A hope for early application of AI stereo cameras for bluefin tuna farming

Introduction

Technological innovation using AI (artificial intelligence) is progressing rapidly, and it has become possible to do amazing things. In the Atlantic bluefin tuna farming, attempts are being made to introduce new stereo cameras (SC: it can determine the size of an object by recording images with two cameras) with AI to measure the length of fish. What is the background behind this? As the production amount of farmed Atlantic bluefin tuna exceeds the amount of bluefin tuna caught and landed, I feel that it is becoming even more important to accurately measure the body length composition of fish caught and caged live for farming.

This article briefly outlines how body length measurement of farmed fish, which is one of the essential information for research on the stock and management of Atlantic bluefin tuna, has evolved to the present day, and also touches on remaining problems and future prospects. The table below shows the current status of SC usage for bluefin tuna farming.

Use of SC in bluefin tuna farming

	Is SC used?	Is the use of SC mandatory?	Are there any rules for the use of SC?
Atlantic bluefin	Yes	Yes	Yes
Pacific bluefin	Yes	No	No
Southern bluefin	No	No	No Only Australia conducts farming. Australia is developing a new SC

Changes in body length measurement methods for farmed fish

Let's take a look at the changes in the data collection method for length of farmed Atlantic bluefin tuna (length is converted to body weight from the length-weight relationship formula) in four stages. In the first stage, when the majority of Atlantic bluefin tuna were sent to farming, it became impossible to implement a traditional way of measurement, i.e., to measure body length and weight at the time of landing, and as a result, it became impossible to accurately determine the amount of fish caught. Initially,

underwater cameras were used to estimate the amount of fish caught without touching the fish, and the images were used to count the number of fish. However, a monocular camera was not able to measure body length without knowing the distance to the target, so at the time fish were picked up in part and measured for their average weight, or the average weight was estimated visually.

As picking up a fish out of water often caused the death of the fish, however, with the development of SC that can measure body length without touching the fish, opportunities for its use increased, and its use became mandatory (the second stage). In addition, ICCAT (International Commission for the Conservation of Atlantic Tunas), which manages the Atlantic bluefin tuna fisheries, produced a table which shows the expected growth of a certain size of fish after a certain period of farming, i.e., how much weight gain is likely to occur by the size of bluefin tuna caged and the duration of farming (If the weight increase exceeds this, there is a possibility that the caged weight was under-reported.). ICCAT also had introduced a catch certification system for Atlantic bluefin tuna, which records on the catch certificate the data related to the catch, caging, harvest from cages, and export/import/re-export.

However, a problem arose in the second stage. There were delays in customs clearance due to suspicions that the weight gain between caging and harvest of farmed Atlantic bluefin tuna imported by Japan was too large compared to the table. In response, ICCAT instructed the Scientific Committee (SCRS) to improve the table by adding the large amount of length measurement data recorded by SC and accumulated in the second stage, and a new table was created and started to be used from 2022. This is the third stage.

Although there are no longer any suspicious cases about the weight gain rate, there are still several problems. The body length measurements of fish recorded by SC are carried out manually by humans while looking at the recorded images on the screen: each fish is measured by clicking two points (the tip of the head and the center of the caudal fin) on the screen. This is quite cumbersome and time-consuming, and the possibility of arbitrary measurements (clicking to shorten the body length on purpose) cannot be ruled out. As a result, attempts have been made to develop and put into practical use automatic measuring devices using AI. This is the fourth stage.

<u>How many farmed fish should be measured for their body length?</u>

In addition to the issues mentioned above, there are still several issues with measuring body length from SC records. Accurate estimation of body length composition

at the time of caging is one of the important ones. According to ICCAT's regulations for measuring body length when caging fish, 20% of the number of fish caged must be measured, and if possible, one out of every five fish (equivalent to 20%) should be measured at random.

However, no scientific basis for this 20% has been shown. How many fish should be measured to accurately estimate the body length composition of the entire catch is a rather complex and difficult issue, and according to experts, there seems to be no established general method. I can imagine that in the case of a catch consisting only of small fish and in the case of a catch with a wide range of composition from small to large fish, the number of individuals to be sampled should be larger in the latter case than in the former case. When it comes to the specific number of fish that should be measured, there are many different size compositions, and it is not easy to find an answer that satisfies all of them. There would be no problem if all measurements could be performed, but in reality, it is difficult. Therefore, random measurements are often performed, but it is also difficult to objectively determine how randomly the measurements should be performed. I guess that when measuring length of Atlantic bluefin tuna by SC, scientists intuitively decided that the rate should be at 20% across the board.

Aiming for counting all caged fish using SC with AI

Attempts to improve SC using AI have recently begun as a way to solve the problems of body length measurement using SC described above. Researchers and several Japanese companies are participating in this attempt, and if it is successful, it will be possible to automatically measure the body length of all individuals, instead of measuring part of individuals manually. I hope that the major remaining issues will be resolved accordingly. Furthermore, if a large number of complete measurements can be easily obtained, new methods may be developed using that data to determine the appropriate number of samples. I hope that Japan, the largest importer of farmed bluefin tuna, will demonstrate more leadership than ever to keep the momentum for the development.