NPFC-2025-SC10-IP06

NPFC 10th Scientific Committee Meeting
16-19, December 2025
Nagoya, Japan
Agenda Item 6.1.2

6.1.2 Observation of Domestic Stock Assessment of Blue Mackerel in Japan in 2023 FY (July-June)

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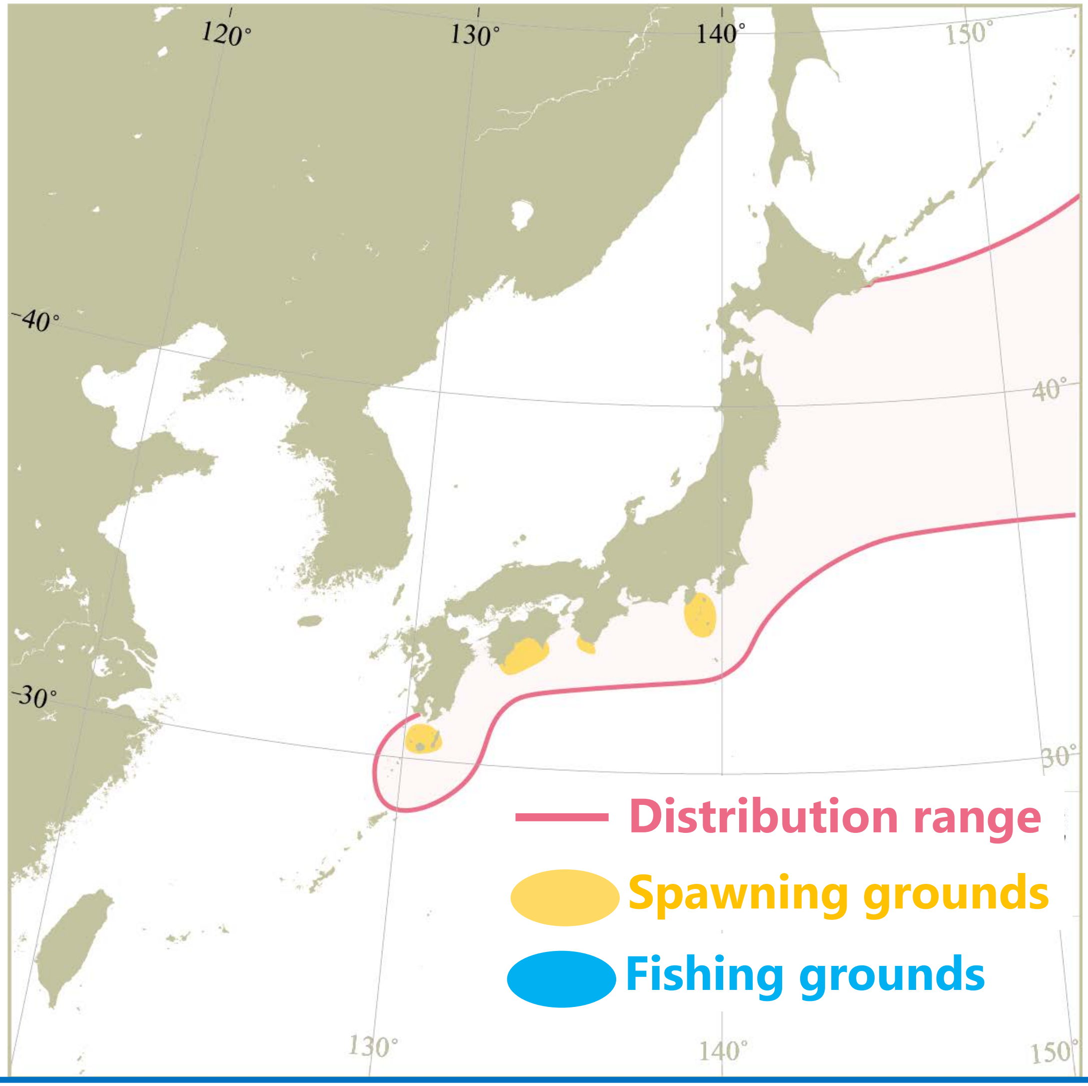
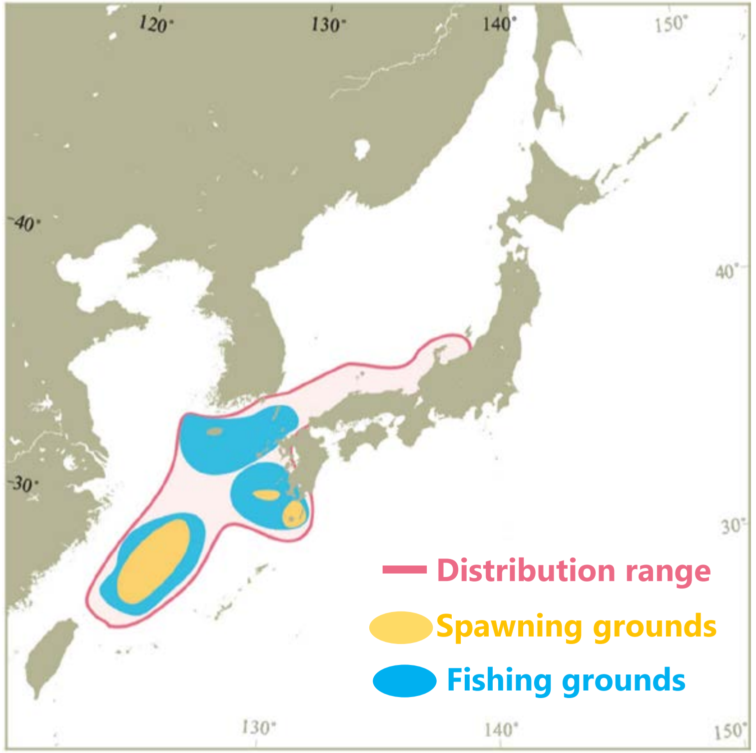
Spatial Structure of BM Stocks

Pacific stock



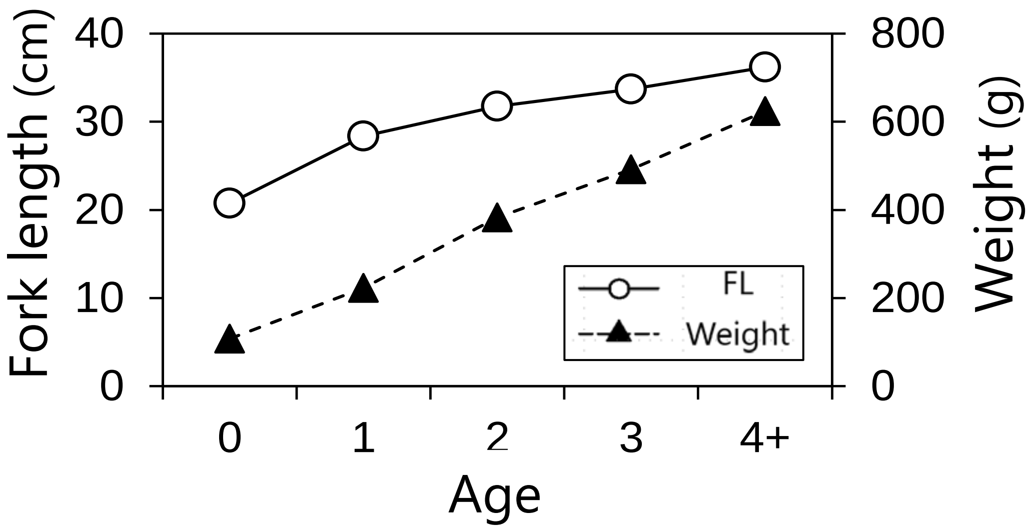
East China Sea stock

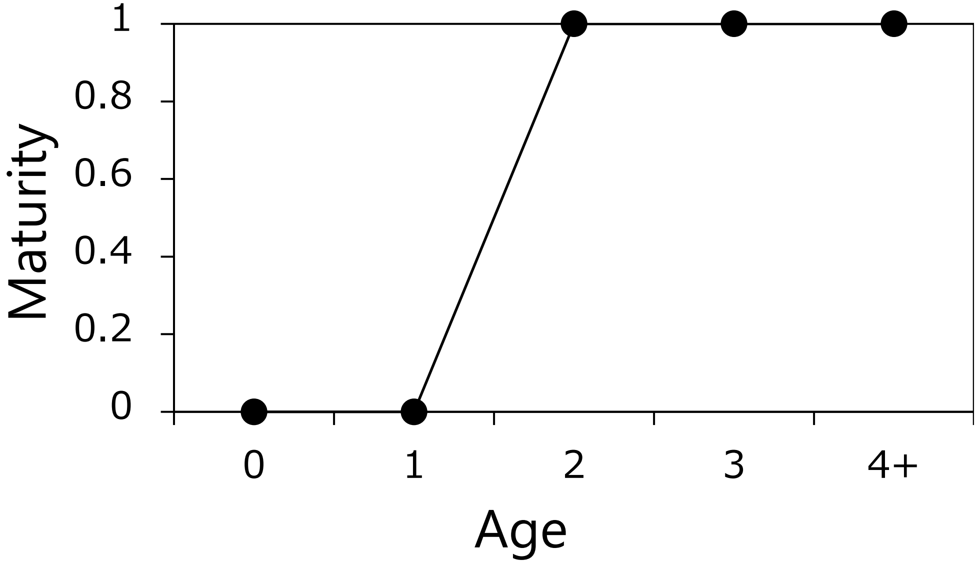


- There are two stocks depending on distributions and biology
- Only the Pacific stock is distributed in the NPFC Convention Area

Biological characteristics

Average of fished individuals during the most recent 5 years （2019-2023）





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

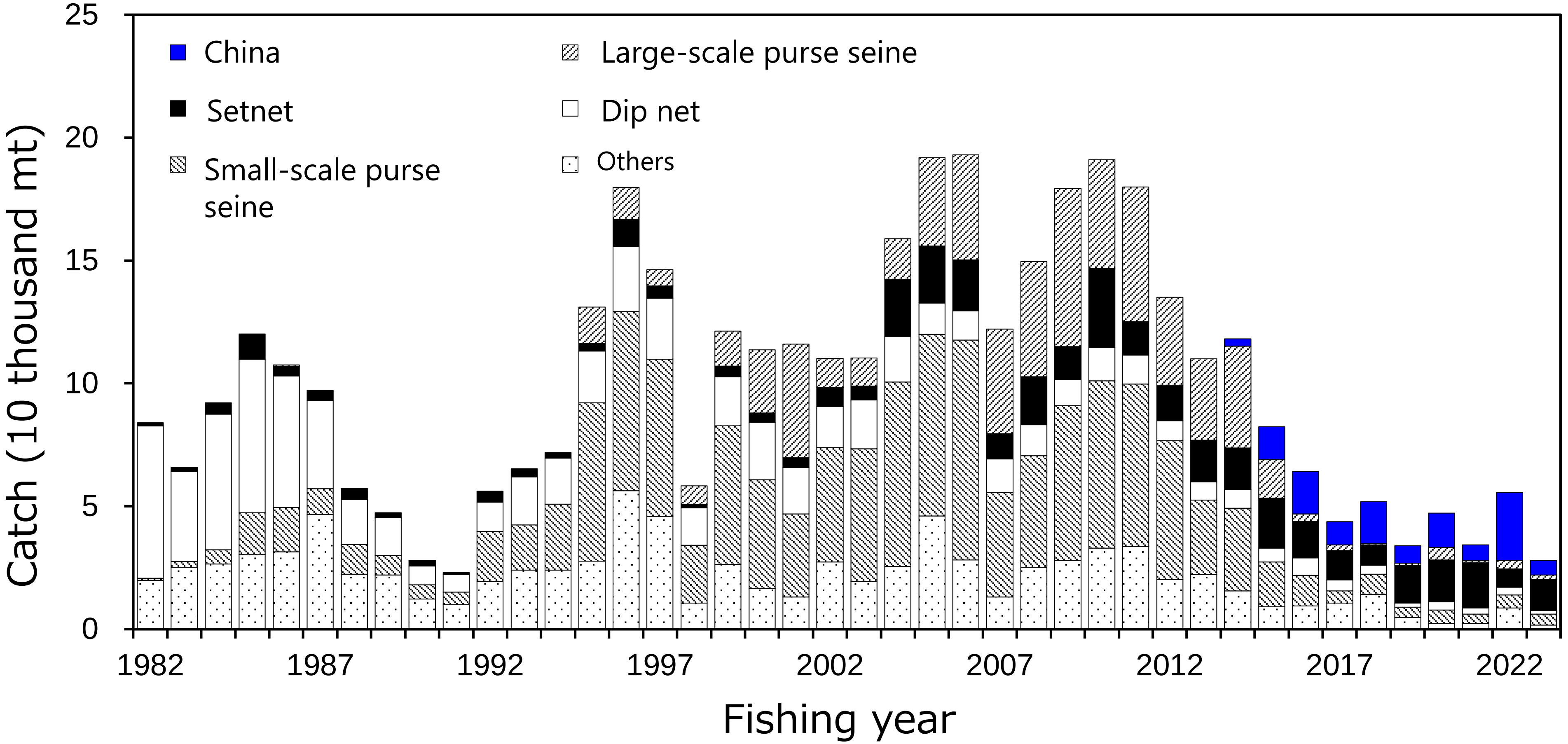
Spawning : From December to June in Kuroshio Current area west of the Izu Islands

Feeding : Planktonic crustaceans and whitebait (juvenile stage)

Squids and small fishes (immature stage)

Predator : Large fish such as skipjack tuna

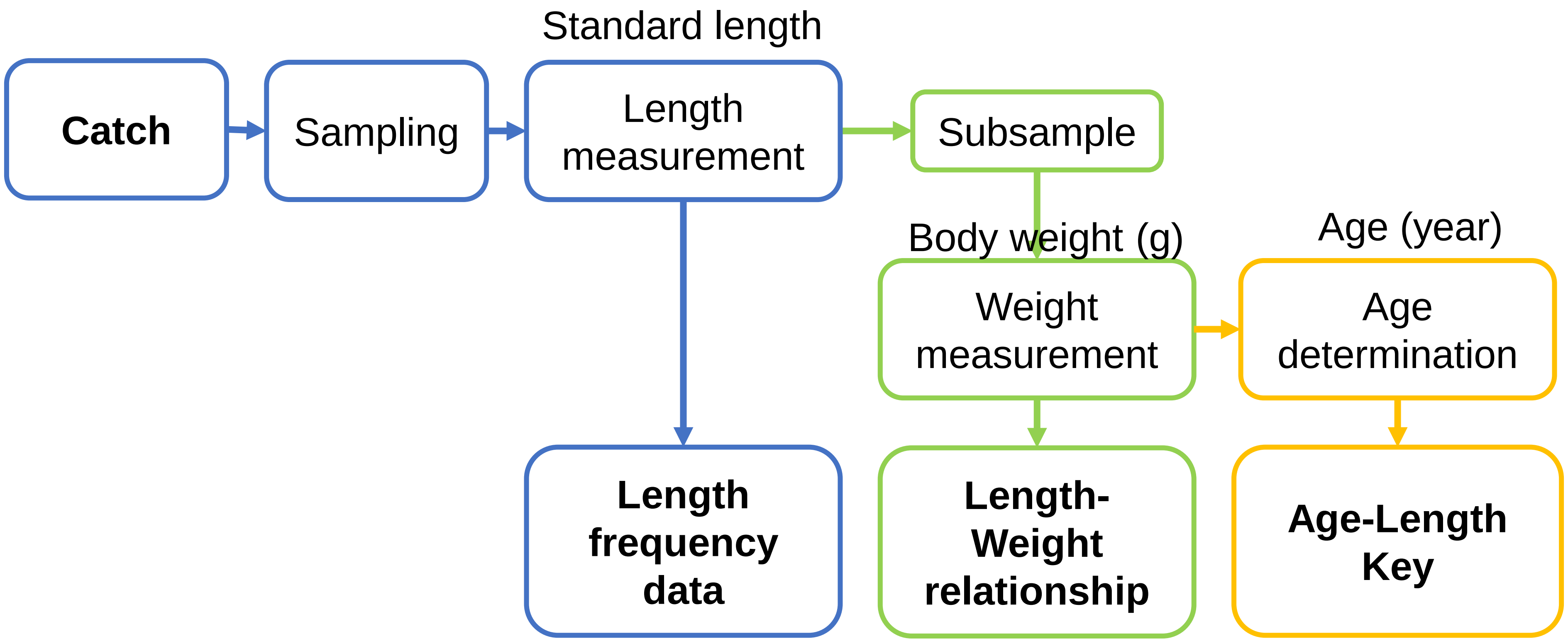
Catch statistics



- Fishing year: July to June in the next year
- FY2023: 22,000 ton (China: 6,000 ton)

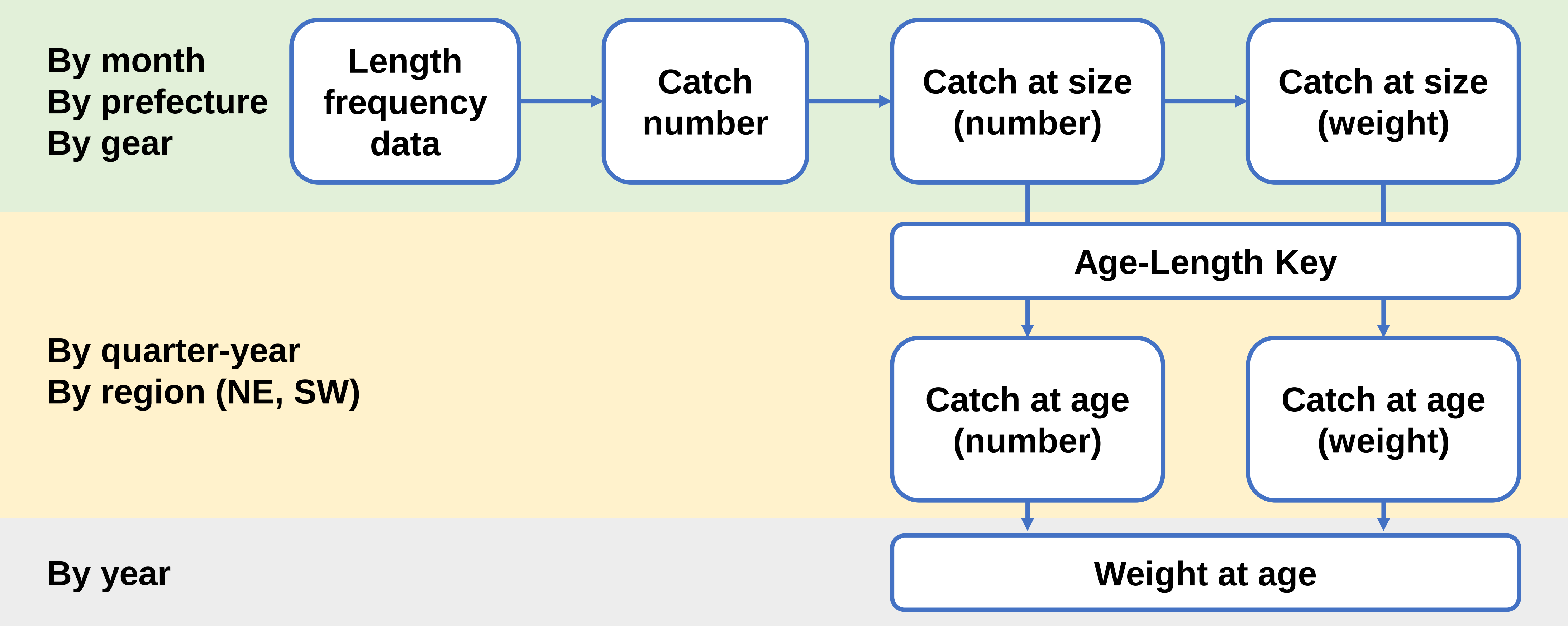
Length, Weight and Age Data

- 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



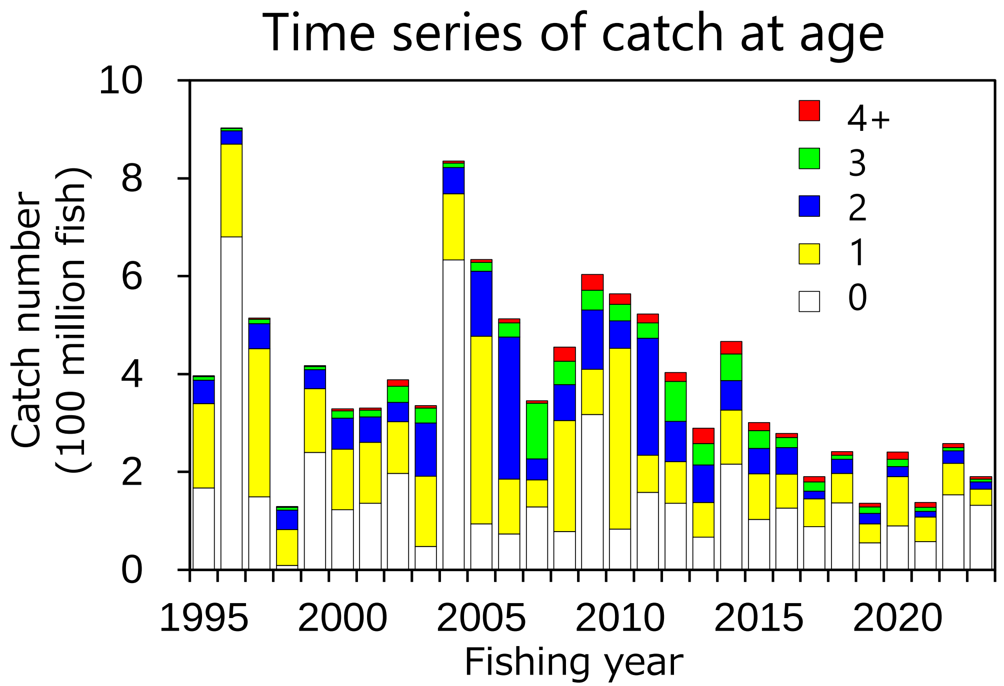
Catch at Age and Weight at Age in Japan

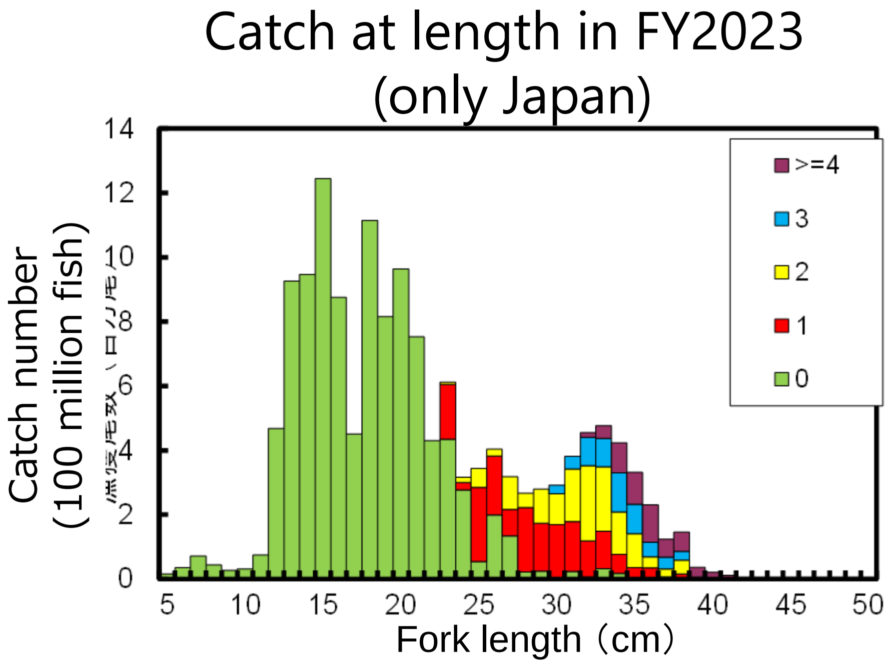
- Catch at size is derived from length frequency and L-W relationship
- ALK is applied to derive catch at age
- Weight at age is estimated from catch at age (weight)/catch at age (num)



Age composition for China
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)
- A wide range of age classes has recently been caught

Overview of stock assessment

Tuned VPA (Virtual Population Analysis)

Tuned VPA (1st step)

1995–2023 fishing year

Assumptions

- Age classes: 0 to 4+
- Time span: 1995–2023 fishing year
- Assume $F_{3,y} = F_{4+,y}$
- Use the Pope's approximation

Estimate the selectivity at age in the terminal year

Constrain: F in 2023 at age is identical to the average of F from 2019 to 2022

Overview of stock assessment

Tuned VPA (Virtual Population Analysis)

Tuned VPA (2nd step)

Estimate stock abundance using the following tuning indices

- CPUE in Stick-held dip net : whole stock
- Egg abundance : spawning stock biomass

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

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

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

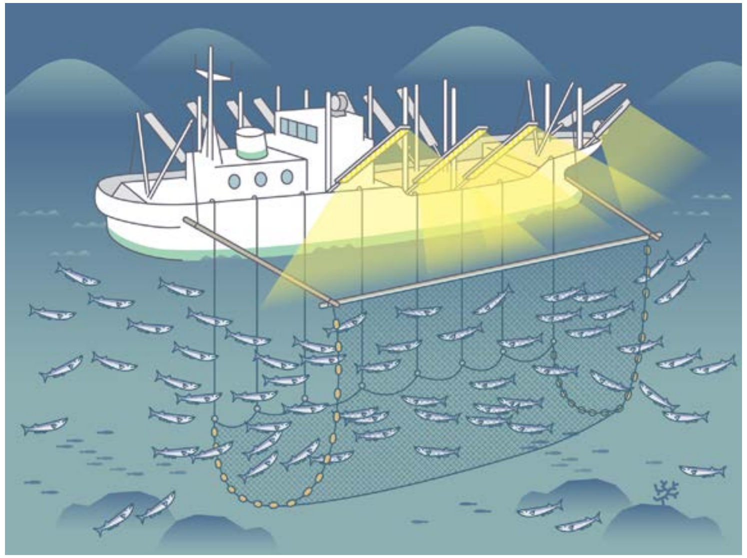
Other assumptions

- 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

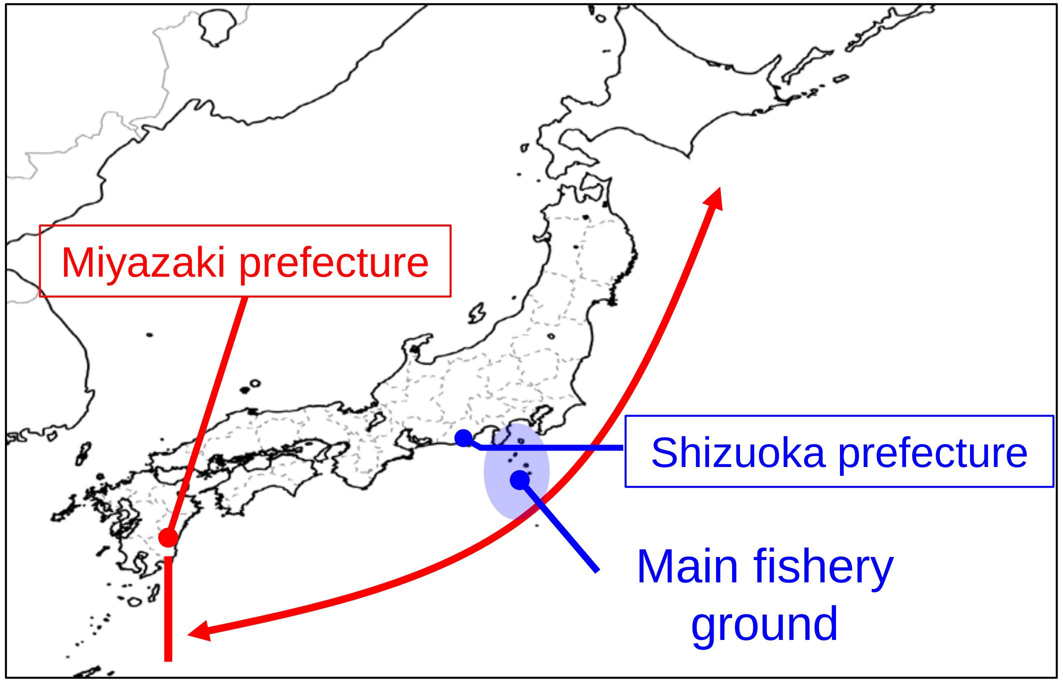
The following abundance indices are used for BM stock assessment;

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



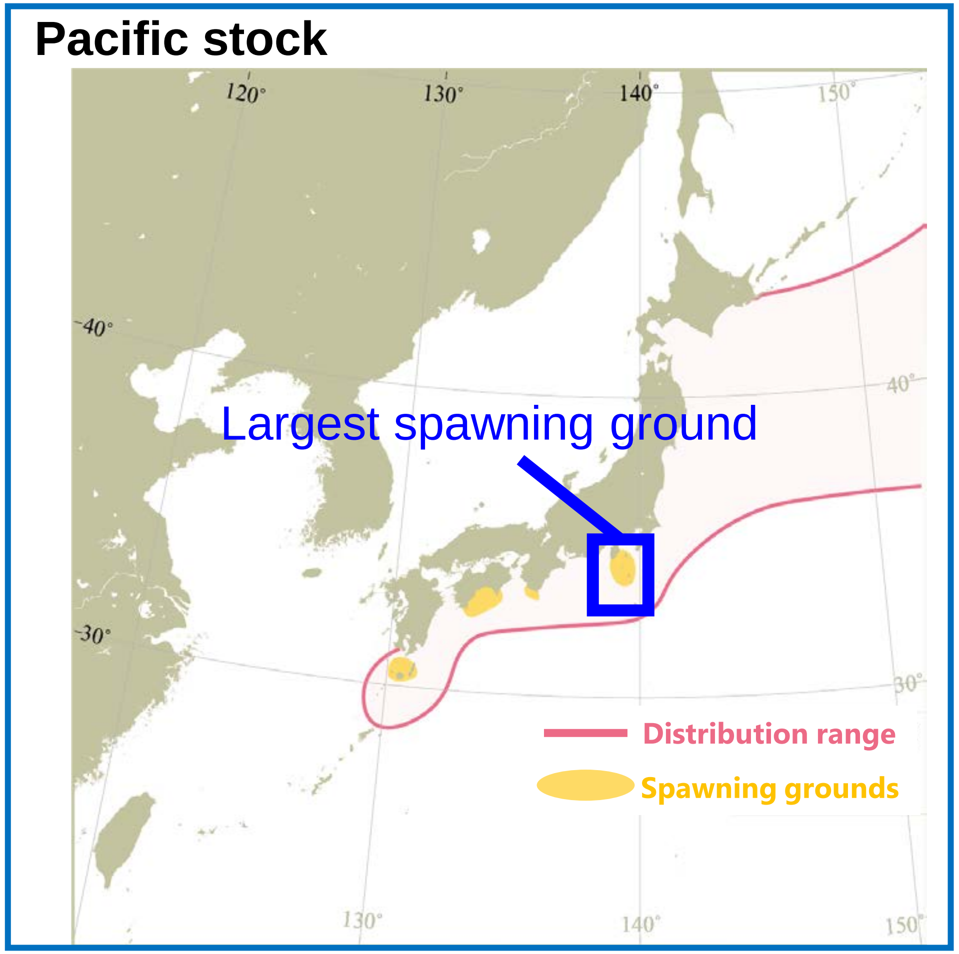
stick-held dip net

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.)



Sampling method

- Blue mackerel was identified from the catch statistics of Shizuoka pref.

CPUE standardization method

- delta-GLM (Lo et al. 1992)

  $occurrence\ (logit) \times catch\ (log)$

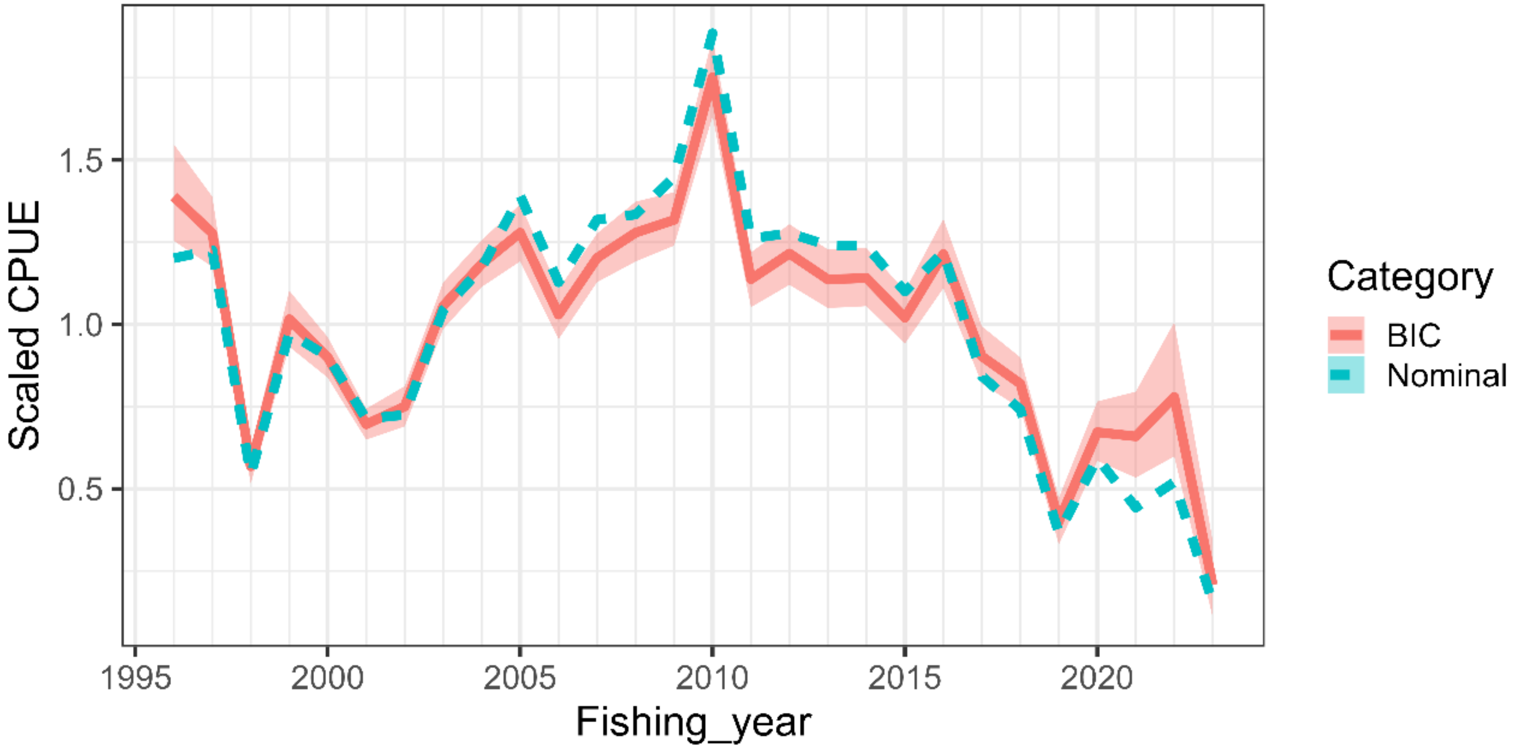
  $(Year) * (Month) * (Area) * (Ship) * (SST) * (SST\text{^}2)$
- Best models were selected by BIC

  $(occurrence) = (Year) * (Area) * (SST) * (SST\text{^}2)$

  $(catch) = full\ model$

Stick-held dip net (Shizuoka pref.)

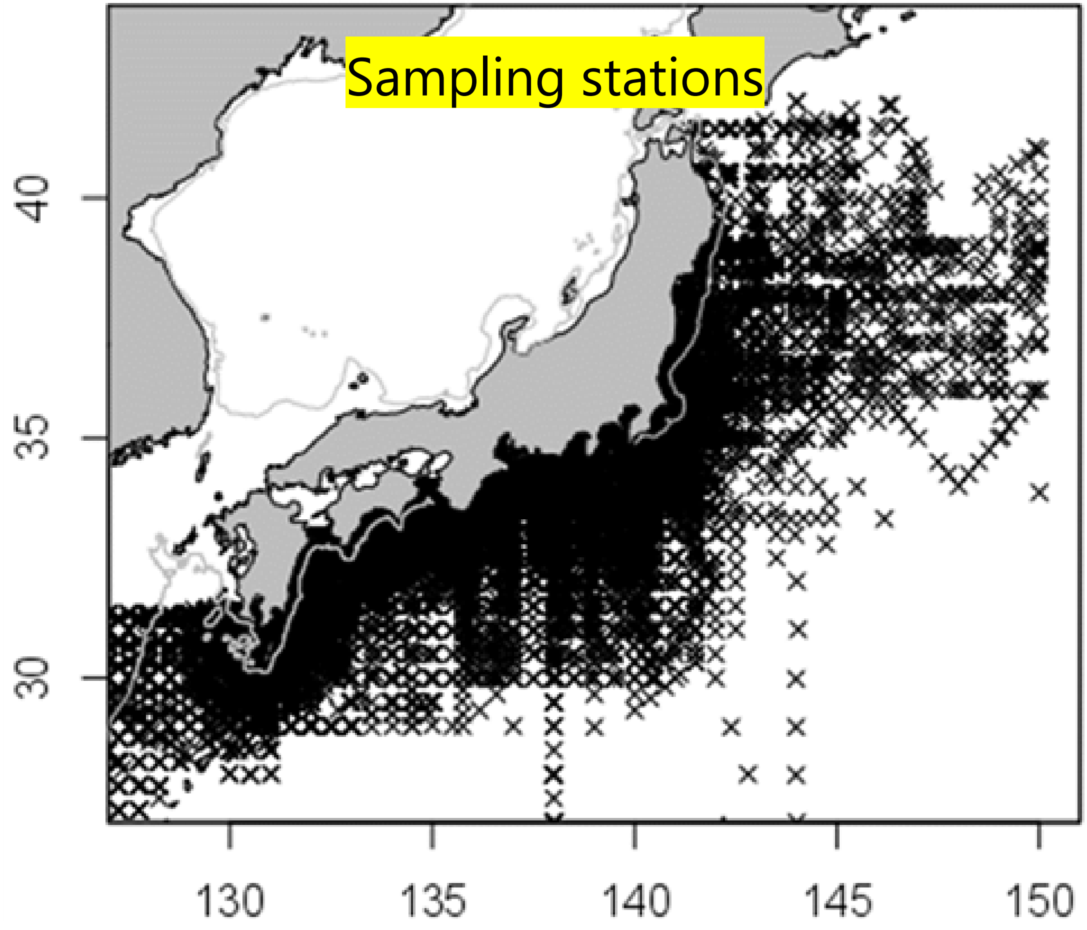
Nominal vs Standardized



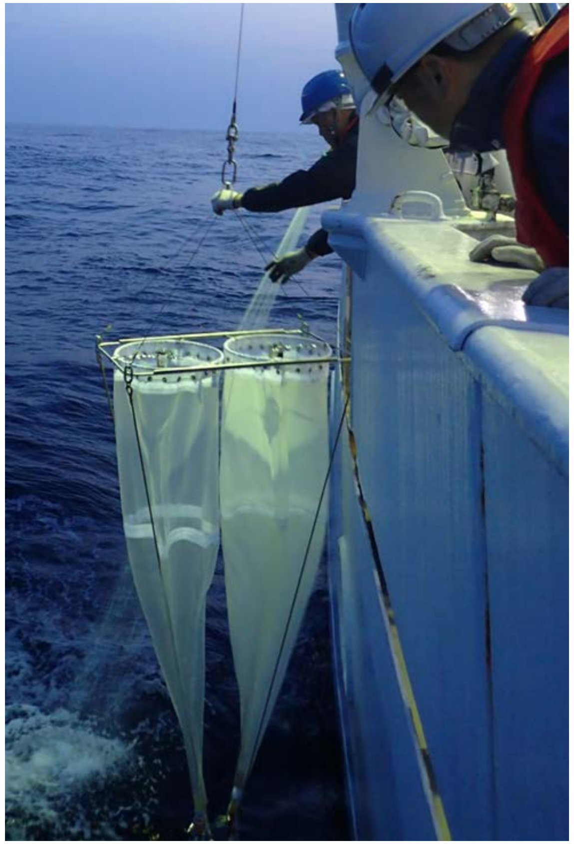
The shading indicates 95% confidence intervals

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)



Sampling net



Egg abundance (standardization)

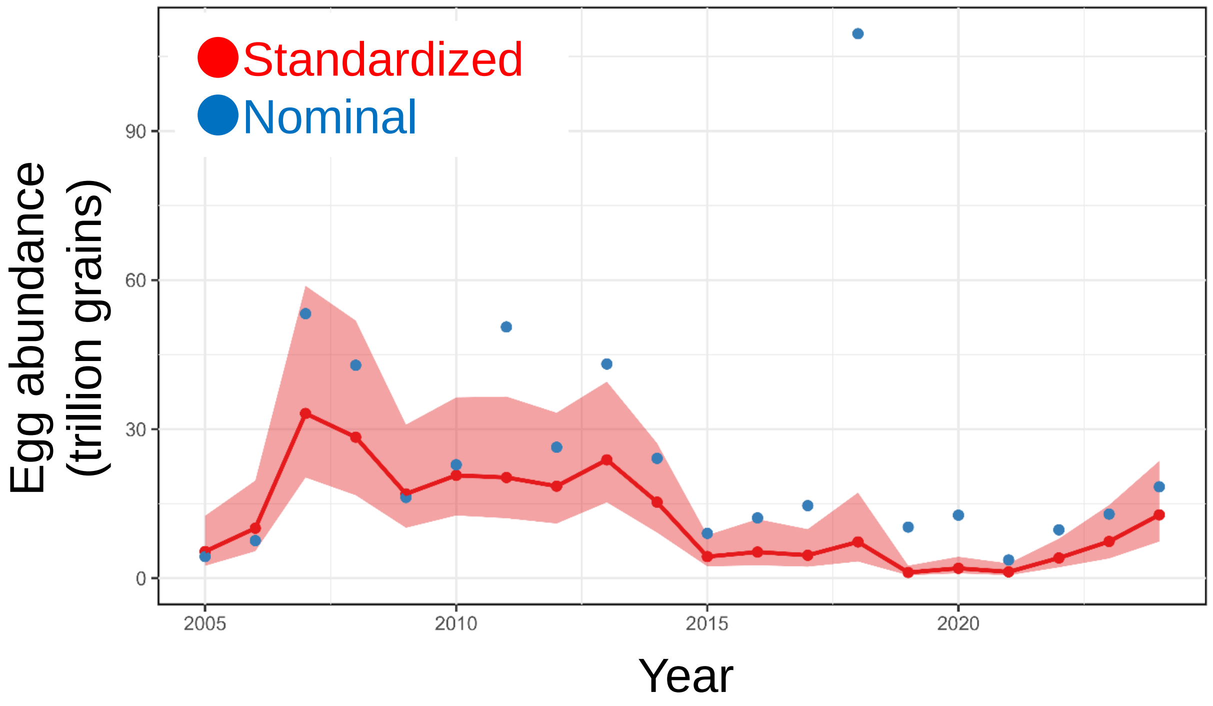
Vector autoregressive spatio-temporal (VAST) model (Thorson, 2018)

- 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)

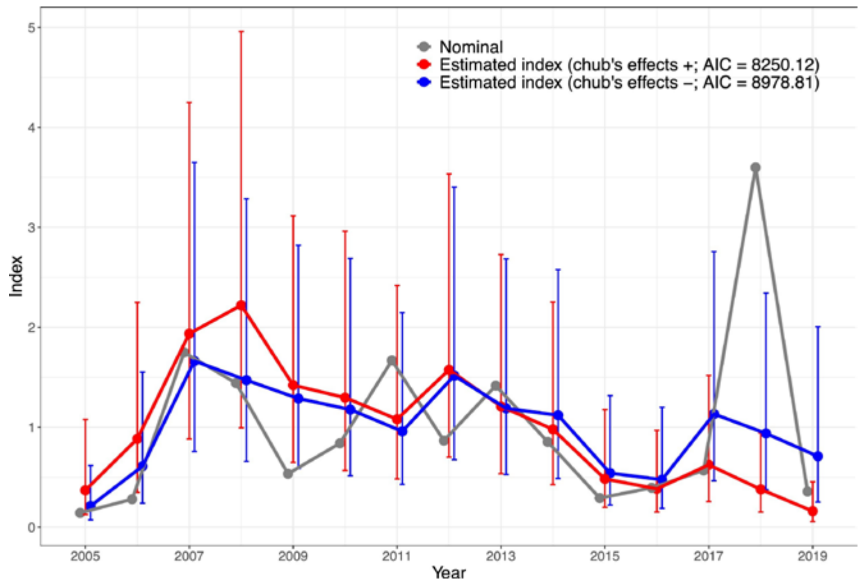
Model assumptions

- 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

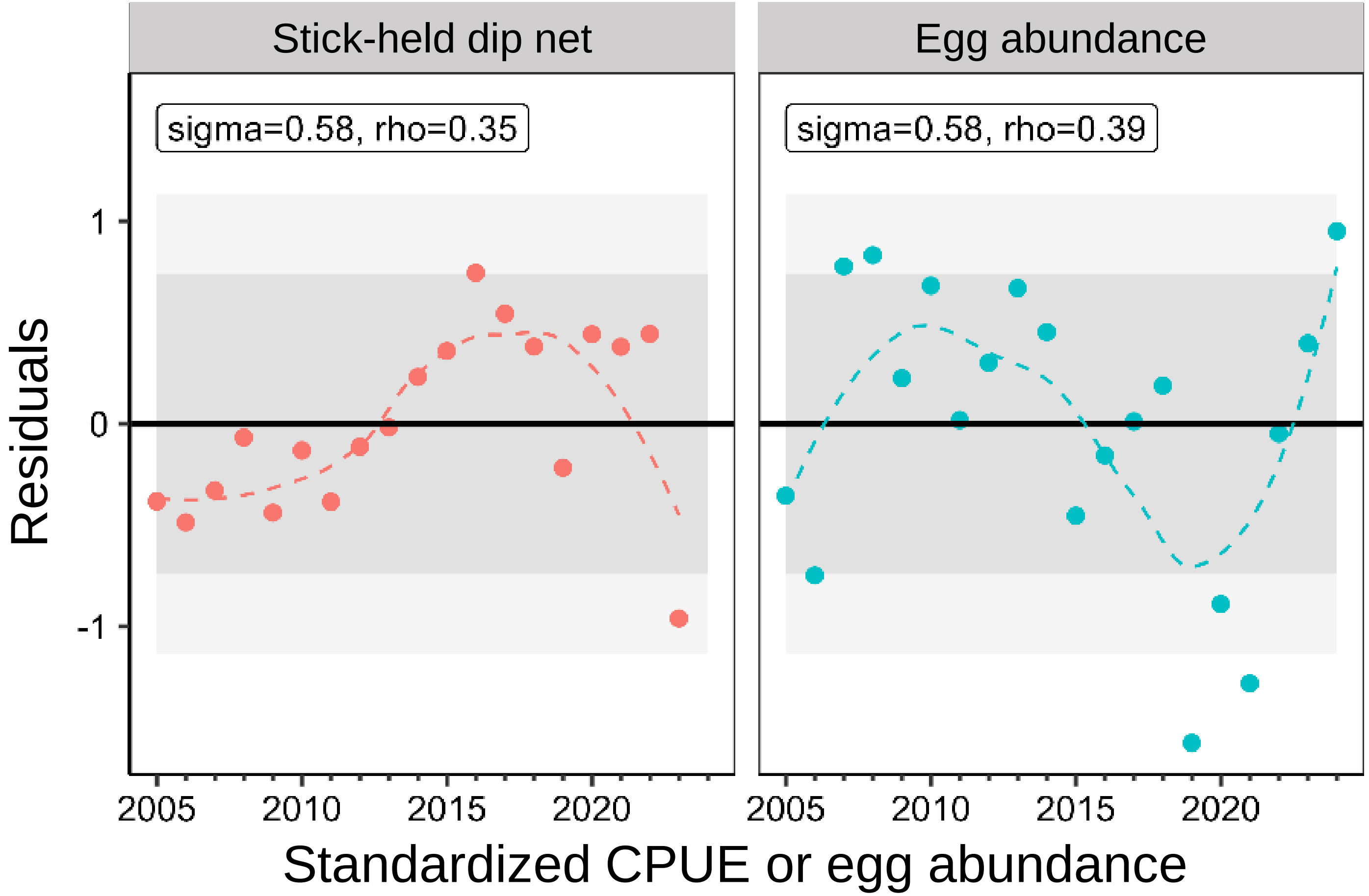


Kanamori et al., 2022

The shading indicates 95% confidence intervals

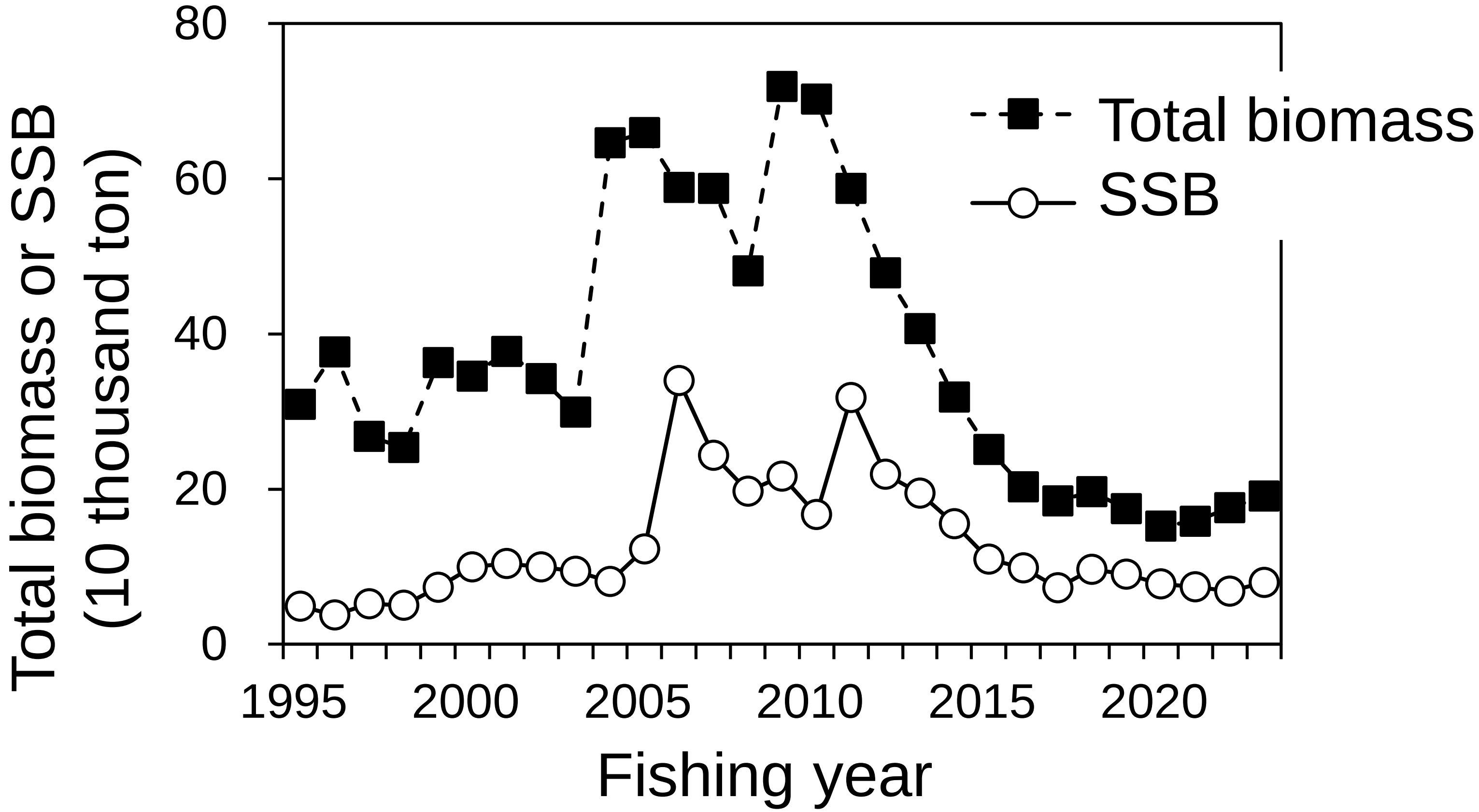
Nominal value in 2018 was extremely high
→It can be attributed to the effect of chub mackerel eggs

Residual plot as a model diagnostic for biomass indices



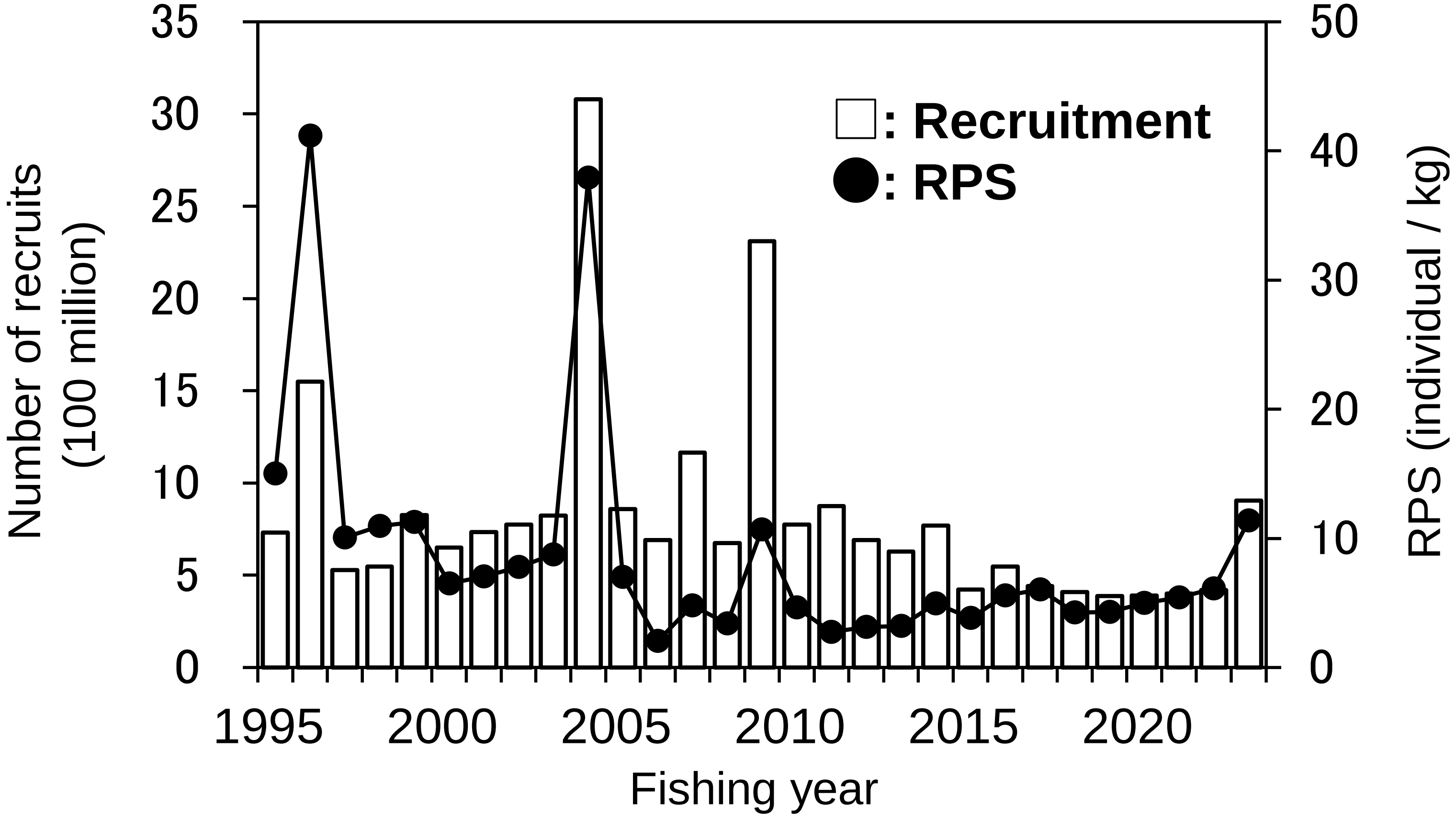
No significant temporal patterns of residuals were found

Total biomass



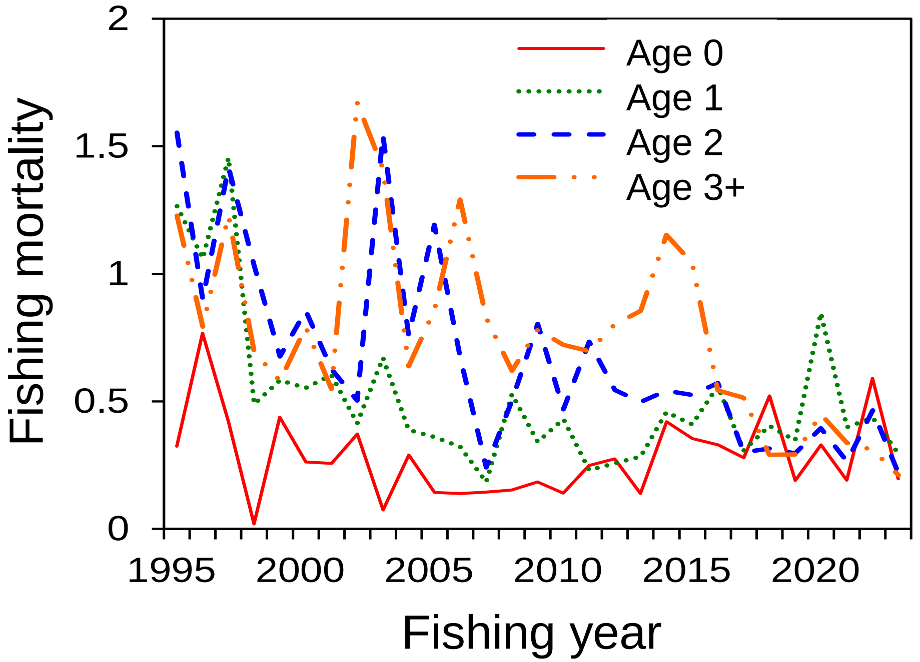
Total biomass and SSB decreased since 2010s
(Biomass in 2023: 191,000 mt, SSB in 2023: 79,000 mt)

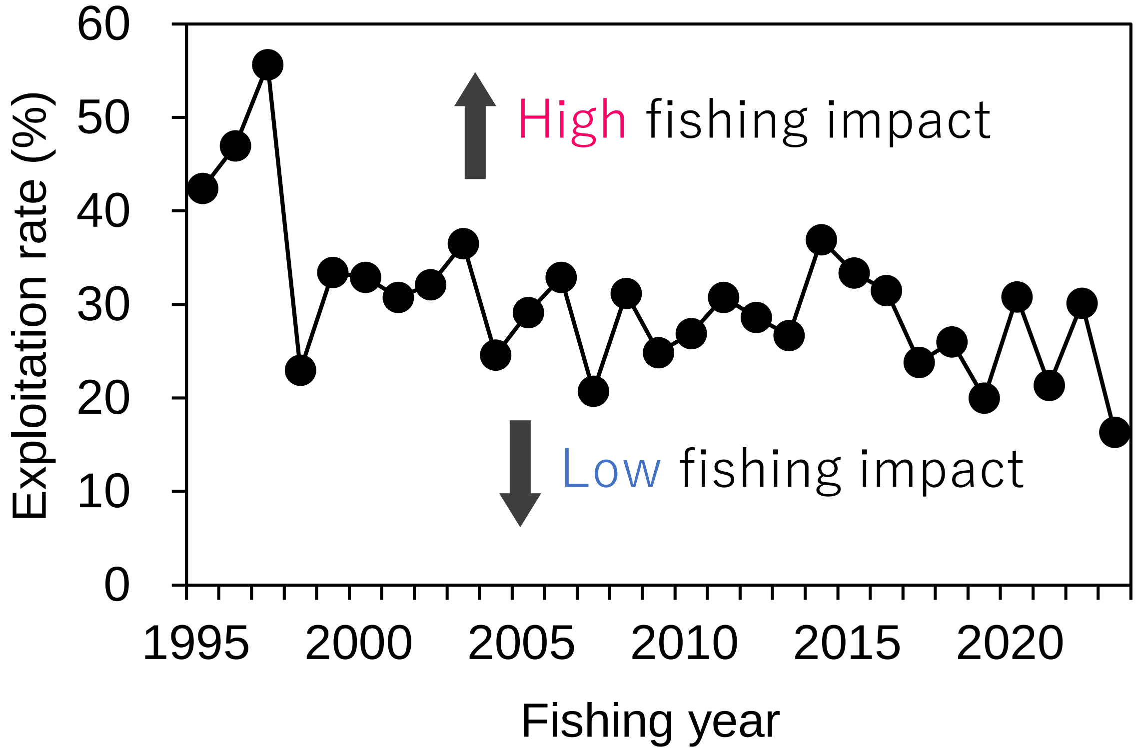
Recruitment and RPS



- Recruitment remains at a low level, but showed recovery in FY2023
- RPS (recruits per spawning biomass) remains low in FY2023

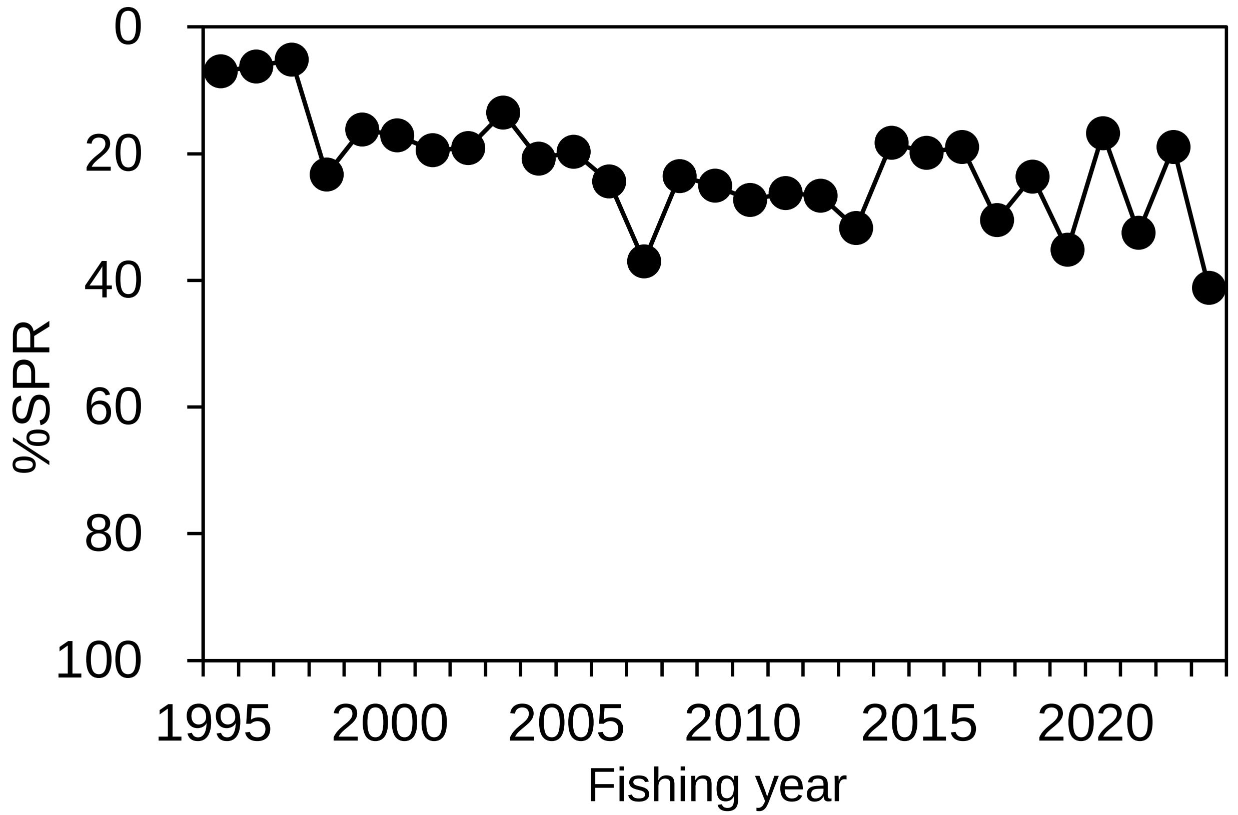
Fishing mortality and Exploitation Rate





Fishing mortality and exploitation rate are decreasing

%SPR

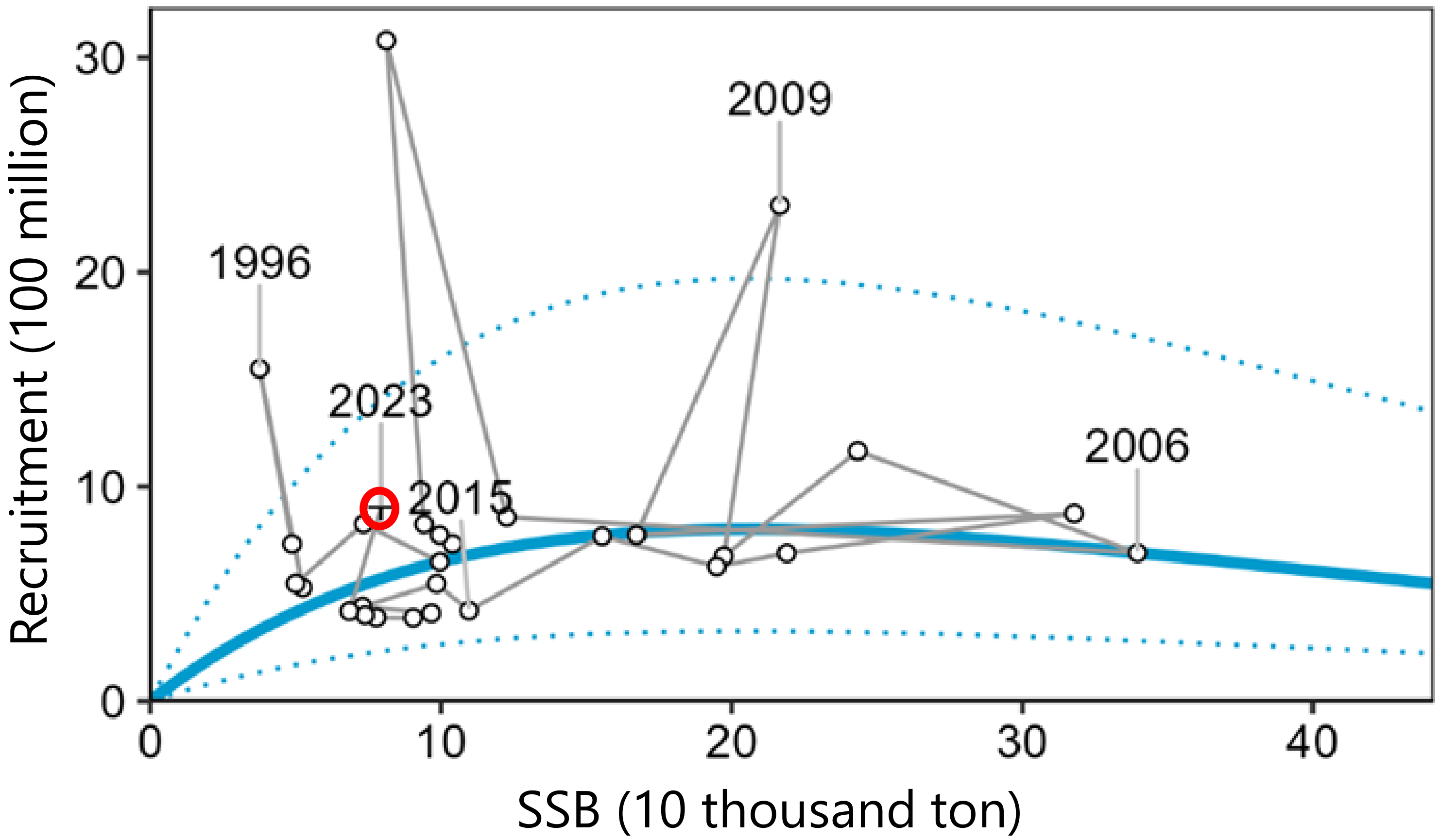


*%SPR: the ratio of SSB with fishing to the SSB without fishing

→When fishing mortality is high , %SPR becomes low

%SPR remains low

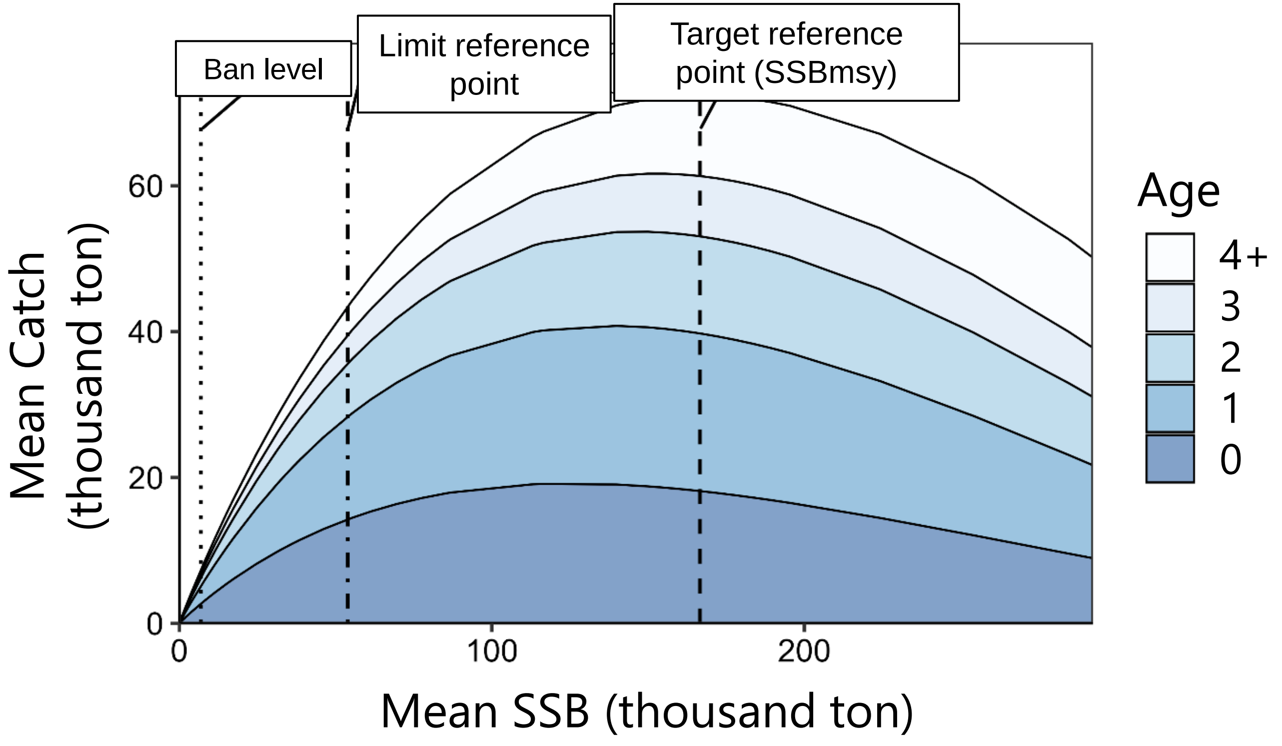
Stock-Recruitment relationship

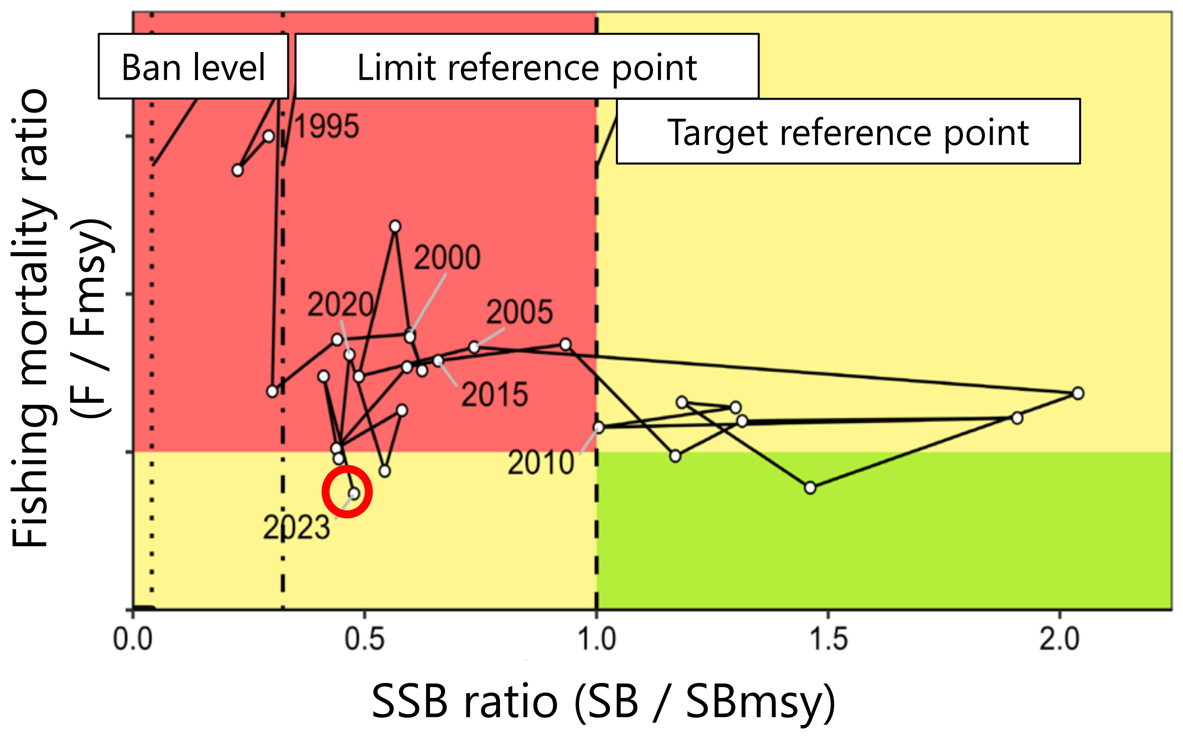


Ricker SR relationship has been adopted

Dotted line indicates the 90% confidence interval

Yield curve and Kobe plot





- MSY reference points were estimated by a stochastic simulation with a random recruitment variability from the SR relationship (see Ichinokawa et al. 2017, for details)
- SSB was lower than SSBmsy
- F in 2023 was lower than Fmsy

Summary

- BM (Pacific stock) stock assessment conducted by the tuned VPA with two abundance indices
- The MSY-based reference points were estimated from the stochastic simulation from the Ricker SR relationship
- Total biomass and SSB has been decreasing since 2010s
- Fishing mortality and exploitation rate are decreasing
- SSB was lower than SSBmsy and fishing mortality was lower than Fmsy in 2023