NPFC-2025-SC10-IP07

NPFC 10th Scientific Committee Meeting
16-19, December 2025
Nagoya, Japan
Agenda Item 6.3.2

6.3.2 Observation of Domestic Stock Assessment of Japanese Sardine in Japan in 2024 FY (January-December)

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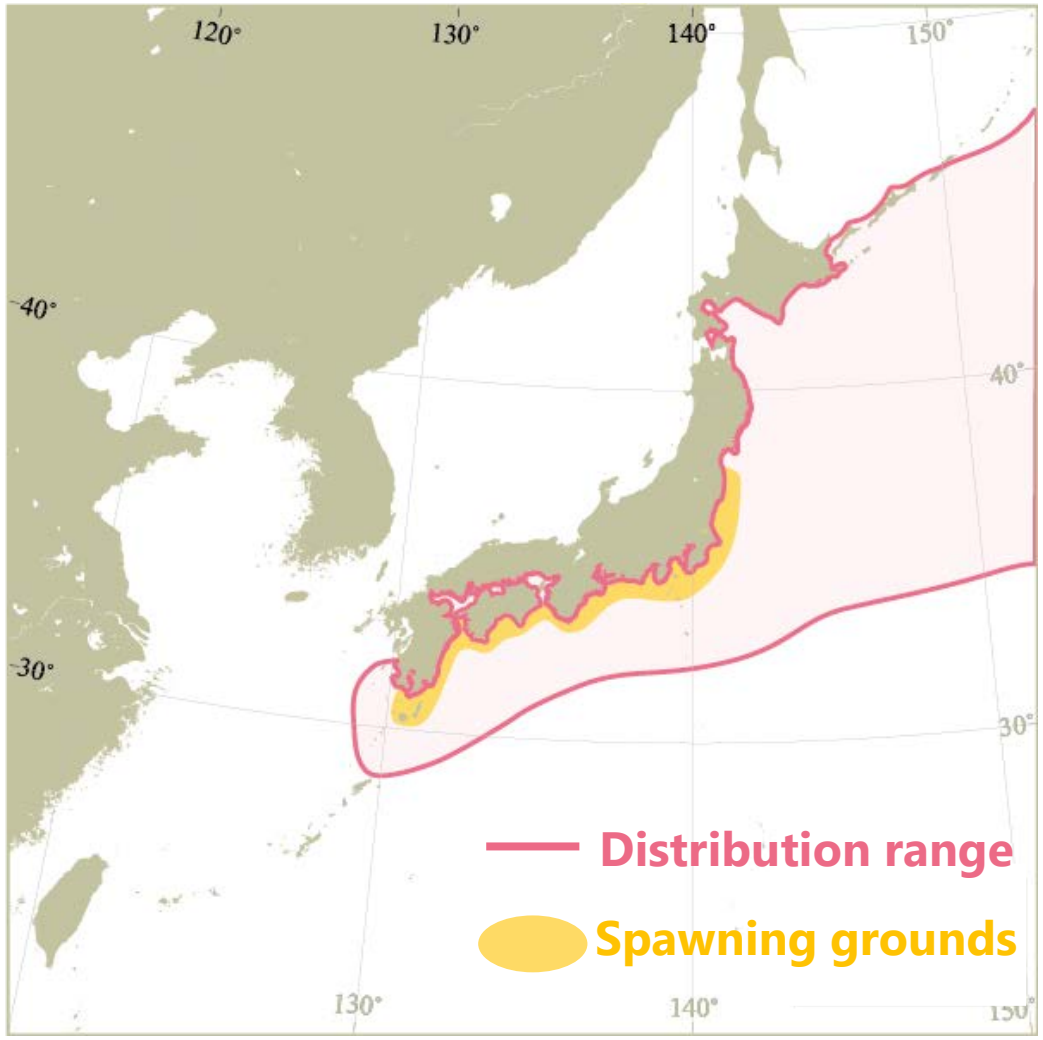
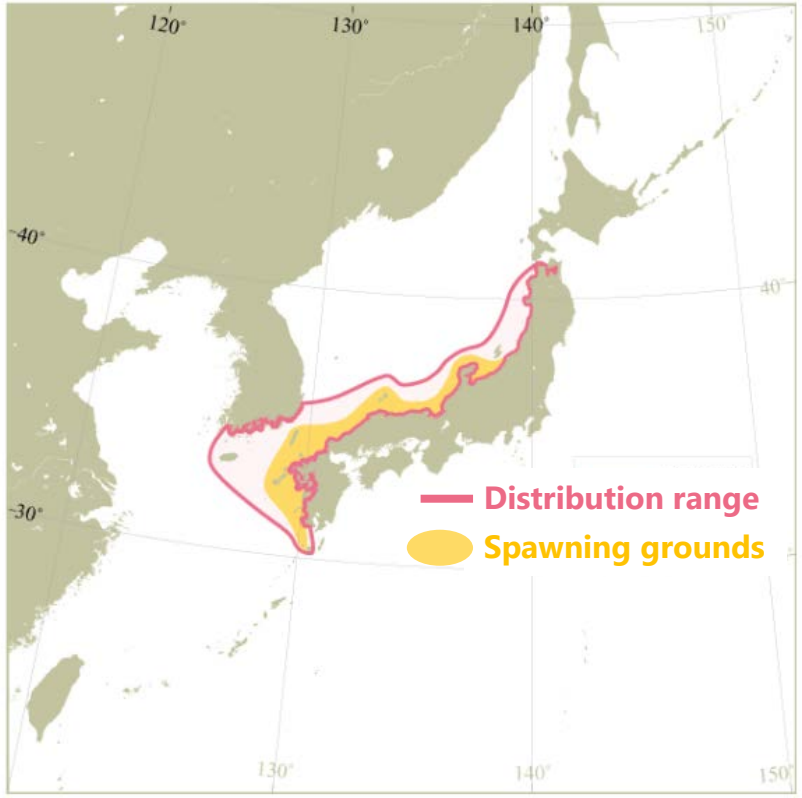
Spatial Structure of JS Stocks

Pacific stock



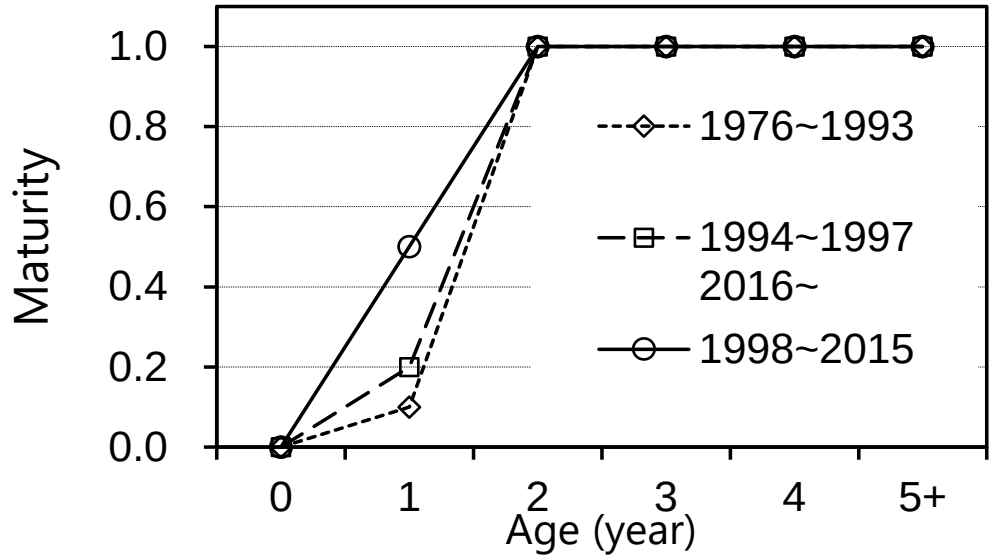
Tsushima Warm Current stock

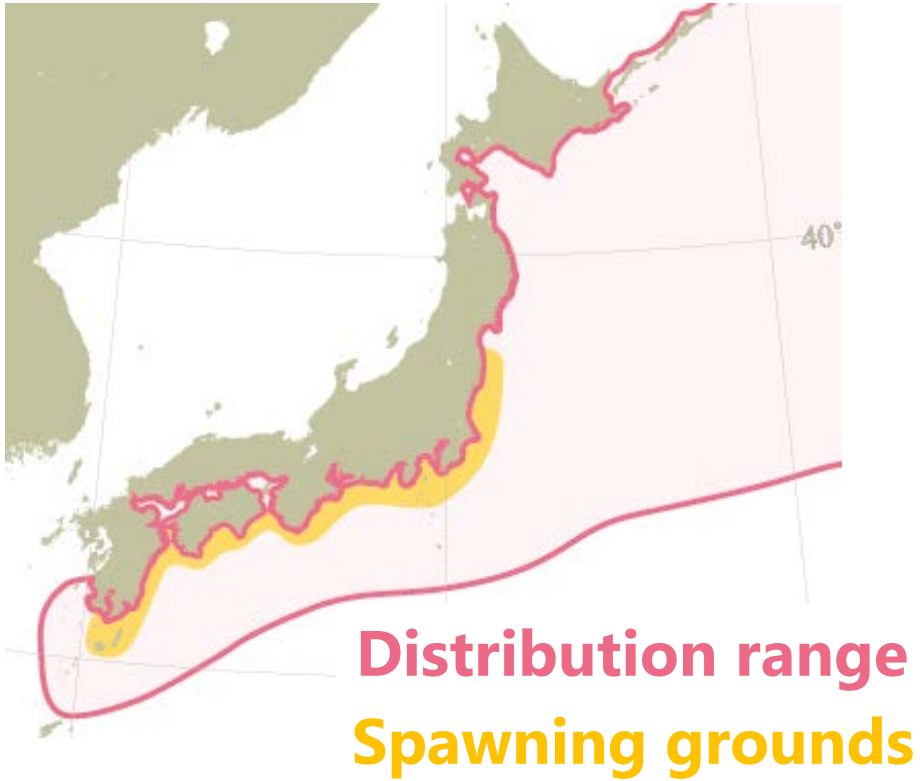


- There are two stocks depending on distributions and biology
- Only the Pacific stock is distributed in the NPFC Convention Area

Biological information for Japanese sardine

Maturity by age





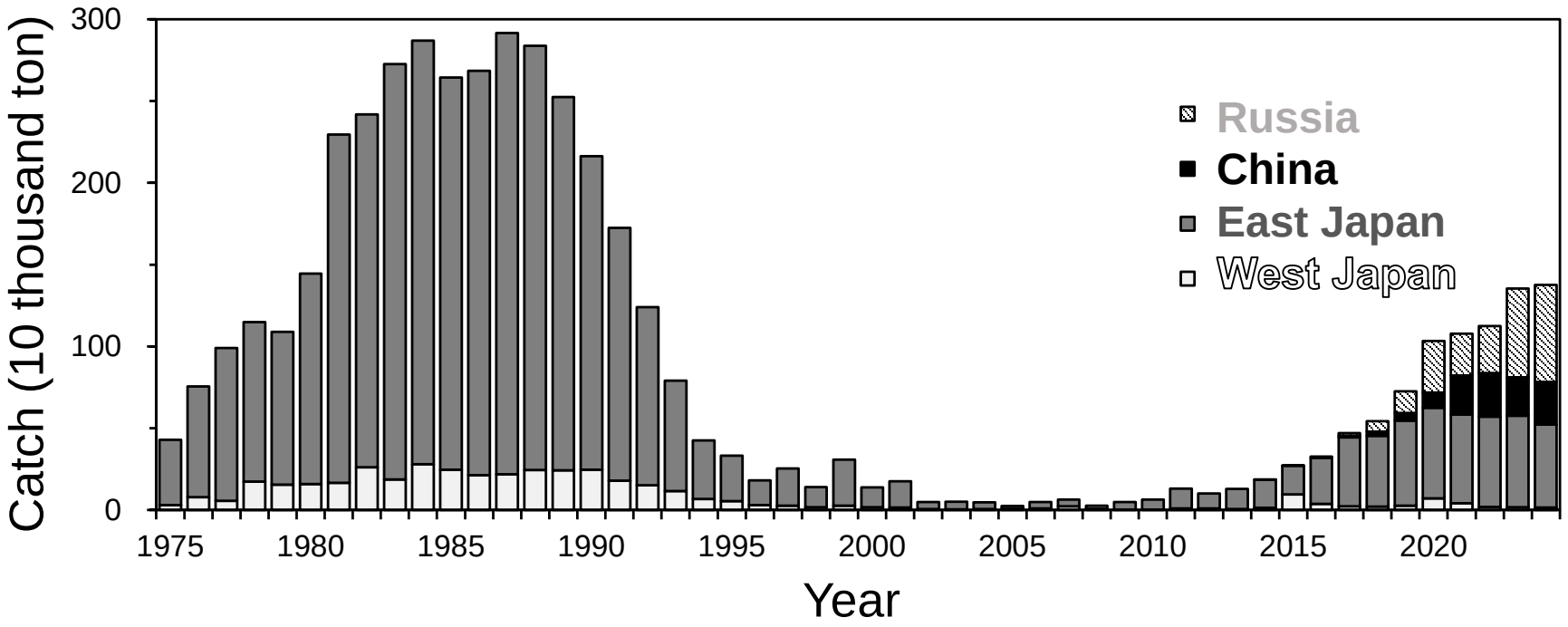
Longevity	: Longevity : 7 years old
Maximum body length	: 22-24 cm
Maturity	: age 1+（depends on stock abundance）
Spawning	: From November to June along the Pacific coast of Japanese archipelago

Catch statistics

- Catch weights by China and Russia were taken from the NPFC statistics
- Data in Japan were collected from 18 prefectures in the Pacific coast by month by gear

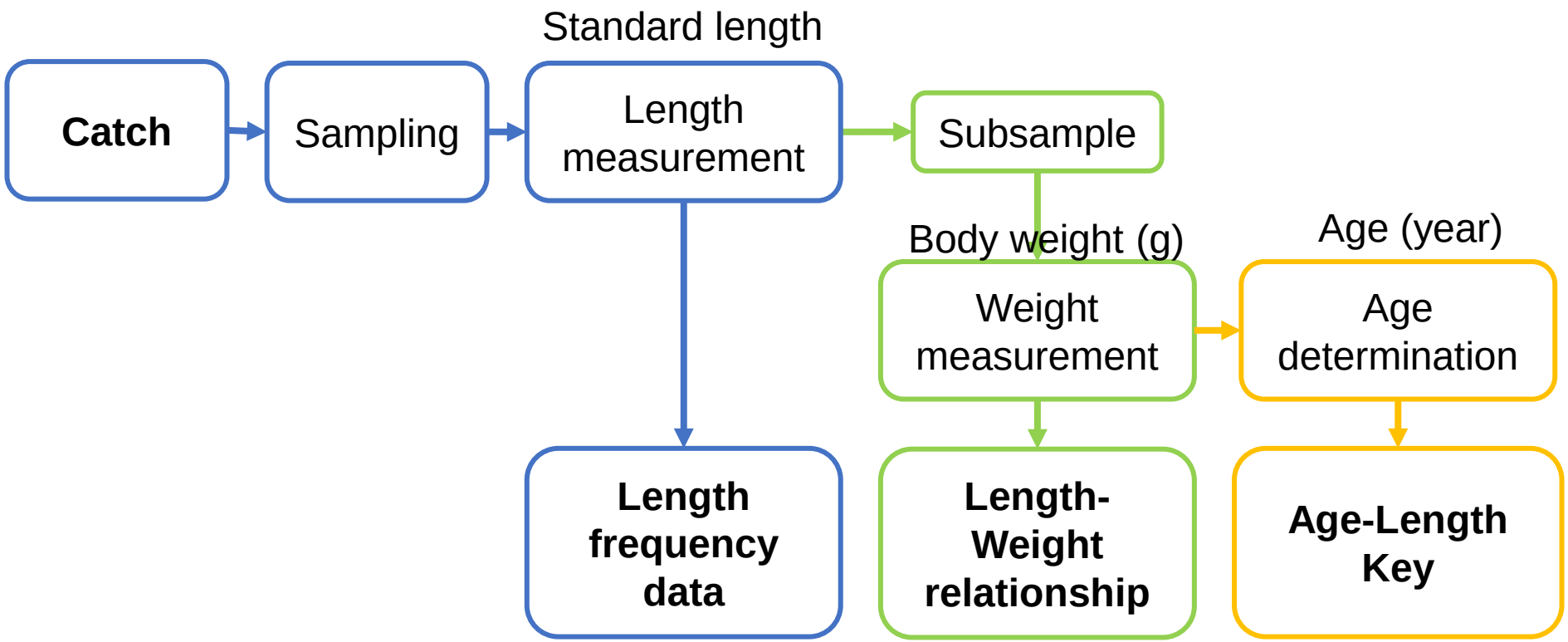
  Main fishery gears: purse seine, set net, others

Increase in East Japan catch
Increase in Chinese and Russian catch since 2020



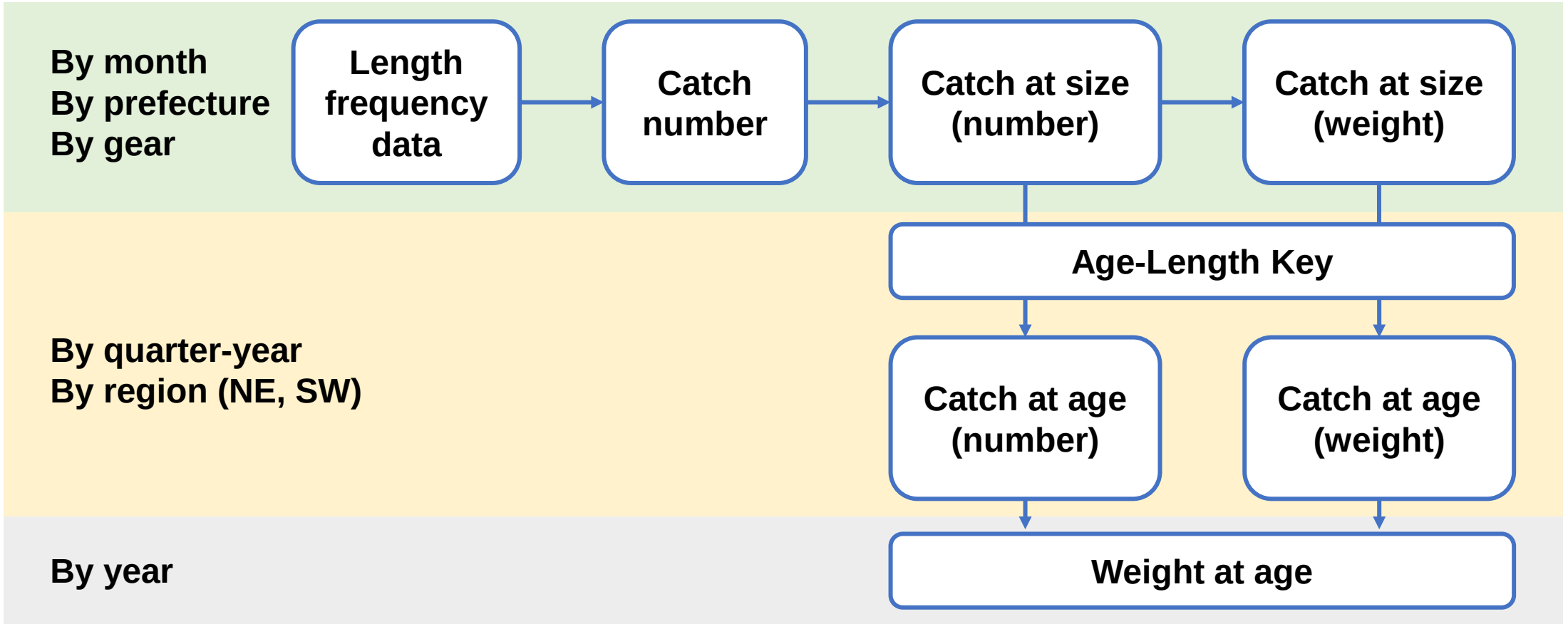
Length, Weight and Age Data

- Measurement data are collected from all 18 prefectures
- Data are treated by month and by fishing gear
- Age is estimated by otolith or scale reading



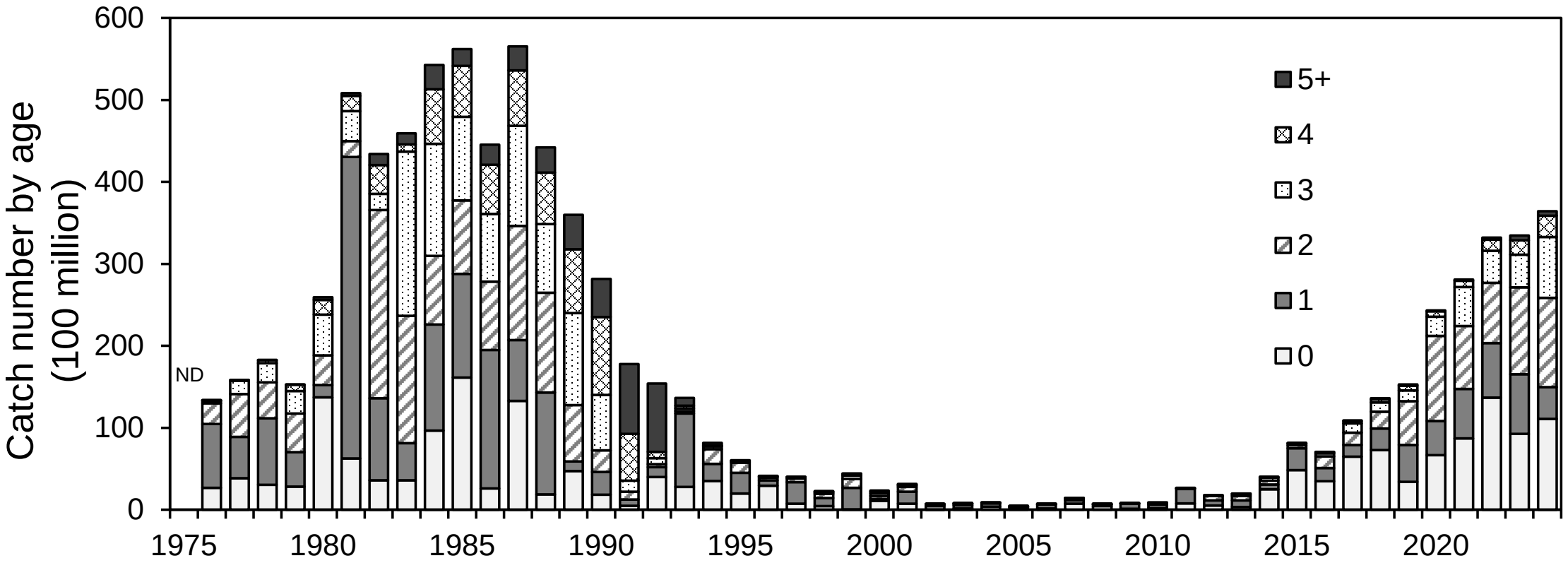
Catch at Age and Weight at Age in Japan

- 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: Japanese ALK was applied for Catch at Length submitted by Chinese colleague
Russia: Assumed to be identical to that of the purse seine fishery in north of Miyagi pref. from Jul. to Dec.

Catch at Age



- Wide age classes were caught recently
- The catch of 0 age fish is increasing since 2020

Stock assessment model

Stock assessment model: **ridge VPA (a kind of tuned VPA)**

Age classes: 0 ~ 5+

Use the Pope's approximation

Assume $F_{4,y} = F_{5+,y}$

Natural mortality: M = 0.4
from Tanaka's equation: M = 2.5/maximum age (Tanaka 1960)
2.5/7 = 0.357 ≈ 0.4

Stock assessment model

Ridge VPA (Okamura et al. 2017, ICES JMS)

$$(1-\lambda)\sum_{k=1}^{4}\sum_{y}\left[\ln\left(I_{k,y}\right)-\ln\left(q_k X_{k,y}^{b_k}\right)\right]^2+\lambda\sum_{a=1}^{4}\left(F_{a,2024}-\frac{1}{3}\sum_{y=2021}^{2023}F_{a,y}\right)^2$$

Select λ so that a retrospective bias is minimized

Pose a penalty for squared F to avoid divergence of F

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

Abundance indices for JS stock assessment

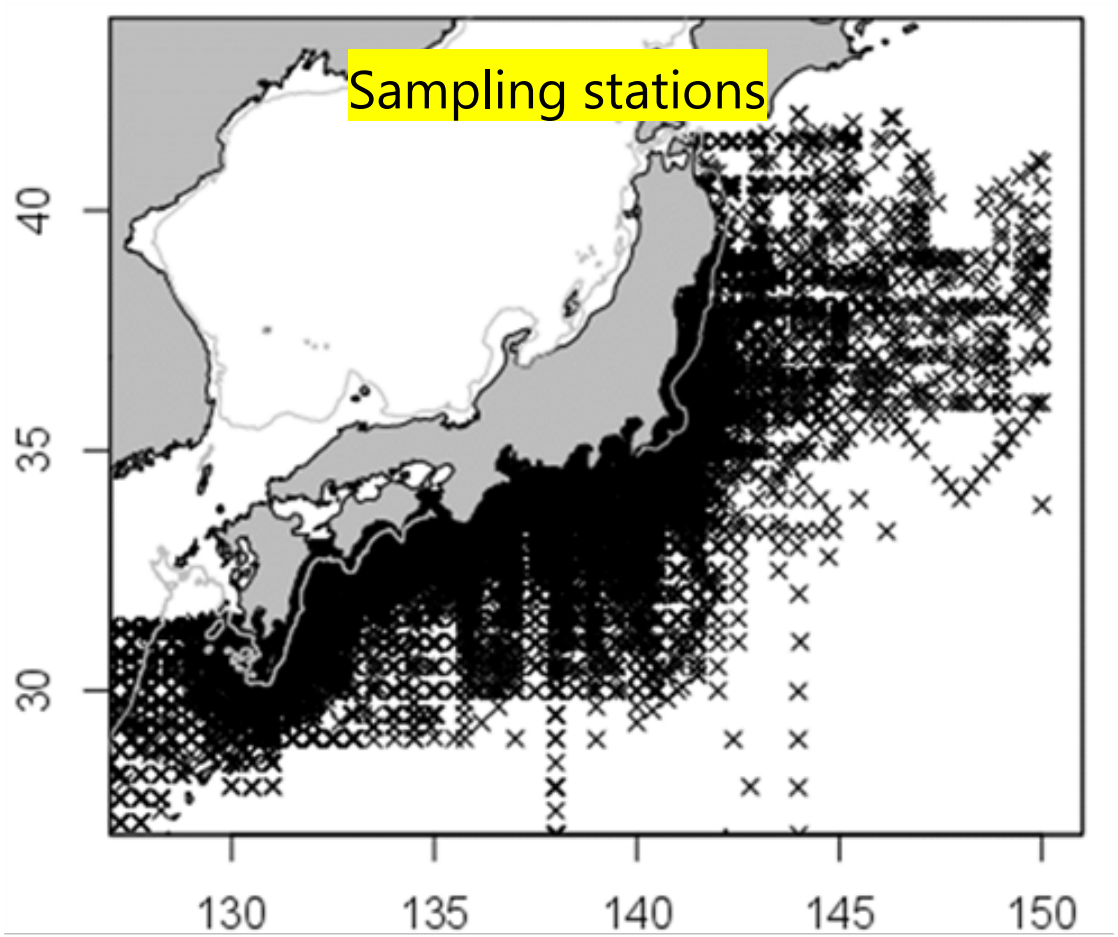
Three time series of abundance indices are used
for JS stock assessment (ridge VPA);

- **Egg abundance of East Japan** : spawning stock biomass
- **Autumn (Sep-Oct) acoustic survey** : age 0 (recruitment)
- **Summer (Jun-Jul) trawling survey** : age 0 (recruitment) and age 1

All abundance indices applied this year were obtained from
fishery-independent surveys

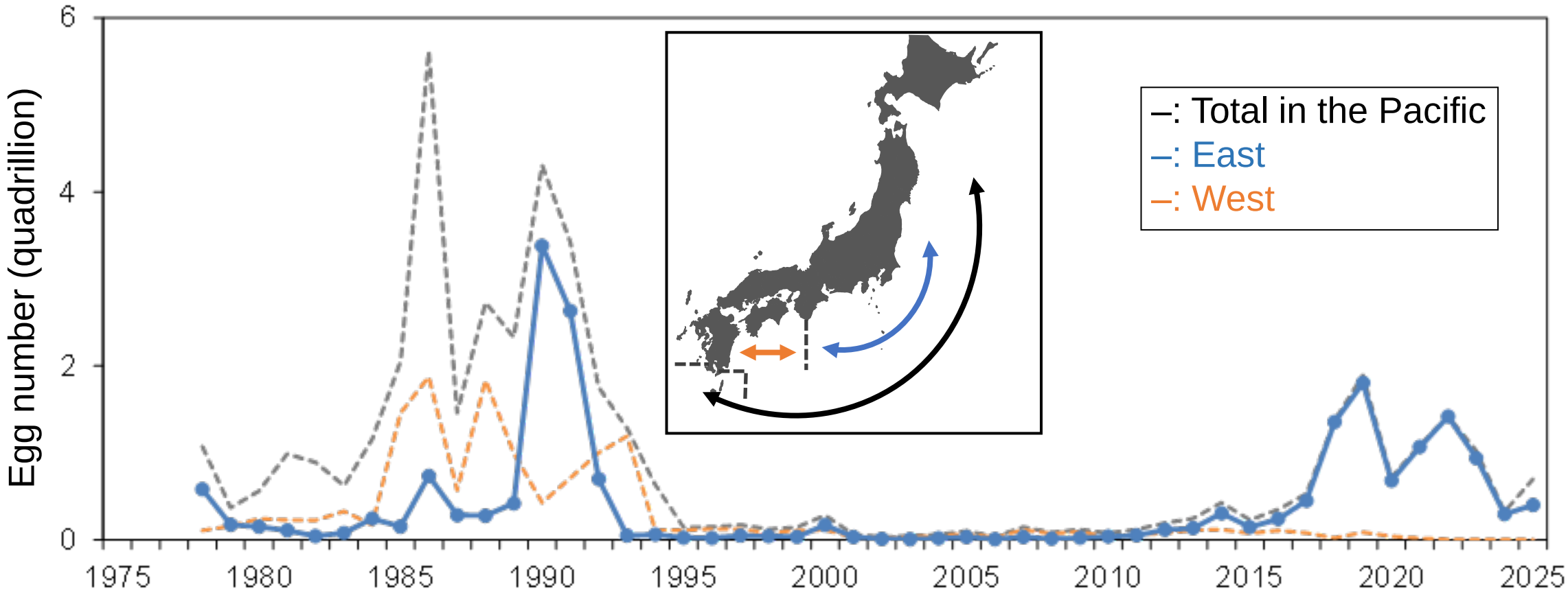
Egg abundance of East of Miyazaki pref. (survey)

- 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 of East Japan



Almost all of eggs were observed in East Japan

→ Egg abundance of East Japan was adopted as the index

Autumn (September-October) survey

Based on the result of the autumn survey in September to October, total density of age 0 fish was estimated by acoustic survey and sea surface temperature (SST)

Sampling method

- Approximately 40 sampling stations
- Sampling range
  Latitude: 37.0 °E–50.0 °E
  Longitude: 141.5 °E–179.0 °W
- Net mouth: 30 m × 30 m
- Sampling depth : less than 40 m
- Sampling duration: 15–60minutes

Density estimation method

(Estimated area in the Northwest Pacific with SST of 10–15 °C)
×
(Mean density estimated by acoustic and trawling survey)

Summer (June-July) survey

Based on the result of the summer survey in June to July, standardized CPUE was adopted as the indices for age 0 and 1 fish

Sampling method

- Approximately 150 sampling stations
- Sampling range
  - Latitude: 32.0 °E–48.5 °E
  - Longitude: 141.0 °E–165.0 °W
- Net mouth: 30 m × 30 m
- Sampling depth : less than 40 m
- Sampling duration: 15–60minutes

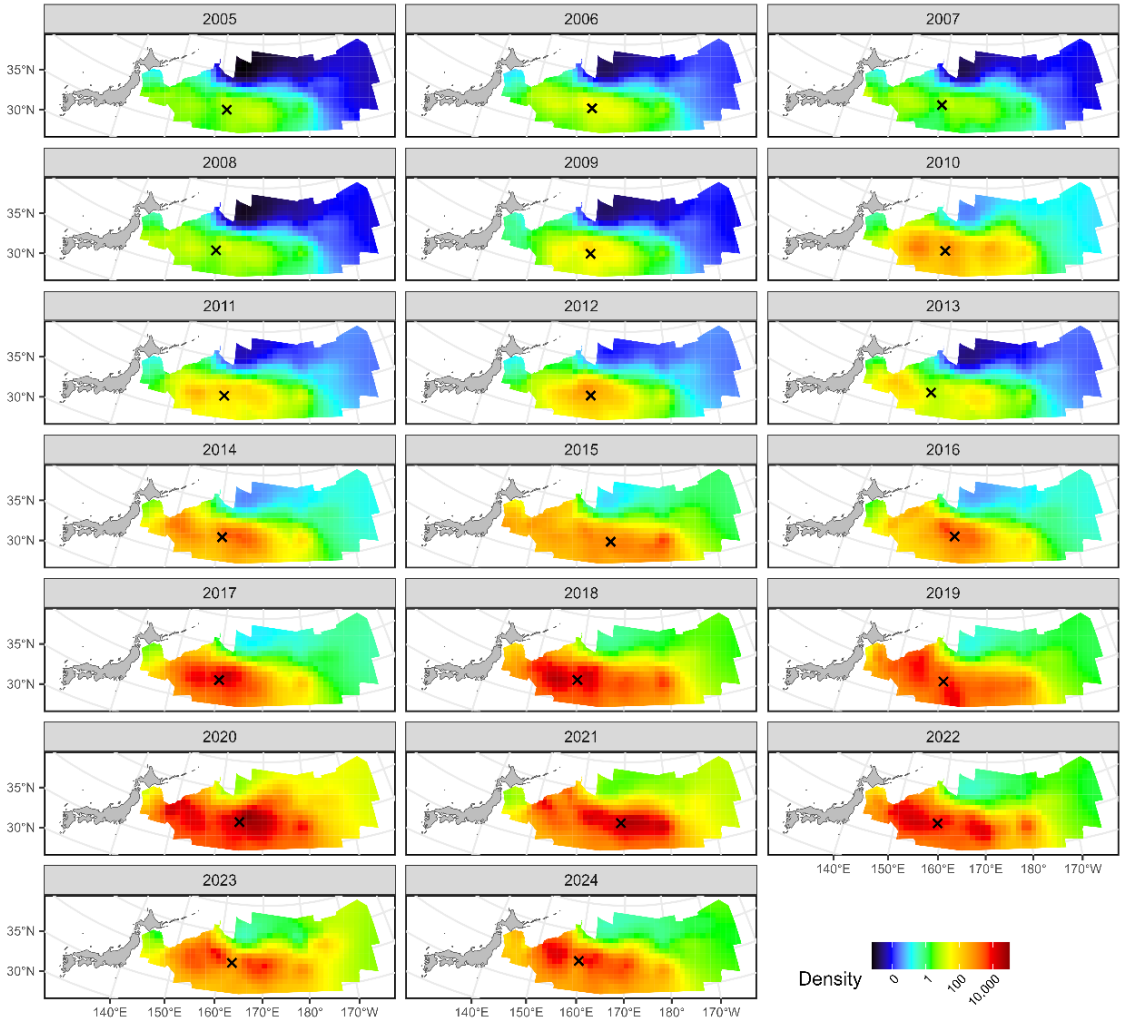
CPUE standardization method

To eliminate sampling bias, we used **vector autoregressive spatio-temporal (VAST) model** (Thorson, 2018)

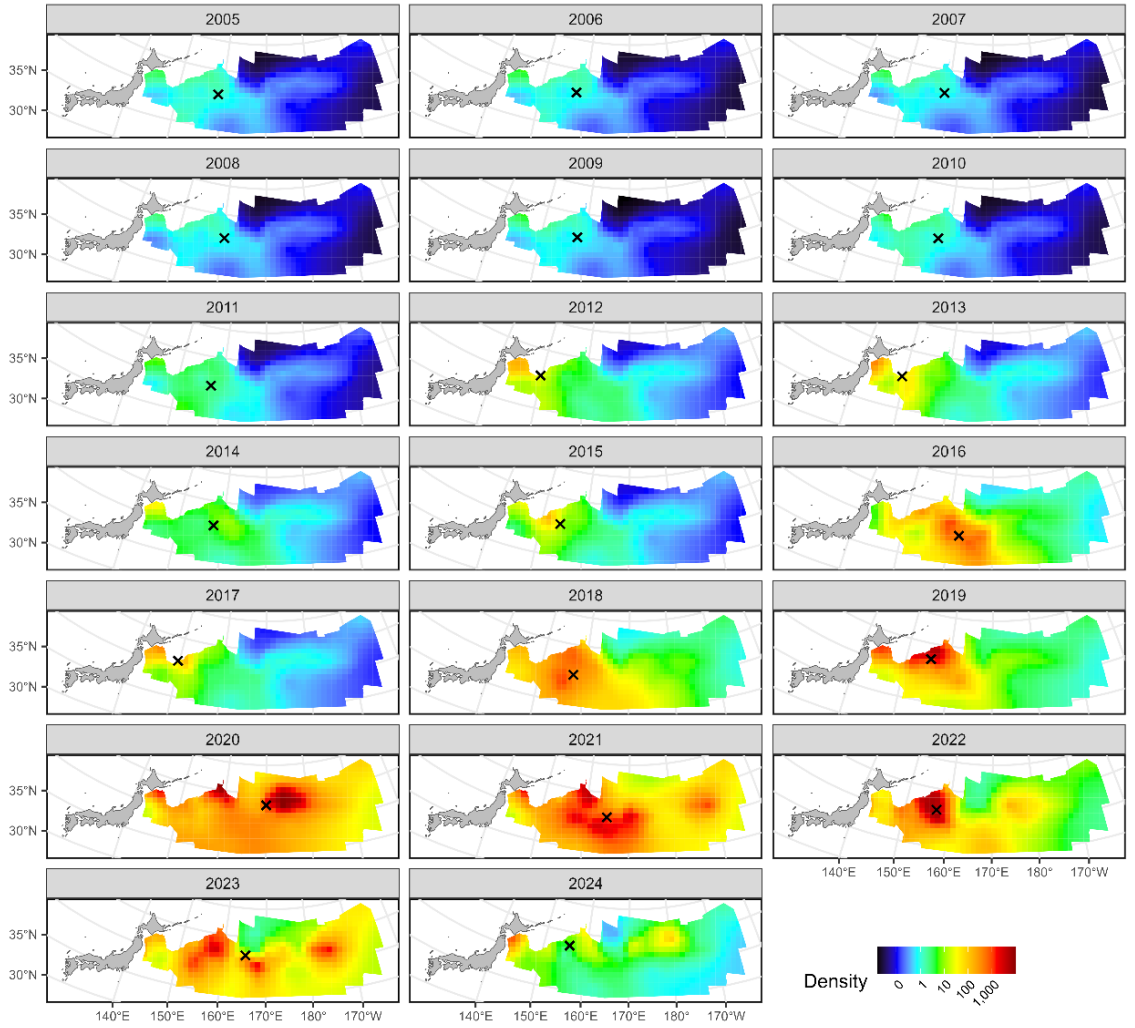
- Probability distribution: binominal × Gamma
- Knot number: 100
- Assumed effects
  - Temporal effect: random effect
  - Spatial effect: random effect
  - Spatio-temporal effect: random effect
- Anisotropy: not adopted
- Covariations: not adopted

Summer (June-July) survey

Age 0 fish (recruitment)

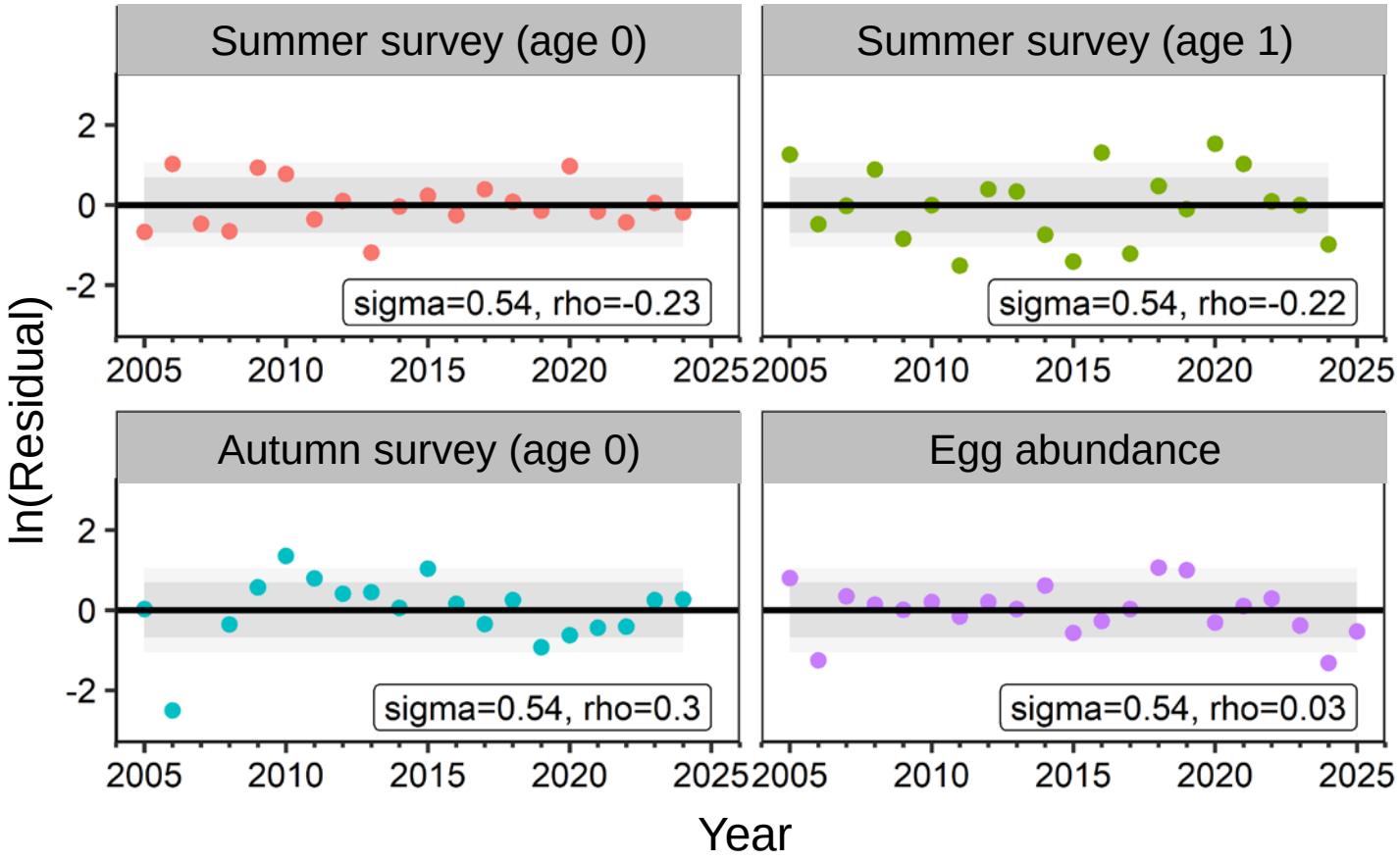


Age 1 fish



The abundance is increasing in recent years

Residual plot



: 80% confidence intervals

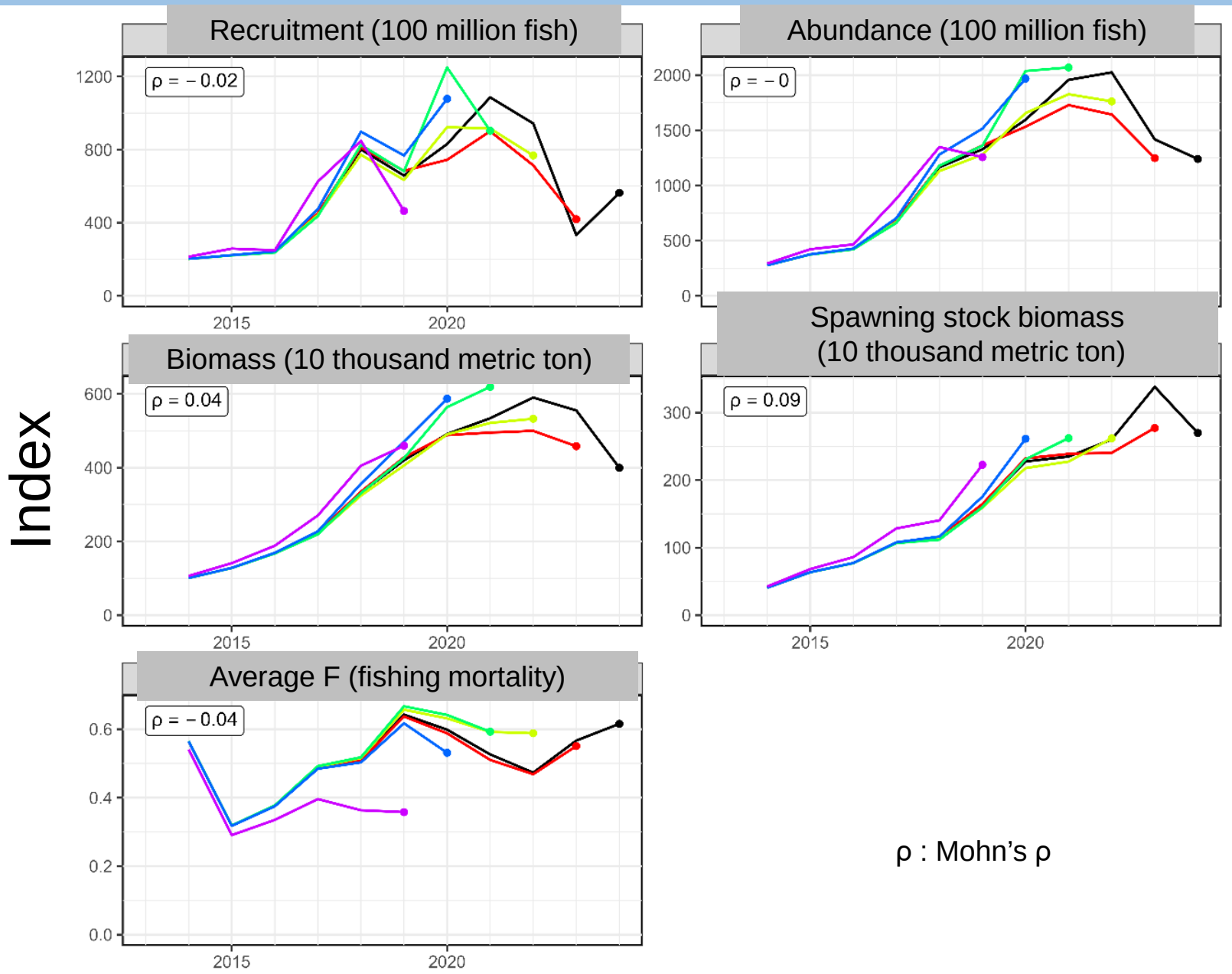
: 95% confidence intervals

sigma: standard deviance of indices

rho: autocorrelation coefficient

Neither significant autocorrelation nor deviation from normal distribution for all the indices

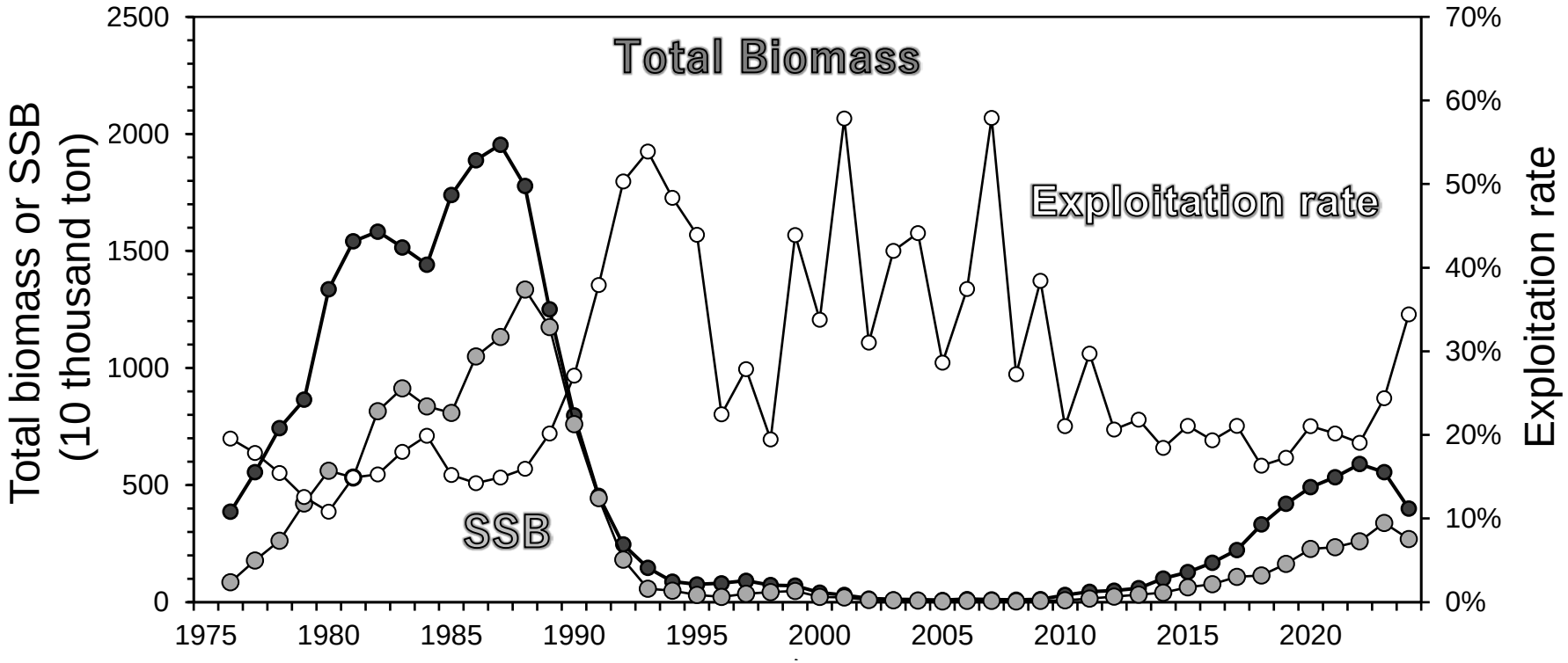
Retrospective analysis as a model diagnostic



No severe retrospective biases

ρ : Mohn's ρ

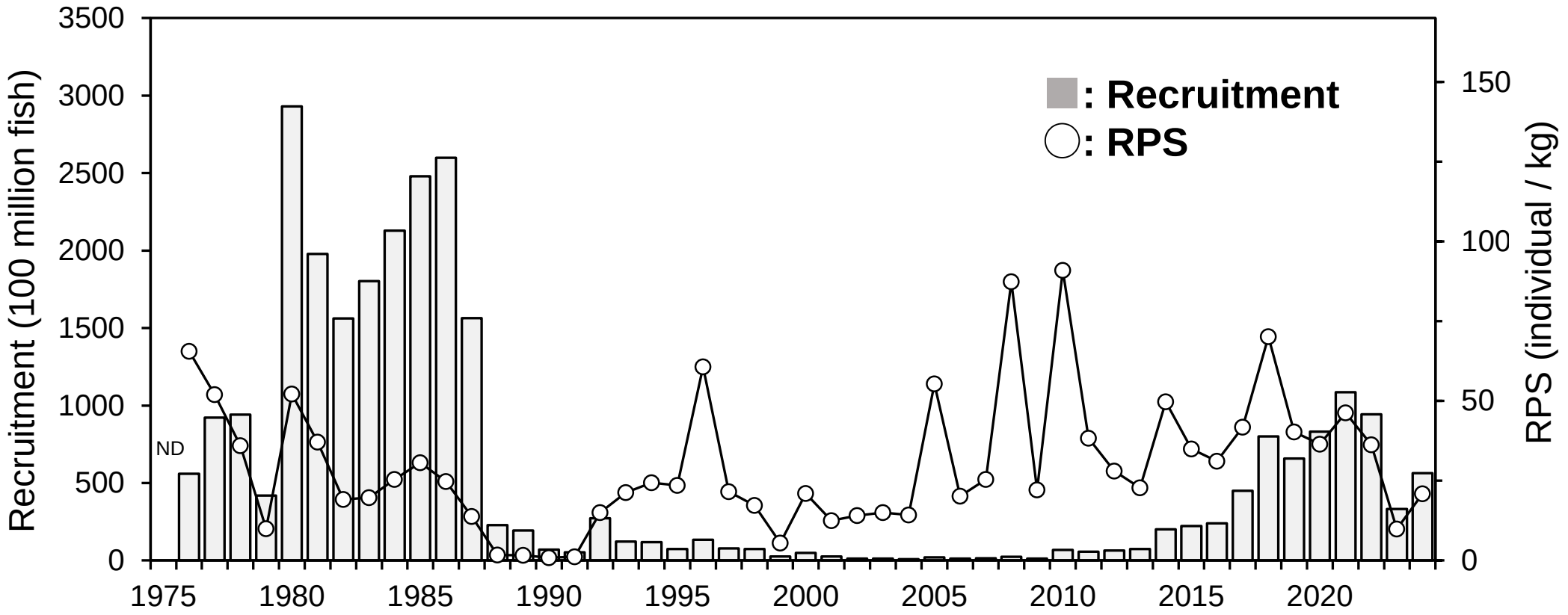
Biomass and Exploitation Rate



Total biomass and SSB increased since 2010s, but declining since 2023
(Biomass in 2024: 4.00 million mt, SSB in 2024: 2.70 million mt)

Exploitation rate remained low in the 2010s
However, it has increased from 2022

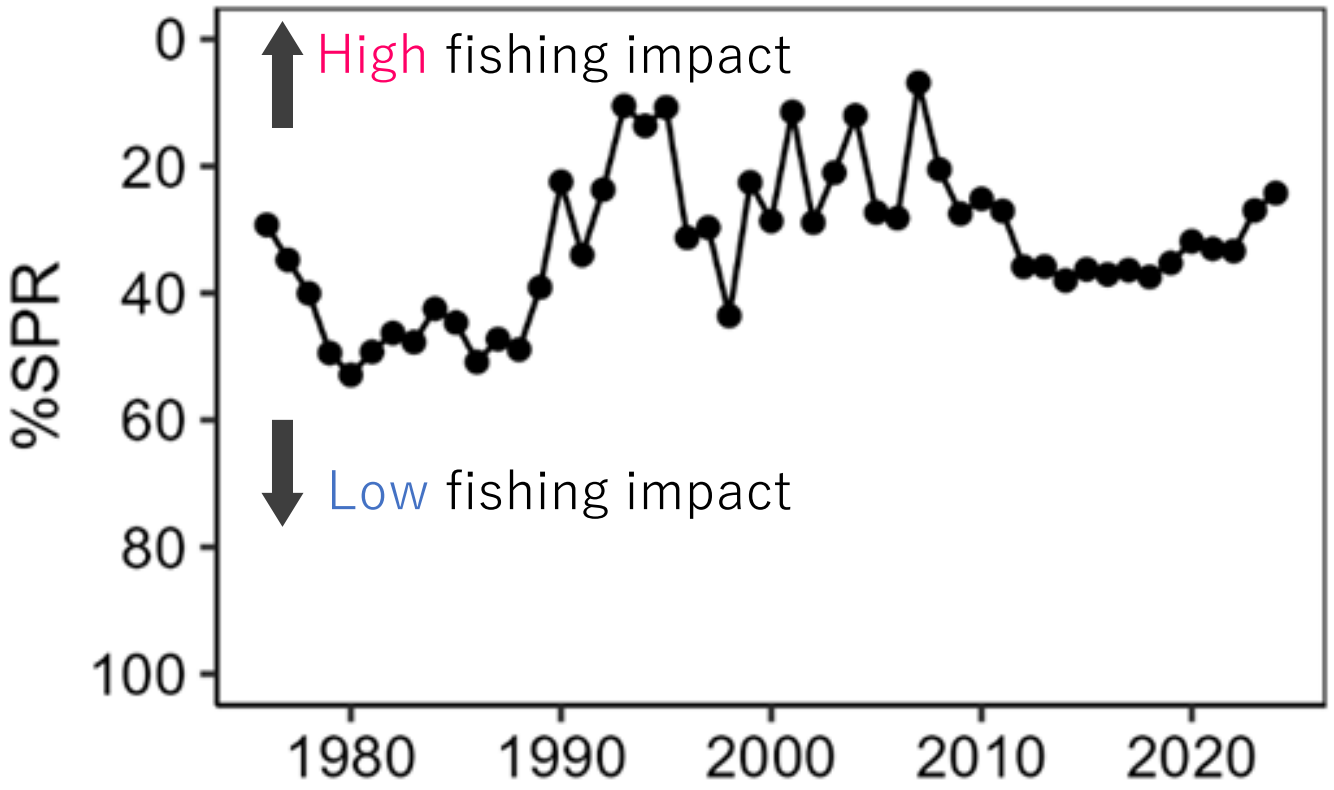
Recruitment and RPS



High RPS (Recruitment /SSB) increased recruitment in 2010
RPS and recruitment is declining since 2021

Fishing Mortality (%SPR)

%SPR：Ratio of SPR (SSB/R) with fishing to SPR without fishing

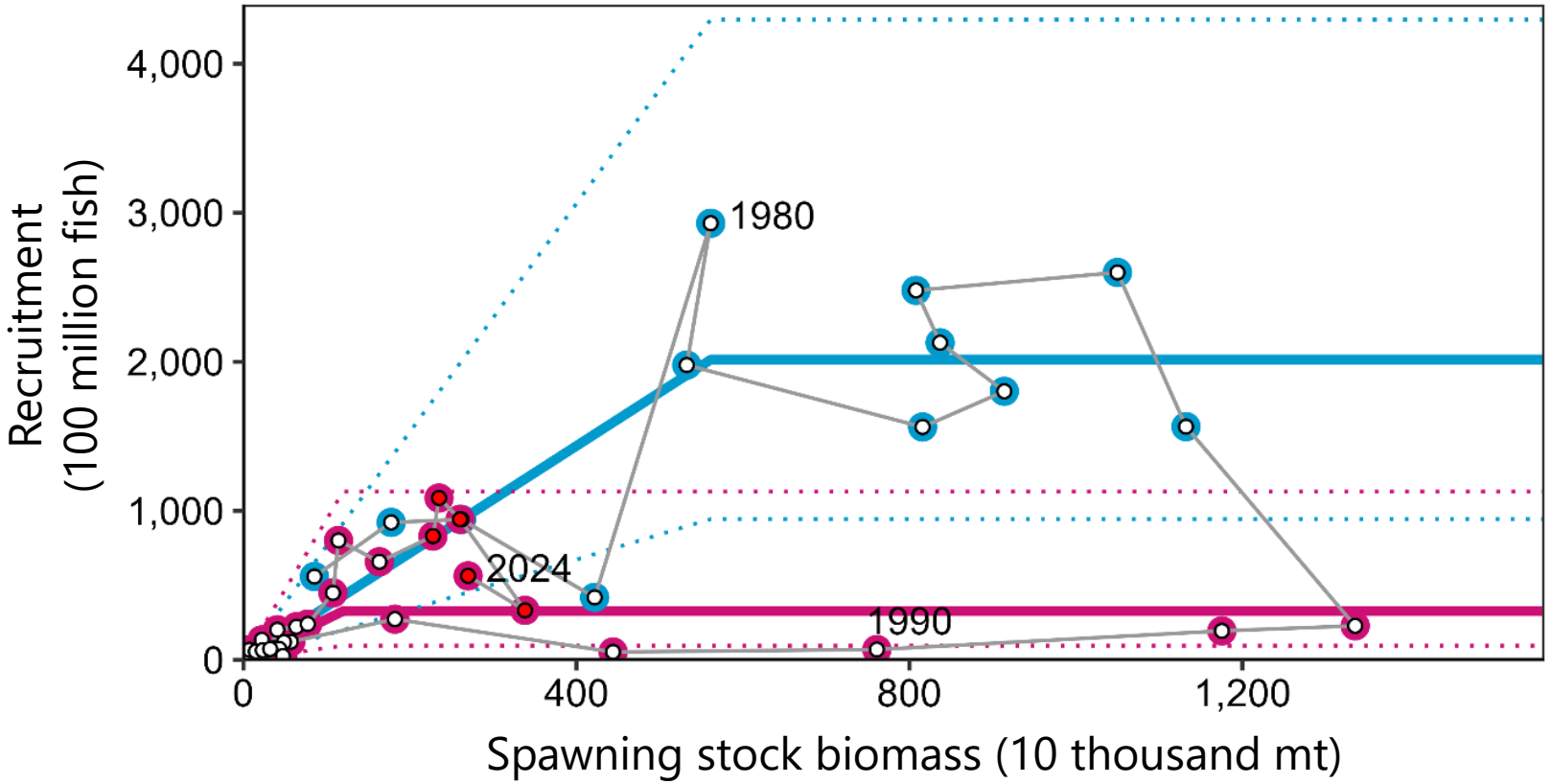


Fishing mortality in the 2010s remained low (≈ 40%SPR)

Fishing mortality in 2022-2024 increased (≈ 25%SPR)

Stock-Recruitment Relationship

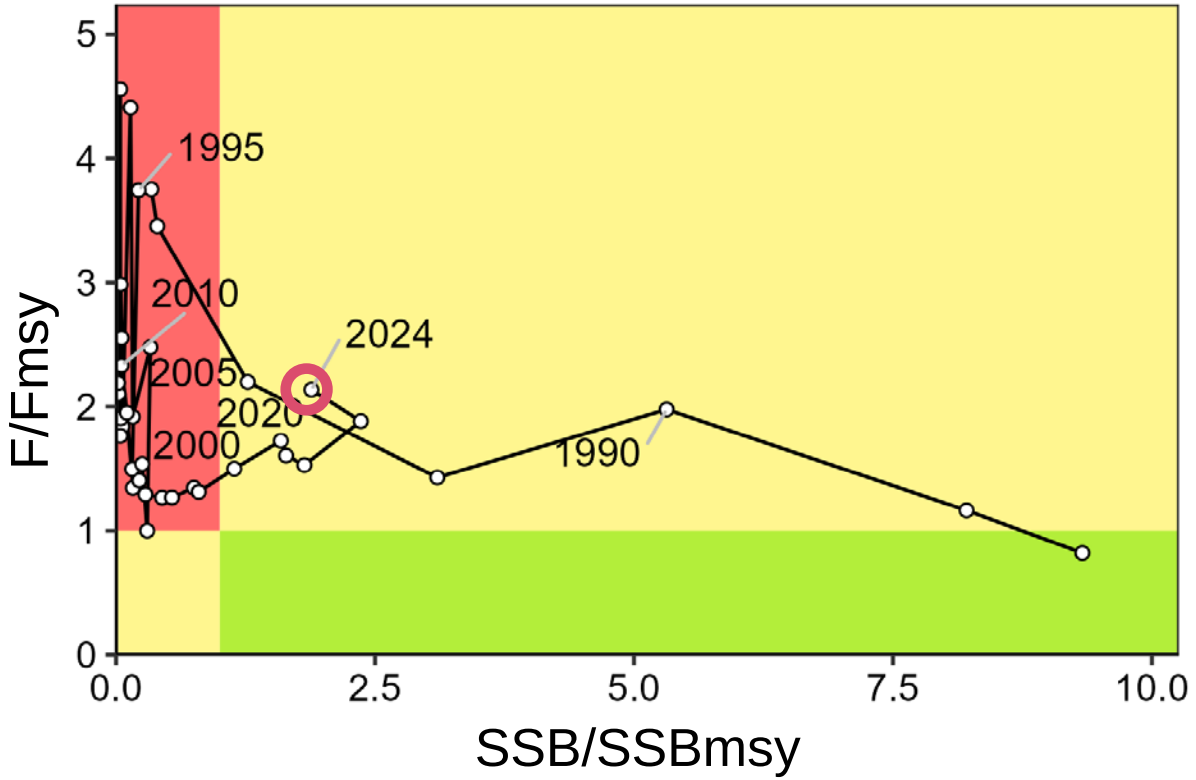
- Post-hoc estimation of the hockey-stick (HS) relationship from VPA outputs
- High recruitment regime (1976–1987) and normal recruitment regime(1988–2024)



High recruitment in recent years

But slow increase in SSB (probably due to decline in weights)

Kobe plot



- MSY reference points were estimated by a stochastic simulation with a random recruitment variability from the normal recruitment regime SR relationship (Ichinokawa et al. 2017, ICES JMS)
- SSB in 2024 exceeded SSBmsy
- F in 2024 exceeded Fmsy

Summary

- Japan conducts the JS stock assessment by the tuned VPA with ridge penalty
- The MSY-based reference points were estimated from the stochastic simulation from the normal-regime SR relationship of the hockey stick function
- In 2023, estimated total biomass was 4.00 million mt and SSB was 2.70 million mt
- SSB in 2024 exceeded SSBmsy
- F in 2024 exceeded Fmsy

Future Issues

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