxygen, pH, ammonia and phosphate. Among the water parameters monitored, temperature, transparency, dissolved oxygen, pH, ammonia and phosphate were within the acceptable range for fish culture.
Thirty (30) species of phytoplankton were identified belonging to four classes. Division Chlorophyta (14 genera), was the most abundant followed by Bacillariophyta (10 genera), Cyanophyta (4 genera), and Euglenophyta (2 genera). The most dominant microalgae documented includes: *Pediastrum, Scenedesmus, Closterium, Merismepodia* and *Nitzschia.*

Keywords: Water parameters, Cage culture, phytoplankton, Magat Reservoir

1. Introduction
The Magat Dam Reservoir is located in the Northern part of the Philippines covering major portions of Nueva Vizcaya and part of Quirino and Isabela provinces of Region 2, Philippines. Magat Dam is one of the largest dams in the Philippines. It is a multi-purpose dam with a storage capacity of 1.08 billion m^3 providing irrigation to 95,000 ha of land and hydroelectric power generation (360 megawatts) [11]. Fish cage culture is an activity that has industrialized at Magat Dam Reservoir due to increased fishing productivity in Philippines. However, the structure of the phytoplankton community through changing the physical and chemical characteristics of the water column in the Magat Reservoirs and the increase in the quantity of nutrients caused an increase in phytoplankton biomass.
Phytoplankton is very sensitive to their environment, and any change in their habitat may lead to the change in the planktonic communities in terms of tolerance, abundance, diversity and dominance in the habitat. Therefore, population of plankton observation can be used as a reliable tool to assess the pollution status of waters [2, 19]. Moreover, the physico-chemical properties and nutrient status of the water plays an important role in production of plankton, which is essential in maintaining healthy and productive aquatic organisms [20, 14].
Water quality is determined by various physico-chemical and biological parameters. These parameters change generally due to many factors like source of water, type of pollution, seasonal fluctuations and adjacent human intervention that directly or indirectly affect its quality and consequently its suitability for the distribution and production of fish and other aquatic animals [27]. Several researchers have reported the status of water bodies (lentic and lotic) after receiving various kinds of pollutants altering water quality characteristics (physical, chemical and biological). All living organisms have tolerable limits of water quality parameters in which they perform optimally. A sharp drop or an increase within these limits has adverse effects on their body functions [10, 15]. The study was conducted to identify phytoplankton and characterize the physico-chemical attributes of waters from Fish-Cage Belt at Magat Dam Reservoir. The present study is a novel or pioneering study on the Identification of phytoplankton and water quality monitoring at Magat Dam Reservoir, Philippines.

2. Materials and Methods

2.1 Study area. The study was carried out along the major fish cage belt areas of Magat Reservoir at Ramon (coordinates: 16° 46'79" N latitude, 121° 23'00.48" E longitude), Isabela, Philippines.

2.2 Collection of Water Samples. Water samples were collected between 9:00 – 11:00 in the morning and 1:00 – 3:00 in the afternoon twice weekly for a period of three months from October to December, 2014. Water samples were collected from the surface column with the depth ranging from 70 cm to 100 cm and were transferred in separate plastic containers (1.5 l capacity). During the time of sampling and collection, water parameters such as temperature and dissolved oxygen were measured using dissolved oxygen (D.O.) meter (Lutron DO 5519); transparency using Secch disc; while pH, ammonia and phosphate were measured using titration method.

2.3 Water quality monitoring. Water quality parameters (temperature, dissolved oxygen, pH, turbidity, nitrate, nitrite, ammonia, phosphate, nitrate, nitrite) were monitored twice weekly during the whole duration of the study. Dissolved oxygen and temperature from the surface, middle and bottom cage water was monitored, transparency, expressed as Secchi disc visibility depth (in cm) was determined along the lee side of the boat using an improvised Secchi disc, while pH, ammonia and phosphate levels of the water were determined using water test kits (API Freshwater Master Test kits). Determination of water quality parameters were determined using the methods described by Boyd and Tucker (1998) [7].

2.4 Phytoplankton Identification. Water sample for plankton study were preserved for 24h and identified under an LED compound microscope (N− 100 model, Germany). Phytoplankton was identified on the generic level using published literatures [29, 4]. Photomicrographs were taken for proper identification of each phytoplankton.

2.5 Statistical Analysis. Treatment means were compared using the Student-Newman-Keuls (SNK) Test. Means were given with ± Standard Deviation (SD). Statistical analysis of water quality parameters used descriptive statistics and correlation (Pearson's r).The data obtained in the study were analyzed statistically using one-way analysis of variance (ANOVA) and linear regression using statistical software (SPSS, version 20).

3. Results and Discussions

Water quality parameters were analyzed in this study to observe any appreciable changes that might have occurred in response to the aquaculture farms. A favourable condition of water quality is very important for healthy aquatic environment and better production. Physical parameters like temperature and turbidity, chemical parameters such as dissolved oxygen (DO), pH, ammonia-nitrogen (NH_3-N) and phosphate-phosphorous (PO_4-P) were measured bi-weekly while the phytoplankton were identified and documented throughout the study period.

3.1 Identified phytoplankton. A total of thirty (30) species of microalgae were identified belonging to four classes. Division Chlorophyta (14 genera) (Fig. 2a), was the most abundant followed by Bacillariophyta (10 genera) (Fig. 2b), Cyanophyta (4 genera) (Fig. 2c), Euglenophyta (2 genera) (Fig. 2d). The most dominant species of microalgae along the fish cage belt of Magat Resevoir includes: *Pediastrum, Scendesmus, Closterium. Merismepodia* and *Nitzschia*. The identified species categorized according to major groups includes: Chlorophyta (*Actinastrum, Chlorella, Closterium, Coelastrum, Crucigenia, Dictyosphaerium, Golenkinia, Monoraphidium, Oedogonium, Pediastrum, Scenedesmus, Staurastrum, Tetraedron, Tetrastrum*), Bacillariophyta (*Aulacusiera, Amphipleura, Craticula, Cyclotella, Cymbella, Navicula, Nitzschia, Rhopalodia, Pinnularia, Synedra*), Cyanophyta (*Anabaena, Cylindrospermopsis, Merismopedia, Microcystis*) and Euglenophyta (*Euglena* and *Phacus*). Phytoplankton diversities are natural existence, and their abundance is dependent on weather and water quality conditions of the certain habitat. The occurrence of rich algal flora results generally at the place where there are high levels of nutrients present, together with the occurrence of favourable environmental conditions [16]. Similar to the observations of Schabetsberger (2004), in a freshwater ecosystem phytoplankton is dominated by green algae [23]. Phytoplankton may compete with nitrifying bacteria for ammonia and that nitrate produced can also be rapidly consumed by phytoplankton and zooplankton [5]. The nitrogen and phosphorus in fertilizers enhanced the growth of small unicellular algae that provide food for fish and other aquatic animals [9].

3.2 Temperature. Water temperature is one of the most important factors for aquatic organisms because it influences other physical and/or chemical factors. The temperature in cages ranges from 25.17 °C to 30.50 °C. The water temperature remains almost stable from week 1 to 6 and gradually decreased from week 7 to 10 (Fig. 1a). The maximum value of temperature in cage (30.5 °C) was recorded at station 3 from the surface in week 1 (Fig. 1b). Temperature of a water body depends upon the time of collection, season and depth of the water that has both direct and indirect effect on the water body [22]. However, ANOVA showed highly significant difference ($p<0.001$) in water temperatures between stations (Table 1). Water temperature was high due to low water level of the Reservoir, and clear atmosphere. The findings of the present study was more or less similar to the findings of Boyd (1982) [6].

3.3 Transparency (SDVD reading in cm). Water transparency is of the most important factor and related inversely with plankton abundance and primary productivity. During the study period, water transparency ranged from 94 cm to 238 cm with the lowest (94 cm) at station 5 during week 2 of the monitoring and highest (238 cm) at station 2 during week 3 of the study period (Fig. 1c). The transparency values in the present study indicated that cage water was within the productive range fish culture. A highly significant difference ($p<0.001$) between the different stations was observed (Table 1). Transparency reduces the light penetration and affects the photosynthesis of phytoplankton which finally produces oxygen [12]. Higher transparency of water were observed due to absence of rain as well as gradual settling of suspended particles and other organic matter [13].

3.4 Dissolved oxygen (DO). Dissolved oxygen concentrations were above 5 mg l^{-1}, which was suitable enough to support aquatic animals. Result showed no significant difference (p>

0. 134) among the different stations (Table 1).The DO levels in cages ranged from 4.93 to 21.73 mg l^{-1} from the surface. The minimum value of D.O. in cage (4.93 mg l^{-1}) was recorded at station 3 during week 1 of the monitoring (Fig. 1e). The maximum value of D.O. in cage (21.73 mg l^{-1}) from the surface was recorded at the station 3 during week 5 of the study (Fig. 1f). The increase in dissolved oxygen concentration in the study could be due to the effect of high runoffs during the onset of rainy season [26], and due to algal photosynthesis during daylight [8]. The decreased of dissolved oxygen concentration in the study was due to the low solubility at high temperature and high degradation of organic matters [21]. High dissolved oxygen is an indication of healthy aquatic ecosystem.

3.5 Hydrogen-ion concentration (pH). pH is considered as an important factor in aquaculture and treated as the productivity index of the water quality. Differences in the pH values of the water between stations were found not significant (p= 0.232) (Table 1). Water with pH values of about 6.5 to 9 are considered best for fish production. The pH in cage ranges from 6.20 to 8.0.The minimum value of pH in (6.20) was recorded at station 4 during week 4 of the study. The maximum value of pH in cage (8.0) was recorded at station 4 almost throughout the duration of the study, except weeks 7 and 8 (Fig. 1d). Similar observation was found in Manair Reservoir and Sagar lake at Madhya Pradesh [28]. Variations in the concentration of pH is probably due to the presence of domestic wastes such as soap, detergent, cleansers and other organic matters. The different factors such as photosynthesis, respiratory activity, temperature exposure to air, disposal of industries wastes etc. carry out changes in the pH [25]. The variation in pH of water indicates highly productive nature of water body [24].

3.6 Phosphate (PO_4-P). The Phosphate-phosphorus concentration in the water has been considered very important nutrient and a limiting factor for plant in the maintenance of Magat Reservoir. Highest phosphate value of water (0.667 mg l^{-1}) was recorded in station 5 during week 1 of the study period (Fig. 1h). Minimum value of phosphate during study was probably due to its fast utilization by the over growth of phytoplankton [18]. This finding more or less similar results in case of Manair Reservoir at Andhra Pradesh [28]. Phosphate-phosphorus concentration between 0.2 to 2.8 mg l^{-1} is favourable for growth of blue green algae and diatoms as natural food for aquatic animals [17].

3.7 Ammonia nitrogen (NH_3-N). During the study period, ammonia values ranged from 0.083 to 0.667 mg l^{-1} with the lowest (0.08 mg l^{-1}) at station 1, 2, 3 and 5 during weeks 1, 2, 3, 5, 6, 9 and 10 and highest (0.66 mg l^{-1}) at station 4 during week 4 of the study period (Fig. 1g). The difference in total ammonia concentrations between station is not significant (p=0. 603). Similar results were observed by Wahab *et al.* (1995) [30]. The high stocking densities leads to an increase of ammonia levels in the environment due to overfeeding, fish excretion decomposition of organic matter [1]. High ammonia concentration in water also affect the permeability of fish by water and reduce internal ion concentration and increases oxygen consumption by tissues, damage gills, destroy mucous producing membranes, "sub- lethal" effects like reduced growth, poor feed conversion, reduced disease resistance, osmoregulatory imbalance, kidney failure and fish suffering from ammonia poisoning generally appear sluggish or often at the surface gasping for air [3]. Decomposing organic matter releases ammonia, which is converted to nitrate if oxygen is present [7]. Unionized ammonia (NH_3) is highly toxic to fish, but ammonium ion (NH_4+) is relatively nontoxic. In culture condition, the lower value of total ammonia, the better quality of water for fish culture.

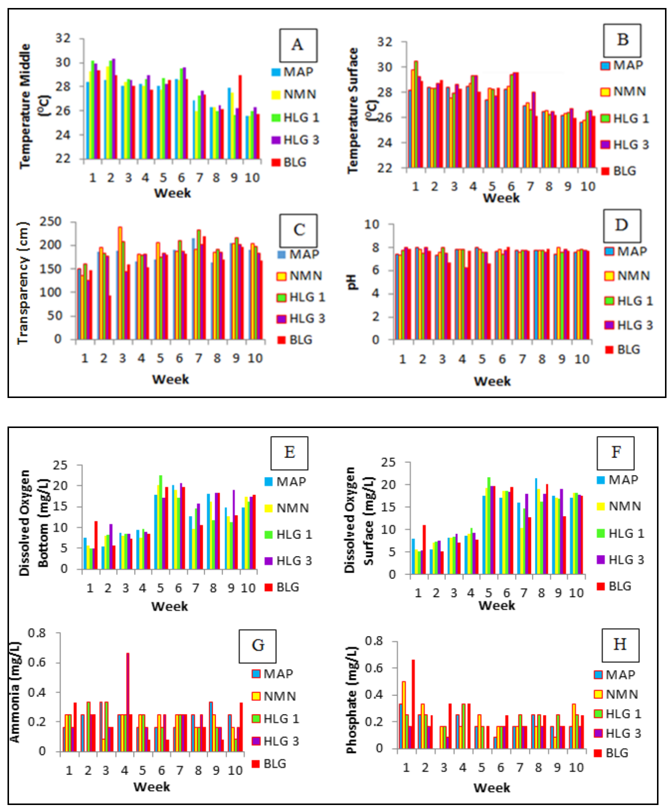

Fig 1: Physico-chemical parameters of water along the fish cage belt of Magat Reservoir: A) Temperature (middle); B) Temperature (surface); C) Turbidity; D) pH; E) Dissolved oxygen (bottom); F) Dissolved oxygen (surface); F) Ammonia; and H) Phosphate concentration.

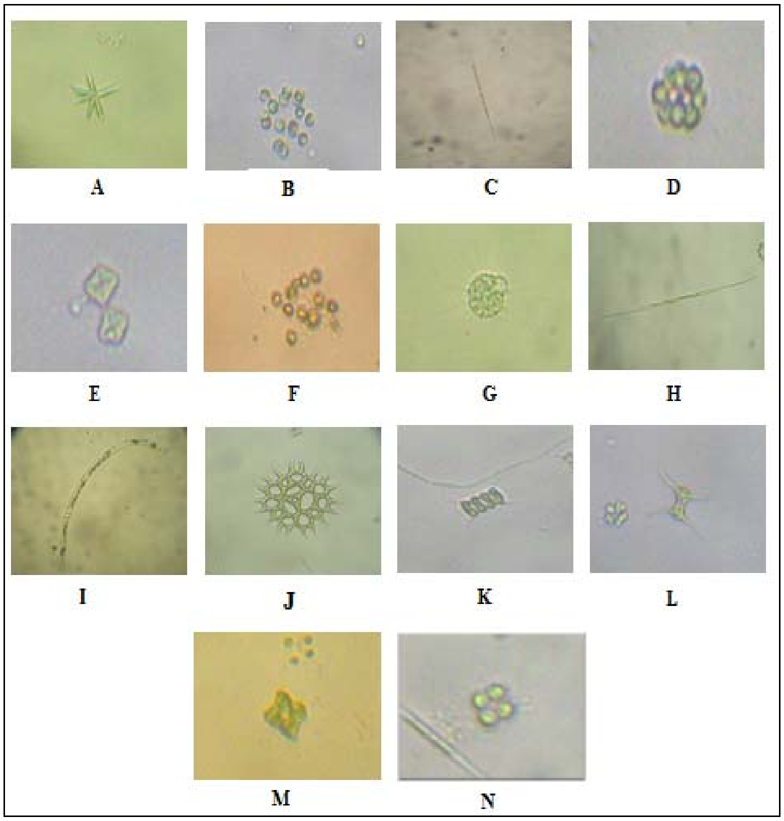

Fig 2a: Identified Chlorophyta species along the fish cage belt of Magat Reservoir, Philippines.

(A)	*Actinastrum* sp.	(B)	*Chlorella* sp.	(C)	*Closterium* sp.
(D)	*Coelastrum* sp.	(E)	*Crucigenia* sp.	(F)	*Dictyosphaerium* sp.
(G)	*Golenkinia* sp.	(H)	*Monoraphidium* sp.	(I)	*Oedogonium* sp.
(J)	*Pediastrum* sp.	(K)	*Scenedesmus* sp.	(L)	*Staurastrum* sp.
(M)	*Tetraedron* sp.	(N)	*Tetrastrum* sp.		

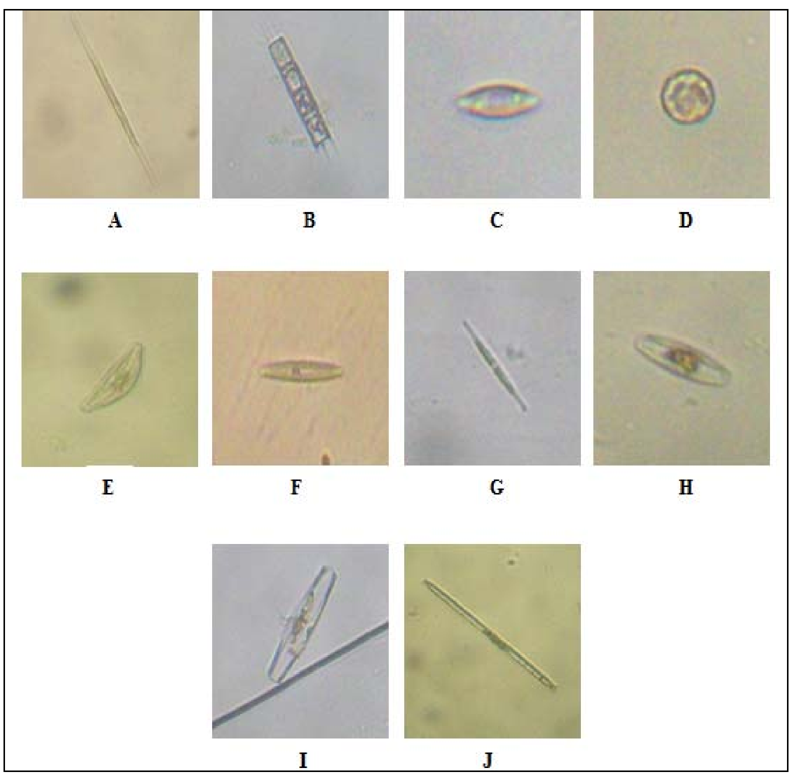

Fig 2b: Identified Bacillariophyta species along the fish cage belt of Magat Reservoir, Philippines.

(A)	*Aulacusiera* sp.	(B)	*Amphipleura* sp.	(C)	*Craticula* sp.
(D)	*Cyclotella* sp.	(E)	*Cymbella* sp.	(F)	*Navicula* sp.
(G)	*Nitzschia* sp.	(H)	*Pinnularia* sp.	(I)	*Rhopalodia* sp.
(J)	*Synedra* sp.				

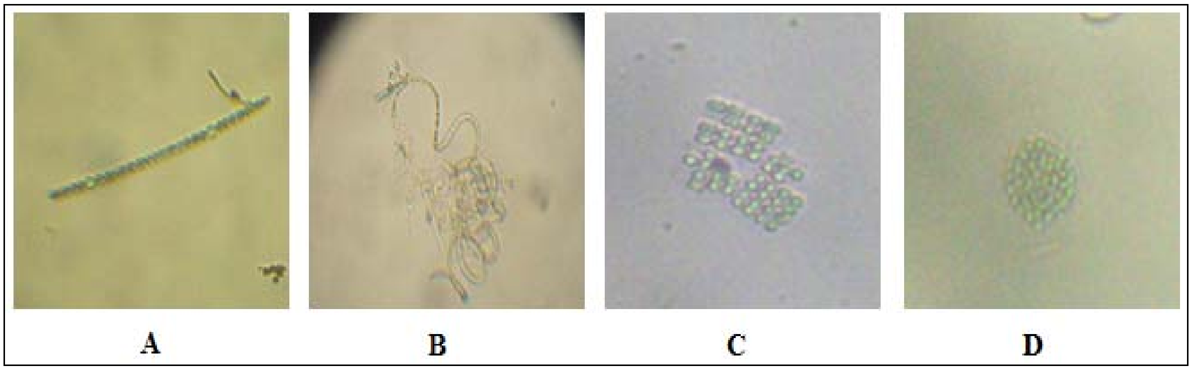

Fig 2c: Identified Cyanophyta species along the fish cage belt of Magat Reservoir, Philippines.

(A)	*Anabaena* sp.	(B)	*Cylindrospermopsis* sp.	(C)	*Merismopedia* sp.
(D)	*Microcystis* sp.				

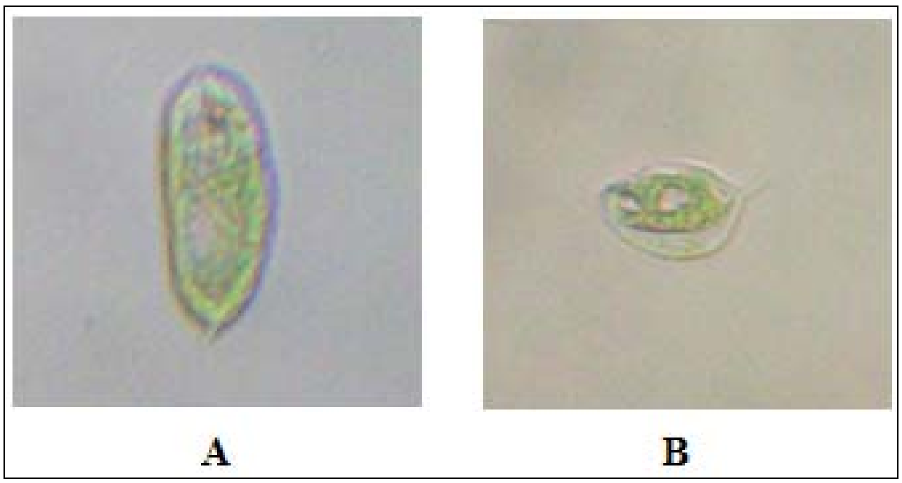

Fig 2d: Identified Euglenophyta species along the fish cage belt of Magat Reservoir, Philippines.

(A)	*Euglena* sp.	(B)	*Phacus* sp.

Table 1: Comparison of mean water quality parameters between stations.

Water parameters	Station 1 Magat Aqua Park	Station 2 Namnama	Station 3 Halag 1	Station 4 Halag 3	Station 5 Baligatan	P(sig)
Temperature	27.61±1.16^{b}	27.64 ±1.32^{b}	27.90±1.45^{ab}	28.06±1.43^{a}	27.75±1.24^{ab}	0.006**
Transparency	181.05±25.09^{a}	187.95±29.73^{a}	185.48±25.8^{a}	169.93±24.5^{b}	167.81±32.32^{b}	<0.0001**
Dissolved oxygen	13.77±5.29	13.42±5.42	13.68±5.29	14.32±5.67	12.85±5.28	0.134 ns
pH	7.71±0.34	7.77±0.36	7.69±0.44	7.58±0.59	7.66±0.49	0.232 ns
Phosphate	0.21±0.14	0.22±0.15	o.24±0.13	0.18±0.16	0.27±0.15	0.013 ns
Ammonia	0.20±0.17	0.21±0.11	0.22±0.11	0.23±0.16	0.19±0.12	0.603 ns

** Highly significant; Mean with different letter notations were statistically different

3.8 Correlation between different parameters. Correlation Pearson's (r) between any two parameters, x and y is calculated for the different parameters like depth, temperature, transparency, dissolved oxygen, pH, phosphate, ammonia of the of water along the fish cage belt of Magat Dam Reservoir (Table 2). A highly significant (p<0.001) inverse correlation between depth of water and temperature was observed. The water temperature showed highly significant (p<0.001) negative correlation between transparency and dissolved oxygen, while significant (p<0.005) positive correlation was observed between ammonia. The dissolved oxygen showed highly significant (p<0.001) positive correlation between pH and transparency. Water ammonia showed a highly significant negative correlation (p<0.001) with pH, while significant (p<0.005) inverse correlation with phosphate.

Table 2: Correlations of Water Parameters along the fish cage belt of Magat Reservoir

Correlation matrix	Depth of Water	Temperature	transparency	Dissolved Oxygen	Water pH	Phosphate	Ammonia
Depth of Water	1						
Temperature	-.152**	1					
Transparency	.[b]	-.263**	1				
Dissolved Oxygen	-.058	-.391**	.404**	1			
Water pH	.[b]	.008	.050	.164**	1		
Phosphate	.[b]	-.059	-.192**	-.069	.097	1	
Ammonia	.[b]	.132*	-.063	-.157**	-.167**	-.139*	1
**. Correlation is significant at the 0.01 level (2-tailed).							
*. Correlation is significant at the 0.05 level (2-tailed).							
b. Cannot be computed because at least one of the variables is constant. ns = non-significant ($p \geq 0.05$), * = significant ($p<0.05$), ** = highly significant ($p<0.001$)							

4. Conclusions

Among the water parameters monitored along the fish cage belt of Magat Reservoir, temperature, transparency, dissolved oxygen, pH, ammonia and phosphate were within the acceptable range for fish culture. Their good population is often influenced by the available nutrients and the physico-chemical conditions of the ecosystem.

5. Acknowledgements

The authors would like to thank the Microbiology Laboratory of the Department of Natural Sciences and Mathematics, College of Arts and Sciences, Isabela State University, Main Campus for providing research facilities during the conduct of this study.

6. References

1. Avault JW. Water management in ponds, some basics reviewed: Ammonia and nitrite. Aquaculture Magazine, 1993, 76-80.
2. Basu M, Roy N, Barik A. Seasonal abundance of net zooplankton correlated with physico-chemical parameters in a freshwater ecosystem. Int. J Lakes and Rivers. 2010; 3(1):67-77.
3. Bhatnagar A, Devi P. Water quality guidelines for the management of pond fish culture. Int. J Environ Sci. 2013; 3(6):1980-2009.
4. Bellinger EG, Sigee DC. Freshwater Algae: Identification and Uses as Bioindicators. John Wiley-Blackwell, Ltd, Publication, United Kingdom, 2010, 270.
5. Bosstrom B. Factors controlling the seasonal variation of nitrate in Lake Erken. Int. Revue. Ges. Hydrobiol 1981; 66:821-836.
6. Boyd CE. Water Quality Management for Pond Fish Culture. Elsevier Science Publishers B. V., 1000 Amsterdam, The Netherlands, 1982, 318.
7. Boyd CE, Tucker CS. Pond aquaculture water quality management. Kluweracademic Publisher, Boston, Massachusetts. 1998, 700.
8. Chattopadhyay C, Banerjee TC. Temporal changes in environmental characteristics and diversity of net phytoplankton in a freshwater lake. Turk. J Bot. 2007; 31:287-296.
9. Culver DA, Madson S, Qin J. Percid pond production technique: timing, enrichment, and stocking density manipulation. J Appl Aquacult. 1993; 2:9-31.
10. Davenport Y. Responses of the *Blennius pholis* to fluctuating salinities, Marine Ecology Progress Series 1993; 1:101-107.
11. Elazegui DD, Combalicer EA. Realities of the Watershed Management Approach: The Magat Watershed Experience. Discussion Paper Series No. 2004-21. Philippine Institute for Development Studies. Makati City, Philippines, 2004, 31.
12. Iqbal J, Mumtaz MW, Mukhtar H, Iqbal T, Mahboob S, Razak A. Particle size distribution analysis and physico-chemical characterization of Chenab river water at Marala Headworks. Pak. J Bot. 2010; 42(2):1153-1161.
13. Kadam MS, Pampatwar DV, Mali RP. Seasonal variations in different physico-chemical characteristics in Mosoli reservoir of Parbhani district, Maharashtra, J of Aquatic Biol. 2007; 22(1):110-112.
14. Khangarot BS, Das S. Acute toxicity of metals and reference toxicants to a freshwater ostracod, Cypris subglobosa Sowerby, 1840 and correlation to EC50 values of other test models, J Hazard Mat. 2009; 172(2-3):641-9.
15. Kiran BR. Physico-chemical characteristics of fish ponds of Bhadra project at Karnataka. Rasayan J Chem. 2010; 3(4):671-676.
16. Kumar A, Sahu R. Diversity of Algae (Cholorophyceae) in Paddy Fields of Lalgutwa Area, Ranchi, Jharkhand. J App Pharm Sci. 2012; 2(11):092-095.
17. Margalef R. Life Forms of Phytoplankton as Survival Alternatives in an Unstable Environment Oceanologia Acta 1978; 1:493-509.
18. Narshima R, Jaya R. Limmnological investigations and diversity of plankton in sewage feed fish culture pond at Nambur near Guntur. A.P. India, J Aqua Biol. 2001; 16(1-2):11-14.
19. Prabhahar C, Saleshrani K, Tharmaraj K. Hydrobiological investigations on the planktonic diversity of Vellar River, Vellar Estuary and Portonovo coastal waters, South East Coast of India. Int. J Pharmaceutical and Biological Archives. 2011; 2(6):1699-1704.
20. Rahman S, Hussain AF. A study on the abundance of zooplankton of a culture and non-culture pond of the Rajshahi University campus. Univ. J Zool Rajshahi Univ. 2008; 27:35-41.
21. Rajagopal T, Thangamani A, Sevarkodiyone SP, Sekar M, Archunan G. Zooplankton diversity and physic-chemical conditions in three perennial ponds of Virudhunagar district. Tamilnadu. J Environ Biol. 2010; 31:265-272.
22. Saxena M. Water quality and trophic status of Raipur reservoir in Gwalior, Madhya Pradesh. J Nat Sci Res. 2012; 2(8):82-96.
23. Schabetsberger RG, Drozdowski I, Drozdowski CD, Jersabek Rott E. Limnological aspects of two tropical crater lakes (Lago Biao and Lago Loreto) on the island of

Bioko (Equatorial Guinea). Hydrobiologia 2004; 524:79-90.
24. Sreenivasan A. Limnological studies and primary production in temple pond ecosystem. Hydrobiologia 1976; 48:117-123.
25. Swaranlatha S, Narsingrao A. Ecological studies of Banjara Lake with reference to water pollution. J Environ Biol. 1998; 19(2):179-186.
26. Tepe Y, Mutlu E. Physico-Chemical Characteristics of Hatay Harbiye Spring Water. Journal of the Institute of Science and Technology of Dumlupınar University. 2004; 6:77-88.
27. Tiwari TN. Pollution of Lake Hussain Sagar, Hyderabad, India: Correction and cluster analyses. In: Mishra SR, Saksena DN, eds. Aquatic ecology. Ashish Publishing House, New Delhi, 1992, 213-29.
28. Thirupathaiah M, Samatha C, Sammaiah C. Analysis of water quality using physico-chemical parameters in lower Manair Reservoir of Karimnagar district, Andhra Pradesh. International J Environ Sci. 2012; 3(1):172-180.
29. Van Vuuren SJ, Taylor J, Van Ginkel C, Gerber A. Easy Identification of the most common Freshwater Algae, A guide for the identification of microscopic algae in South African freshwaters. North West University and Department of Water Affairs and forestry, 2006, 210.
30. Wahab MA, Ahmed ZF, Islam MA, Rahmatullah SM. Effect of introduction of common carp, *Cyprinus carpio* (L), on the pond ecology and growth of fish in polyculture. Aquacult. Res 1995; 26:619-628.