Estimation of the PBF length-composition for the Japanese purse seine with new data collected at young PBF farming operation using stereoscopic camera

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Introduction

Japanese small pelagic fish purse seine (JSPF-PS) fishery which operated in the East China Sea has been catching age 0-1 PBF since early 1990's. This was one of the biggest fleets during 1990's to 2000's until the catch quota was firstly introduced for this fleet in 2011 as an unilateral measure of Japan. That quota gradually got stricter year after year in accordance with the amendments in the conservation and management measure of WCPFC for PBF. Current quota allocated to this fleet has decreased to about 10% of its peak in 1995 of 13 thousand tons. Given the major transformation of the management measure for the PBF fisheries, this fleet changed their operational strategy from a fishery suppling sashimi to the market into a fishery for farming. This type of fishery has gradually increased since 2012, and it occupied about 50% of total catch of this fleet in recent years.

JSPF-PS fleet is one of the Ministry licensed fisheries of Japan. They have an obligation to submit a log-book and the accumulation of catch amount is also monitored by the TAC system of Japan. In both of the log-book and TAC report, the number of fish caught as well as the average weight of PBF for each farming operation are recorded, and the catch in weight in each farming operation is calculated by multiplying the number of fish with average weight. The number of fish caught in each operation was counted by the both of fisherman and farmer and it was secured by the certification of transaction between those two parties. The average weight of individual PBF was measured using a stereoscopic camera during farming operations since 2017. Thus, we currently have available information of catch in number of fish and relevant size measurements.

In the stock assessment of PBF, JSPF-PS is assigned as "Fleet 2". For this fleet, catch in weight, which included both unloaded operation and farming operation, and length composition data, which were collected by the port sampling (Oshima et al., 2012), were used in the assessment to depict the removal process of this fleet. Even though the catch in weight by the farming fishery was calculated from the number of fish caught and average weight of them, the current assessment is re-estimating the number of fish caught from the input data (catch in weight and size comp) with certain process error. To have a simpler and more accurate observation model for the Japanese purse seine farming operation, it would be better to use the catch in number information directly with the length composition data measured by the stereoscopic camera.

In this document, we firstly present some results of the accuracy tests of the length measurement system using stereoscopic camera during farming operation to validate the reliability of the length measurement data. We also present how to raise the measurement data by the total catch in number of fish caught to estimate the size composition data

Validation of the length measurements by Stereoscopic camera

For the validation of the length measurement system using a stereoscopic camera, we

conducted a test by measuring a pre-measured bar as well as a dead fish for several different distances between the camera system and measuring objects. Results showed a high precision of the length measurement within 5 m of the distance between the camera system and the measuring objects (Figure 1). The range of the measurement error was less than 5 % in most of the cases in which the distance between the camera system and objects was close (< 5 m).

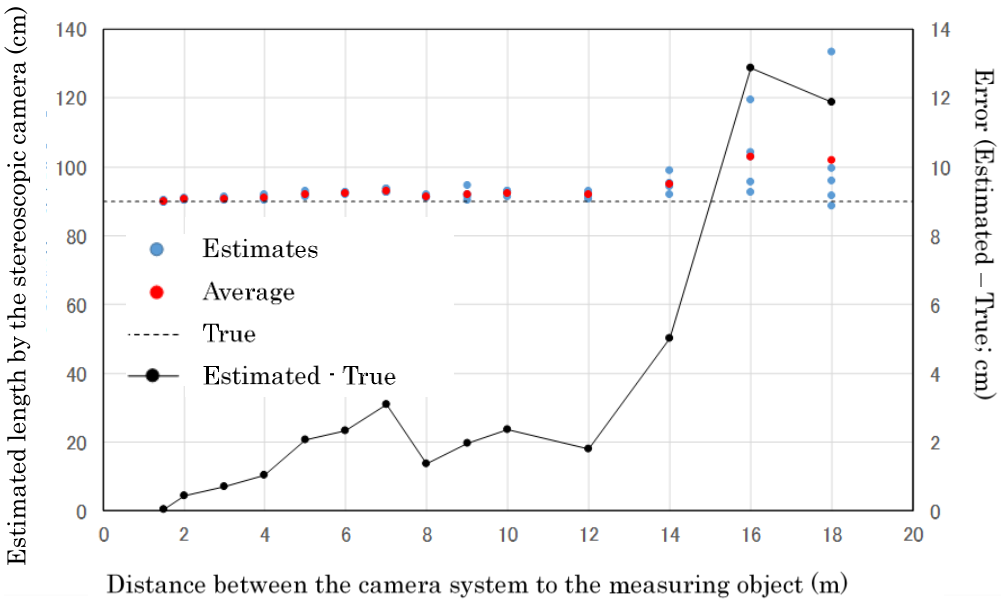

Figure 1 Validation of the length measurement by stereoscopic camera. Blue and red plots indicated each estimation (5 times for respective distances) and those average. The broken and solid lines indicated True length and length estimation error, respectively.

Accuracy testes of the stereoscopic camera measurements during farming operation

In general, PBF seedlings are transported from fishing ground to an aquaculture facility by the carrying ship or transportable cage. PBF seedlings were put into an interim cage of the aquaculture facility, and then, they were transferred to actual rearing cage. At the time of the transferring from the interim cage to rearing cage, the size of the seedling is measured using stereoscopic camera.

To validate the precision of the stereo-camera measurement during the transferring operation, we compared length of PBF measured both by the stereoscopic camera and the actual measurements. In a similar way with the usual transferring process, we measured about 100 PBF individuals, which were caught by a JSPF-PS fleet in the East China Sea, using the stereoscopic camera system (AM100, AQ1 systems). After this operation, all the transferred PBF were landed and measured physically.

The distances between the stereoscopic camera system and the target PBF were estimated and all of them were less than 2.0 m. The size distributions drown based on the stereo-camera measurement data were similar with that drown based on the actual measurement data (Figure 2). Although former's size distribution was shifted to the smaller side for a length bin (2 cm width), this difference was minimal and will have a limited effect to the stock assessment. The assessment model could be informed a right number of removed fish at right age from the stereo-camera measurement data in conjunction with the catch in number of fish data.

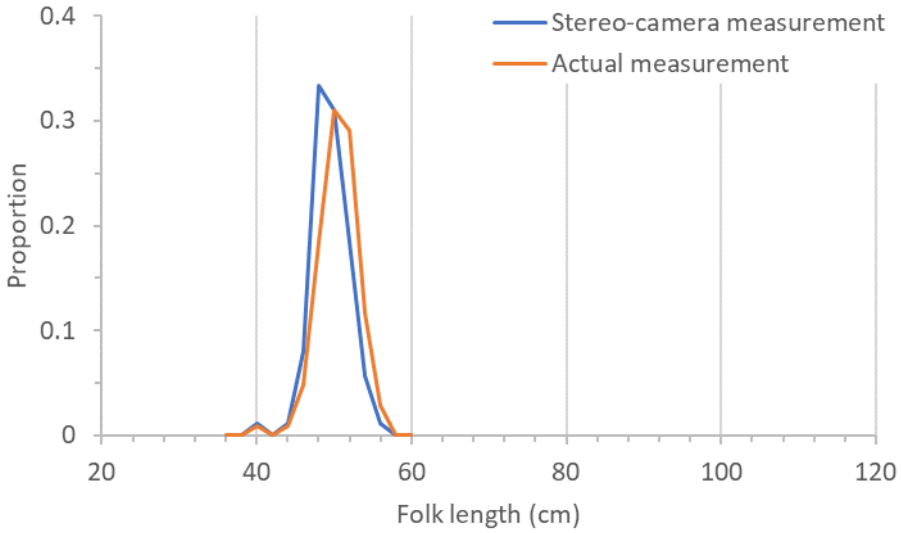

Figure 2 Estimated PBF length composition based on the stereoscopic camera data (blue) and actual measurement data (orange) for the length measurement validation test

Estimation of the length composition for the JSPF-PS farming operation

The probability that the fish at the length bin of *i* occurred in the quarterly catch at length distribution can be described as follows:

$$P_i = \sum_{k=1}^{K} r_k p_{ik}$$

where, r_k is catch in number in transferring operation (k) and p_{ik} is proportion at the length bin of i in the transferring operation (k). PBF catch in number for each transferring operation was obtained from the log-book or TAC report of Japan. The length measurement data were provided from the Japanese purse seine industry. Since there were limited observation that different age groups (age 0 or 1) occurred in the same farming operation of the JSPF-PS fleet, we raised a size measurement data by the catch in number of each farming operation.

In 2017, we obtained stereo-camera measurement data from 89 out of 91 farming

operations (98% of coverage in number of farming operation). In total, 9,247 fish were measured using stereoscopic camera, where the total number of PBF caught by the JSPF-PS farming operation was 218,681 fish (4.2% of coverage in number of fish). Average distance from the camera system to the measured fish in each transferring operation ranged from 1.6 to 4.4 m. The size composition of JSPF-PS farming operation in quarter 2 of 2017 was shown in Fig x and indicated a similarity with the size composition of JSPF-PS obtained from port sampling.

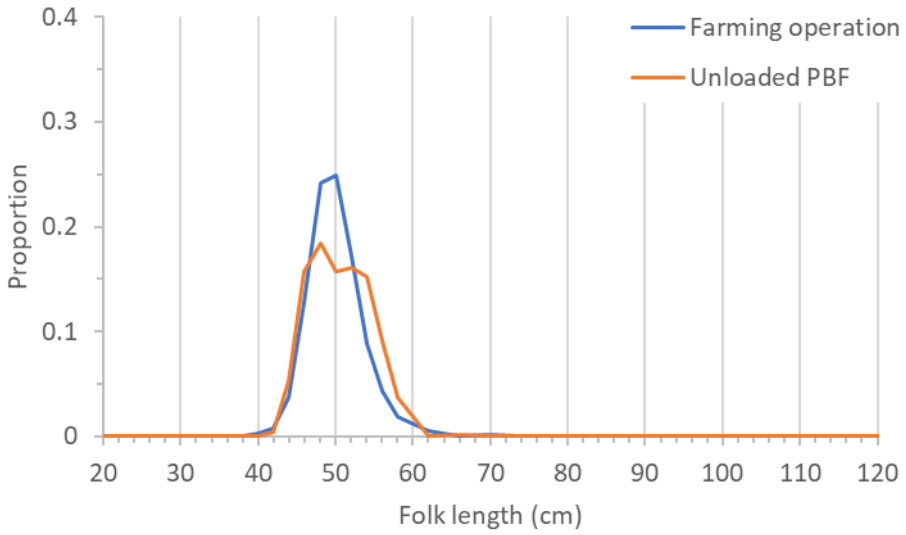

Figure 3 The size composition data for the Japanese small pelagic fish purse seine (orange) and that of the farming operation (Blue) in 2nd quarter (April to June) of 2017.

Conclusion

This document performed several validation tests of the length measurement using stereoscopic camera and the authors concluded that the length data for JSPF-PS farming operation were reasonably reliable. Size samples for this fishery were collected in a high coverage in terms of the farming operation and estimated size composition was consistent with the size composition of unloaded fish by JSPF-PS fleet.

Newly available size composition data for the farming operation was not the indicative of the change in the length selectivity for the Japanese PS fleet catching small PBF. Rather, this available new data could inform the assessment model more accurate number of removed fish at more accurate age. For this purpose, the authors recommend for the next bench-mark assessment to develop a new fleet for the JSPF-PS farming operation in the stock assessment model. So far, we did not observe major change in the selectivity for this fishery, thus a new fleet may be able to have a time invariant length/age selectivity to avoid the large increase in the number of parameters to be estimated for this purpose.

References cited

Oshima, K., Kai, M., Iwata, S. and Takeuchi, Y. 2012. Reconsideration of estimation of catch at size for young Pacific bluefin tuna caught by Japanese small pelagic fish purse seine fisheries. ISC/12/PBF-1/02.