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Water Quality Monitoring and Early Warning Technology of Zebrafish Behavior Based on 3s Technology

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Abstract: The development and key technology research of zebrafish online biomonitoring technology can realize real-time monitoring of water quality safety from the perspective of ecosystem by means of 3s technology, and realize early warning of water quality according to the response characteristics of zebrafish. The purpose of this paper is to study the water quality monitoring and early warning technology of zebrafish behavior based on 3s technology. Use GIS technology to process a large number of graphics, data and models, combine graphics and mathematical models, and implement the results of operations on the map. By analyzing the factors that affect the behavior of the indicator biological zebrafish, the results show that these potential physical stress factors have an impact on the normal behavior of zebrafish, but they are also acceptable in the normal range. Zebrafish can adjust and adapt within the fluctuation range of normal water quality, such as pH value and dissolved oxygen, and the behavioral difference is not obvious.

1. Introduction

Compared with other biological monitoring instruments, the online monitoring system based on fish behavior is stable, convenient, reliable, and low in management and operation costs. Advantages, this is also the best choice for water quality monitoring in rivers, coastal areas, sewage treatment plants and other places at this stage, which can save costs and complete the work of water quality monitoring, but in practical applications, the effect often does not reach the expected vision. Because in the actual environment, there are various environmental factors that will affect the behavior of zebrafish, which will eventually lead to errors in the water quality obtained by analyzing the behavior of zebrafish, making the results of water quality monitoring inaccurate [1-2].

With the development of industry and agriculture, industrial wastewater and synthetic organic pollutants enter the water environment, and some pollutants accumulate through the biological

chain, posing a threat to human life and health. Integrate mathematical models of social behavior into the design of realistic feedback laws for robot interaction with live animals [3]. Pietro takes advantage of recent advances in data-driven modeling of zebrafish behavior. A novel robotic platform was eventually built that allows real-time actuation of bioinspired 3D printed zebrafish replicas for model-based control of animal behavior [4]. In a scholar's study, adult zebrafish were exposed to triclosan (0.3 and 0.6 mg/L) for 48 hours, and exploratory behavior was analyzed using ZebraTrack. Exercise was significantly reduced in the triclosan-exposed group, while duration of freezing was increased. They also exhibited erratic movements, suggesting that triclosan induces anxiety-like behaviors in adult zebrafish [5]. By monitoring the behavioral changes of zebrafish, in the case of water quality changes, zebrafish can quickly warn of potential water pollution, and carry out emergency prevention of sudden water pollution events [6].

Based on the behavioral changes of zebrafish population, this study simulates and summarizes the behavioral response laws of zebrafish under several typical water quality conditions and their relationship with the internal response mechanism. Combining 3s technology is a better water quality early warning system based on fish behavioral changes. The application provides reference and basis. By analyzing the zebrafish behavior data, it can be found that the zebrafish's circadian rhythm will be disturbed at an ambient temperature of about 20 ℃.

2. Research on Water Quality Monitoring and Early Warning Technology of Zebrafish Behavior Based on 3s Technology

2.1. Zebrafish

Zebrafish has many advantages: small size, easy to breed, easy to breed, etc. It is an internationally recognized standard aquatic model organism. For a normal zebrafish individual, in a suitable living environment, its behavioral rhythm has a strict circadian rhythm. Under the toxic stress of different drug environments, it will inevitably affect the normal oscillation of the circadian rhythm [7-8]. According to the obtained experimental data and the comparison with the normal zebrafish behavioral rhythm oscillation, we can immediately conclude that the water quality has changed, so that emergency measures are taken for follow-up treatment. The monitoring and early warning method based on the behavior of aquatic organisms is one of the most rapid and promising online dynamic water quality detection methods [9-10].

2.2. 3S Technology and Its Integration

(1) GIS

GIS is a system that contains a lot of spatial information: in which we can extract a lot of water conservancy information. In the planning stage of a project construction, it is necessary to have a general understanding of the overall area of the region, the area of the river, lake and reservoir, the length of the original river, and the length of the water transmission line: the traditional method is to mobilize a large number of manpower for on-site exploration and measurement, and when the digital map is established in the GIS system, all needs can be displayed by simply using the mouse in the electronic map to display the length, width, and elevation of the river. After determining the parameters of the excavation channel, the calculation of the excavation and filling can be carried out [11-12]. The calculation area in any range can be determined, such as rivers, lakes, reservoirs, administrative areas, planning areas, etc. The accuracy of measurement and calculation depends on the scale of the electronic map. In the electronic map, slope analysis, river section analysis, etc. can

also be performed [13].

(2) Remote sensing

Remote sensing is to use the principle of electromagnetic wave characteristics of different objects to find the appearance of electromagnetic waves through surface objects and the electromagnetic waves emitted by them, and extract the information of these objects [14]. Because RS techniques can be analyzed cause-by- cause, direct information from satellite imagery, such as parameters, can be used to develop flood forecasting scenarios. Through the combined use of satellite or air sensor systems, the geographic distribution of land objects is determined, and together with data such as land and slope, it is converted into digital form and stored in GIS systems [15-16].

(3) Global Positioning System

GPS can accurately determine the location of an entity, thereby providing a powerful means for the entity to obtain the location of the information source. The spatial positioning of a large number of entities on the opposite side of GPS plays a pivotal role. When creating a vector map in GIS, the first task is to perform image registration, which requires very accurate coordinates. In order to meet the accuracy requirements, GPS positioning technology must be used for on-site positioning [17-18].

(4) 3S integration meaning

3S fusion is an organic fusion of the above technologies. The purpose of GIS is to analyze, process and process different types of information, which can be expressed by formula (1):

$$I = I_1 + I_2 + ... + I_n \tag{1}$$

Among them, I represents the source information; I1, I2, ..., In represent different kinds of information [19].

The essence of RS is to use the principle of spectral reflection of ground objects to obtain ground coordinates (x, y) through satellite sensors and ground receiving systems; the relationship between reflection value (z), band (λ) and time (t), so as to obtain the required The real reflection of the ground objects: the obtained information can be expressed by the formula (2):

$$I = f(x, y, z, \lambda, t) \tag{2}$$

A still image is obtained when t=t0 [20-21]. The 3S integration model is shown in Figure 1.

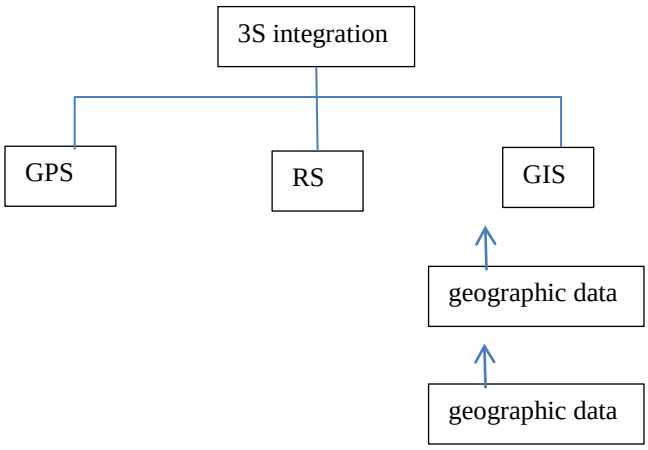

Figure 1. 3S integration model

3. Experiment of Zebrafish Behavioral Water Quality Monitoring Based on 3s Technology

3.1. Zebrafish Fry Domestication

(1) Selection of fry: the same batch of zebrafish, the same size, healthy and no obvious deformity, was used as the experimental fish;

(2) Feeding: feeding once a day, the dosage should be finished within 5min;

The mortality rate of the experimental zebrafish was recorded 48 hours after domestication. If the mortality rate is less than 5% within 7 days, it can be used for the test; if the mortality rate is between 5.10%, the domestication should be continued for 7 days unavailable. That is to ensure that the laboratory is domesticated for more than 2 weeks, and the mortality rate is SlO%, otherwise the fish will be re-trained.

3.2. Data Cllection

Water quality data were obtained through field measurements. Use GPS satellite positioning system to collect coordinate information of monitoring points. The contents entered into the database include: monitoring point location, location description, monitoring depth, monitoring items, etc., which lays a good data foundation for future data analysis. The water quality indicators for on-site monitoring and investigation include: water temperature, dissolved oxygen and residual chlorine.

3.3. Data Processing

The preprocessing of remote sensing images mainly includes geometric correction, image registration, image stitching and edge trimming. On the ArcGIS 9.3 work platform, the images are digitally processed by manual interaction and visual interpretation method. The Editor tool in ArcMap is mainly used to create a feature layer composed of points, lines and polygons. Based on remote sensing images, the actual monitoring values of water quality indicators can only be obtained at limited representative monitoring points., the concentration information of these limited monitoring points is extrapolated to the entire study area for spatial interpolation. The spatial distribution evaluation of water quality based on GIS can comprehensively query the evaluation result data quickly.

4. Analysis of the Relationship between Zebrafish Behavior and Water Quality Data

4.1. Residual Chlorine

Monitoring data residual chlorine 0, 0.05, 0.10, 0.15 and 0.5mg/L four concentration gradients exposed to 30min zebrafish movement speed and height changes. Residual chlorine greater than 0.05mg/L can produce acute toxicity to the behavior of zebrafish, and the average speed within half an hour increases to 1.8 times the average value of blank time. Under the exposure of high concentration of 0.5mg/L residual chlorine, zebrafish quickly lost their activity due to the oxidative toxicity of chlorine, the average speed was only 10.2mm/s, and most of them floated on the water surface, and the average swimming height was 240mm. Due to the oxidative damage to the fish gills caused by the high concentration of residual chlorine, it is difficult for the fish to breathe and stay near the water surface to obtain oxygen more easily.

4.2. Dissolved Oxygen

When dissolved oxygen was 1, 5, 10, and 15 mg/L, its effects on zebrafish motor behavior were investigated, as shown in Table 1.

Table 1. The relationship between zebrafish motor behavior and dissolved oxygen

dissolved oxygen (mg/L)	High (mm)	Speed (mm/s)
1	180	38
5	135	32
10	66	26
15	58	18

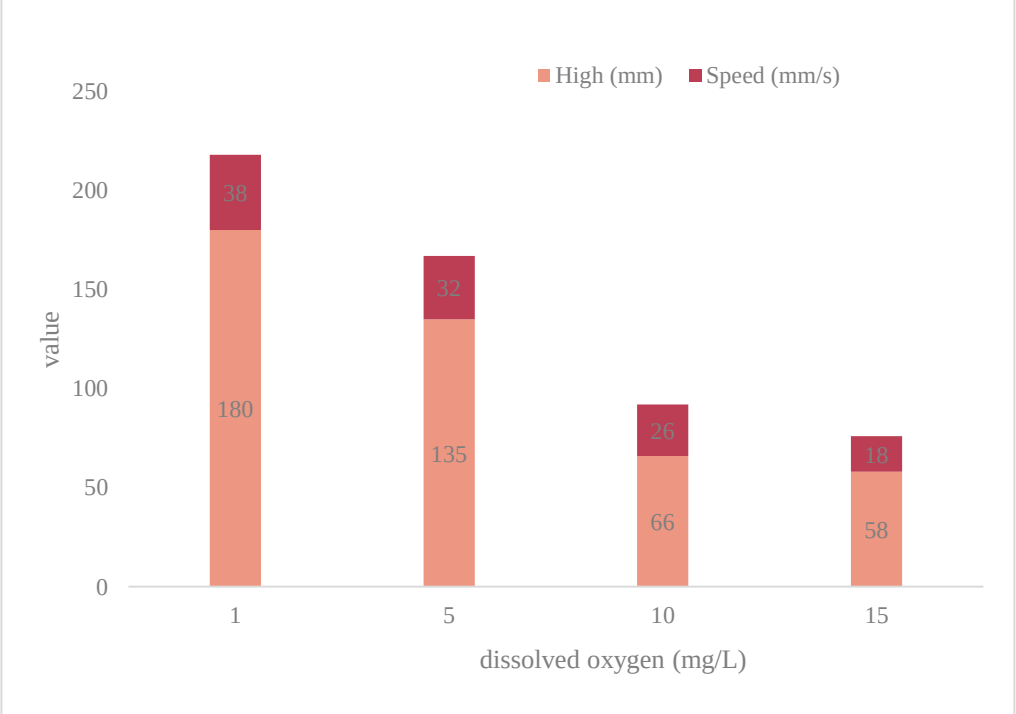

Figure 2. The effect of dissolved oxygen on the swimming behavior of zebrafish

Dissolved oxygen at 1 or 5 mg/L had a significant effect on the behavior of fish after exposure for half an hour, and the height decreased rapidly. Due to the discomfort caused by hypoxia, the activity intensity of zebrafish was reduced as much as possible, and the speed dropped to about 18 mm/s. The height also dropped significantly, from 180mm to about 50mm, as shown in Figure 2.

4.3. Temperature

Zebrafish are ectotherms and are sensitive to changes in ambient temperature. As shown in Table 2, the movement height of zebrafish varies in the range of 150~200mm under each temperature exposure. When the temperature is 20℃~25℃, the changes of zebrafish's behavioral parameters are relatively stable, and the average speed is 50mm/ s; and when the temperature is 30 ℃, the average value is as high as 68 mm/s, showing a certain mania phenomenon of metabolic enhancement

symptoms.

Table 2. The relationship between zebrafish locomotion behavior and temperature

Temperature (℃)	High (mm)	Speed (mm/s)
15	156	52
20	177	41
25	182	40
30	151	68

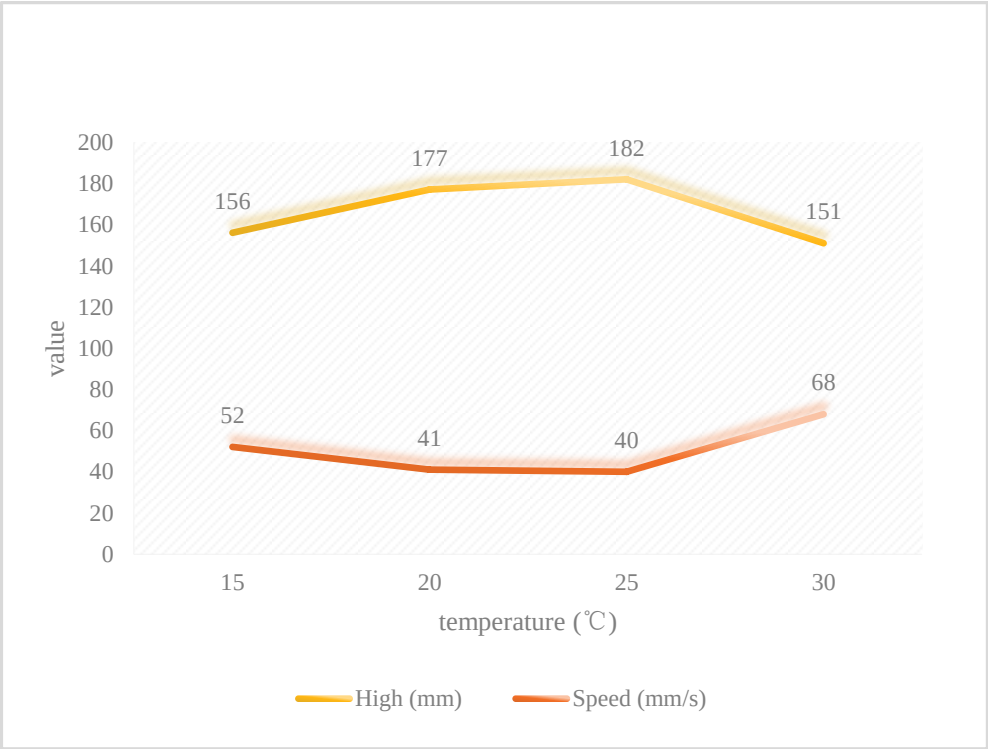

Figure 3. The effect of temperature on the swimming behavior of zebrafish

Zebrafish are best adapted to temperatures between 20 and 25 ℃, as shown in Figure 3.

5. Conclusion

The pollution of the water environment will threaten the life of aquatic organisms and destroy the stability of the ecosystem. Therefore, people gradually realize that the problem of water pollution in the environment has become one of the important problems affecting the sustainable development and even survival of human beings became a hot topic of public opinion. In this paper, by analyzing the influence of water quality on the behavior of zebrafish, the optimal operating environment and monitoring conditions of water quality monitoring equipment were determined, and all behavioral parameters fluctuated smoothly within a certain range, which is a reliable means for water quality early warning. The relationship between behavioral response and physiological function regulation of fish needs further research. The mechanism of behavioral stress response is very complex, involving a series of activities of the nervous system, endocrine system and immune

system. So far, the research and understanding of behavior change and internal response mechanism at home and abroad is still less, and further research is needed.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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