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Estimation of catch at size (CAS) for Japanese stick-held dip net fishery

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1. Introduction

Catch at size (CAS) data is necessary for developing age-/size- structured stock assessment model. We describe the information about the Japanese data used to estimate CAS and estimation procedure of CAS for Japanese stick-held dip net fishery for Pacific saury (PS) in this report.

2. Concepts to estimate CAS

It is well-known that the length frequency of PS changes spatio-temporally (Fukushima 1979). Thus, we aggregate the length frequencies and catch data for every 10-days period (hereafter, we simply call as "period") and each fishing area. Frequent body size measurements make it possible to cover the spatio-temporal changes of length frequency of PS as indicated in the following sections.

3. Data set

We used the following three kinds of data:

1) Interview data
2) Length frequency data
3) Landings for each period.

3-1. Interview data

The interview data are the same data set used for Japanese CPUE-standardization (detailed described in Sakai et al. 2017 and Suyama et al. 2018). The interview data were obtained from the chief radio operators or fishing masters of fishing vessels through interviews by fishing information takers deployed at the major landing ports such as Hanasaki, Kushiro, Ofunato, Kesennuma, Onagawa and Choshi (Fig. 1). Those ports accounted for over 80 % of Japanese landing (Suyama et al. 2018). The sum of catch in the interview data were equivalent to 32.3 % of the annual total catch in average (Suyama et al. 2018). Those data contained the information on date, position, fishing effort and catch on a fishing-day basis.

3-2. Length frequency data

The size measurements for the PS landing from a part of the interviewed fishing vessels were carried out by the fishing information takers. In the size measurement, individual knob length (distance from the tip of the lower jaw to the posterior end of the muscular knob on the caudal peduncle; Kimura 1956) and total weight of fish for measurement were recoded. The frequency of the size measurements varied seasonally depending on the change of landing amount (Fig. 2a); the frequency was high during the main fishing season (Sep-Nov), although it was low during the beginning and the end of the fishing season (Aug and Dec). The length frequency data were obtained extensively from the Japanese fishing ground in each period (Fig. 3). In general, the taker selected approximately 100 fish per vessel (Fig. 2b). The length-frequency data were made for each vessel. The vessel-specific catch by length were raised with a ratio of the total weight of fish for measurement against the landing in weight of the vessel.

3-3. Landing for each period

The port-specific landing in weight at each period was compiled by the fishing industry. Using this information, the landing in weight derived from the interview data was raised consistent with the total landings in Japan.

4. Procedure for estimation of CAS

4-1. Define the fishery areas

In most periods, sole area (no area definition) was defined. On the other hand, we defined multiple areas when Japanese fishing ground spread broadly and when following two conditions were met.

- ✓ Condition 1: Distance between the boundaries of two fishing grounds was larger than 30 nautical miles.
- ✓ Condition 2; Every fishing ground had its own length frequency data.

Then, we estimated the CAS data for each year (annual CAS data) in following procedure (schematically summarized in Fig. 4).

4-2. Estimation of areal length frequency for each period

The vessel-specific catch by length data with fishing information were used for estimating the area-specific catch by length for each period. The vessel-specific catch by length data were distributed into each fishing area according to the fishing information and then, were summed within each area. The area-specific catch by length was converted into that per one metric ton (areal length frequency) for further process.

4-3. Estimation of areal catch for each period

The catch of interview data was raised to total landing of the period, then the raised catches of interview data were classified into each fishery area according to the fishing information and summed up to develop the total areal catch for the period.

4-4. Estimation of the CAS of each fishery area for each period

Areal CAS for each period was derived by raising the areal length frequency estimated in 4-2 to areal total catch estimated in 4-3. We acquired CAS for each period by summing up areal CAS of the period. Annual CAS could be derived by summing up the CAS of all periods.

5. References

Fukushima S (1979) Synoptic analysis of migration and fishing conditions of saury in the northwest Pacific Ocean. Bull Tohoku Reg Fish Res Lab 41:1–70. (In Japanese with English abstract)

Kimura K (1956) The standard length of the Pacific saury, *Cololabis saira* (Brevoort). Bull. Tohoku Reg Fish Res Lab 7:1–11. (In Japanese with English abstract)

Sakai M, Naya M, Suyama S, Kidokoro H, Vijai D, Kitakado T (2017) Standardization of CPUE data of Pacific saury (*Cololabis saira*) caught by the Japanese stick-held dip net fishery during 1980 to 2015. NPFC-2017-TWG PSSA01-WP-01

Suyama S, Kidokoro H, Naya M, Hashimoto M, Vijai D (2018) Standardization of CPUE data of Pacific saury (*Cololabis saira*) caught by the Japanese stick-held dip net fishery during 1994 to 2017. NPFC-2018-SSC PS03-WP05

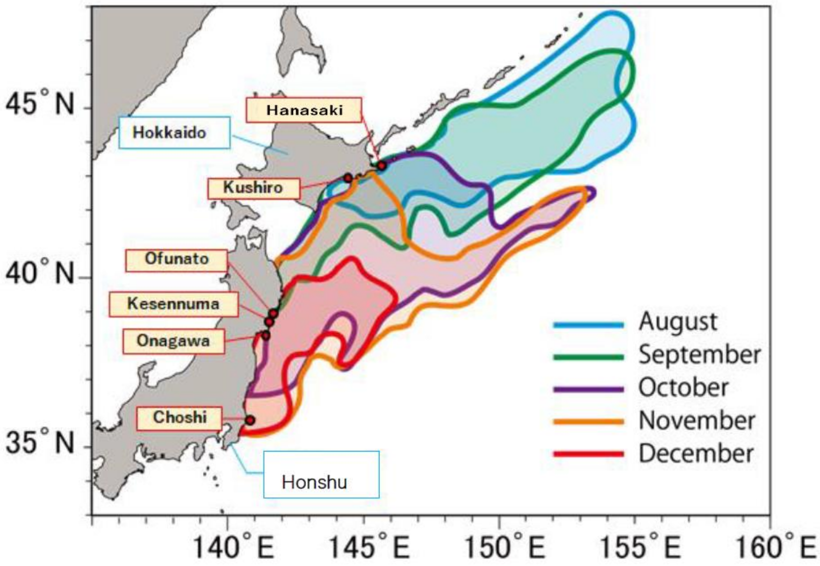

Figure 1. Main fishing ports and seasonal shift of fishing ground of Japanese stick-held dip net fishery for Pacific saury.

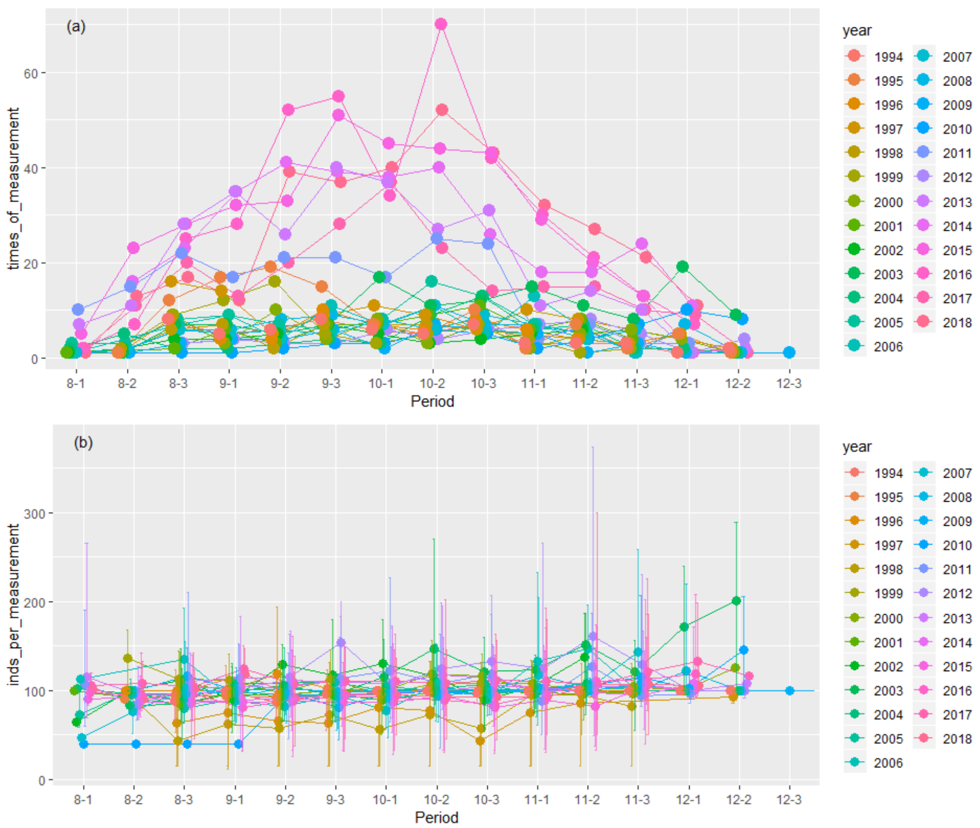

Figure 2. Size measurements for Japanese PS fishery. (a) Times of measurement for each period (10 days) and (b) Mean number of individuals per measurement for each period. Error bars show the maximum and minimum data.

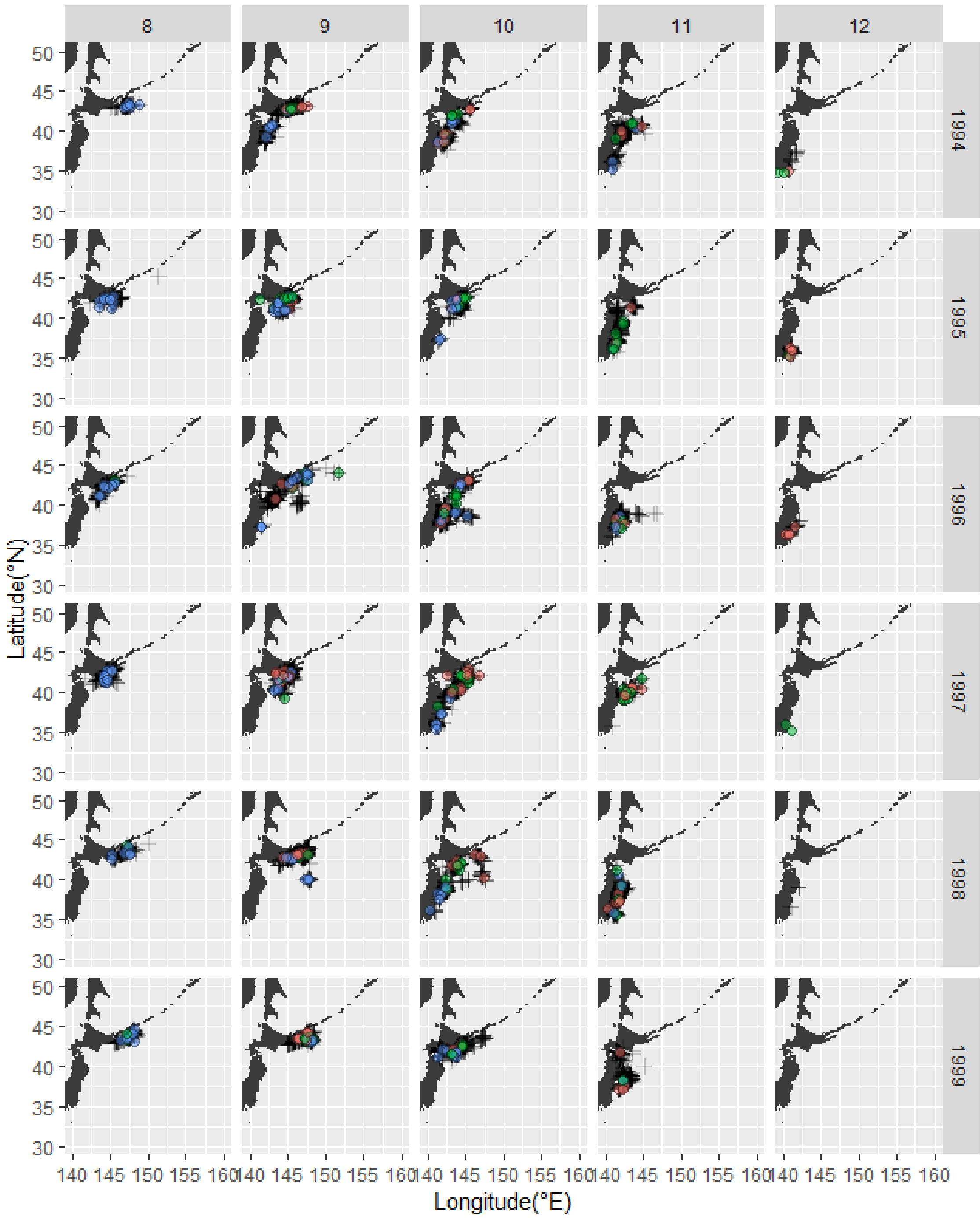

Figure 3a Spatial-temporal distribution of size measurement data in 1994-1999. Red, green and blue plots show the first, second and third period of the month. Black crosses show the positions of all interview data.

Figure 3b Spatial-temporal distribution of size measurement data in 2000-2005. Red, green and blue plots show the first, second and third period of the month. Black crosses show the positions of all interview data.

Figure 3c Spatial-temporal distribution of size measurement data in 2006-2011. Red, green and blue plots show the first, second and third period of the month. Black crosses show the positions of all interview data.

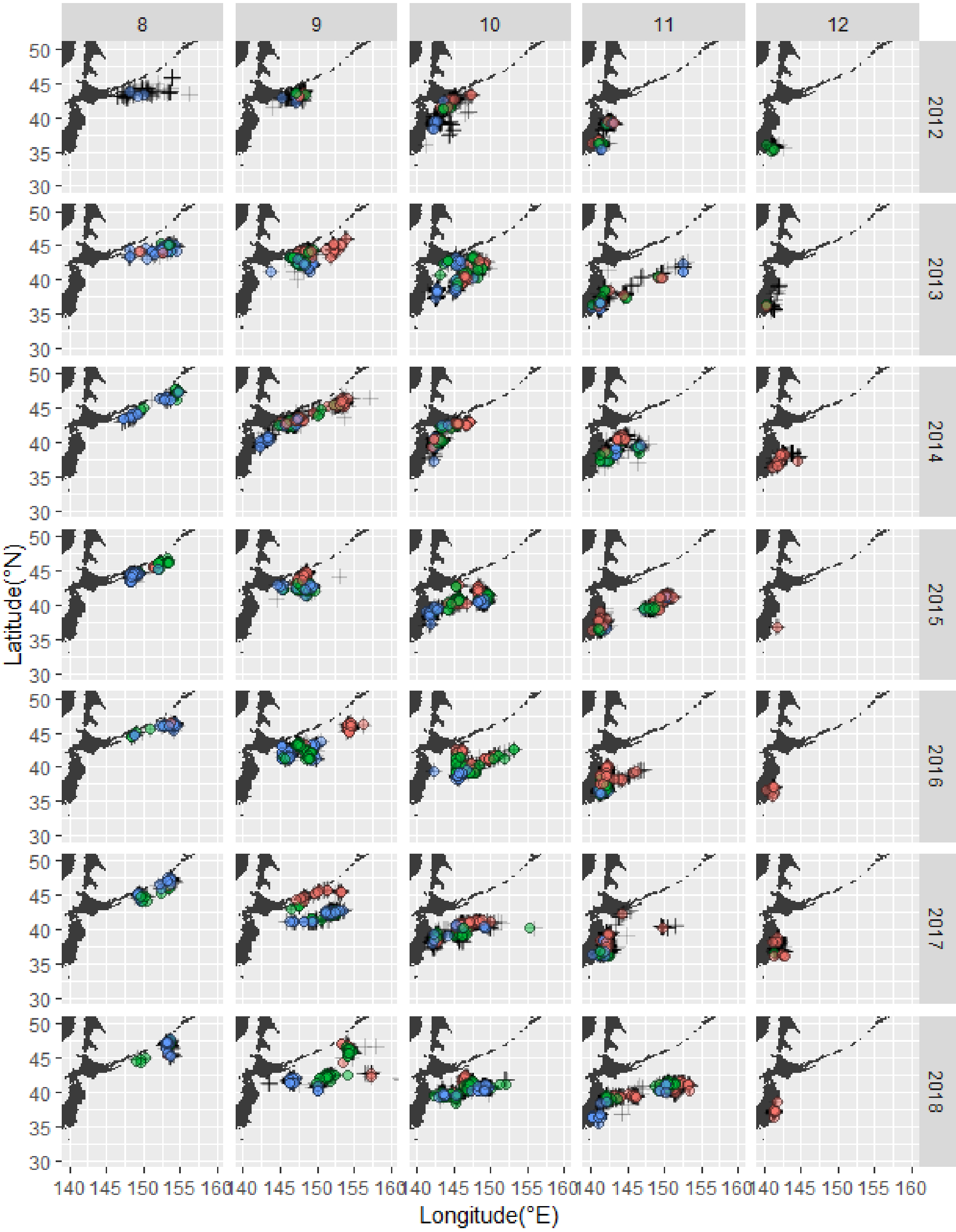

Figure 3d Spatial-temporal distribution of size measurement data in 2012-2018. Red, green and blue plots show the first, second and third period of the month. Black crosses show the positions of all interview data.

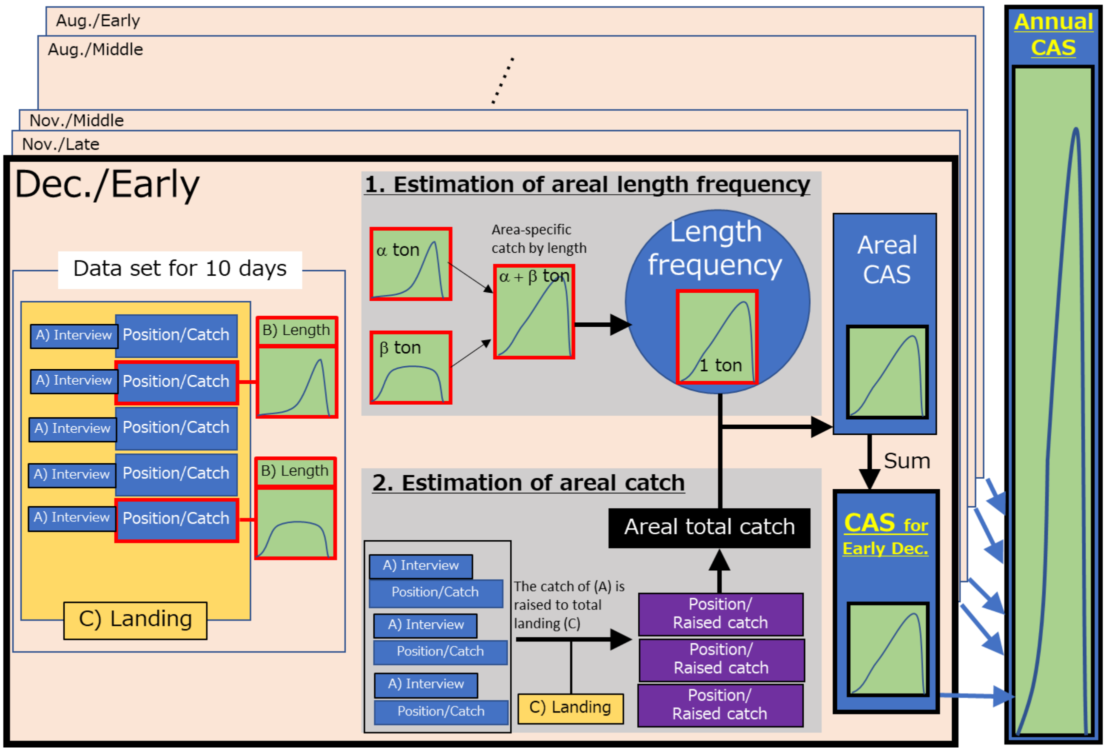

Fig. 4 Flow chart for estimation of Japanese CAS.