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Agenda Item 6.3
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6.3 Domestic Stock Assessment of Blue Mackerel in Japan in 2022 FY (July-June)

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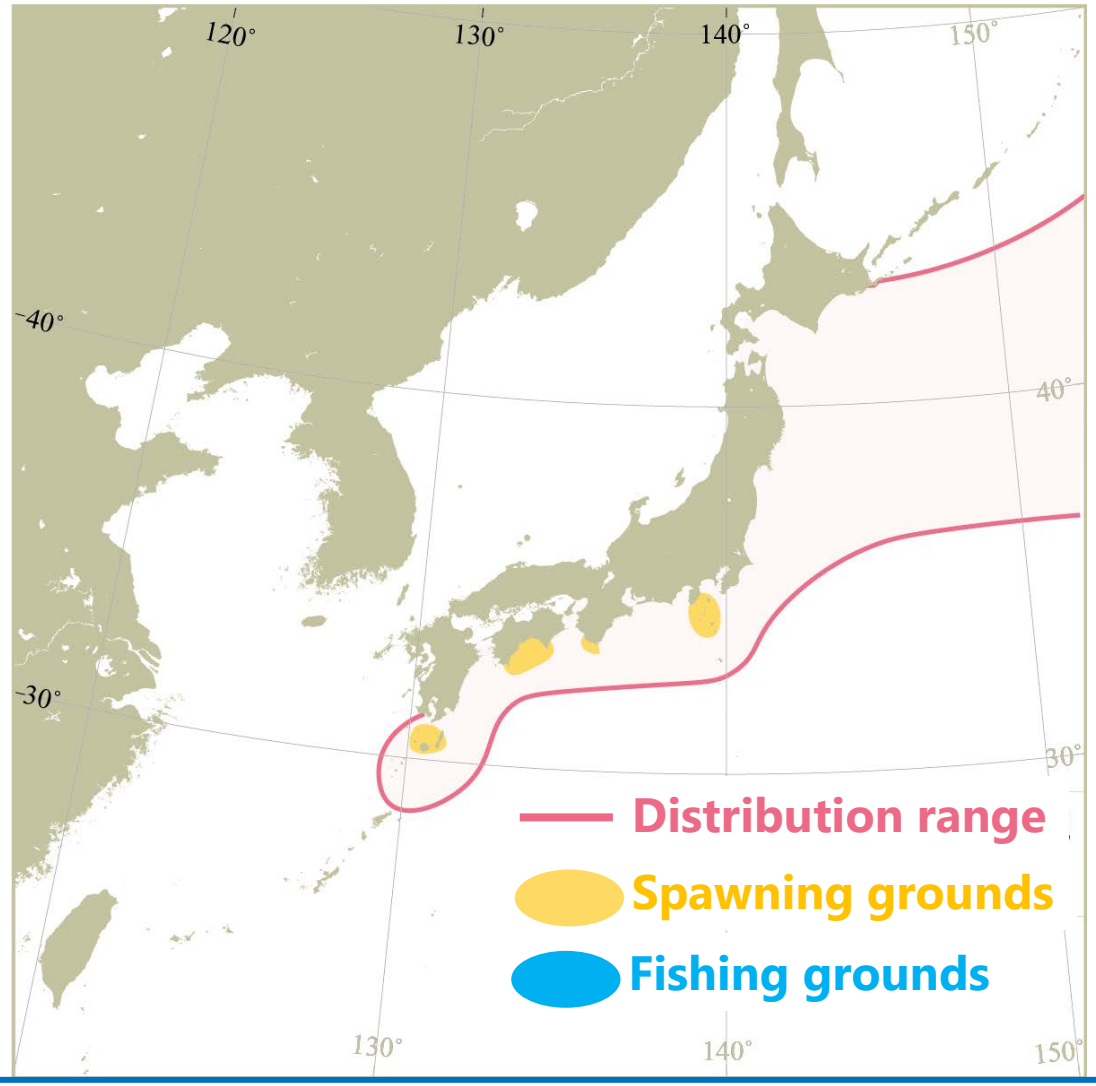
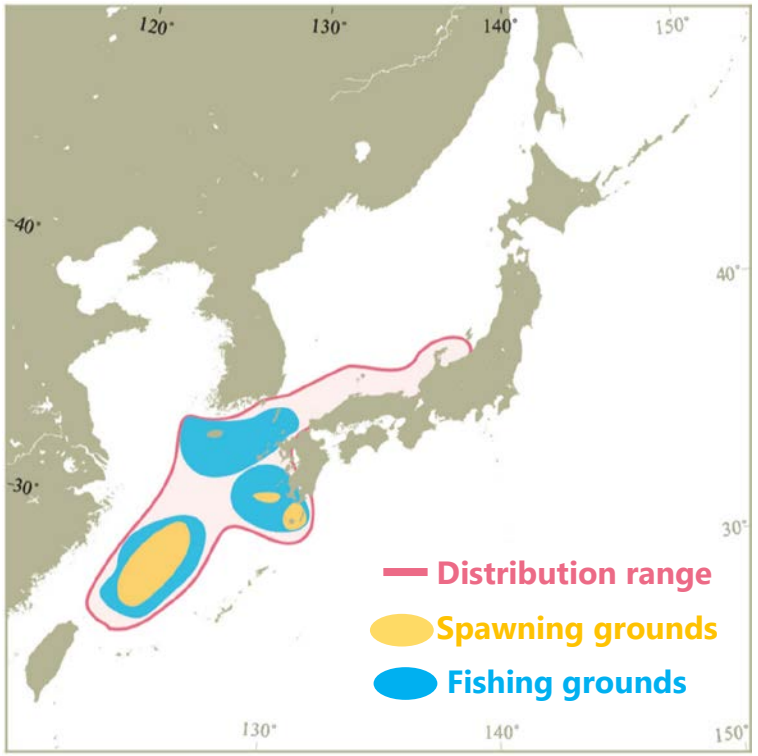
Spatial Structure of BM Stocks

Pacific stock



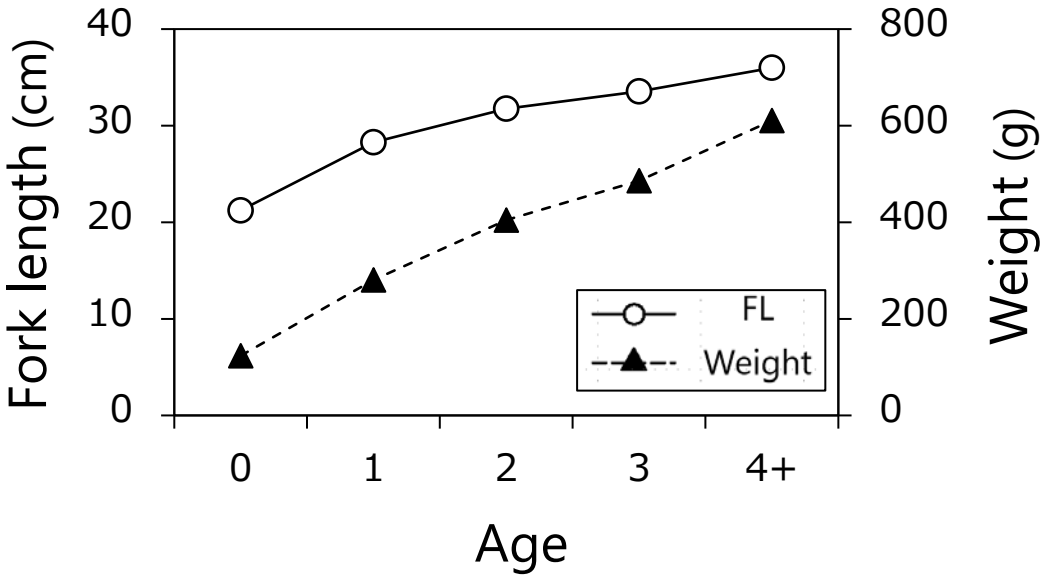
East China Sea stock

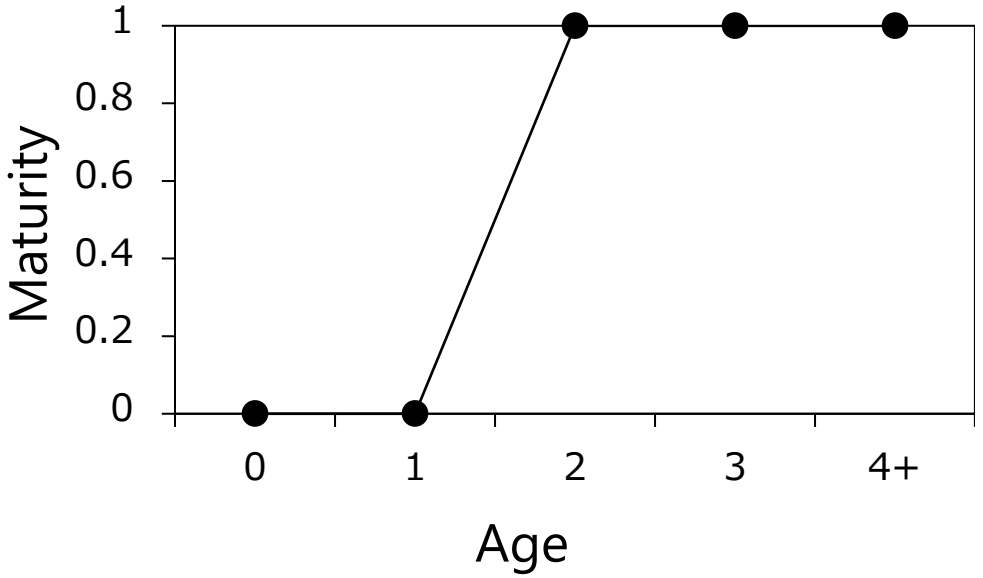


- There are two stocks depending on distributions and biology
- Only the Pacific stock is distributed in the NPFC Convention Area

Biological characteristics

Average of fished individuals during the most recent 5 years （2018-2022）





Longevity: about 6 YO

Maximum fork length (FL)： about 45 cm

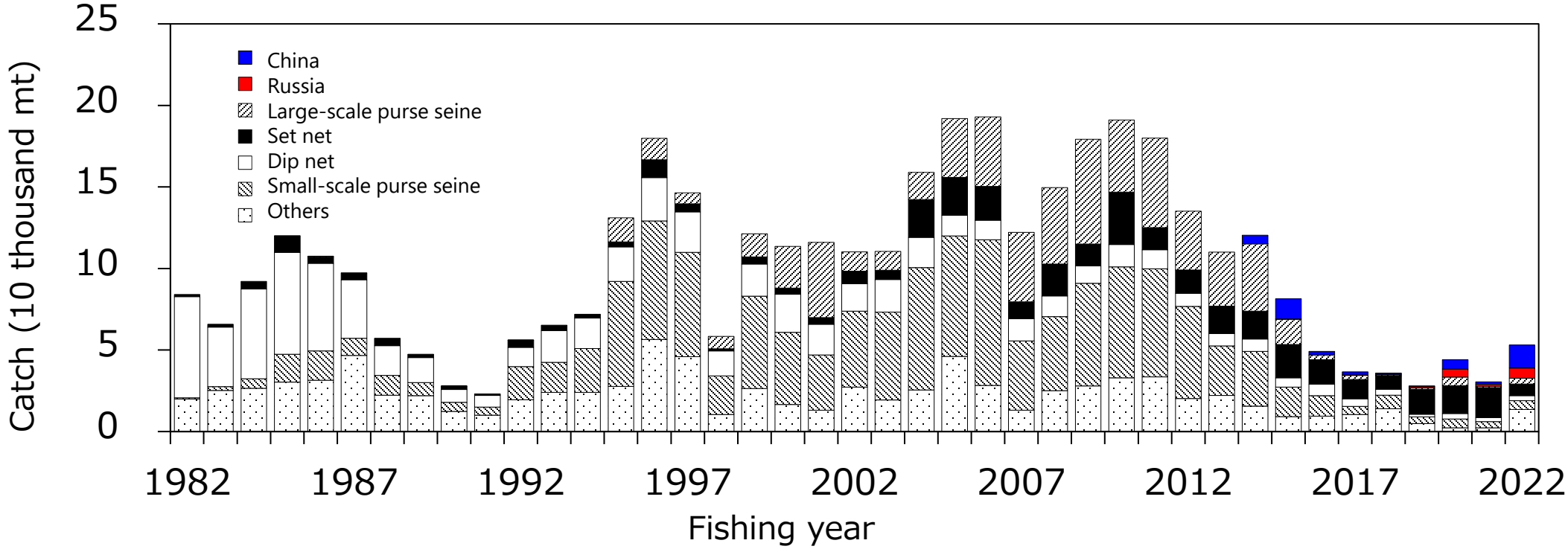
Maturity: Longer than 30 cm of FL（age 2+）

Spawning: From December to June in Kuroshio Current area west of the Izu Islands

Feeding: Planktonic crustaceans, whitebait, etc. in the juvenile stage. Squids and small fishes after immature stage.

Predator: Large fish such as skipjack and sometimes baleen whales

Catch statistics



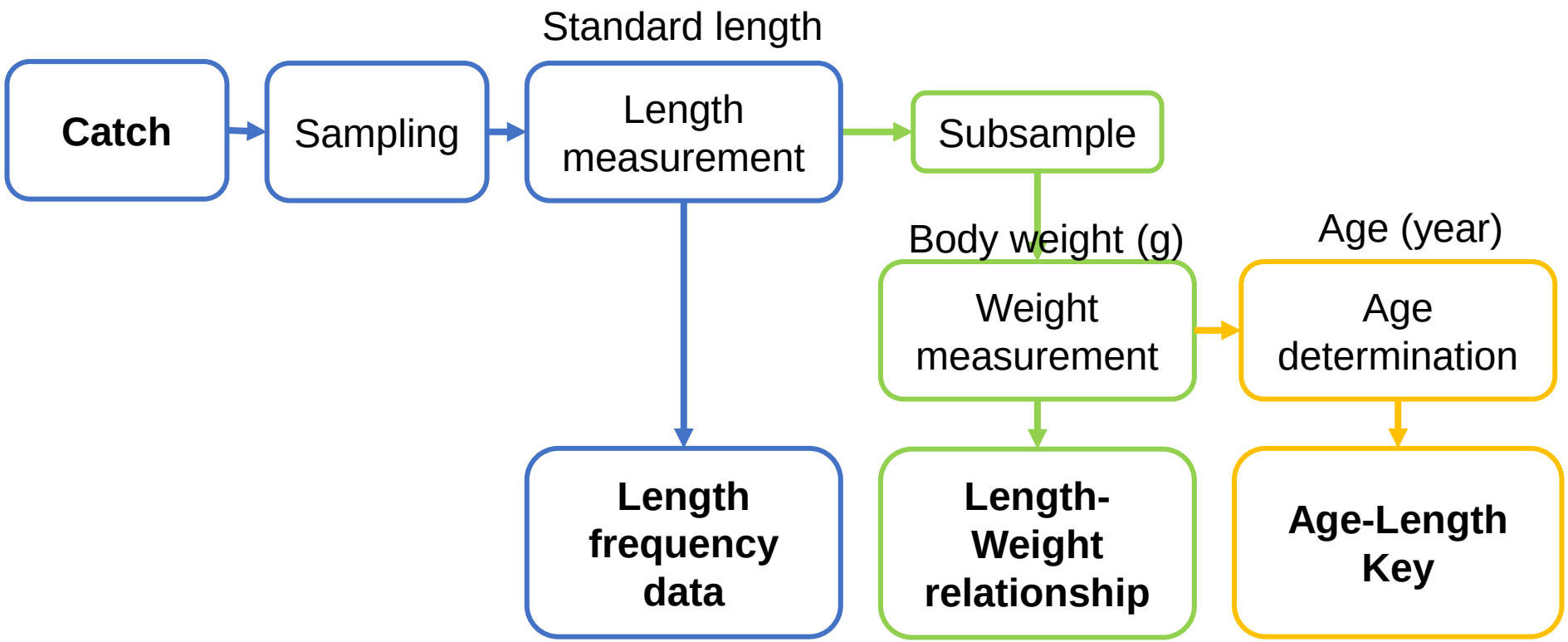
- Fishing year is from July to June in the next year
- The NPFC official statistics report the aggregate of chub mackerel and BM catch as ‘mackerel’ catch

  The proportions of BM and CM were assumed to those of northern large-scale purse seine fishery from July to December
- FY2021: 31,000 ton, FY2022: 53,000 ton (Russia: 6,300 ton, China: 14,000 ton)

  The catch data for China and Russia is based on assumptions.

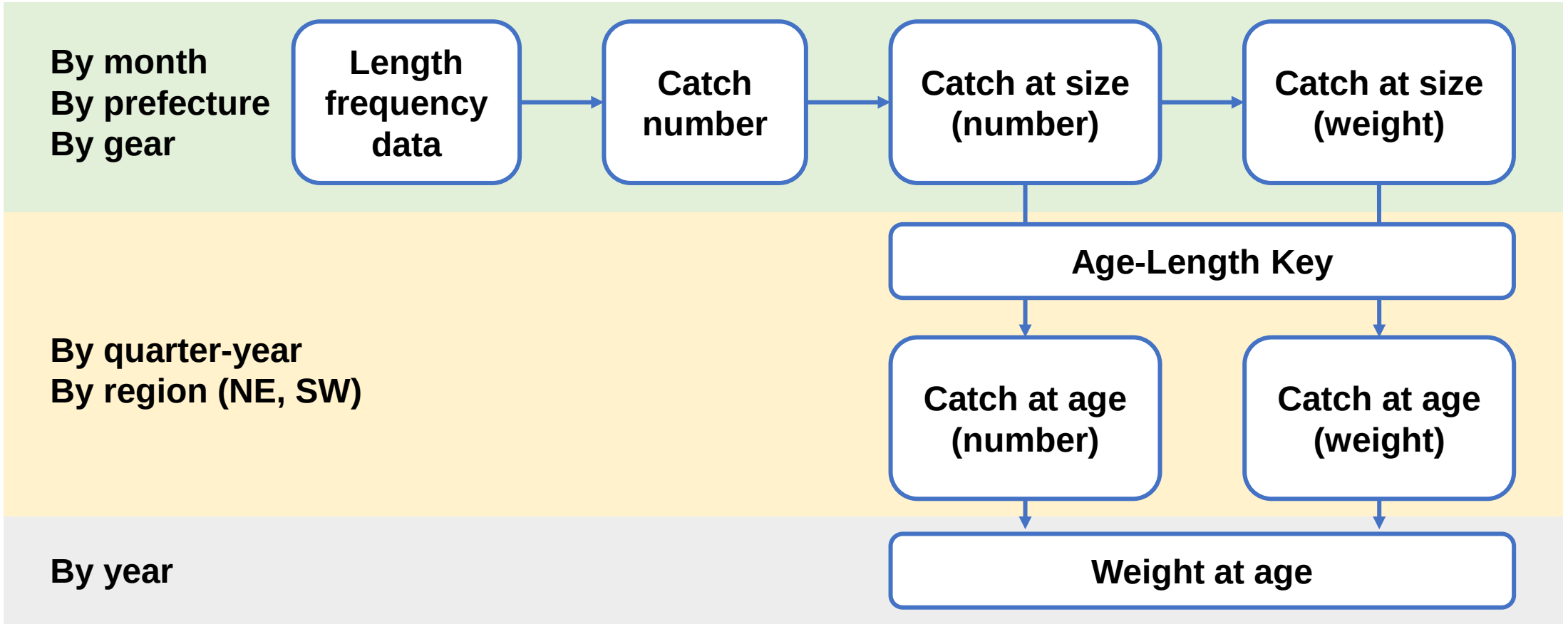
Length, Weight and Age Data

- Measurement data are collected from all 18 prefectures
- Data are treated by month and by fishing category (e.g, gear, area)
- Age is estimated by scale reading



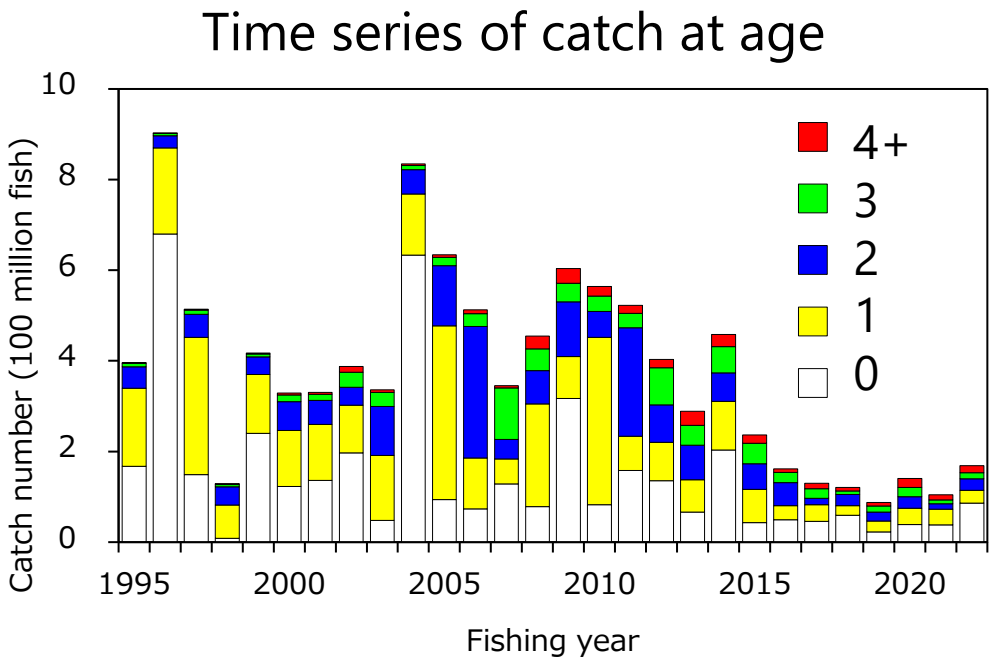
Catch at Age and Weight at Age in Japan

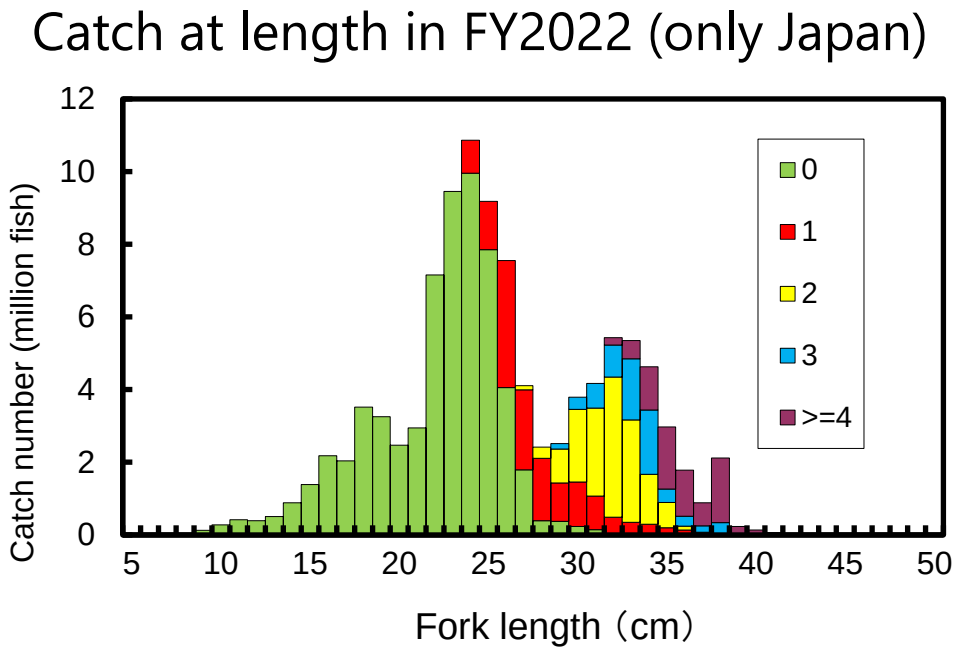
- Catch at size is derived from length frequency and L-W relationship
- ALK is applied to derive catch at age
- Weight at age is estimated from catch at age (weight)/catch at age (num)



Age composition for China and Russia
Assumed to be identical to that of the purse seine fishery in north of Chiba pref. from Jul. to Dec.

Catch number by age and length





The almost same method as JS was used for the estimation of catch at age for BM (see also a working paper for TWG CMSA: NPFC-2020-TWG CMSA03-WP02)

The age compositions in foreign catches were assumed to those of northern large-scale purse seine fishery from July to December

A wide range of age classes has recently been caught

Overview of stock assessment

Tuned VPA (Virtual Population Analysis)

Tuned VPA (1st step)

1995–2022 fishing year

Assumptions

- Age classes: 0 to 4+
- Time span: 1995–2022 fishing year
- Assume $F_{3,y} = F_{4+,y}$
- Use the Pope's approximation

Estimate the selectivity at age in the terminal year

Constrain: terminal F at age is identical to the average of F from 2018 to 2022

Overview of stock assessment

Tuned VPA (Virtual Population Analysis)

Tuned VPA (2nd step)

Assuming that the selectivity at age is
the same as the values estimated in the 1st step

+

Estimate stock abundance using the following tuning indices

- Stick-held dip net: age 0 (recruitment) fish
- Egg abundance: spawning stock biomass

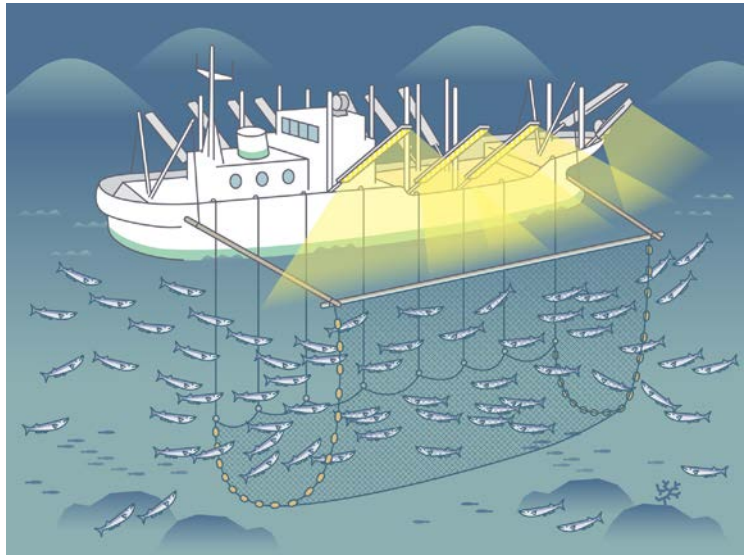
Other assumptions

- Natural mortality: M = 0.4 (from Tanaka's equation)
- All individuals over 2 years old are assumed to be mature

Abundance indices for BM stock assessment

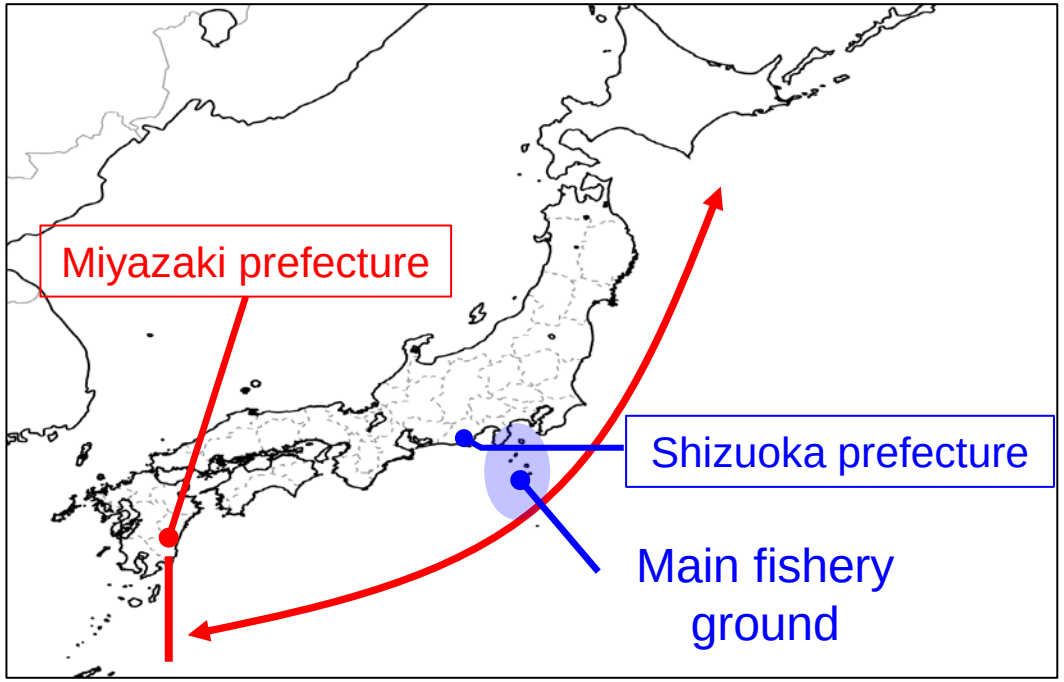
The following abundance indices are used for BM stock assessment;

- **Stick-held dip net (Shizuoka pref.)**: age 0 (recruitment) fish
  →Fishery-dependent
- **Egg abundance (East of Miyazaki pref.)**: spawning stock biomass
  →Fishery-independent



stick-held dip net

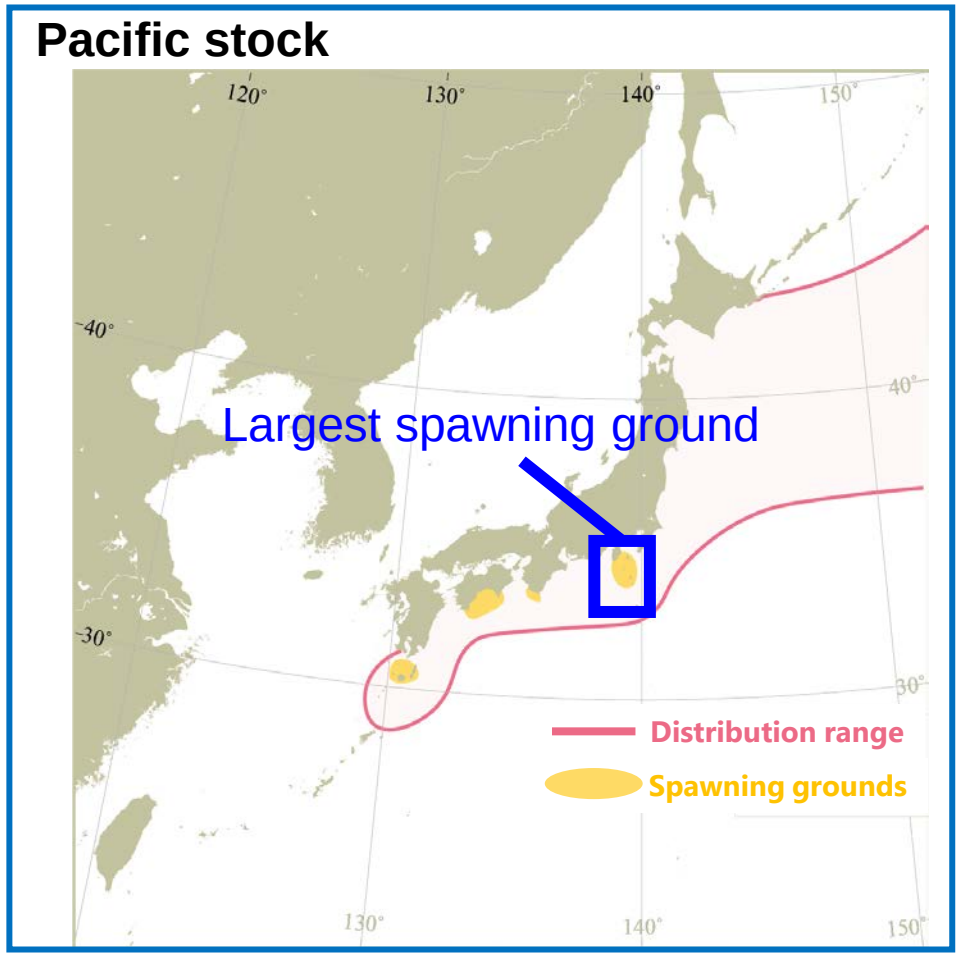
https://www.maff.go.jp/j/tokei/census/img/sanma2.jpg



https://www.freemap.jp/itemFreeDlPage.php?b=japan&s=japan1

Stick-held dip net (Shizuoka pref.)

Based on the catch statistics of Shizuoka prefecture, nominal CPUE was used as the abundance index of age 0 fish



Sampling method

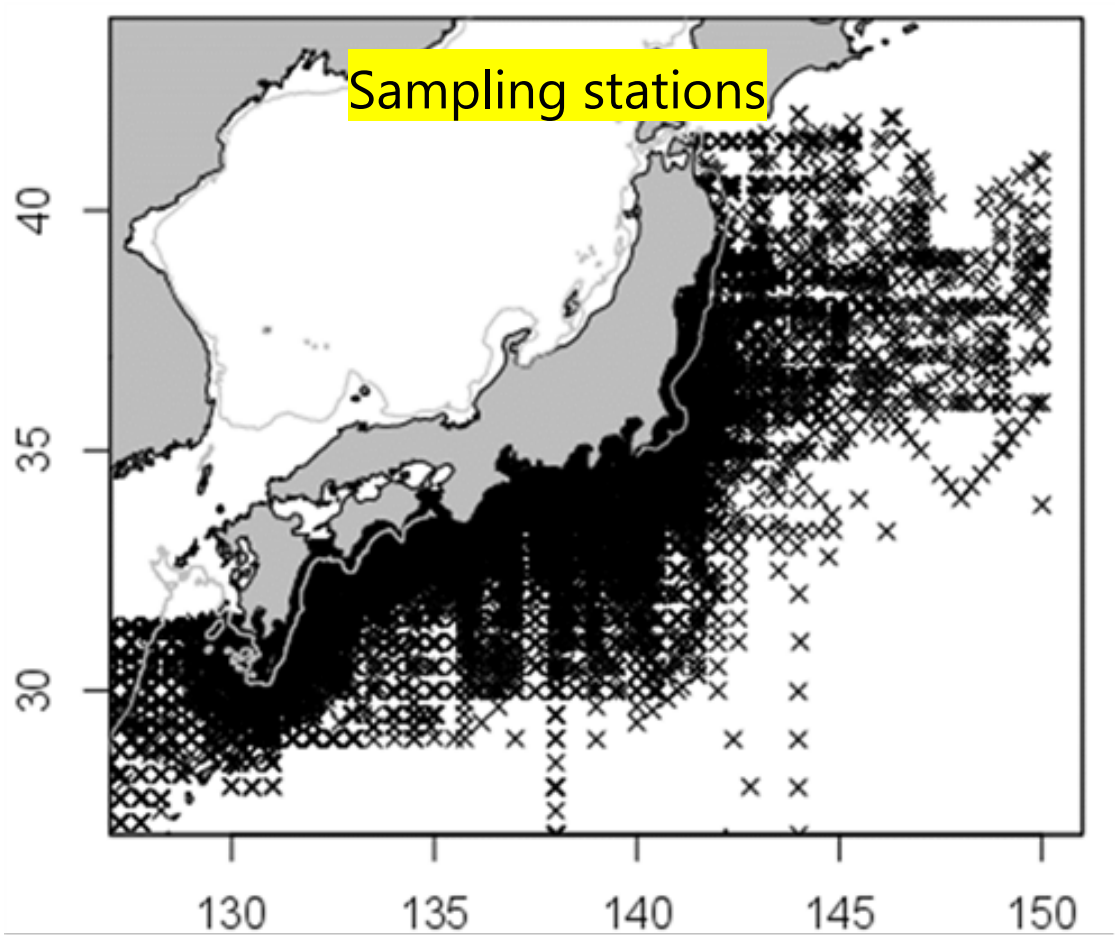
- Estimated 0 age fish were identified from the catch statistics of Shizuoka pref.
- Age-0 fish were determined based on the body length of randomly sampled individuals

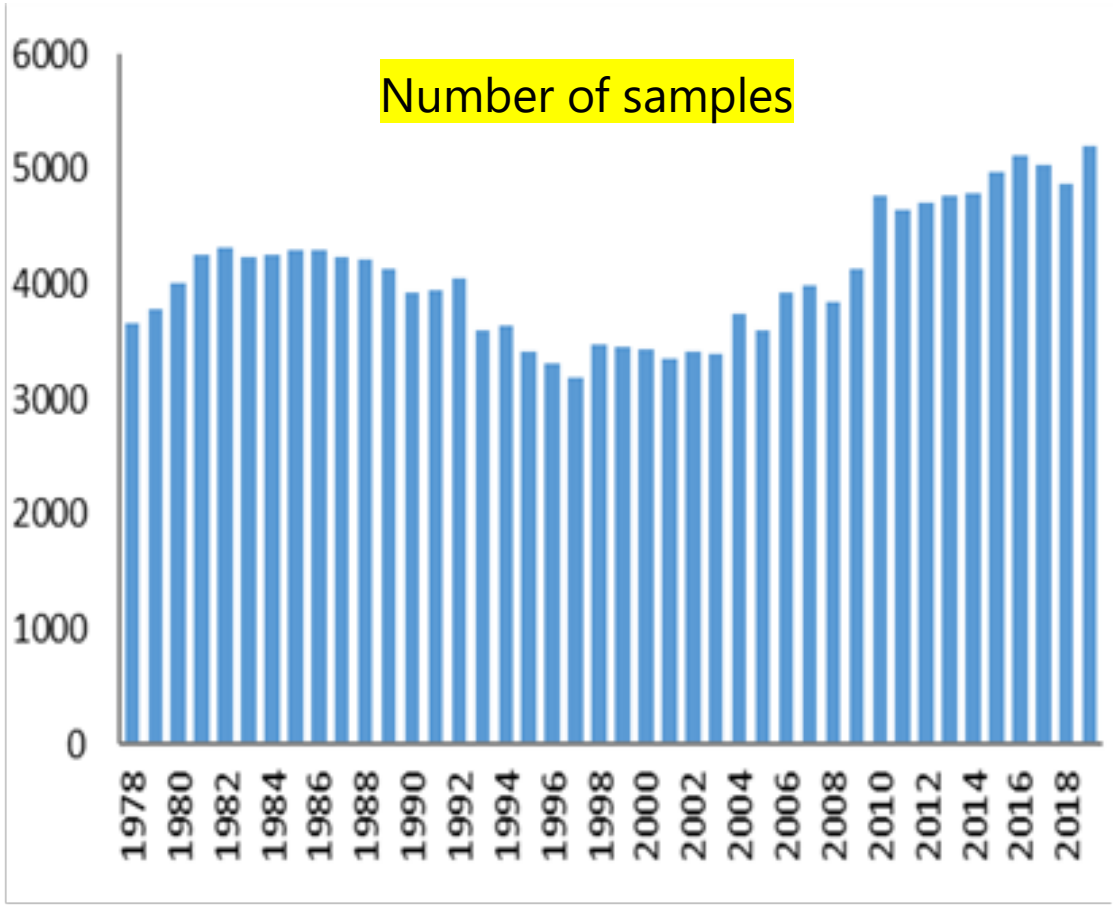
CPUE standardization method

No standardization was conducted

Egg abundance of East of Miyazaki pref. (survey)

- The Egg and Larval survey is conducted by 19 prefectural fisheries institutes and FRA in every month along the Pacific coast of Japan using NORPAC net
- Number of samples per year is approximately 5,000 (depends on the oceanographic condition)





Egg abundance (standardization)

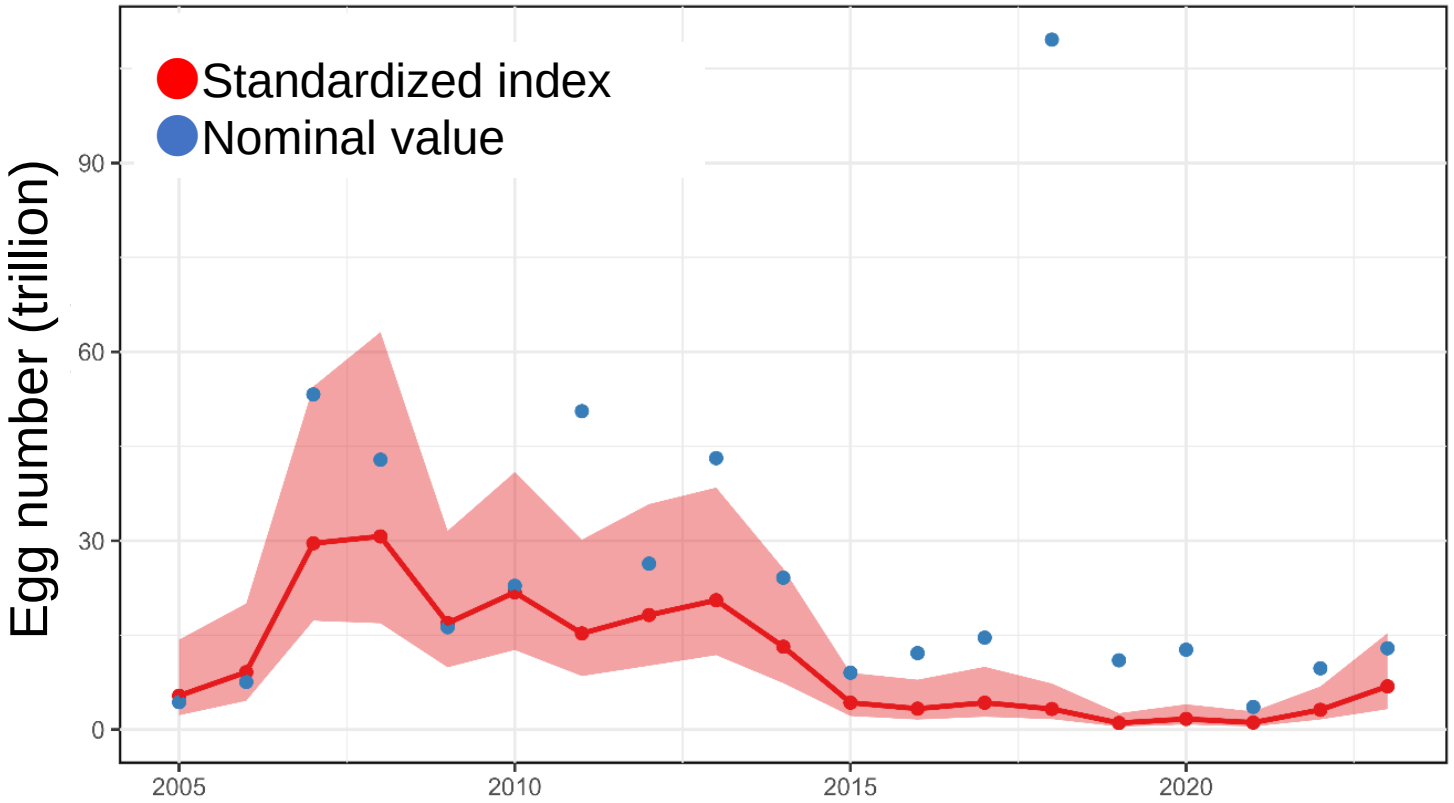
Vector autoregressive spatio-temporal (VAST) model (Thorson, 2018)

- Using VAST, sampling biases can be mitigated
- Including the egg density of chub mackerel in the model enables the differentiation between blue and chub mackerel eggs (Kanamori et al., 2021)

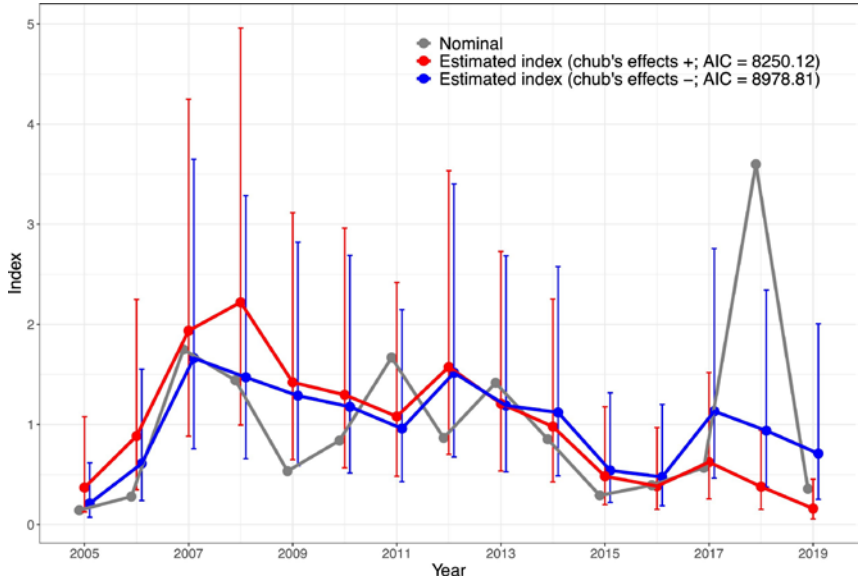
Model assumptions

- Probability distribution: binominal × log-normal
- Knot number: 100
- Assumed effects
  - Temporal effect: fixed effect
  - Spatial effect: random effect
  - Spatio-temporal effect: random effect
- For temporal effect, the effect of year and month are included
- Covariations: egg density of chub mackerel at the same sampling station

Egg abundance of East Japan



Standardized egg abundance vs Nominal value



Kanamori et al., 2022

The shading indicates 95% confidence intervals

Nominal value in 2018 was extremely high
→It can be attributed to the effect of chub mackerel eggs

Stock assessment model

Stock assessment model: **Tuned VPA**

$$\sum_y (ln(I_y) - ln(qX_y))^2$$

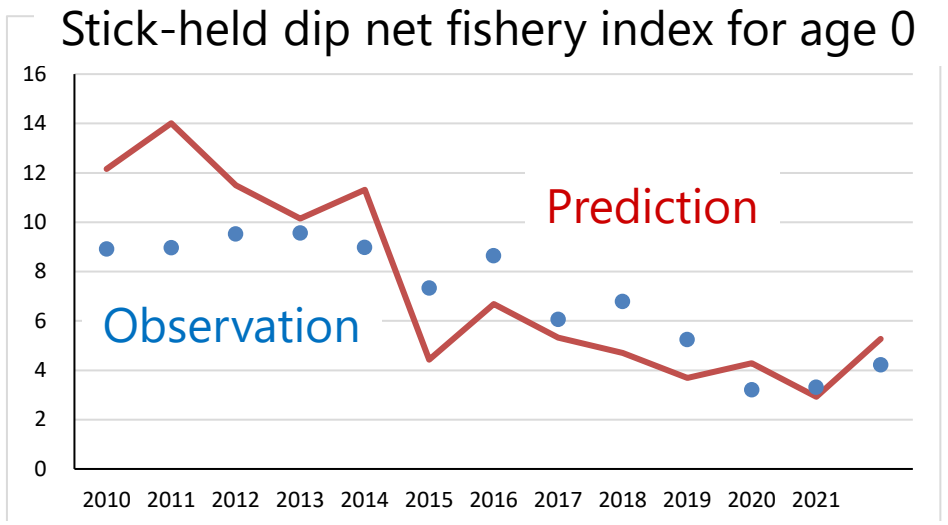
$$q = exp\left\{\frac{1}{n}\sum_{y=1}^{n} ln\left(\frac{I_y}{X_y}\right)\right\}$$

$I_{k,y}$: Index values
$X_{k,y}$: Corresponding abundance estimate
(SSB, N at age 0, or N at age 1)
q_k: Proportional constant

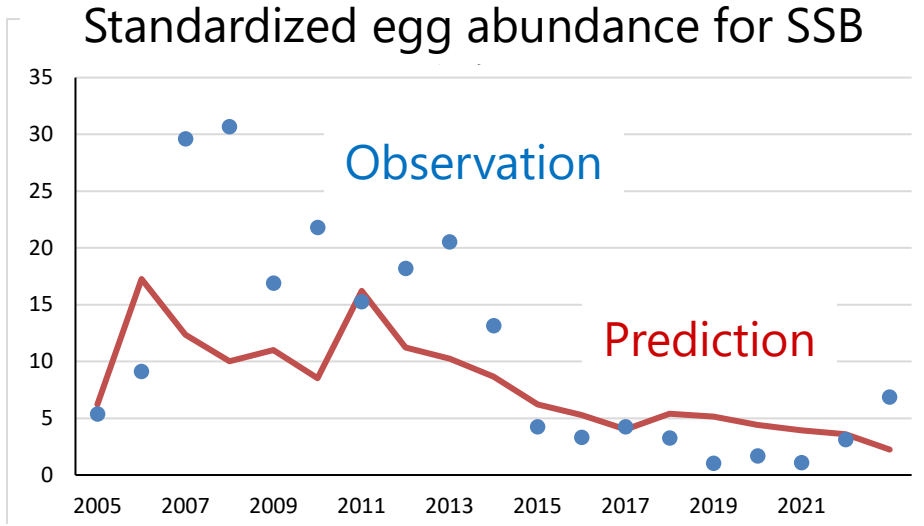
The other assumptions

- Natural mortality: M = 0.4
- Use the Pope's approximation
- Assume $F_{3,y} = F_{4+,y}$
- Maturity rate
  - Age 0, 1: no mature individuals
  - Age 2+: all individuals are mature

Residual plot as a model diagnostic



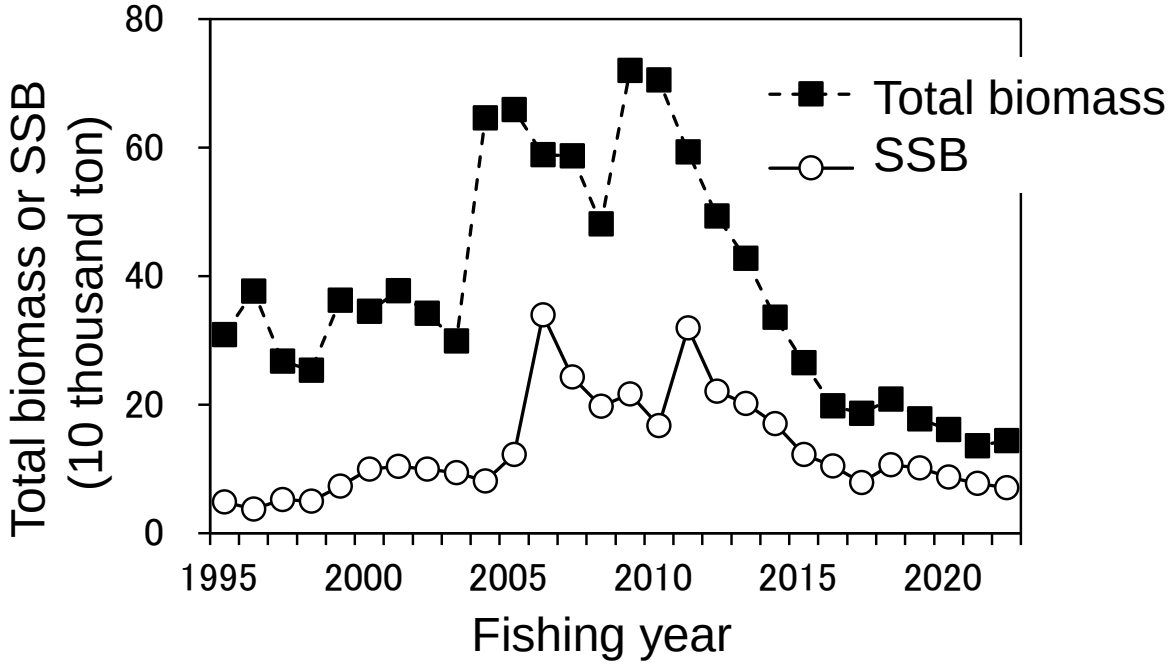
Negative → Positive



Positive → Negative

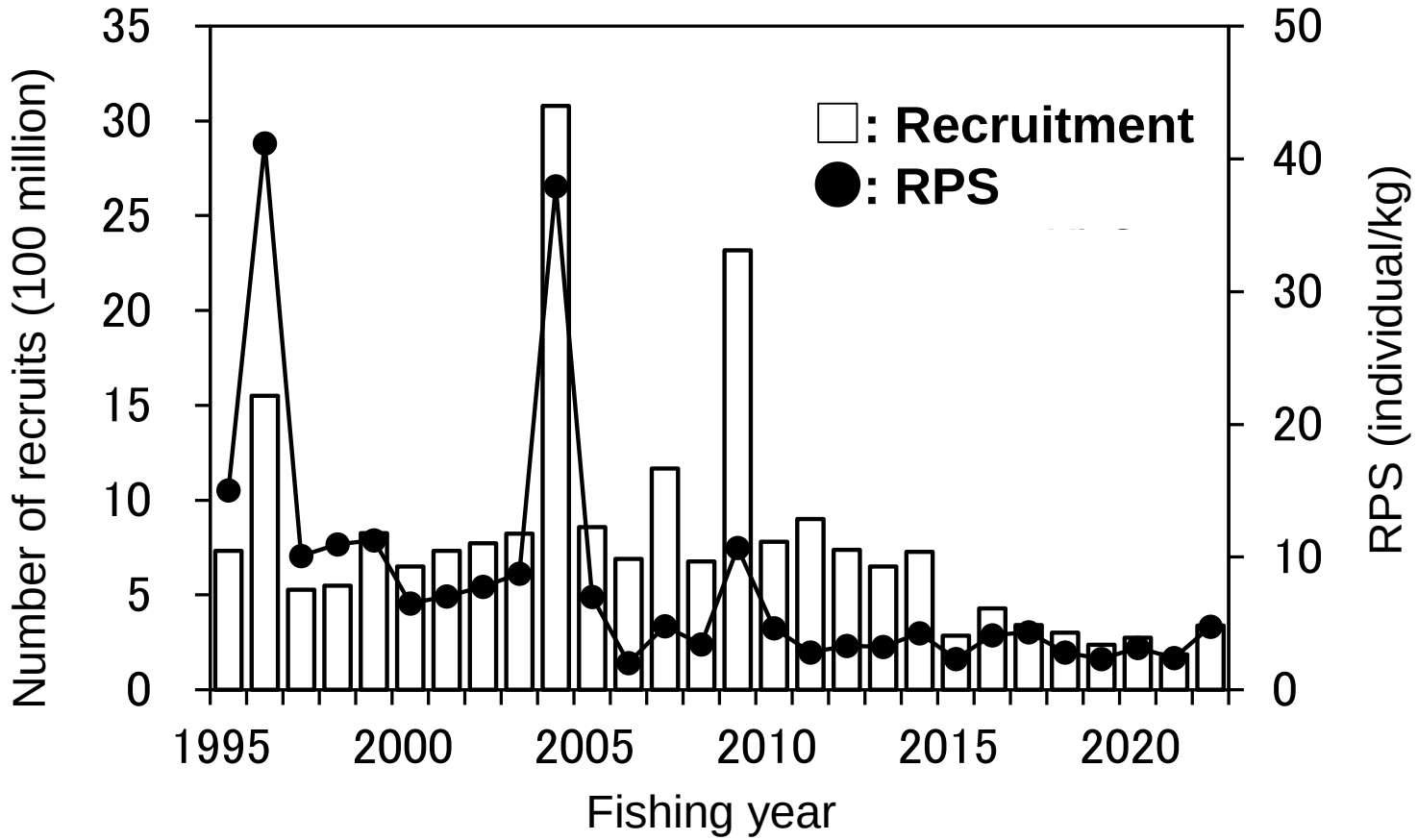
Temporal patterns of residuals were found

Total biomass



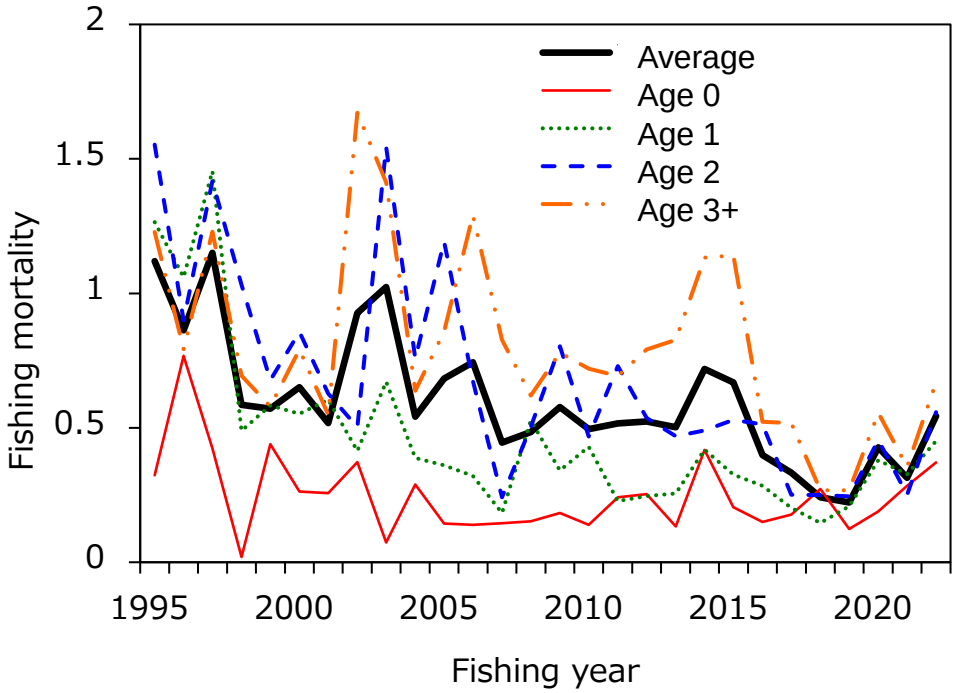
Total biomass and SSB decreased since 2010s
(Biomass in 2022: 144,000 mt, SSB in 2022: 71,000 mt)

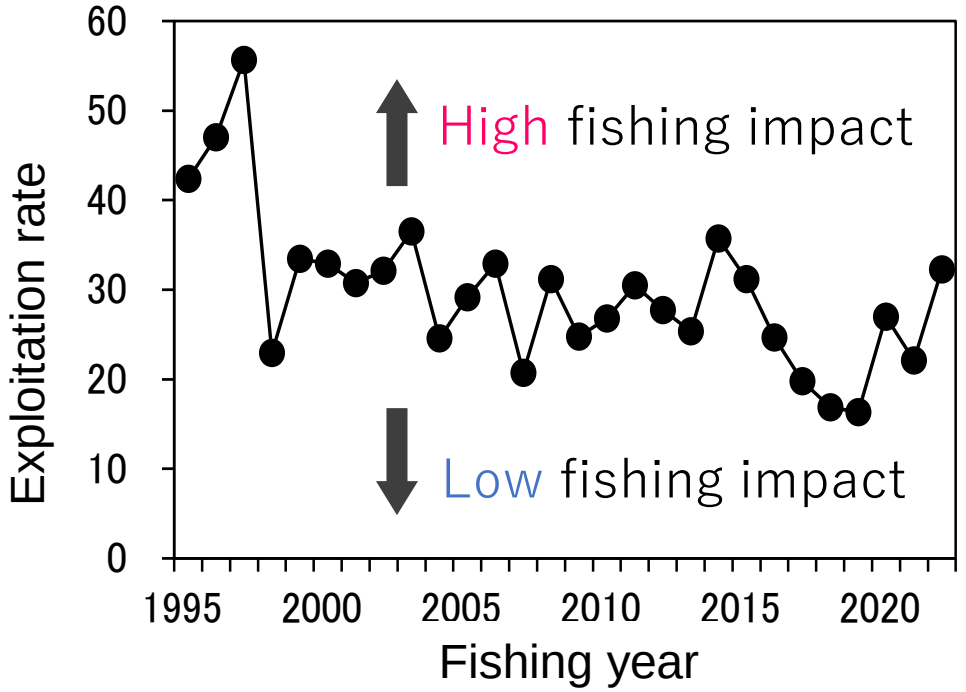
Recruitment and RPS

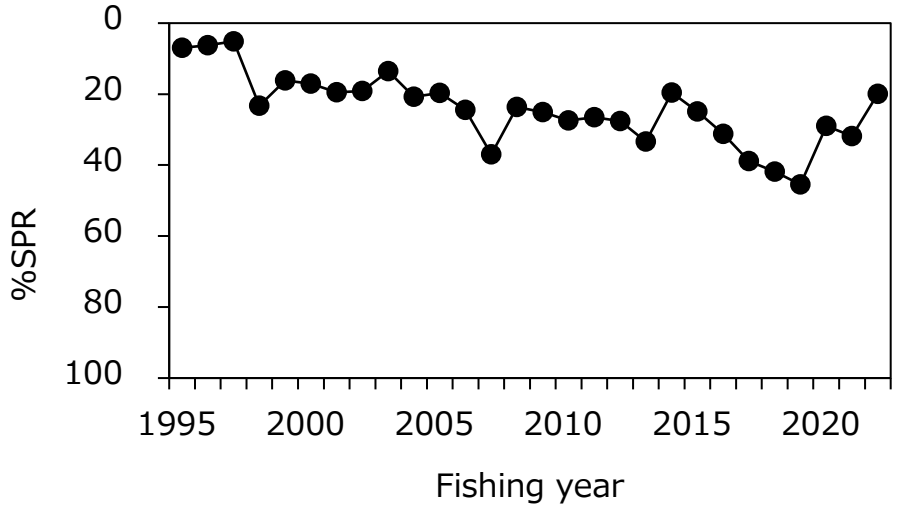


SSB is stable in recent years but the value is lower than the historical value
RPS is stable since 2004

Fishing mortality and Exploitation Rate

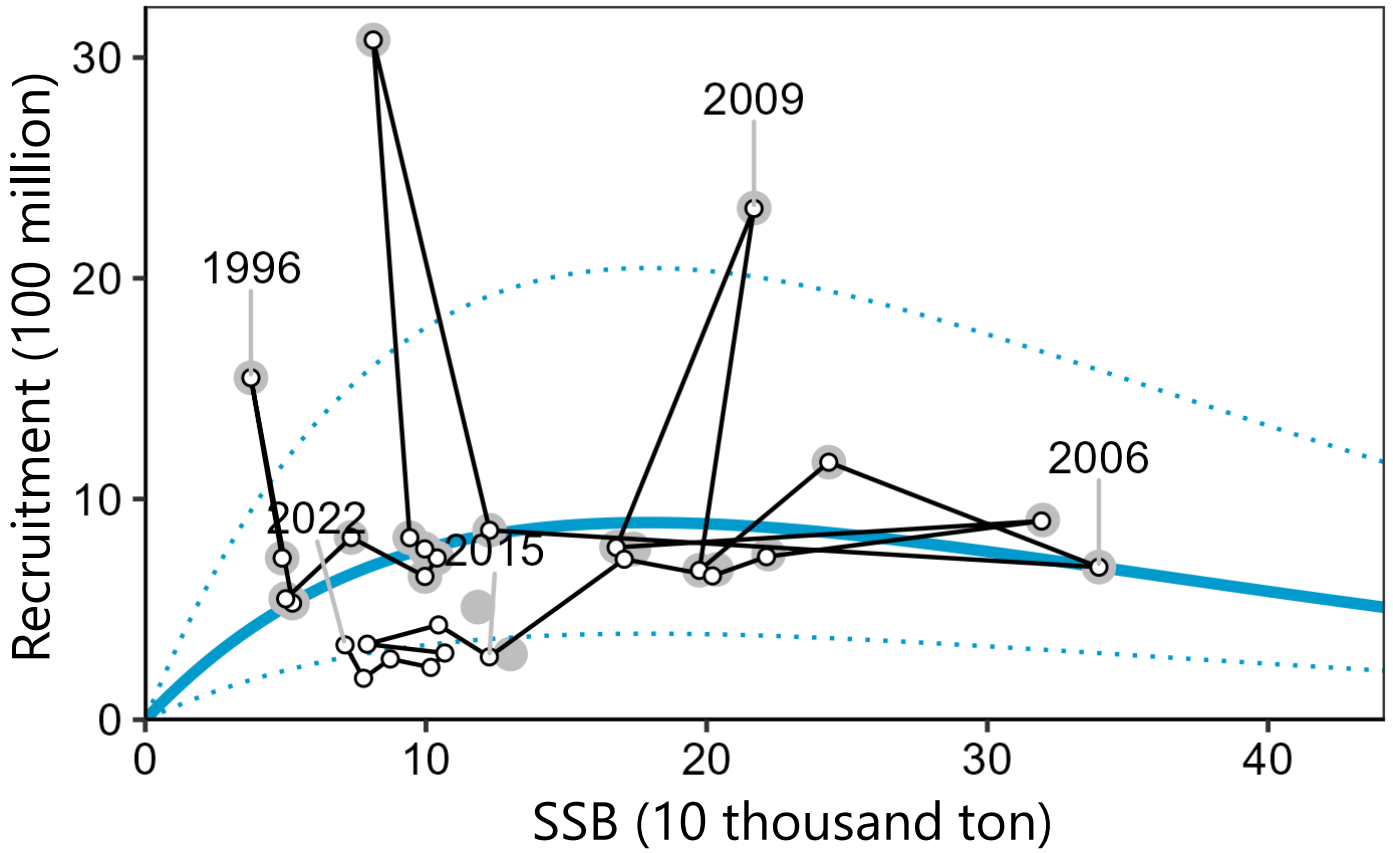






Exploitation rate had been increased by 2020

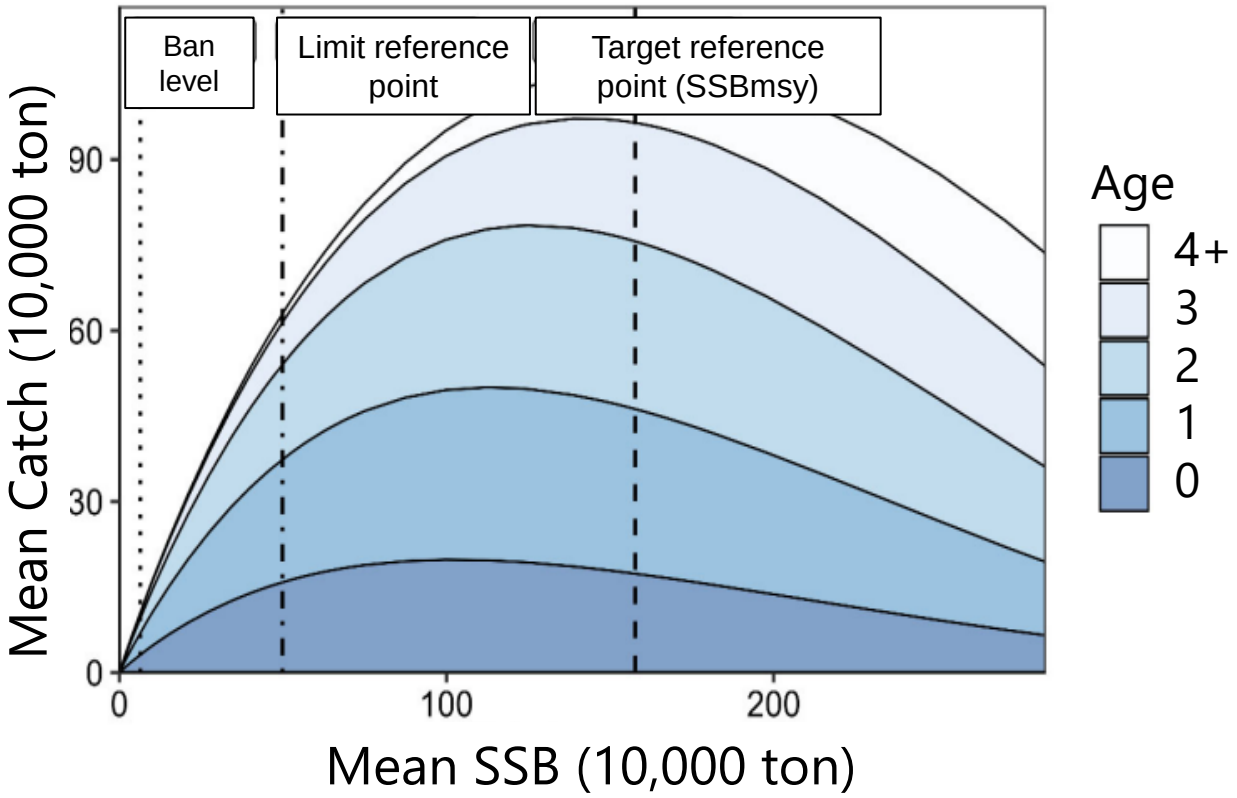
Stock-Recruitment relationship

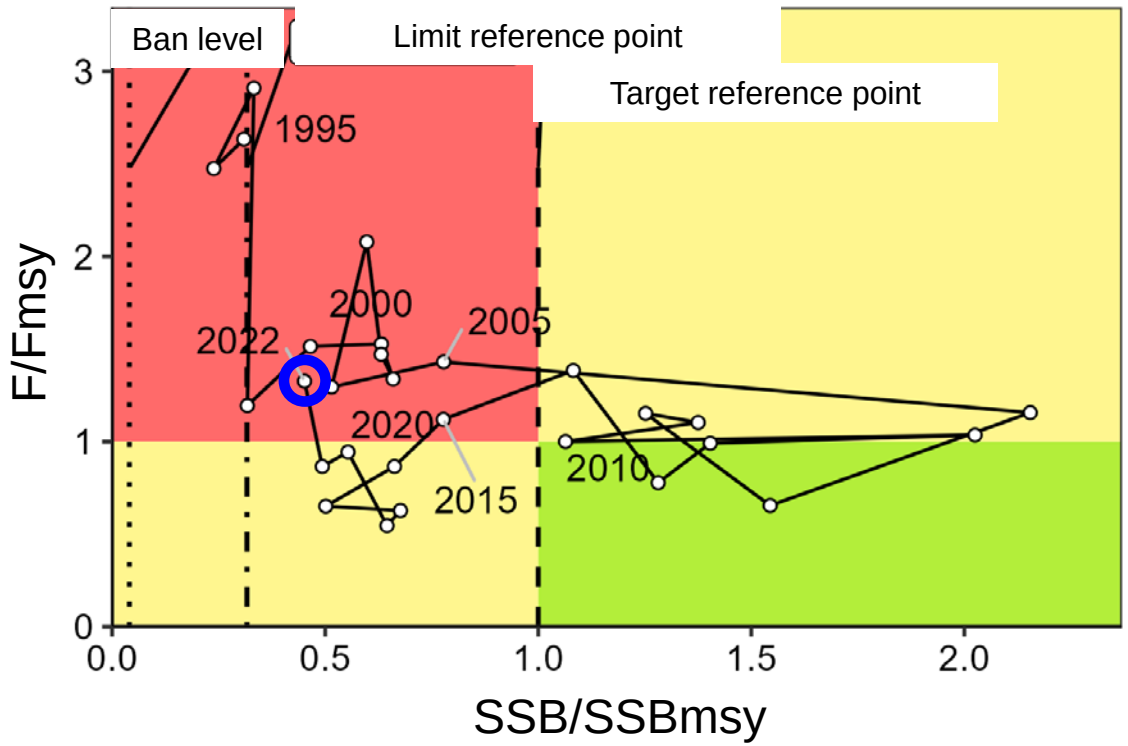


Ricker SR relationship has been adopted

→estimated at the benchmark stock assessment in 2019

Yield curve and Kobe plot





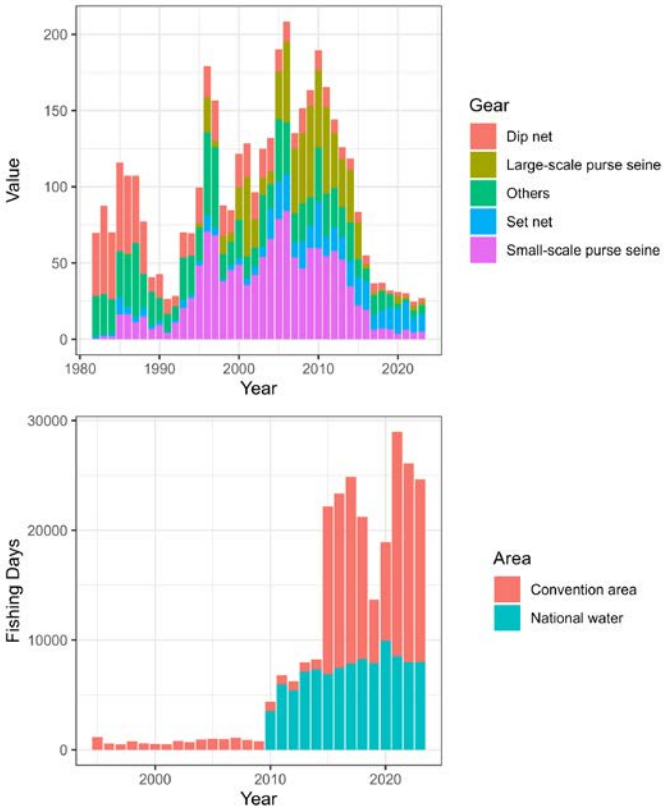
- MSY reference points were estimated by a stochastic simulation with a random recruitment variability from the normal-regime SR relationship (see Ichinokawa et al. 2017, ICES JMS, for details)
- SSB was lower than SSBmsy
- F in 2022 exceeded Fmsy

Small Working Group on Blue Mackerel (SWG BM)

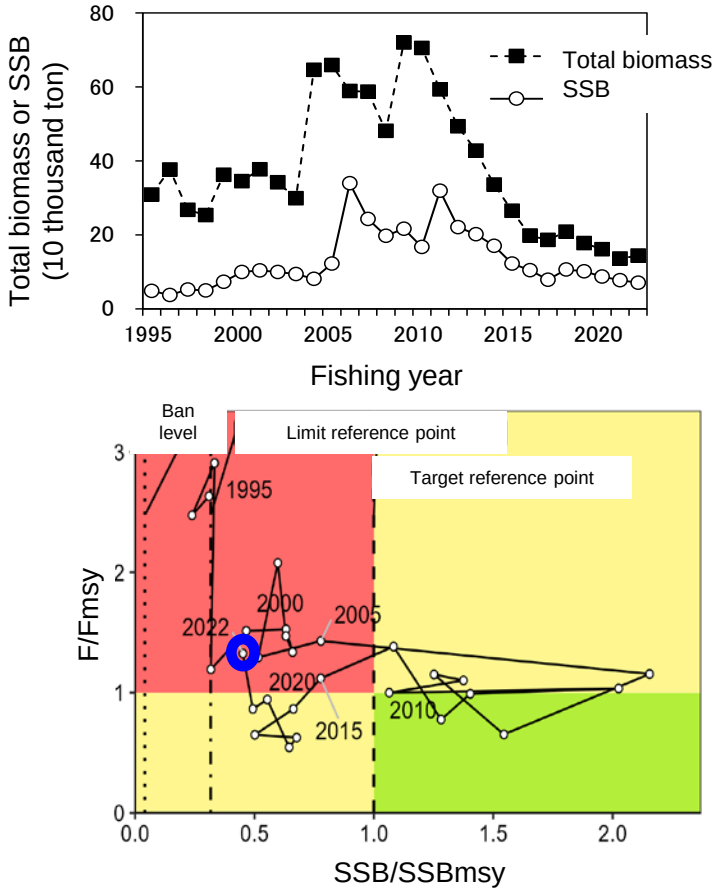
Lead: Dr. Kazunari Higashiguchi (Japan)

Blue mackerel

Convention Area



Domestic Assessment



Comments on Status

- SSB is **under SSBmsy**
- Fishing mortality is **above Fmsy**

- Japanese catch are from its national waters
- Chinese and Russian catch is based on assumptions

Summary

- Japan conducts the BM stock assessment by the tuned VPA
- The MSY-based reference points were estimated from the stochastic simulation from the Ricker SR relationship
- Biomass and SSB has been decreasing since 2011 and recruitment has been greatly lower than the expectation from the SR relationship
- The current status is overfishing (F > Fmsy) and overfished (SSB < SSBmsy)

Future Issues

- Necessary to reflect actual age composition in the outside of Japanese EEZ