The Evaluation of Eutrophication of Tiande Lake

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Abstract:

Aim of this study was to provide a scientific basis for ecological environmental assessment and comprehensive management of water quality in urban lakes. Field experiment was carried out in Tiande Lake, Taizhou City, Jiangsu Province from Dec 2014 to Jun 2015. The total nitrogen (TN), total phosphorus (TP), transparence (SD), permanganate index (COD_{Mn}) and chlorophyll (Chla) were monitored and evaluated by using comprehensive nutrition status index in this paper. The results showed the average content of TN was 0.499 mg•L^{-1},TP was 0.067 mg•L^{-1}, COD_{Mn} was 5.756 mg•L^{-1}, Chla was 11.78 μg•L^{-1}, transparence was 0.65 m. TN, COD_{Mn} accord with standard of surface water quality of China Ⅲclass, while TP was Ⅳclass. The comprehensive nutrition state index (TLI(Σ)) range from 45.3 to 55.43 with average of 49.38, the lake belongs to mesotrophic waters, close to eutrophication. The eutrophication prevention measure was put forward.

Keywords: *Tiande Lake, water quality, eutrophication, environmental assessment*

I. INTRODUCTION

Being one of important parts of urban landscaping and greening, Artificial Lake would alleviate the growing problems of urban heat island effect (Huang, 2008) andprovidea better outdoor recreation place for the public to play and relax. However, human activities lead to eutrophication of artificial lake. The excessive TP and TN would cause phytoplankton blooms, which would reduce the transparency, release stench of harmful algal and accelerate to consume the dissolved oxygen, torelease toxic and hazardous substances. Some researchershad study the impact of eutrophication on water quality of artificial lake (Huang, 2008; Zhang, 2013).Carlson was the first to establish nutritional status index (Carlson, 1977). Aizaki and Goda amended and improved the method and established the classification of composite index of nutritional status (Aizaki, 1981; Goda, 1981). The evaluation factors of later were consisted of total nitrogen, total phosphorus, permanganate index, transparency, and chlorophyll a, which were widely applied by Chinese researchers (Wang, 2012).

The Tiande Lake was built in 2009, which is located in Hailing district, Taizhou city, Jiangsu province. With 1010 meters from east to west and 1100 meters from north to south, a total area of about 100 hectares, include barbecue, fishing, beach entertainment, catering, accommodation and other facilities. There was little study on Tiande Lake's eutrophication. The aim of this study was to provide a scientific basis for ecological environmental assessment and integrated management.

II. MATERIALSAND METHODS

A. Setup of Sample Point:

Tiande Lake (32°25'~32°26'N 、 119°54'~119°55'E) is located in Hailing district of Taizhou City. Four sample point have been set up; the distribution of sample points is in Table1

B. Sampling and Analysis Methods:

Samples of the points were collected at different season, from December 2014 to September 2015. pH (PHB-4 type, Shanghai REX Instrument Factory)and the conductivity rate (DDB-303A type, Shanghai REX Instrument Factory) were measured immediately. Chlorophyll a (Chla),(Jin, 1990), transparency (SD), total phosphorus (TP), total nitrogen (TN), and

permanganate index (COD_{Mn})(GB3838-2002 of China) were tested in the lab, latter (Chen,2013).

Table1 The Sample Points' location of Tiande Lake

Points	Label	longitude-latitude
Dining club	Site A	32°25'35.29"N 119°54'51.58"E
Beach	Site B	32°25'33.21"N 119°55'13.79"E
Fishing area	Site C	32°25'46.37"N 119°55'18.71"E
Hotel	Site D	32°25'49.51"N 119°55'01.68"E

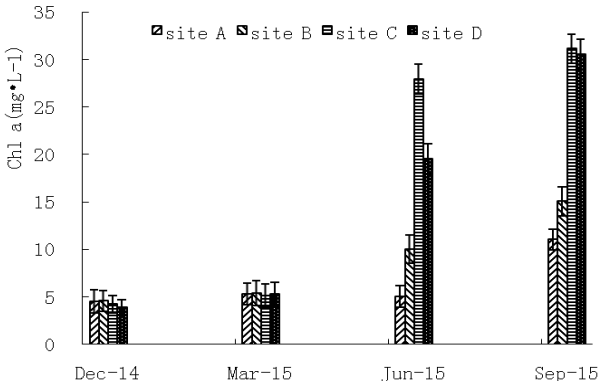

Fig.1 Seasonal Variation of Chlorophyll a in Sampling Site

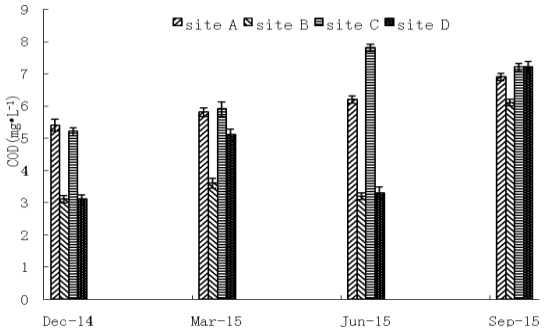

Fig.2 Seasonal Variation of COD_{Mn} in Sampling Site

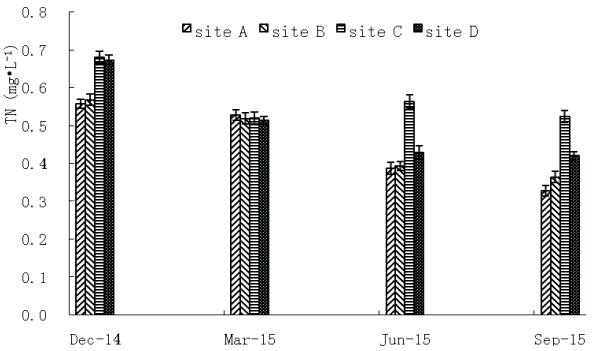

Fig.3 Seasonal Variation of Total Nitrogen in Sampling Site

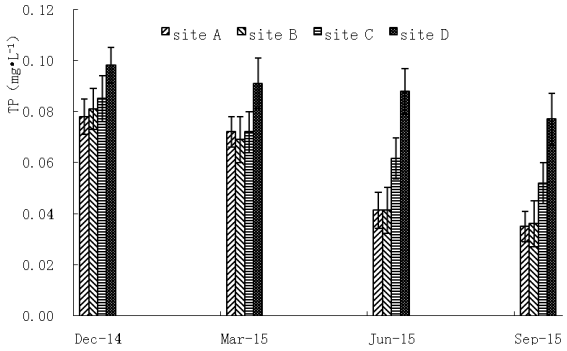

Fig.4 Seasonal Variation of Total Phosphorus in Sampling Site

C. Data Processing:

Eutrophication assessment adopts Carlson's comprehensive nutritional state index (*TLI* (∑))(Carlson, 1977), and the calculated formulas data processing is mainly using Microsoft Office Excel.

III. RESULT AND DISCUSSION

A. Water Quality Indicators and Classification*:*

The results of Chla, COD_{Mn}, TN, TP of the four points were present in fig.1-fig.4.

According to surface water environmental quality standards of China, the total phosphorus content reachesto the Ⅳ class,the total nitrogen and the permanganate index content arrived at Ⅲ class. The permanganate index was at Ⅲ class in December and March, and which was taken as Ⅳ class in June and September.The total nitrogen content reaches to Ⅲ class in December and March, then reaches to Ⅱ class in June and September, but the fishing area still in Ⅲ class. Total phosphorus content of water reaches to Ⅳ class in point C and the point D throughout the year, A and B points show out the features of type Ⅳ water in winter and spring, as well as type Ⅲ water in summer and fall.

The average content of total nitrogen was 0.451 mg•L^{-1} in point A, 0.462 mg•L^{-1} in point B, 0.572 mg•L^{-1} in point C, and 0.510 mg•L^{-1} in point D. The average content of total phosphorus was 0.057 mg•L^{-1} in point A, 0.057 mg•L^{-1} in point B, 0.068 mg•L^{-1} in point C, 0.088 mg•L^{-1} in point D. The average content of COD_{Mn} in point A was 6.075 mg•L^{-1}, 4 mg•L^{-1} in point B, 6.525 mg•L^{-1} in point C, 4.675 mg•L^{-1} in point D. The average content of chlorophyll a in point A is 6.46 μg• L^{-1}, 8.767 μg• L^{-1} in point B, 17.106 μg• L^{-1} in point C, 14.807 μg• L^{-1}in point D. The average transparency in point A is 0.693 m, 0.65 m in point B, 0.613 m in point C, and 0.645 m in point D. The water temperature showed a significant seasonal nature, the annual average temperature is 18.1℃. The content of dissolved oxygen (DO) is range from 7.8 mg•L^{-1} to 9.1 mg•L^{-1}, the annual average dissolved oxygen is 8.63 mg•L^{-1}, The pH was range from 7.68 to 8.5 with an average of 8.15, the conductivity (Cond) was from 238 to 535μs•cm^{-1} with an average of 430μs•cm^{-1}, the dissolved solids (TDS) content was from 220 to 268 mg•L^{-1} with an average of 240 mg•L^{-1}. The content of ammonium nitrogen (NH_4^+-N) was from 0.045 to 0.085 mg•L^{-1} with an average of 0.064 mg•L^{-1} . The content of nitrate (NO_3^--N) was from 0.005 to 0.02 mg•L^{-1} with an average of 0.012 mg•L^{-1}. The content of nitrite nitrogen (NO_2^--N) was from 0.006 to 0.015 mg•L^{-1} with an average of 0.01 mg•L^{-1}, and the content of soluble phosphate (SP) was from 0.002 to 0.048 mg•L^{-1} with an average of 0.025 mg•L^{-1}.

The contents of TN、COD_{Mn} and Chla in point C of fishing area were higher than the ones of other points, but the transparency was lower. Compared with other months, June was higher. That results were correspond to the fishing activities. The fishing district main breeding varieties including *mylopharyngodon piceus*, *carassius auratus*,

hypophthalmichthys molitrix and *hypophthalmichthys nobilis*. The total nitrogen may be related with protein baits fed by anglers. With the decomposition of nitrogen-containing organic matter of residual baits, the content of COD_{Mn} improved. The content of nitrate and nitrite nitrogen in fishing area were the highest, nutrient-rich and suitable temperature were conducive for the growth of phytoplankton, the content of chlorophyll a also showed the highest biomass in fishing area.

B. Evaluation of Nutritional Status:

The water nutritional Status was evaluated by Integrated Nutrition Index Method (TLI (Σ)), which use the Chla, TN, TP, COD_{Mn} and SD as the main water quality indicators (Table2), TLI (Σ) value was from 45.3 to 55.43 with an average of 49.38, which was very close to the slight eutrophication status (TLI (Σ)> 50).The average TLI (Σ) value in point A was 47.6, the average TLI (Σ) value in point B was 47.29, the average TLI (Σ) value in point C was 51.80, and the average TLI (Σ) value in point D was 50.82, point A and point B are in mesotrophic levels, point C and point D are in light eutrophication levels. It indicated that a part of the lake has reached a mild eutrophication, the water body of entire lake is in the transition phase between mesotrophic level and light eutrophication level, it is relatively higher in fishing area, and the difference is not significant by the analysis of variance ($p < 0.05$).

Table2 Results Calculated By Comprehensive Nutrition State Index Method

Month	Points	TLI（∑）	nutritional status
Dec-2014	site A	47.93	mesotropher
	site B	45.30	mesotropher
	site C	48.15	mesotropher
	site D	46.00	mesotropher
Mar-2015	site A	48.20	mesotropher
	site B	46.08	mesotropher
	site C	48.44	mesotropher
	site D	48.32	mesotropher
Jun-2015	site A	45.86	mesotropher
	site B	48.51	mesotropher
	site C	55.43	Light eutropher
	site D	53.55	Light eutropher
Sep-2015	site A	48.43	mesotropher
	site B	49.26	mesotropher
	site C	55.17	Light eutropher
	site D	55.42	Light eutropher

IV. CONCLUSION

The average of water transparency in Tiande Lake was 0.65 m; the average of total phosphorus (TP) was 0.067 $mg•L^{-1}$; the average of total nitrogen (TN) was 0.499 $mg•L^{-1}$; the average of COD_{Mn} was 5.756 $mg•L^{-1}$, and the average content of chlorophyll a was 11.78 $\mu g• L^{-1}$. According to the environmental quality standards of surface water, the individual indicators of total nitrogen and permanganate index content belong to Ⅲ type water standard; total phosphorus content arrived at Ⅳ type water standard. It was generally considered that the critical point of Eutrophication when TN>0.2 $mg•L^{-1}$, TP >0.02 $mg•L^{-1}$, the chlorophyll content reached to10 $\mu g •L^{-1}$.The water body of Tiande Lake has reached eutrophication criteria. Water quality trophic level index TLI（∑）ofTiande Lake was from 45.3 to 55.43, with an average of 49.38, it was inmesotrophic level but close to light eutrophication level, the TLI (Σ) values in part areas such as fishing areas and hotelswere over 55, reachedto light eutrophication level.

Therefore, the following several ecological restoration techniques are brought out for the control of eutrophication. (1) Strengthen the input control of exogenous nutrient sources. Fishing areas and hotels played the core roles on water eutrophication; Feeding must be strictly control in the enclosure culture zone. The domestic wastewater discharge of hotel must be strictly control, too. (2) Strengthen the ecological restoration. It should be stocking silver carp and bighead carp, snails, shellfish and other filter aquatic animals scientifically to effectively control algae in water. Float-plants, submerged-plants or emerged-plants such as cattail bulrush, water onion, sweet grass would be another choice to absorb nitrogen, phosphorus and other nutrients in the water.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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