North Pacific Fisheries Commission

NPFC-2023-SC08-WP11 (Rev. 1)

Comparison of Length-Weight Relationships and Catch Numbers by Size and Age between China and Japan for Japanese Sardine and Blue Mackerel

Shota Nishijima, Kazunari Higashiguchi, Sho Furuichi, Yasuhiro Kamimura, and Ryuji Yukami
Fisheries Resources Institute, Japan Fisheries Research and Education Agency

It was agreed that the domestic stock assessments in Japan will be observed by SC at its annual meeting. However, Japan currently had to roughly assume that the age composition of foreign catches was identical to a Japanese fishery, which could lead to increased uncertainty in the stock assessment results. China and Japan shared the baseline data of weight-length relationships and the number of fish caught by size from 2020 to 2022. Here, we report the results of comparing the weight-length relationships and catch numbers by size between China and Japan to accurately estimate the stock status and fishery impacts.

Japanese Sardine

Length-weight relationship

China and Japan have shared the information on the length-weight relationship (LWR) of Japanese sardine (JS) from 2020 to 2022 on the Collaboration Site. Japan only shared the parameters of LWR, while China kindly shared the individual data on fork length (FL) and body weight. Here, the LWRs of JS from the shared Chinese data and our Japanese data are shown and compared to understand the biology and stock assessment of JS.

Japan uses standard length (SL), but not FL, so we transformed SL to FL based on the equation: FL[cm] = 0.559 + 1.03×SL [cm] (Furuichi et al. 2021). Then, we estimated the parameters of LWR for per member per year data and also for aggregated data as well by regressing log(weight) by log(FL).

The LWRs in Chinese and Japanese fisheries were little different in 2020, while those in Chinese fisheries were certainly higher than those in Japanese fisheries in 2021 and 2022 (Fig. 1). This difference indicates that there are many fatter Chinese samples than Japanese samples at the 10 cm FL level. When Chinese and Japanese data were aggregated, the shape and parameters were generally closer to the Japanese results because the sample size was much larger in Japan (Table 1). We further examined the

LWRs per quarter and found that Chinese fisheries had much higher and steeper LWRs in the fourth quarter (October to December) than Japanese fisheries in 2021 and 2022 (Fig. 2), although such a clear difference was not found in 2020 and other quarters.

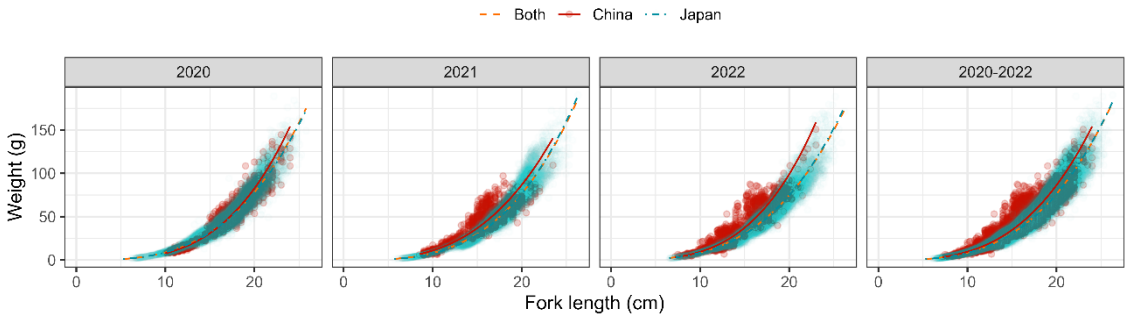

Figure 1: Relationships between fork length and weight in Chinese (red) and Japanese (green) fisheries in each year from 2020 to 2022 and in the aggregated data of these three years for JS. 'Both' (orange dashed lines) indicates the LWR when Chinese and Japanese samples are aggregated.

Table 1: Parameters of the relationship between fork length (cm) and weight (g) by Member from 2020 to 2022. The parameters are estimated by the least square method from the equation $W = aL^b$. 'Both' in the 'Member' column represents China + Japan and *N* represents sample size.

Year	Member	*a*	*b*	*N*
2020	Both	0.0061	3.16	15555
2020	China	0.0029	3.42	1511
2020	Japan	0.0066	3.13	14044
2021	Both	0.0048	3.23	15977
2021	China	0.0113	2.99	1218
2021	Japan	0.0037	3.32	14759
2022	Both	0.0067	3.11	19736
2022	China	0.0038	3.39	1509
2022	Japan	0.0054	3.18	18227
2020-2022	Both	0.0058	3.16	51268
2020-2022	China	0.0063	3.18	4238

2020-2022	Japan	0.0052	3.20	47030

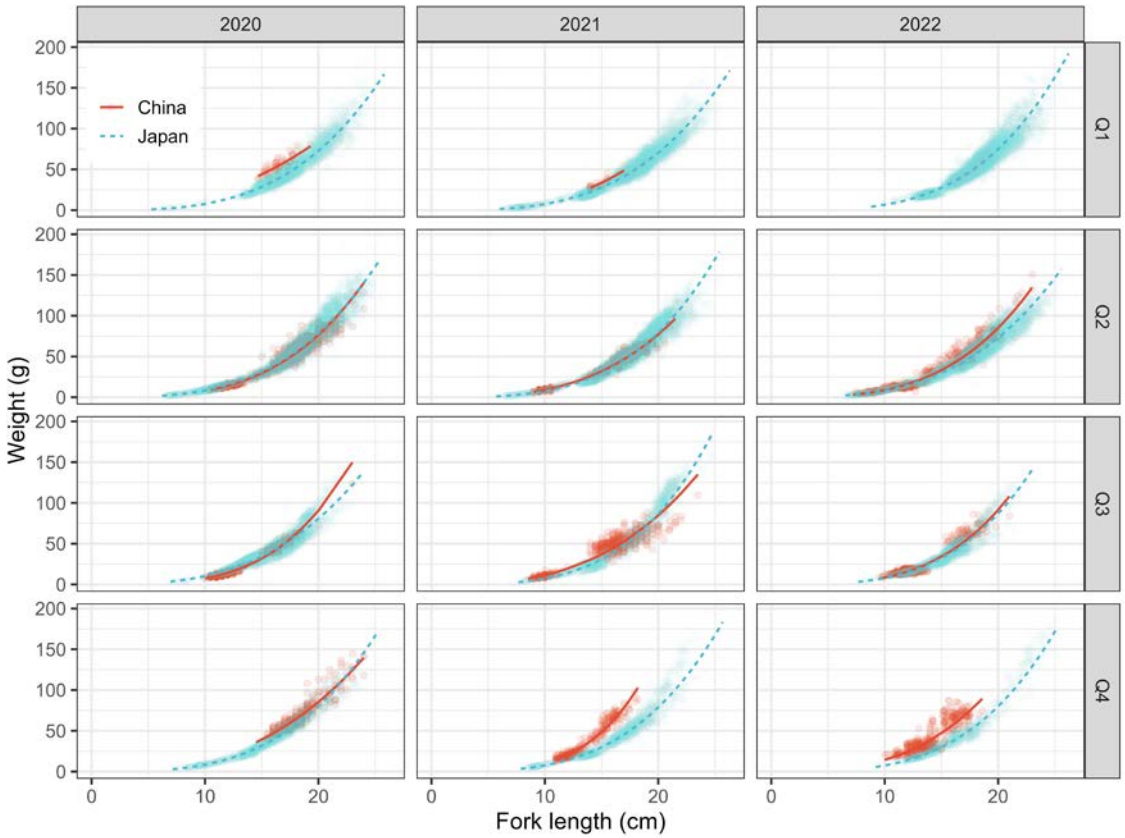

Figure 2: LWRs per quarter (row) per year (column) in Chinese (red) and Japanese (blue) fisheries for JS.

Number of fish caught by size and age

China and Japan have also shared length-frequency or catch-at-size data for JS on the Collaboration Site. China conducts the JS fishery in the NPFC Convention Area, while Japan conducts the JS fishery only within the Japanese EEZ. Fishing gear would also differ between China and Japan. Comparing the number of catches by size between China and Japan is important to understand the size-dependent distributions and fishing impacts on JS. We also performed age decomposition of the Chinese catch using the quarterly age-length key (ALK) used for north of Shizuoka Prefecture in Japan, so that the Chinese catch composition could be used for the age-structured model (virtual population analysis; VPA) in the Japanese stock assessment. Because the ALK in Japan uses standard length (SL), we transformed fork length (FL) to SL in the Chinese data following Furuichi

et al. 2021. As a result, a remarkable difference between Chinese and Japanese size composition was found (Fig. 3): the modes in the Chinese catch were fish with SL equal to or less than 10 cm, mostly estimated to be age 0, while the modes in the Japanese catch were fish with SL around 16-17 cm, mostly estimated to be age 2.

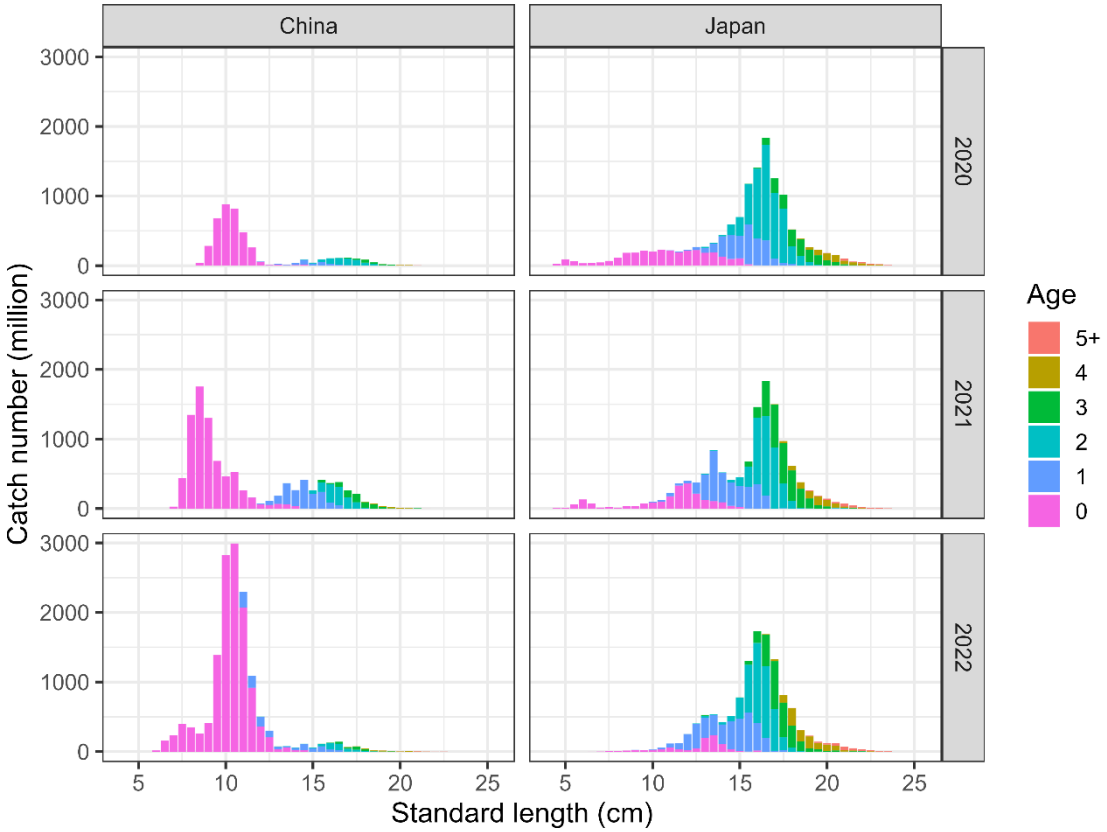

Figure 3: Frequency of catch numbers along standard length in Chinese (left) and Japanese (right) fisheries for JS Colors represent age classes from 0 to 5+ that were estimated from an ALK in Japan.

Blue Mackerel

Length-weight relationship

As with Japanese sardine, China and Japan have shared the information on the length-weight relationship (LWR) of blue mackerel (BM) from 2020 to 2022 on the Collaboration Site. Japan only shared the parameters of LWR, while China kindly shared the individual data of fork length (FL) and body weight. Here, the LWRs of BM from the shared Chinese data and our Japanese data are shown and compared to understand the

biology and stock assessment of BM. Japan uses FL for BM, unlike JS. We estimated the parameters of LWR for per member per year data and also for aggregated data as well by regressing log(weight) by log(FL).

In contrast to JS, the shapes of LWR were almost identical in all the years (2020-2022) for BM (Fig. 4). The estimated parameters of LWR were slightly different between China and Japan, probably because the sample size of China was small (Table 2). When Chinese and Japanese data were aggregated, the shape and parameters were generally closer to the Japanese results because the sample size was larger in Japan.

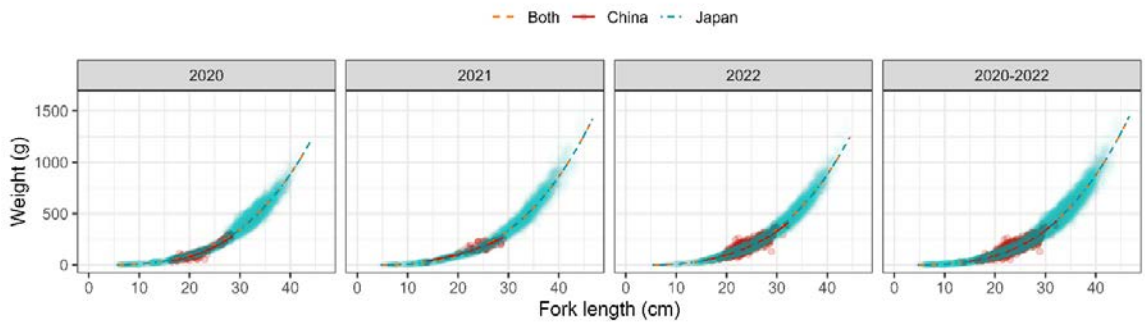

Figure 4: Relationships between fork length and weight from 2020 to 2022 for BM (see Fig. 1 for legend).

Table 2: Parameters of the relationship between fork length (cm) and weight (g) by Member from 2020 to 2022 for BM (see Table 1 for explanation).

Year	Member	*a*	*b*	*N*
2020	Both	0.0054	3.25	9818
2020	China	0.0024	3.49	218
2020	Japan	0.0056	3.25	9600
2021	Both	0.0053	3.25	7711
2021	China	0.0398	2.62	56
2021	Japan	0.0052	3.26	7655
2022	Both	0.0051	3.27	12405
2022	China	0.0117	3.01	632
2022	Japan	0.0051	3.27	11773
2020-2022	Both	0.0053	3.26	29934

2020-2022	China	0.0049	3.28	906
2020-2022	Japan	0.0053	3.26	29028

Number of fish caught by size and age

As with JS, China and Japan have shared length-frequency or catch-by-size data for BM on the Collaboration Site. We compared the number of catches by size between China and Japan to understand size-dependent distributions and fishing impacts on BM. We also performed age decomposition of the Chinese catch using the quarterly age-length key (ALK) used for the north of Shizuoka Prefecture in Japan, so that the Chinese catch composition could be used for the age-structured model (virtual population analysis; VPA) in the Japanese stock assessment. As a result, there was a clear difference between the Chinese and Japanese catch composition (Fig. 5): the frequency distributions in China were sharp and mainly composed of ages 0 and 1, while the frequency distributions in Japan were broader and evenly composed of different age classes.

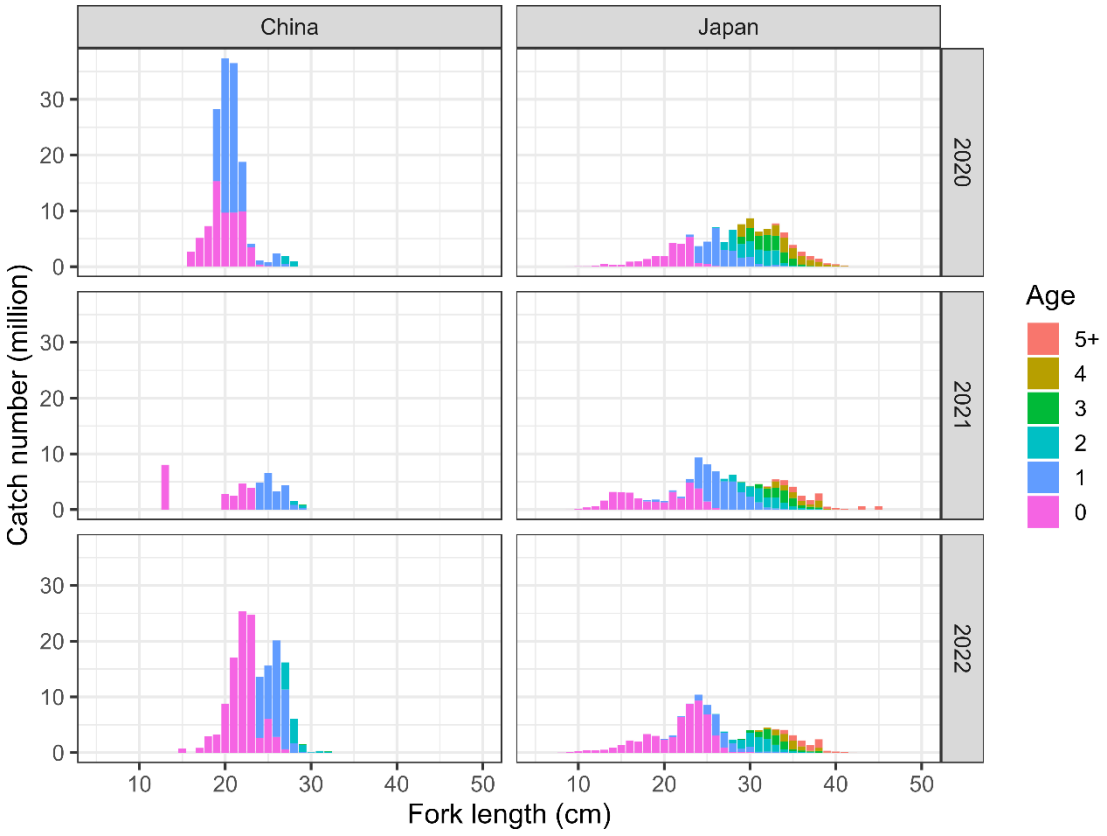

Figure 5: Frequency of catch numbers along standard length in Chinese (left) and Japanese (right) fisheries for BM. Colors represent age classes from 0 to 5+ that were

estimated from an ALK in Japan.

Conclusions

In this paper, we compared the LWR and catch numbers by size and age between China and Japan, and found that

- JS fish caught by the Chinese fishery may be fatter than those caught by the Japanese fishery in 2021 and 2022, while the degree of obesity for BM did not differ much between China and Japan, and
- Fish caught by the Chinese fishery were smaller and probably younger than those caught by the Japanese fishery for both JS and BM.

These differences may reflect size-dependent spatial distributions of JS and BM: large and old fish may be distributed mainly along the Pacific coast of Japan, while only small and young fish may be distributed as far as the NPFC Convention Area.

The current domestic stock assessment for the Pacific stocks of JS and BM in Japan assumed that the age composition of foreign catches was identical to that of the northern purse seine fishery in Japan (Furuichi et al. 2023; Yukami et al. 2023). However, according to the current results, this assumption would be invalid and risky because the Chinese JS and BM fisheries are composed of smaller and younger fish, and the Chinese catch weight and number of JS and BM have been increasing. It will be important to search for a cause of the difference between China and Japan and to continue the exchange of basic data for JS and BM. Continued sharing of data on length-weight relationships and size and age composition in Members' fisheries will be important for accurate estimates of stock abundance and fishery impacts through Japanese domestic stock assessment on those species.

References

Furuichi, S., Kamimura, Y., & Yukami, R. (2021) Length–length and length–weight relationships for four dominant small pelagic fishes in the Kuroshio–Oyashio current system. Thalassas: An International Journal of Marine Sciences, 37: 651-657.

Furuichi, S., Yukami. R., Kamimura, Y., Nishijima, S., Watanabe, R. (2023) Stock assessment and evaluation for Japanese Sardine Pacific stock (fiscal year 2022). In *Marine Fisheries Stock Assessment and Evaluation for Japanese Waters (fiscal year 2022/2023)*. Japan Fisheries Agency and Fisheries Research and Education

Agency of Japan. Tokyo, 58pp. (https://abchan.fra.go.jp/wpt/wp-content/uploads/2023/07/details_2022_01.pdf)

Yukami. R., Nishijima, S., Kamimura, Y., Furuichi, S., Watanabe, R. (2023) Stock assessment and evaluation for Blue Mackerel Pacific stock (fiscal year 2022). In *Marine Fisheries Stock Assessment and Evaluation for Japanese Waters (fiscal year 2022/2023)*. Japan Fisheries Agency and Fisheries Research and Education Agency of Japan. Tokyo, 79pp. (https://abchan.fra.go.jp/wpt/wp-content/uploads/2023/04/details_2022_05.pdf)