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Research on Acoustic Monitoring of Escape of Large Yellow Croaker Cultured in Cages

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Abstract: It is an important problem for large yellow croaker culture to escape due to the damage of net coat. In this study, a horizontal moving fish finder was installed in a cage to monitor large yellow croaker groups with different numbers and body lengths by acoustic means, and the behavioral characteristics of fish groups were observed after the experimental net was damaged by using the nesting method. Through the identification of large yellow croaker group individual, swimming speed, size, direction and other group behavior characteristics, in order to prevent the escape of fish, set green (normal), yellow (ordinary alarm), red (strong alarm) three state display. This study will provide technical support for the more scientific and safe development of large yellow croaker cage culture.

Keywords: Acoustic; Cage Culture; Escape.

1. Foreword

Large yellow croaker (*Larimichthys crocea*) is a major economic fish in the coastal waters of China. The meat of large yellow croaker is delicious, which not only has rich nutritional value, but also has high economic and cultural value [1-3]. Since the 1980s, the national large yellow croaker fishing ground has been unable to form a fishing season because of the artificial overfishing. In order to supplement the resources of large yellow croaker, China began to vigorously develop the work of breeding and releasing large yellow croaker in 1987, and has achieved a lot since then [4]. However, due to the low catch rate of marked release, the data accumulation of breeding and releasing populations has been limited [4]. In terms of increasing aquaculture, a key breakthrough was made in large-scale artificial breeding technology of large yellow croaker in 1990 [5], which promoted the rapid development of large yellow croaker breeding industry and made it one of the most important mariculture and export varieties in China. In 2014, the total production of large yellow croaker in China reached 127,900 tons, making it the most productive mariculture fish in China [6-7]. At present, the main breeding methods of large yellow croaker are: traditional ordinary cage culture, large-scale deep-water cage culture against wind and waves, and sea area stocking (Marine pasture, breeding and release).

Figure 1. Large yellow croaker cage culture

2. Large Deep Water Anti-storm Cage

The main goal of the traditional cage culture model is to maximize productivity and economic benefits, while focusing on increasing production in a very short time [8]. At present, the main problems include: bait sedimentation waste, aquatic environment pollution, unsustainable utilization of aquatic resources, drug residues in fish, drug hormone residues in water, eutrophication in water, etc. [9-12], which have threatened the health of wildlife and human beings [13]. Therefore, while enjoying the social and economic benefits created by large yellow croaker culture, we need to pay more attention to the potential pollution risks brought by its aquatic ecosystem, and should gradually push the offshore cage culture industry to the direction of open water Marine ranching. The advantages of large-scale deep-water wind wave-resistant cage culture and Marine stocking are that the cage is large in size and placed in deeper waters, which can better restore the wild growing environment of large yellow croaker, the water flow inside and outside the cage is large and the water quality is good, and the cultured fish can absorb part of the bait from natural water, and the quality of cultured fish is higher than that of traditional ordinary cage cultured fish [7]. The disadvantages are the wide range of fish in large water bodies, difficult monitoring and management, difficult control of bait feeding strategy, high breeding cost, difficult manual management and operation at sea, with safety risks; The open sea environment is complex, with low rate of recapitulation and low accumulation of population data, which increases the difficulty of evaluating the effect of release [4, 14]. In addition, for large yellow croakers with sensitive hearing, the impact of environmental noise at sea on the health of farmed fish should also be considered. The existing acoustic monitoring technology of cages at home and abroad mainly uses fish detector [15].

Because light and electromagnetic waves decay quickly in

water, in the case of turbidity or insufficient light, the distance of light and electricity monitoring is limited, and the attenuation of sound waves in water is very small, so the main means of cage monitoring is acoustic monitoring.

3. Research Ideas

Identifying the biomass of large yellow croaker population in cages and preventing the escape of fish caused by damage of net coat have always been important problems faced by large yellow croaker cage culture. In this study, a horizontal moving fish finder was installed in a cage to monitor large yellow croaker groups with different numbers and body lengths by acoustic means, and the behavioral characteristics of fish groups were observed by using the nesting method after the experimental net was damaged. On the one hand, the biomass of large yellow croaker population in the cage was identified by indicators such as target intensity and broadband acoustic characteristics; on the other hand, group behavior characteristics such as individual identification of large yellow croaker population, swimming speed, size and direction were used to set up three state displays of green (normal), yellow (ordinary alarm) and red (strong alarm) in order to prevent fish from escaping. This project will provide technical support for the more scientific and safe development of cage culture of large yellow croaker by studying the acoustic recognition of its biomass and behavioral characteristics.

There are mainly the following methods for acoustic monitoring of foreign cages: First, the transducer is placed on the rotating mechanical device in the water below the cage to monitor the escape of fish or the loss of multi-cast feed when the net breaks [16-17]; The second is to place the transmitting transducer on the bottom of the network and the receiving transducer on the water surface for monitoring [18]. There are also methods of horizontal detection by placing the detecting transducer in the middle of the cage [19], the first two of which have been patented in the United States.

At present, the acoustic monitoring of domestic cages is in the research stage and there are no products coming out. The research plan of the School of Oceanography of Xiamen University is to place the detecting transducer underwater in the center of the cage to conduct a 360° horizontal mechanical scanning to monitor fish swimming around the edge of the cylindrical net [20]. The East China Sea Research Station of the Institute of Acoustics, Chinese Academy of Sciences, equipped with sonar sensor, sets a warning belt as the walking route of the robot to monitor fish escaping from the cage [21].

Some of the above schemes have high costs, some have great shortcomings in the stability of operation, and there is a certain difficulty in the application of deep-sea cages. By installing a horizontal mobile fish detector in the cage, the camera in this study is simple to install, reliable to operate, and scientific and effective to monitor the data, which can play a scientific and technological supporting role in the biomass identification of large yellow croaker groups in the cage and the prevention of fish escape caused by the damage of net clothing, as follows:

(1) With the objective of acoustic identification of the biomass of rhubarb shoals in cages, the number and density of rhubarb shoals in cages were adjusted, and mobile fish detector was used to detect Rhubarb shoals with different number and density, so as to master the change rule of acoustic data.

(2) Taking the acoustic identification of the growth of rhubarb fish schools in cages as the goal, the changes of acoustic data were studied by placing Rhubarb fish schools of different body lengths in cages.

Taking the damage of the net coat of the cage and the escape behavior characteristics of the rhubarb fish as the research object, the changes of the behavior characteristics of the fish after the damage of the net coat were observed. On the one hand, the biomass of large yellow croaker population in the cage was identified by indicators such as target intensity and broadband acoustic characteristics; on the other hand, group behavior characteristics such as individual identification of large yellow croaker population, swimming speed, size and direction were used to set up three state displays of green (normal), yellow (ordinary alarm) and red (strong alarm) in order to prevent fish from escaping.

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