STATISTICAL INFERENCE OF A CASE STUDY IN CHINA: ACTIVE PHOSPHATE REMOVAL FROM EUTROPHIC WATER

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1. Introduction

China is a country that exports a huge amount of duck meat. Recently, more and more people raise ducks in ponds together with fish. Previous research has shown that the yield of fish in a duck-fish integrated system pond is greater than the yield in non-integrated system ponds. At the same time, the duck-fish system reduced the pollution significantly. However, there is still polluted water left due to the entering phosphorous and nitrate from ducks (Adel K. Soliman, 2000).

Nitrogen and phosphorus contained in agricultural are mainly responsible for eutrophication(Li, Wu, Yu, Sheng, & Yu, 2007). Nitrogen and phosphorus are restrictive elements in any freshwater ecosystem. Therefore, one of the major goals is to eliminate these contaminants from freshwater in order to restore the ecosystem. An important approach is a macrophytes-based treatment. Plant transpiration can reduce the effluents through recirculation systems (Garland, Levine, Yorio, & Hummerick, 2004). Statistics has demonstrated that a macrophytes-based treatment for removal of nitrogen and phosphorus is very efficient in the restoration of eutrophic water, such as ponds and marshes. However, one of the key problems is that the absorption by plants of contaminants in wastewater is always limited because the root biomass fills the pore spaces of the substrate (usually gravel). The constructed wetland directs wastewater to deeper wetland media, which makes the absorption more efficient (Joseph Kyambadde, 2005). Harvesting aquatic plants with assimilated and stored nitrogen and phosphorus are effective for controlling freshwater eutrophication, and the harvested plants can also be used as food and agricultural fertilizer (Gideon, 1990). Water spinach (Ipomea aquatic) has significant ability to remove nitrogen and phosphate from wastewater(Costa-Pierce, 1998).

To further study the effects of growing water spinach in terms of the removal efficiency of ammonia nitrogen and active phosphate from the polluted ponds, we performed a control-treatment experiment in Anhui, China. We measured the concentration of ammonia-nitrogen and active phosphate at various places in the pond every other 15 days. A paired t-test to compare the contents of ammonia-nitrogen and active phosphate between the control and treatment was done. Meanwhile, water spinach can be sold and increase economic benefits.

2. Experimental Design and Sample Collection

The experiments were performed in Anhui, China. Three ponds, A, B and C, were selected. Pond A is our treatment pond where we planted the water spinach. It had ducks and fishes. Pond B is a pond with ducks and fishes without water spinach. Pond C is the control pond with fishes only. We built a floating bed of size 5m*1.2m to fix the water spinach in pond A. Figure 1 shows the structure of Pond A. I is the Duck Sheds which built beside the pond, II is area with water spinach on floating beds. A1 is a sampling point between two floating beds with the distance around 20m to Duck Sheds and we get sample from middle layer of water. III is the area outside spinach and sampling point A2 is in this area, which distance is about 50m to Duck Sheds. And the sample was also got from middle layer of water.

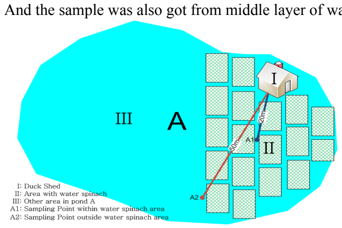

Figure 1. Duck shed and floating beds in the pond A

The measurement items of water quality include the concentration of Ammonia-nitrogen, active phosphate and cod value. The samples were obtained each of these locations in three ponds:
A1: concentration from water within water spinach area in pond A;
A2: concentration from water outside water spinach area in pond A;
B1: concentration from water under duck sheds in pond B;
B2: concentration from water away from duck sheds in pond B;
C1: concentration from water in pond C without duck or water spinach.
The experiments began on May 18, 2009. We went to the three ponds every 15 days. The samples were obtained during 8 visits. The average concentration of Ammonia-Nitrogen at each visit for each pond is shown in Table 1. The date shown as 5.18 means the visit on May 18, 2009.

Table 1. The average concentration of ammonia-Nitrogen

	Average concentration on different dates							
	5.18	6.08	6.24	7.12	7.27	8.13	8.30	9.12
A 1	1.245	0.477	0.303	0.266	0.401	0.353	0.278	0.288
A 2	1.058	0.65	0.397	0.229	0.363	0.325	0.332	0.300
B 1	1.201	0.536	0.238	0.346	0.669	0.400	0.506	0.524
B 2	0.86	0.397	0.236	0.315	0.605	0.388	0.543	0.497
C 3	0.437	0.363	0.244	0.325	0.502	0.253	0.407	0.267

Table 2. The average concentration of active phosphate

	Average concentration on different dates								
	5.18	6.08	6.24	7.12	7.27	8.13	8.3	9.12	5.18
A 1	0.059	0.332	0.165	0.054	0.026	0.018	0.028	0.01	0.059
A 2	0.503	0.469	0.189	0.058	0.031	0.029	0.032	0.018	0.503
B 1	0.579	0.736	0.932	0.947	0.606	0.244	0.302	0.181	0.579
B 2	0.517	0.718	0.913	0.872	0.58	0.23	0.32	0.182	0.517
C 3	0.635	0.888	1.22	0.321	0.46	0.573	0.545	0.421	0.635

in the morning and in the evening. The average of the two measurements on the same day was used as our concentration measurement for the active phosphate. The samples were obtained during 8 visits. The average concentration of active phosphate at each visit for each pond is shown in Table 2. The date shown as 5.18 means the visit on May 18, 2009.

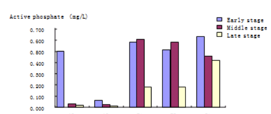

Figure 2 The change of active phosphate concentration in different time at the same pond

3. Data Analysis Result

When we plot the measurements from a same pond, we get Figure 3. The observations for both ammonia nitrogen and active phosphate from A1 continuously decrease. The observations for ammonia-nitrogen from C1 do not show decreasing trend.

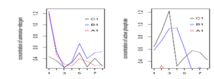

Figure 3 The observations from a same pond at various dates

We performed multiple paired t-test to compare the mean concentrations of ammonia-nitrogen at various locations. The p-value between samples from A1 and A2 is greater than 0.1, so there is no real difference in the concentration of ammonia-nitrogen at two different locations within pond A.

There is a real difference in the concentration of active phosphate at two different locations within pond B. The significance test recommends that the water near the ducks is more polluted by the active phosphate content than the water elsewhere. The p-value between samples from A1 and B2 is close to 0.0005, so there is a significant evidence that planting water spinach reduces the active phosphate content in the water.

4. References

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