Evaluation of the Aquaculture Pond Water Quality Based on Fuzzy Mathematics Model

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Abstract. Water quality management plays a very important role in fish life and aquatic product quality. The paper firstly selects the index system and confirm the weight of each of the water quality factors dependent on the fish tolerance to the factors of water quality integrated with the result of the expert questionnaire by the Delphi method with the Water Quality Standard, then constructs the fuzzy evaluation model of the multiplex water quality parameter and classifies the standard of water quality into five classes of standard. At last the paper give an experimental model based on the monitored datum in North China. It shows that it can evaluate the water quality integrative and provide the degree of membership that the water quality belongs to all the standards.

1 Introduction

In the recent years, many fish, the shrimp and the shellfish death and the frequent emerging of all kinds of disease had reduced the fishermen income and brought out the quality unsafety due that the serious aging and eutrophicated aquaculture ponds and the unbalance of ecosystem of aquaculture water [4]. So water quality management has becoming the most important element for constraining the output of the fish. Water quality evaluation is the first step for water quality management, which can justify the current pond water quality situation and provide the water quality management with scientific proof. It is inevitable to construct the complete, rational and scientific index system to achieve better evaluation result of pond water quality. Thus, this paper puts forward the pond water quality model, which consists of evaluation index system and evaluation standards combined the fuzzy theory with expert questionnaire.

2 Confirming the Pond Water Quality Evaluation Indices

There are many factors that influence the pond water quality. An evaluation system can not include all the factors, and for a single factor its influence on the pond water

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quality is different. The influencing factors of the fresh breeding pond water quality include physical factors, chemical factors and biological factors. The physical factors include the macro environmental factors and the pond water quality factors. The chemical factors include some basic chemicals and some microelements such as DO (dissolved oxygen), pH, and the biological factors include plankton and other benthic organism and microbes.

Production proves that in the process of the pond water quality evaluation, some factors such as the microelements and toxicants are negligible. Different experts give different values on these factors. That is, experts hold different ideas on selecting which factors to evaluate generally the pond water quality. Because of this, we confirm the pond water quality evaluation indices by the expert questionnaire. Under the instruction of the experts, we choose 14 factors, and ask the experts to give importance on each of the 14 factors. The determination of the factors' importance degree coefficients is the main step of comprehensive judgment. Whether the subset of factor A is appropriately determined or not, will influence the comprehensive judgment directly. We choose the Delphi method to choose the factors' importance degree, and confirm the evaluation indices system.

Suppose that the pond water quality evaluation will choose the appropriate factors to evaluate from the following m factors, such as DO, pH value, transparency, and let the factor set be U, The importance degree fuzziness subset of the factor U is A

$$U = \{u_1, u_2, \cdots, u_m\}, \quad \underset{\sim}{A} = \{a_1, a_2, \cdots, a_m\}. \tag{1}$$

We determine the factors' importance degree coefficients $a_i (i = 1,2,\cdots,m)$ by the Delphi method, the Delphi method is also called expert evaluation method, which combines the experts' intelligence and is one of the effective ways to determine the factors' importance coefficients in the process of problem solving. The work of calculating the factors' importance degree coefficient must be done by the experts, requiring the experts' profound knowledge and the whole situation of the problem needed to be solved.

2.1 Determination of Importance Rank of the Pond Water Quality Factor

According to the concrete situation of the Tianjin fresh water pond water breeding, when choosing the evaluation indices, we must delete the irrelevant and unimportant influential factors.

The factors' importance ranking values F_i by the experts are statistic as follows:

When $\frac{F_{j-k}}{F_{i-k}} \le 1$, *Denote* $A_{ij-k} = 1$ When $\frac{F_{j-k}}{F_{i-k}} > 1$, *Denote* $A_{ij-k} = 0$

Suppose that there are n experts in total. Sum up all the A_{ij-k} value of all the experts. That is,

$$A_{ij} = \sum_{k=1}^{n} A_{ij-k}, i = 1,2,\cdots,m, \quad j = 1,2,\cdots,m. \tag{2}$$