AN EARLY WARNING SYSTEM FOR FLOUNDER DISEASE

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Abstract: With the constant expansion of the scale and mismanagement in aquaculture,the diseases of flounder occur more and more frequently than before, which has brought great economic losses to fish farmers. For the sake of the problem described above, based on a great number of surveys, the early warning theory of flounder disease, the analysis of the outbreak and development of diseases and the relationship between disease and factors, the logic process of the early warning for flounder disease was confirmed. It consists of five parts: specifying the target, searching for the source, distinguishing the sign, predicting the degree and eliminating the menace. Using the expert survey method the early warning indexes which affect the normal life of the flounder and calculated the range of the water environment factors were also confirmed. Finally, an early warning system was implemented, which can reduce the damage from the flounder disease.

Keywords: flounder disease, predict, early warning, artificial neural network

1. INTRODUCTION

In recent years, flounder has become the most important aquaculture species in China's coastal areas. However, with the constant expansion of the scale and mismanagement in aquaculture, the diseases of flounder occur more and more frequently than before, which has brought great economic losses to fish farmers, and it has threaten the stabilization of aquiculture and sustainable development (Liu, 2006). The arbitrariness of China's aquaculture technology and its current management lead to the spread of disease, decline product quality, and even affect the food safety. In order to solve these problems many experts and scholars have done a lot of researches in the aquaculture disease diagnosis and treatment. With the guidance of knowledge-based diagnosis reasoning theory, J.W.Wen developed fish disease diagnosis expert system and proposed a theory of fish disease diagnosis knowledge conceptualization, the description of diagnosis problems, diagnosis knowledge representation, the construction and solution of diagnosis, the development of diagnosis system and so on(Wen, 2003). Wei Zhu developed an expert system for fish disease diagnosis with the method of CBR & RBR that can make accurate diagnosis (Zhu, 2006). Xiaoshuan Zhang developed an intelligent decision support system, which presents the effort to apply evolutionary prototyping model in the intelligent decision support system for fish disease and health management (Zhang, 2008). However, the majority researches in aquaculture disease are relatively for diagnosis and disease treatment, and do not pay much attention on the early prevent, which lead to fish disease management lagging behind.

So in order to reduce the crisis and loss, it is very important to develop an early warning system to monitor the water environment, examine fish disease and take treatment measures as early as possible. The aim of this paper is to design and implement an early warning system for flounder disease to reduce the damage from the disease. In this paper, based on the analysis of factors that affect flounder, eleven indexes were selected, and using the expert survey method the range of the factors were also calculated. Using expert knowledge and neural networks and genetic algorithms, status early warning and trending early warning model for water environment was established. Based on the method of case-based reasoning, we established symptom early warning model for flounder disease. Finally, an early warning system for flounder disease was implemented.

2. ANALYSIS OF EARLY WARNING SYSTEM

2.1 The logic process of the early warning system and the early warning index

The process of the implement of the early warning system is shown in Fig 1. It consists of five parts: specifying the target, searching for the source, distinguishing the sign, predicting the degree and eliminating the menace.

Each of the process is indispensable, so, analysis and design this early warning system should keep to the early warning logic process. As far as flounder are concerned, flounder diseases are the target that we should early warn. Water environments are the source which can result in flounder diseases directly, such as dissolve oxygen, water temperature and so on. Distinguishing the sign of flounder diseases is to determine the relationship between symptom and disease. After the analysis of the water environments and symptom for flounder, we can predict the degree of the flounder disease and take measures to eliminate the menace.

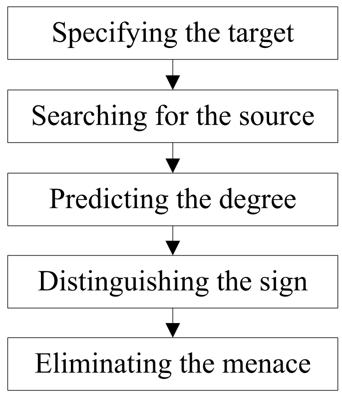

Fig1. The logic process of the early warning system and the early warning index

According to the logic process of early warning, the early warning index for flounder diseases can be divided into warning situation index, warning omen index and warning source index (Wu, 1999). After making consultation from the aquaculture disease experts and the technician of the intensive aquaculture factory, we chose the important and easy monitoring index and removed the index that is hard to monitor and not very important to flounder. The index system of flounder disease can be described as Fig 2. According to the consultation of the domain experts, the interval of no-warning, mid-warning, bad-warning for each early warning index were established. The equation confirming of the border values is

$$V = \frac{\sum E(w_i) * a_i}{N} \qquad (1)$$

Where: $E(w_i)$ is the weight of the experts, and it depends on the Qualifications, age and employment time of the expert. a_i is the value set by each expert. N is the number of the domain experts. V is the border value of each water environment early warning index that the domain experts give. Based on the equation, we can calculate the border values, and some of the border values are as follows in table 1.

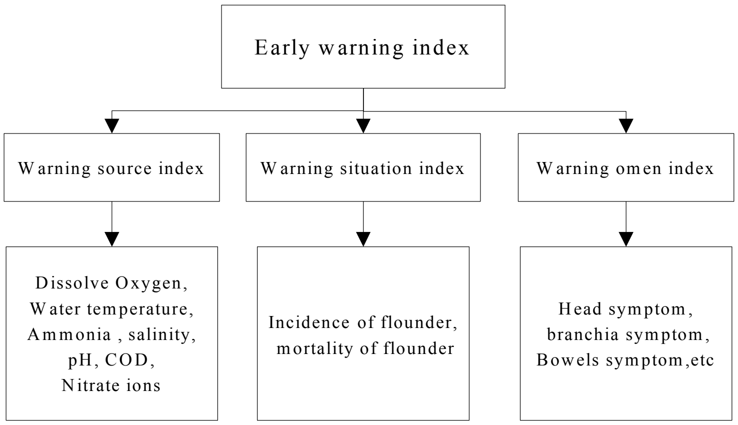

Fig2. Early warning index for flounder disease

Table 1. The interval of the water environment early warning index

Water environment early warning index	no-warning	mid-warning	bad-warning
Dissolve oxygen	>6	(3,6)	(0,3)
Water temperature	(11,24)	(24-26) or (8-11)	>26 or <8
Ammonia	<0.5	(0.5,1)	>1
Salinity	(15,32.5)	(32.5,40) or (9.5,15)	>40 or <9.5
pH	(7.0,8.8)	(6.5-7)	<6.5
Surface damage rate	(0, 1%)	(1%, 3.7%)	>3.7%
Mortality of ascites	(0, 0.21%)	(0.21%,0.48)	>0.48%
Incidence of ascites	(0, 0.75%)	(0.75%, 5.5%)	>5.5%
Mortality of white spot disease	(0, 1.9%)	(1.9%, 3.78%)	>3.78
Incidence of white spot disease	(0, 2.1%)	(2.1%, 4.85%)	>4.85
⋮	⋮	⋮	⋮

2.2 Demand analysis of the early warning system

The function demand can be described as follows: first, this system can implement the water environment status early warning and trending early warning, non water entrainment early warning and symptom early warning. The early warning results can be informed to the users through website, short message, Speaker Systems and so on. Second, the system has the diagnosis function for the flounder disease, and can gives the diagnosis results and prevent treatment to the users. Third, the function of query, update, insert and delete of all sorts of information can be implemented in the system. There are three kinds of users for this system, flounder farmers, domain experts and administrators, and each kind of users has different competence.

Flounder farmers can make early warning, enquiry the history information of early warning. As for domain experts, besides the competence that flounder farmers have, they can query and update the diseases cases database and knowledge database. Administrators can query and update any kind of information.

3. DESIGN OF EARLY WARNING SYSTEM FOR FLOUNDER DISEASE

3.1 Design of function module

According to the analysis of function demand and the consultant to the domain expert, the system can be divided into three parts: early warning module, knowledge browse module and system maintenance module. The details of each module can be shown in Fig 3. The most important module is early warning module, which contains four parts: water environment status early warning, water environment tendency early warning, non water environment early warning and symptom early warning.

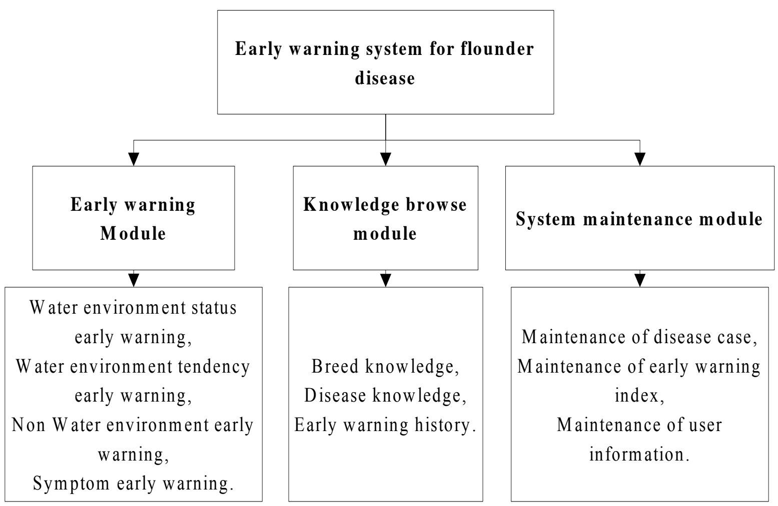

Fig3. Function module of early warning index for flounder disease

As to water environment status early warning, according to user's input and the real time water quality data from the sensors, the border values of each index from the table given above can be searched, and the single-factor early warning level could be calculated. After that, using the knowledge of domain experts, multi-factor early warning level could also be confirmed.

Combine neural networks and genetic algorithms, the next half hour index for each water environment can be predicted. And then, using the same method used in the status early warning to confirm the early warning level in the future and water environment tendency early warning can be achieved. If the Fish farmer inputs the symptoms and the mortality of the flounders, first the disease of the flounders can be diagnosed, and then according to the mortality the symptom early warning level can be calculated.

3.2 Design of databases

In this system, three tables were designed including: water environment early warning, non water environment early warning, and symptom early warning, publish of the warning level, symptom and disease cases. Some main database tables are show as follows in table 2 to 4.

Table 2. Table of Water environment early warning:

Field name	Type	Description
ID	Int	id
Warning_level	varchar	Warning level
Warning_plan	Varchar	Warning plan
DO	Varchar	Dissolve oxygen
pH	Varchar	pH
NH3	Varchar	Ammonia
Salt	Varchar	salinity
NO3	Varchar	Nitrate ions
COD	Varchar	COD
Temperature	Varchar	temperature

Table 3. Table of *n*on water environment early warning

field name	type	description
ID	Int	id
Warning_level	varchar	Warning level
Warning_plan	Varchar	Warning plan
Parasite	Varchar	Parasite
Weight	Varchar	weight
injury	Varchar	Flounder injury

Table 4. Table of symptom early warning

field name	type	description
Warning3_ID	Int	id
Warning_level3	varchar	Warning level
Warning_plan	Varchar	Warning plan
Disease_id	Varchar	Disease id
Disease_rate	Varchar	Incidence
Death_rate	Varchar	mortality

4. IMPLEMENT OF THE EARLY WARNING SYSTEM

According to the theoretical contents and the analysis and design of early warning for flounder diseases described above, the early warning system was implemented. The system is developed based on MVC, which has better reuse and can be expanded and revised more easily than before. This early warning system is developed by java language, so it can be run in any platform. Some interfaces are as follows in Fig.4. The first three figures are the input interfaces, which include water environment early warning, non water early warning and symptom early warning, and the fourth figure is the early warning results for the flounder disease.

Fig 4. Interfaces of early warning system for flounder disease

5. DISCUSSION AND CONCLUSION

Using the knowledge of domain experts, the interval of no-warning, mid-warning, bad-warning for each water environment early warning index was confirmed. Diagnosis and treatment and early warning knowledge database were established. A case database was constructed for flounder diseases. All these knowledge can provide data for the effective early warning.

The system used the expert knowledge to do early warning on water environment, non-water environment and symptoms. Trend early warning on the water environment by use of neural networks and genetic algorithms, and confirmed symptoms and diseases using case-based method, and it provided the effective decision support for a diagnosis and treatment and prevention on the flounder diseases.

The system is limited because only the influence factors that affect flounder disease in intensive aquaculture mode were considered and in other mode this system may not suitable for disease early warning. So the next step is to develop a common early warning system for flounder disease which can be adapted to any early warning for flounder disease according to the different aquaculture mode.

ACKNOWLEDGEMENTS

The research was funded by National Key Technology R&D Program (2006BAD10A02-05). We are grateful to the help from many domain experts from Aquaculture Department of college of Tianjin agricultural university, and we also would like to thank all members of our lab.

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